Pre-white-nose syndrome assessment of body condition and use of foraging and roosting sites in tricolored bats in NW Arkansas

PROJECT SUMMARY
Arkansas is home to cave dwelling bat species sensitive to the wildlife disease white-nose syndrome (WNS). The project addresses the need to establish a baseline understanding of pre-WNS habitat use and body reserves depletion over winter. We propose to identify and characterize tree roosting sites and foraging areas of tricolored bats and assess their pre- and post-hibernation body condition in a population still free of WNS. This will help to adapt forest management plans to a guild of bat species in a way that will minimize the devastating effect of WNS on cave-dwelling bats.

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Total Project Cost = $148,295
Total Arkansas SWG request = $96,310
Total Matching Funds* provided = $51,985
(35% Match Requirement)

Total Project Cost = $170,295
Total Arkansas SWG request = $85,109
Total Matching Funds* provided = $85,186
(50% Match Requirement)

*Non-federal dollars supplied by Arkansas State University

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Introduction – Bats provide important ecosystem services, primarily pest control for agriculture and farming through their consumption of insects, but also in nutrient cycling by bringing nutrients into caves. These functions are being compromised as bat populations are declining as a result of habitat loss, human disturbance at hibernacula, and more recently wind turbines and white-nose syndrome (WNS). WNS is a fungal disease of hibernating bats that causes up to 90-100% mortality in bat colonies through wing damage, dehydration, and starvation. The fungus *Pseudogymnoascus* (basionym: *Geomyces*) *destructans* manifests as white hyphal growth on the muzzle, ears, and wings of bats during torpor. Infected bats exhibit abnormally frequent arousals during winter months leading to starvation and dehydration. The fast-spreading disease first appeared in 2006 in New York, and has now killed over seven million bats. In the last two years, WNS has been detected in six new states (Fig. 1). Seven species are affected by WNS, including endangered species such as Indiana bats, *Myotis sodalis*, but also not yet (federally) listed species such as tricolored bats (formerly eastern pipistrelles), *Perimyotis subflavus*.

The tricolored bat is one of the most common species in the US. However, the bat population in Virginia has declined by 90% between 2009 and 2012, as a result of WNS. Tricolored bats are particularly vulnerable to WNS because their hibernation period is longer than for other species. They usually enter hibernacula first and emerge last. This means a longer fasting period for bats and a longer growing period for the fungus. The 2012 occurrences of WNS in Alabama were on tricolored bats. No mortality has been reported in AR but 2012-13 swabs on this species revealed the presence of *P. destructans* in two Arkansas caves. In January 2014, WNS caused the death of five northern long-eared bats in Marion County, AR. Models also project a substantial spread of the disease to AR on a very short term (Fig. 2).

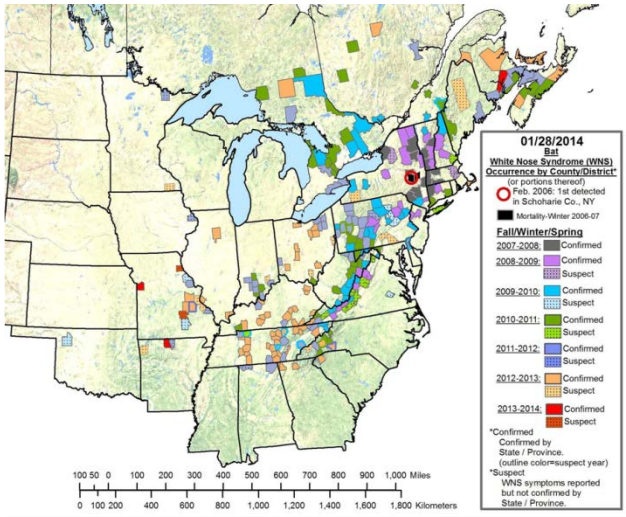

Figure 1. Occurrence of White-nose syndrome by county .
Courtesy of Cal Butchkoski, Pennsylvania Game Commission

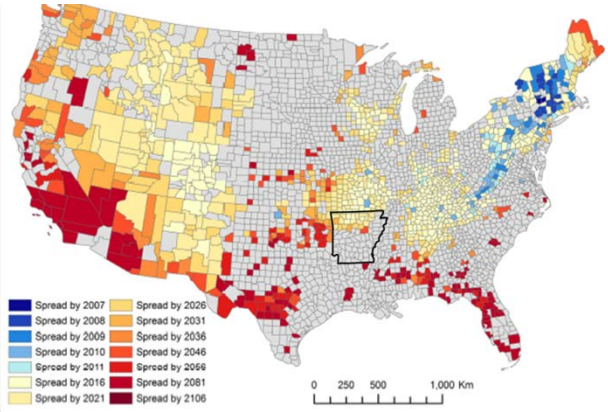

Figure 2. Projected spread of white-nose syndrome in the US. Modified from Maher et al. (2012)

Although bat hibernacula requirements have been well documented, little is known about summer roosting preferences. While tricolored bats of both sexes use clusters of dead leaves in the canopy of oaks and pines, females seem to be more selective when choosing a roosting site. Additionally, there is a paucity of information on their foraging habits. Finally, although it is clear that some bats die of starvation, it remains unknown whether those bats enter hibernation underweight or whether their fat reserves are depleted at an accelerated rate during hibernation.

Priorities Addressed and Need for Research – This project directly addresses the need to protect bats from WNS, which is listed as Emerging Issue – Priority 1 in the 2014 AR State Wildlife Grants request for pre-proposals to implement monitoring and action priorities identified in the AR Wildlife Action Plan. Because of the recent confirmation of WNS in AR, collecting pre-WNS information on non-affected bat species is an urgent need. Although the tricolored bat is not yet a species of greatest conservation need (SGCN) in the Arkansas Wildlife Action Plan, (1) its abundance allows for more data to be gathered (a critical criterion when accuracy is needed), (2) it is known to be susceptible to WNS, and (3) as for other cave-dwelling species that are SGCN (e.g., Rafinesque's big-eared bats), little is known about tricolored bats' foraging and roosting ecology. Determining body condition before and at emergence from hibernation will provide a pre-WNS baseline of weight loss over winter, which will help clarify which individuals (e.g., underweight) contract WNS or how fast WNS develops and damage bat conditions.

Purpose and Objectives – The overall purpose of our project is to establish a baseline understanding of what habitat tricolored bats use for roosting and foraging, while the population is still free of WNS. This will lead to forest management plans adapted to a broader guild of bat species and which can minimize the synergistically devastating effects of WNS in cave-dwelling bats. Specifically, for tricolored bats, we aim to:

1. Characterize tree roosting sites
2. Identify foraging areas and estimate summer home range
3. Assess body condition at entrance into and emergence from hibernation

Location – The study will be conducted at the USDA Forest Service's Sylamore Ranger District, Ozark National Forest in the Ozark Highlands Ecoregion of north-central Arkansas (Fig. 3). The district, located across the counties of Stone, Searcy, Marion, Baxter, and Izard, consists of hardwood and pine forests managed for the recovery of Indiana bats *Myotis sodalis*. The primary drainages of the district are North Sylamore Creek, South Sylamore Creek, and the White River.

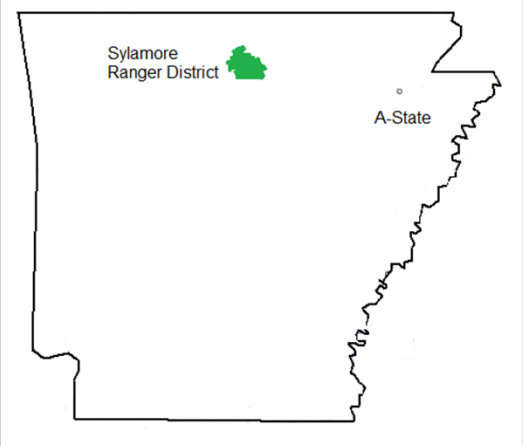

Figure 3. Sylamore Ranger District is located about 110 miles NW of Arkansas State University – Jonesboro campus.

Approach – Procedures common to all (and specific to each) objective(s) are described below and will be conducted according to the timeline below. **Biblography available upon request.*

Capture

Tricolored bats will be captured using mist nets. For Objectives 1 and 2, we will focus mist-netting on forest edges, wildlife ponds, or streams, during summer months (early June to mid-August), whereas for Objective 3, mist-nets will be deployed at the entrance of hibernacula during fall swarming (late August to early September) and for spring emergence (April). Each captured tricolored bat will be banded, weighed, sexed, and aged (juvenile or adult). Additionally, we will record forearm length (mm), reproductive status, and overall condition (e.g., presence of parasites, Reichard Wing-Damage Index, physical abnormalities). Swab samples and photos will be taken for bats with signs of fungal infection. We will attach 0.27-g VHF transmitters (Model LB-2X, Holohil Ontario, Canada), using surgical skin adhesive (Skin Bond®) to 25 female tricolored bats (each year) that weigh <5.4 g, ensuring transmitters never exceed 5% of the captured individual's body mass (Aldridge and Brigham 1988).

Objective1 – Roost site characteristics

Diurnal roost sites will be located using the homing method on radioed bats during the day, visually confirmed as bats leave the roost at dusk, and marked using a GPS unit. We will characterize each tree roost plot (and an associated random plot within 40-100m from the roost location), using forest measurement criteria as listed in a previous tricolored bat study (Perry and Thill 2007). Roost and random plot characteristics (i.e., canopy cover, basal area, diameter at breast height, etc.) will be compared using univariate (or multivariate as appropriate) analysis of variance. Finally, habitat will be characterized within a 0.1-ha radius centered around tree roosts, following Perry and Thill (2007) and the effect of these habitat attributes on roost selection will be analyzed using matched-pair conditional logistic regressions.

Objective 2 – Foraging areas and home range

Radio-tracking will begin the day following capture to avoid monitoring abnormal behavior associated with capture-related stress. Foraging locations will be obtained by triangulation with two-way radios, TRX-1000S receivers, and five-element Yagi antennas (Wildlife Materials, Carbondale, IL), starting from strategically-chosen stations around diurnal roost locations. Tracking stations will generally not exceed 1 km from each other to maintain radio contact in such densely forested, mountainous terrain. Based on our 2013 observations of evening bats in the Sylamore (unpublished data), strong transmitter signals indicate that a foraging individual is most often < 500 m from the tracker's location, making two bearings sufficient for obtaining foraging locations, when a third bearing cannot be obtained because of limited access. Quantum GIS will be used to derive foraging locations, estimate home ranges and produce maps. Habitat use will be analyzed using a compositional analysis or distance-based method.

Objective 3 – Body condition over winter

Body mass, recorded during fall swarming and at emergence will be compared using t-tests. We will also test for a temporal trend in body mass during fall swarming predicting that early captures are heavier than late ones. Similarly, providing recaptured individuals (i.e., already banded and possibly previously radiotracked), body mass and other variables (e.g., time of emergence) will be related to habitat quality and reproductive status. In the event that some swabbed individuals are detected positive, we will specifically compare positive vs. negative individuals in terms of body mass, wing damage, reproductive status, and other available parameters (e.g., summer roosting habitat).

Timeline. The final report will include results from two summer seasons (objectives 1 & 2) and one complete hibernation season (objective 3) while future publications will incorporate a second hibernation season.

		2014	2015			2016			2017	
		F	Sp	Su	F	Sp	Su	F	Sp	Su
Student recruitment		X								
Objective 1	Data collection			X			X			
	Data analysis				X	X		X		
Objective 2	Data collection			X			X			
	Data analysis				X	X		X		
Objective 3	Data collection		X		X	X		X	X	
	Data analysis					X	X		X	X
Deliverables	Meetings				X	X				
	Publications							X	X	X

*Tasks in darker semesters are pre- and post-awards and will be supported with other funds.

Expected results and benefits – Roost data will confirm selected roost characteristics while foraging data will yield estimates of distance travelled, home range, and habitat prospected. This will aid in determining if management regimes, as defined for the Indian bat recovery plan, provide adequate foraging and roost habitat for tricolored bats in the Sylamore Forest District of north-central Arkansas. Combined with knowledge being acquired on evening bats and Indiana bats, these results will enable new management plans that are more inclusive of the habitat requirements of a guild of bat species.

SGCN indirectly affected by this project: Indiana bat*, gray bat* (*Myotis griescens*), Southeastern bat (*M. austroriparius*), Ozark big-eared bas (*C. townsendii*), Eastern small-footed bat (*M. leibii*)*, Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), and Seminole bat* (*Lasiurus seminolus*). Although not yet listed, the tricolored bat will likely be included in 2014 as will the northern long-eared bat (*Myotis septentrionalis*). *Species are present in the Sylamore Ranger District.

Budget

Expense	Justification 35%/50% Match	35% Match Committed		50% Match Committed	
		SWG Req.	ASU Match	SWG Req.	ASU Match
Salary & Fringe	Salary (Fringe)				
Co-PI (Risch)	7% Effort/9% Effort (26.82%)	$ -	$ 19,594	$ -	$ 25,192
Partner (Klotz)	6% Effort/15% Effort (38.87%)	$ -	$ 7,677	$ -	$ 19,194
Grad Students (2)	14 mo each @ $1400/mo (2%)	$ 39,984	$ -	$ 39,984	
Field Technician	6 mo @ $1300/mo (7.86%)	$ 8,413	$ -	$ 8,413	
Travel					
Mileage	20,000 mi @ $0.42/mi	$ 8,400	$ -	$ 8,400	$ -
ATV Maintenance	ASU Contract	$ 1,000	$ -	$ 1,000	$ -
Conferences	2 meetings partial/total	$ 1,000	$ -	$ 1,000	$ 2,000
Supplies and Materials					
Midland 2-way radios	2 @ $100	$ 200	$ -	$ 200	$ -
Headlamps	2 @ $70	$ 140	$ -	$ 140	$ -
TRX-1000s Receivers	2 @ $750	$ 1,500	$ -	$ 1,500	$ -
Wildlife Materials 5-Element Tagis	3 @ $150	$ 450	$ -	$ 450	$ -
Holohil LB-2X Transmitters	50 @ $200	$ 10,000	$ -	$ 10,000	$ -
Miscellaneous supplies		$ 1,500	$ -	$ 1,500	$ -
Tuition					
Grad Students (2)	2 sem each/1 sem each	$ 12,488	$ -	$ -	$ 6,244
Total Direct Costs		$ 85,075	$ 27,271	$ 72,587	$ 52,630
Modified TDC		$ 72,587	$ 27,271	$ 72,587	$ 52,630
Indirect Costs					
IDC AGFC	Rate: 10% TDC	$ 11,235	$ 2,727	$ 12,522	$ 5,263
IDC ASU	Rate: 36% MTDC	$ 35,949	$ 9,818	$ 45,078	$ 18,947
Waived IDC*	ASU rate - AGFC rate		$ 24,714		$ 32,556
Total Cost Per Source		$ 96,310	$ 51,985	$ 85,109	$ 85,186
Total Project Cost		$ 148,295		$ 170,295	
50% Total Project Cost	ASU Match > 50% TPC		$ 51,903		$ 85,148

Qualifications of the individuals and organization involved

Arkansas State University is supplying field ecology lab space and assistance to this project. The research team's lab has studied Arkansas bats for ten years and has students that will assist in field work. Through the integration of ecology, physiology, pathology, and biochemistry the team at ASU offers unique insights into the spread and control of WNS.

Dr. Virginie Rolland has a Ph.D. in Population Ecology from University Pierre et Marie Curie (Paris, France). She is an assistant professor of quantitative wildlife ecology. Rolland's strength is in quantitative analyses of population data. She is currently supervising two graduate students who are studying roosting and foraging habitat of gray bats in the Ozarks and evening bats in the Sylamore district.

Dr. Thomas Risch has a Ph.D. in Zoology from Auburn University. He is professor of animal ecology, curator of mammals, and Chair of the Department of Biological Sciences at ASU. Risch's strength is in field ecology with ten years of experience studying bats in the Eastern United States. He has served on the Board of Directors of the Southeastern Bat Diversity Network and was this group's WNS committee chair. Additionally, Risch is the Arkansas representative to the Midwestern Bat Working Group.

Tracy Klotz has a BS and in Wildlife Ecology and Management and an MS in Biology. His thesis research focused on rare and threatened bats in Arkansas and the Mid-south region. He has over 7 years' experience working with bats in Arkansas including extensive experience with radio-telemetry and netting during the fall swarm. Mr. Klotz will be, in part, responsible for the training and supervision of the field crews involved in this research.