Proposal entitled:

White Nose Syndrome & Illinois Bat Populations: Biology & Monitoring

For Submission To:

Attn: Paul Vehlow
State Wildlife Grant Program
Office of Resource Conservation
Illinois Department of Natural Resources
One Natural Resources Way, Springfield, IL 62702-1271
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Submitted By:

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Make Award To: **The Board of Trustees of the University of Illinois**
c/o Office of Sponsored Programs and Research Administration
1901 S. First Street, Suite A
Champaign, IL 61820

Amount Requested: **$210,000**
Project Period: **1 August 2011 – 31 July 2014**

_____	_____
Steven J. Taylor, Principal Investigator Illinois Natural History Survey	Brian Anderson, Director Illinois Natural History Survey
_____	_____
Kathy Young, Director Sponsored Programs & Research Administration University of Illinois	R. K. Iyer, Chair Research Board University of Illinois

Project Title

White Nose Syndrome & Illinois Bat Populations: Biology & Monitoring

Applicant Information

Drs. Steven J. Taylor[1], Anthony C. Yannarell[2], Andrew N. Miller[1], Edward J. Heske[1], Nohra Mateus-Pinilla[1], and Joseph F. Merritt[1]

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Project Description

We will implement a monitoring program to detect *Geomyces destructans*, the fungus responsible for fatal white-nose syndrome in cave-hibernating bats. The team of experts includes two mammalogists, a mycologist, a microbial ecologist, a wildlife veterinary epidemiologist and a cave biologist, all at the University of Illinois Urbana-Champaign. We will use molecular and culture-based approaches to evaluate dead and live-caught bats and cave and mine substrates for the presence of *G. destructans* and describe the microbial communities of sampled animals and caves. This study will provide crucial data on the occurrence and distribution of *G. destructans* and the microbial ecosystems in which it must compete to become established.

Type of Project

Implementation

BUDGET	Year 1			Year 2			Year 3			Project Total		
Expense Line Item	**Request**	**Match**	**Total**	**Request**	**Match**	**Total**	**Request**	**Match**	**Total**	**Request**	**Match**	**Total**
Salaries and Wages												
Grad Res Asst ac yr [1]	28,701		$28,701	38,268		$38,268	$9,567		$9,567	$76,536	$0	$76,536
GRA - summer (no classes) [1]	5,669		$5,669	5,669		$5,669	$1,417		$1,417	$12,756	$0	$12,756
Total Salaries and Wages	$34,370	$0	$34,370	$43,937	$0	$43,937	$10,984	$0	$10,984	$89,292	$0	$89,292
Fringe Benefits												
Grad Res Asst ac yr @ 6.36%	$1,825	$0	$1,825	$2,437	$0	$2,437	$430	$0	$430	$4,692	$0	$4,692
GRA - summer (no classes) 14.01%	$794	$0	$794	$794	$0	$794	$172	$0	$172	$1,761	$0	$1,761
Total Fringe Benefits	$2,620	$0	$2,620	$3,232	$0	$3,232	$602	$0	$602	$6,453	$0	$6,453
Total Salaries, Wages, and Fringe Benefits	$36,990	$0	$36,990	$47,169	$0	$47,169	$11,586	$0	$11,586	$95,745	$0	$95,745
Travel												
Out of state [2]	$800		$800	$800		$800	$800		$800	$2,400	$0	$2,400
In state [3]	$3,310		$3,310	$5,310		$5,310	$2,000		$2,000	$10,620	$0	$10,620
Total Travel	$4,110	$0	$4,110	$6,110	$0	$6,110	$2,800	$0	$2,800	$13,020	$0	$13,020
Materials & Supplies – General [4]	$9,000		$9,000	$16,000		$16,000	$15,000		$15,000	$40,000	$0	$40,000
Total Materials & Supplies	$9,000	$0	$9,000	$16,000	$0	$16,000	$15,000	$0	$15,000	$40,000	$0	$40,000
Contractual Services – General [5]	$5,000		$5,000	$14,528		$14,528	$6,707		$6,707	$26,235	$0	$26,235
Tuition Remission (56% GRA)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Contractual Services	$5,000	$0	$5,000	$14,528	$0	$14,528	$6707	$0	$6,707	$26,235	$0	$26,235
Total Direct Costs	$55,100	$0	$55,100	$83,807	$0	$83,807	$36,093	$0	$36,093	$175,000	$0	$175,000
Modified Total Direct Costs (MTDC)*	$55,100	$0	$55,100	$83,807	$0	$83,807	$36,093	$0	$36,093	$175,000	$0	$175,000
F&A (20% Direct Costs)	$11,020		$11,020	$16,761		$16,761	$7,219		$7,219	$35,000		$35,000
Match: Unrecovered F&A (20% vs. 44.2%) [6]		$13,334	$13,334		$20,281	$20,281		$8,734	$8.734		$42,350	$42,350
Match: Salary + Fringe [7]		$24,341	$24,341		$23,575	$23,575		$23,811	$23,811		$75,356	$75,356
Total Proposed Project Budget	$66,120	$36,676	$102,796	$100,568	$43,856	$144,424	$43,312	$32,545	$75,857	**$210,000**	**$113,077**	**$323,077**
Percent of Project Costs	64.32%	35.68%		69.63%	30.37%		57.10%	42.90%		**65.00%**	**35.00%**	

(Budget footnotes on following page)

Budget Footnotes:

1 – A Graduate Research Assistant is needed for two years to culture fungal communities and conduct fungal ITS sequencing; a second Graduate Research Assistant is needed to conduct Automated Ribosomal Spacer Analysis (ARISA) and subsequent ITS sequencing in addition to pyrosequencing.
2 – Out-of-State travel is needed to attend regional and national meetings on White Nose Syndrome, to keep abreast of the latest developments and ensure other activities in the region coincide with our studies. No out of country costs will be charged to this project.
3 – In-State travel is needed to collect samples from caves and mines (hibernacula).
4 – Materials and Supplies include: disposable 3 mm biopsy punches, sterile swabs, nalgene microtubes, vials, jars; nytex & latex gloves, batteries, primary helmet-mount lights, caving helmets, kneepads, coveralls, whirl-paks, pencils, pens, paper, disposable tyvek suits for sterile sampling, disposable towels, paper towels, spray bottles, tubs for sterilizations, bleach, other cleaning solutions, clipboards, paper bags, cloth bags, poles, extendable (painter's) pole, sterile disposable scoops, petri plates, agar media, sterile loops, ITS sequencing supplies, Fisher Scientific Isotemp General Purpose Lab Refrigerator (~$3,850) needed for incubation of fungal cultures at cave temperatures, ARISA molecular fingerprinting supplies, pyrosequencing supplies, DNA extraction kits, centrifuge tubes, microcentrifuge tubes, micropipettor tips, PCR primers, PCR buffers, PCR reagents, autoclavable reagent reservoirs, 96-well PCR plates, PCR sealing film, marking pens, nitrile gloves, ethanol, laboratory tissue wipes, miscellaneous laboratory supplies, miscellaneous field supplies, duct tape, tape, flagging, wire.
5 – Contractual Services funds are needed to complete the molecular sequencing, these services will be provided by the Biotechnology Center at the Keck Center on the University of Illinois campus.
6 – The full rate for University of Illinois facilities and administration costs is 44.2%. We are using the unrecovered facilities and administration costs as part of our match.
7 – No investigator salaries are covered in this proposal. We are using a portion of each of the investigator salaries + fringe benefits (5% for Taylor, Miller, Heske, Yanahan; 4% for Mateus-Pinilla; 2% for Merritt) over the three years of the grant, as match. We are assuming a 3% raise beginning FY12 (1 July 2011), and assuming a 1% raise each of the subsequent years.

Need

White-nose syndrome (WNS) is a deadly disease of bats that is decimating cave-hibernating populations of bats in the eastern U.S. Since its initial documentation in New York in early 2006, WNS has moved rapidly into New Jersey, Pennsylvania, Virginia, and West Virginia, and it has recently been documented as far west as central Tennessee. In its current range, WNS has been responsible for the deaths of over one million bats, and it has caused the complete extinction of some local populations. The etiologic agent, *G. destructans*, is a fungus that grows on the muzzles, ears, and wing membranes of bats, and its presence leads to depletion of fat reserves of hibernating bats, leading to death by starvation. *Geomyces destructans* is a cold-adapted (psycrophilic) fungus closely related to soil fungi found in cave environments. It has an optimal growth temperature around 14°C which is typical of year-round conditions in many Illinois caves and mines. While not currently documented in Illinois bat populations, *G. destructans* and WNS are expected to reach Illinois by 2012. Informed management of Illinois' cave-hibernating bats, including both state and federally listed threatened and endangered species, requires knowledge of the status of WNS and *G. destructans* in Illinois. There is a need to establish a monitoring program that can 1) serve as a system to alert natural resource managers to the arrival of WNS in Illinois, and 2) provide essential data relevant to the introduction of *G. destructans* into Illinois, to its potential to spread, and to our understanding of the role of this pathogen within the native microbial ecosystems where it will have to compete to become established.

Objectives

1. **Establish a monitoring program for the rapid and early detection of the fungus, *G. destructans*, on bat specimens from around Illinois**. Protocols exist for both the cultivation of *G. destructans* and the cultivation-independent detection of this organism based on DNA samples (see Approach). We will implement these protocols to provide the earliest possible detection of *G. destructans* and WNS in Illinois. Early detection is essential to provide resource managers the time and data necessary to implement a management or containment plan. We will build upon two currently existing statewide programs to obtain frozen bat specimens from around the state (from the Illinois Department of Public Health [IDPH]) as well as sampling live-caught bat specimens retrieved from mist-netting studies (funded by the Illinois Department of Transportation [IDOT]), and, if allowed, samples from in-cave live-caught bats from cave and mine hibernacula (present study). Samples from these frozen (IDPH) mist-netted (IDOT) and cave (present study) specimens will serve as the foundation of our *G. destructans* detection and monitoring program.

2. **Characterize the background microbial load present in the fur of potential bat vectors of *G. destructans*.** While the pathology of WNS primarily affects hibernating bats, the rapid spread of *G. destructans* through northeastern U.S. bat populations suggests that the spores of this fungus are present in the fur and on skin of active bats. Active bats, therefore, may serve as critical vectors and reservoirs for *G. destructans* and other potential microbial threats. However, little is known about the typical

microbial flora of bats or about the ecology of bat-associated microorganisms at this critical vector stage. As part of our regular monitoring for *G. destructans*, we will address this knowledge gap by using molecular microbial ecology tools and culture-based techniques to sample from frozen IDPH and live-caught bat specimens.

3. **Characterize the establishment potential of *G. destructans* in Illinois cave environments.** Because *G. destructans* is closely related to other species of soil fungi commonly found in caves and mines, there is the possibility that it may persist in the soils of infected caves and mines, presenting a long-term barrier for re-establishment and rehabilitation of bat populations. To persist in cave or mine soil, the fungus must integrate itself within the existing microbial community, which may provide some degree of biotic resistance to the spread or establishment of *G. destructans*. We will address this objective by conducting molecular microbial surveys of soils from Illinois caves and mines in order to establish a microbial community baseline. We will compare our findings to published reports from other surveys from WNS-free and WNS-infected caves in an attempt to better understand how *G. destructans* alters microbial communities of cave soils and, potentially, to identify microbial communities that may inhibit the establishment of *G. destructans*.

Approach

Background. Every year, bats caught by the public are tested for rabies by the Illinois Department of Public Health (IDPH) and then sent (frozen) to the Illinois Natural History Survey (INHS) for identification. These specimens represent a resource for early detection of *G. destructans* from multiple parts of the state. In addition, INHS, in conjunction with the Illinois Department of Transportation, conducts summer mist-netting surveys; swab and wing punch samples collected from these bats will be used in the present study. Finally, we will visit winter hibernation sites to obtain swabs and wing punches from catch and release grab samples of hibernating bats. In addition, we will collect soil and other samples from cave environments.

Sampling. We will test samples collected from frozen (IDPH) and live-caught (IDOT, present study) bats for the presence of *G. destructans*. Under the current IACUC protocol for the existing IDOT research program (IACUC# 09027; PI Chris Phillips) for mist netted summer bats, wing punch samples will be collected (as mandated by USFWS). As part of the present study, we will sample bats from hibernation sites in caves and mines during the winter, under a new IACUC protocol. For all of the above live bats, the fur and wings of bats will be swabbed with four sterile cotton swabs; one pair (two replicates) of swabs will be used for cultivation of the fungal bat flora to detect *G. destructans* and the other pair of swabs (two replicates) will be used for whole-community microbial (fungal + bacterial) molecular analyses. For frozen bats, only two swabs will be used for whole-community microbial molecular analyses, as frozen material cannot be reliably cultured. In addition, two 3-mm wing punches will be collected from each live bat, one of which will be used for culturing, the other for whole-community microbial molecular analyses. Information on species, sex, age, collection location, etc. will be recorded and associated with the samples. Live bat

sampling will be carried out only by individuals covered under appropriate IACUC protocols, led by co-PI Joe Merritt, who is also responsible for species-level bat identifications. The proposed work will result in the collection of swab samples and often (excluding frozen IDPH bats) wing punch samples from up to 100 individual bats (up to 25 mist-netted bats, up to 30 IDPH bats, up to 45 cave/mine bats), with well over 1000 culture plates produced, and a variety of molecular analyses (see below).

For characterization of cave and mine soils, we will sample known bat hibernacula (caves, mines) at the same time and at the same sites that winter bats are sampled. At each site 12 substrate samples will be collected: a) three superficial substrate (soil/guano) samples below bat roost locations; b) three superficial substrate samples in the cave/mine, but away from bat roost locations; c) three superficial substrate samples from just outside the cave entrance; and d) three other samples from various microhabitats (dead bats, raccoon scat, rat middens, organic debris, etc.). These samples will be used for cultivation of fungal flora as described below. A similar set of 12 samples will be collected for whole-community microbial molecular analysis. In addition, we will collect sterile swab samples of various substrates in the caves. Each swab sample will be paired to produce two replicates for cultivation of fungal flora and two replicates for whole-community microbial molecular analysis. Substrate swab samples will be collected in a variety of habitats including swab samples of bedrock at or near bat roost sites, and swab samples of researcher's boot soles just prior to exiting the cave or mine.

Fungal Culture & Identification. Cultivation of samples from bat fur and wing membranes will follow established protocols. Cultivation will take place in a laboratory containing a brand new *BioSafety Level 2* (BSL-2) compliant facility, fully meeting CDC and NIH standards for diagnostic services and research on animal pathogens such as *G. destructans*. Spores will be germinated and isolates grown at 14°C on plastic petri plates containing Potato Dextrose agar (PDA) and plates containing Sabouraud-Dextrose agar (SDA) with chloramphenicol added to prevent bacterial contamination of fungal cultures. For soil samples, we will culture approximately 1 g of each soil sample at four serial dilutions. Cultures will be incubated at 14°C and observed for fungal growth every 48 hours. Any culture observed to be producing asexual spores resembling those of *Geomyces*, as well as a selection of other cultures, will be used to extract DNA for sequencing the internal transcribed spacer (ITS) region using known ITS primers.

Microbial Communities. For molecular characterization, DNA will be extracted from the samples and *G. destructans* will be detected using species-specific PCR primers. For the characterization of other members of the microbial community (various fungi and bacteria) for which little data are available, we will use Automated Ribosomal Spacer Analysis, as well as cloning and sequencing of specific taxonomic genetic markers (16S rRNA for bacteria and ITS for fungi).

Summary of Sampling Protocol

Our sampling protocol is summarized in Figures 1 and 2. Sampling of live and frozen bats from IDOT and IDPH leverages the proposed work with material obtained from other funding sources. The only bats that will be handled in the present study are those encountered at hibernacula during the winter. An approximate timeline for various activities is given in Figure 3.

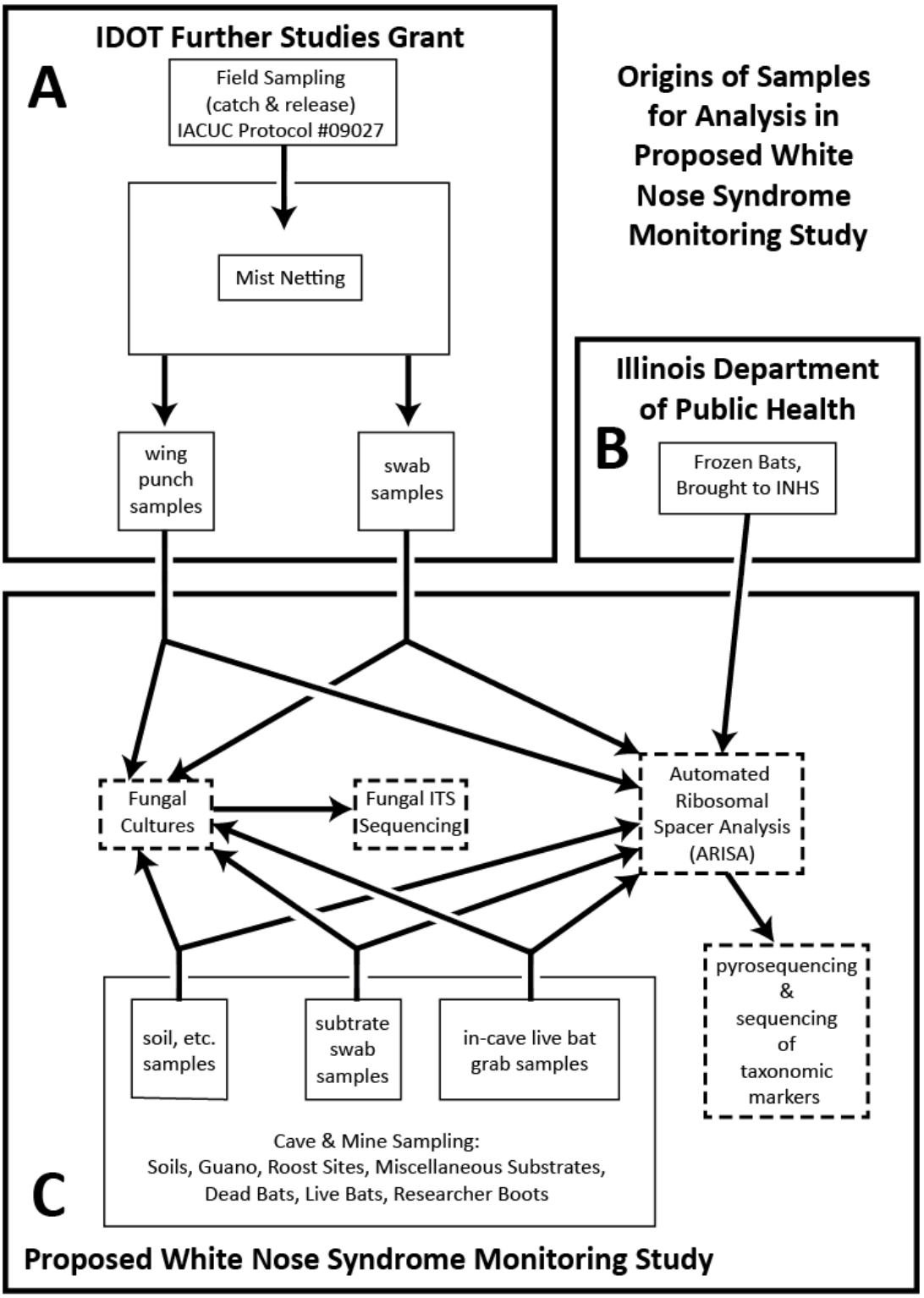

Figure 1. Origins of sample material and analyses to be conducted. A, B. Swab and wing punch samples obtained from studies carried out through other funding sources. C. Work proposed in present study.

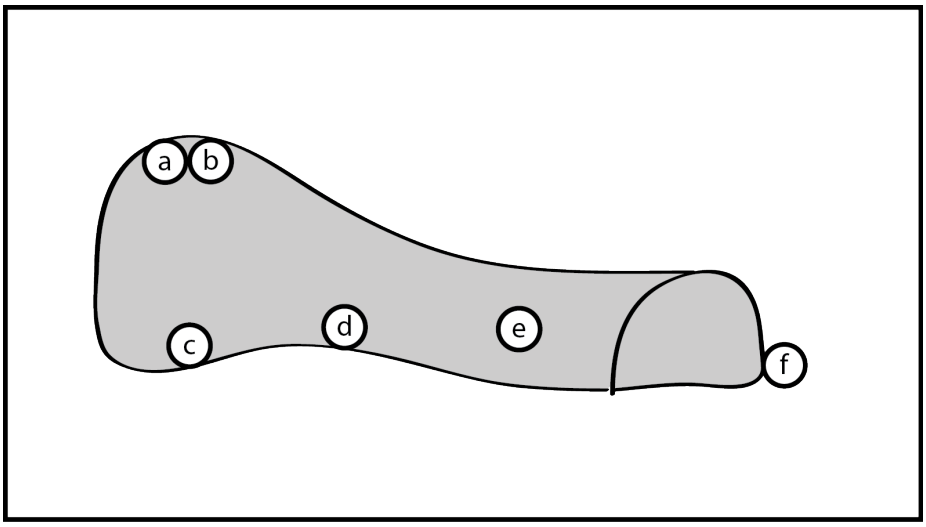

Figure 2. Diagrammatic representation of a cave/mine hibernaculum, showing locations of various samples: a) live bats [swab samples, wing punches]; b) swab samples of roost area substrate; c) soil/guano samples near roost site; d) soil samples away from bat roosts; e) other substrate and swab samples, including swabs from researcher's boots just before exiting cave/mine; f) soil sample from just outside of cave/mine.

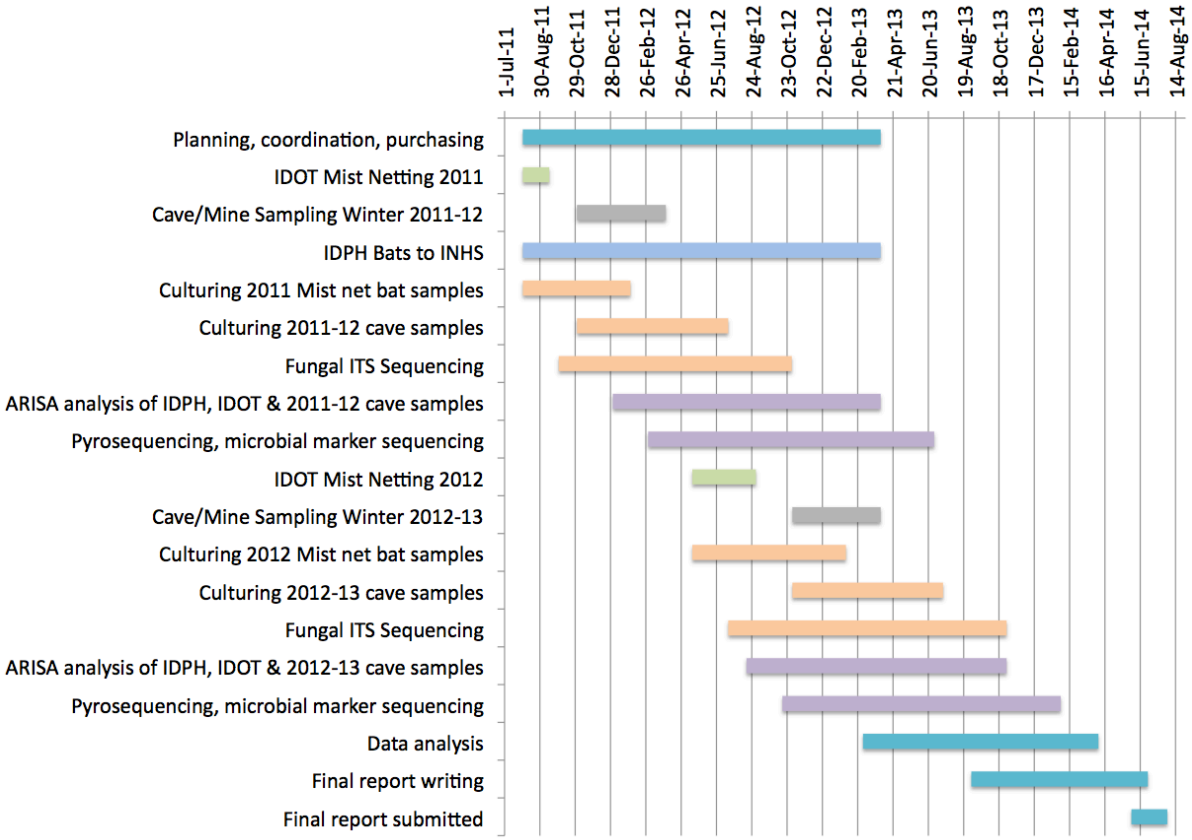

Figure 3. Approximate timeline for activities to be carried out during the proposed study.

Relationship to Illinois Wildlife Action Plan

Four bat species – *Corynorhinus rafinesquii* (eastern big-eared bat), *Myotis austroriparius* (southeastern bat), *Myotis grisescens* (gray bat), and *Myotis sodalis* (Indiana bat) – make up 20% of the mammal species listed as being in "species in greatest need of conservation" in Illinois' Wildlife Action Plan (page 309). All four of these occur in caves and mines, and most also frequent forests and riparian areas. These four species are imminently threatened by WNS, and, at the least, will suffer major population reductions, if not extirpation from Illinois, or extinction of the species due to the spread of this disease.

Several important Illinois caves and mines harboring bats have been identified as important natural areas, and receive some protection from state and federal agencies or private landowners. These include but are not limited to Brasher Cave (Pope County), Burton Cave (Adams County), Fogelpole Cave (Monroe County), Toothless Cave (Jackson County), Blackball Mine (La Salle County), and an important silica mine in Alexander County. Management of sites sampled during our study will benefit from information on bat populations and microbial ecosystems at the sites. Further, these sites span multiple Illinois Natural Divisions within the state, and thus the potential impacts of the findings of this study will have broad implications for natural resource management within the state.

This work would also have direct applicability to two of the eight areas listed as "Priority Actions for Conserving Illinois Wildlife and Habitat Resources" (Illinois Wildlife Action Plan, pages 56-97): A) the Invasive Species Campaign (*G. destructans* is an invasive species) and B) the Priority Locations for Conserving Illinois' Species in Greatest Need of Conservation.

Some Conservation Opportunity Areas identified in the Plan will benefit directly from the findings of this study because they either contain important cave and mine sites, or serve as habitat for summer roosts and bat foraging areas. These include, but are not limited to:

- Cache River - Cypress Creek
- LaRue - Pine Hills - Western Shawnee - Trail of Tears
- Sink Hole Plain
- Eastern Shawnee

This study has clear and direct applicability to at least four of the eight elements (Illinois Wildlife Action Plan, pages viii – xix) in Illinois' Wildlife Action Plan in that it:

- provides knowledge on the relative condition of key habitats and community types essential to conservation of species (Element 2, Illinois Wildlife Action Plan, p x)
- fills priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species (Element 3, Illinois Wildlife Action Plan, p xi)
- carries out conservation actions determined to be necessary to conserve the identified species (Element 4, Illinois Wildlife Action Plan, p xiii)

- provides information that will allow natural resource managers to adapt conservation actions to respond appropriately to new information or changing conditions (Element 5)

Anticipated Outcomes and Benefits

- **Detection and surveillance** – Management, intervention and conservation practices aimed at protecting bat species will be driven by the early detection, allowing proactive management by alerting IDNR and USFWS immediately upon detection of *G. destructans*. We will be able to provide a list of sites at which WNS was detected, a list of species in which the disease has been detected. This study moves us towards being able to calculate prevalence estimates of WNS infection in Illinois bats, stratified by species and study sites. A total of 15 cave/mine sites are proposed for sampling, but the actual number of distinct sites may be less, as some important hibernacula may be sampled during both winters.
- **Managing T&E species** – this study facilitates critical monitoring for a major threat to important state-listed T&E species. In particular, two of two (100%) of the mammals of Illinois listed as endangered by the US Fish & Wildlife Service are subjects of this study (Indiana Bat, Gray Bat). Demographic data obtained in this project will provide complementary information to the distribution, abundance and composition of bat populations in Illinois across time.
- **Cave ecosystem health** – this study will provide data which inform a broader understanding of the health of cave ecosystems, which are, in part, dependant upon bats as an energy source. Although Illinois contains hundreds of caves and mines, only a few of these are of important to the four bat species in the state which are listed as "species in greatest need of conservation" in Illinois' Wildlife Action Plan – our study is relevant to all of these bat species, and, additionally, provides important information on ecosystem health for many of our most important caves & mine sites.
- **Invasive species ecology** –by examining WNS as a biological invasion, this study will evaluate establishment of the fungus in the context of the overall native microbial community. We want to understand the ecosystem in which the species occurs – does the invasion of *G. destructans* alter the microbial community, both in caves and on the bodies of bats, and do some components of the native flora provide basic resistance to it? We will consider temporal changes in microbial communities as the invasion front enters Illinois. We will provide a list of sites at which we detect White Nose Syndrome, as well as the timing of detection (i.e., when sites were sampled).
- **Participation in national crises response** – this study plays an important role by demonstrating that Illinois is shouldering its share of responsibility for dealing with the multi-state WNS crisis. We will rapidly report location likely to be at risk for high mortality events.
- **Addresses multiple components of Wildlife Action Plan** – this study has clear and direct applicability to at least four (4) of the eight (8) elements, or 50% of the elements, in Illinois' Wildlife Action Plan.

Personnel

Our team of five (5) PhD-level natural resources professionals draws on a diversity of relevant expertise to most effectively address White Nose Syndrome issues in Illinois. The background and roles of each person directly involved with the project are listed below.

- **Steve Taylor** is a cave biologist with more than 20 years experience working in Illinois caves, as well as caves throughout the USA and other parts of the world. His research focuses on cave & karst biology, conservation and management, especial subterranean ecosystem structure and function and human impacts on subterranean ecosystems at a variety of scales. He has previously been involved in radio tracking and mist netting studies of bats.

    Steve will serve as the point of contact with IDNR and USFWS for the project, and will be responsible for managing the grant, coordinating effort, and participating in winter hibernaculum fieldwork.

- **Anthony Yannarell** is a microbial ecologist who studies bacterial and fungal community dynamics using DNA-based molecular methods, including whole-community DNA fingerprinting and sequence analysis of phylogenetic and functional gene markers. He has collected and analyzed microbial samples from a wide range of environments, such as lakes, rivers, soil, marine sediments, groundwater, and animal-associated surfaces. He also has extensive experience using multivariate data analysis tools to identify patterns and test hypotheses involving microbial community composition and variability.

    Dr. Yannarell's lab will produce and analyze the microbial community "ARISA" fingerprints and create pyrosequencing libraries in coordination with the W.M. Keck Center for Comparative and Functional Genomics at the University of Illinois at Urbana-Champaign. Dr. Yannarell will also be responsible for analysis and interpretation of the data produced by the ARISA and pyrosequencing.

- **Andrew Miller** specializes in the taxonomy and systematics of the higher fungi (Ascomycota and Basidiomycota) using a combination of traditional morphological methods and modern molecular techniques to investigate phylogenetic relationships and character evolution in these fungi. He is particularly interested in fungal biodiversity and conservation having completed several survey and inventory studies throughout North America and the Neotropics. He is also involved in the monographic treatments and taxonomic revisions of soil- and wood-inhabiting fungi.

    Dr. Miller’s lab will culture live-collected samples for fungi, and will use both morphological and molecular (ITS sequencing) approaches to identify individual fungal taxa. Dr. Miller will be responsible for analysis and interpretation of data produced through laboratory culturing and subsequent sequencing.

- **Joseph Merritt** is a mammalogist who specializes in the study of shrews, and also conducts extensive studies of bats throughout Illinois as part of IDOT-funded research conducted by the Illinois Natural History Survey.

    Dr. Merritt will be responsible for providing samples collected as a part of the IDOT sampling program, and for participating in fieldwork in hibernacula, serving as one of our bat experts for species-level field identification.

- **Edward Heske** is a mammalian ecologist who specializes in population and community ecology, especially conservation biology & ecology of mammals in habitats that are highly fragmented and impacted by human activity.

Dr. Heske will participate in fieldwork in hibernacula, serving as one of our bat experts for species-level field identification, and will participate in sample collection in caves & mines.

- **Nohra Mateus-Pinilla** is a Wildlife Veterinary Epidemiologist whose research focuses on multidisciplinary field and laboratory-oriented studies of wildlife disease ecology with direct application to conservation and management of natural resources. Her research program applies epidemiological theory to native and nonnative species in natural systems to understand the impact of diseases in wildlife populations and the role of natural levels of biodiversity in mediating the persistence of pathogens in the environment. One of the goals of her program is to guide adaptive management strategies that take into account restoration, conservation and preservation initiatives when mitigating diseases at the interface of wildlife, human and livestock health.

  Dr. Mateus-Pinilla will be facilitating the preservation and identification of the rabies tested IDPH bats for ARISA analysis. She will play a key role in the epidemiological interpretations and applications of demographic and ecological data in relation to our findings as they impact mechanisms of disease maintenance and transmission in natural ecosystems.
- Two **Graduate Students** will be funded as a part of this study. One student will work directly under Dr. Yannarell, the other under Dr. Miller. We anticipate that these students will use this program as a major component of their graduate-level thesis projects. Their duties on the project will be similar to those of Drs. Yannarell and Miller, as described above. Specific individuals filling these roles have not yet been finalized.

Locations of work

The field work for this study will be carried out at a variety of locations in Illinois. Bats from IDOT work will be obtained from sites where IDOT crews are tasked to mist net for bats, which could be anywhere in Illinois. IDPH bats, too, can come from anywhere in the state, but are most commonly from the greater Chicago-land area. For the 15 cave/mine hibernaculum sites we will sample in the present study, we anticipate working closely with our IDNR Project Manager, Joe Kath, to select these sites. This number of sites will likely be achieved by sampling some sites twice. Sites sampled more than once will generally be higher priority sites. We are aware of approximately 18 sites in Illinois that are likely to harbor colonial bats (especially Indiana or, occasionally, Gray bats). These sites, from which we will select sampling sites in consultation with Kath, are distributed around the state in four karst areas, plus one mine in the middle of the state (Figure 4), specific sites are listed in Table 1, below.

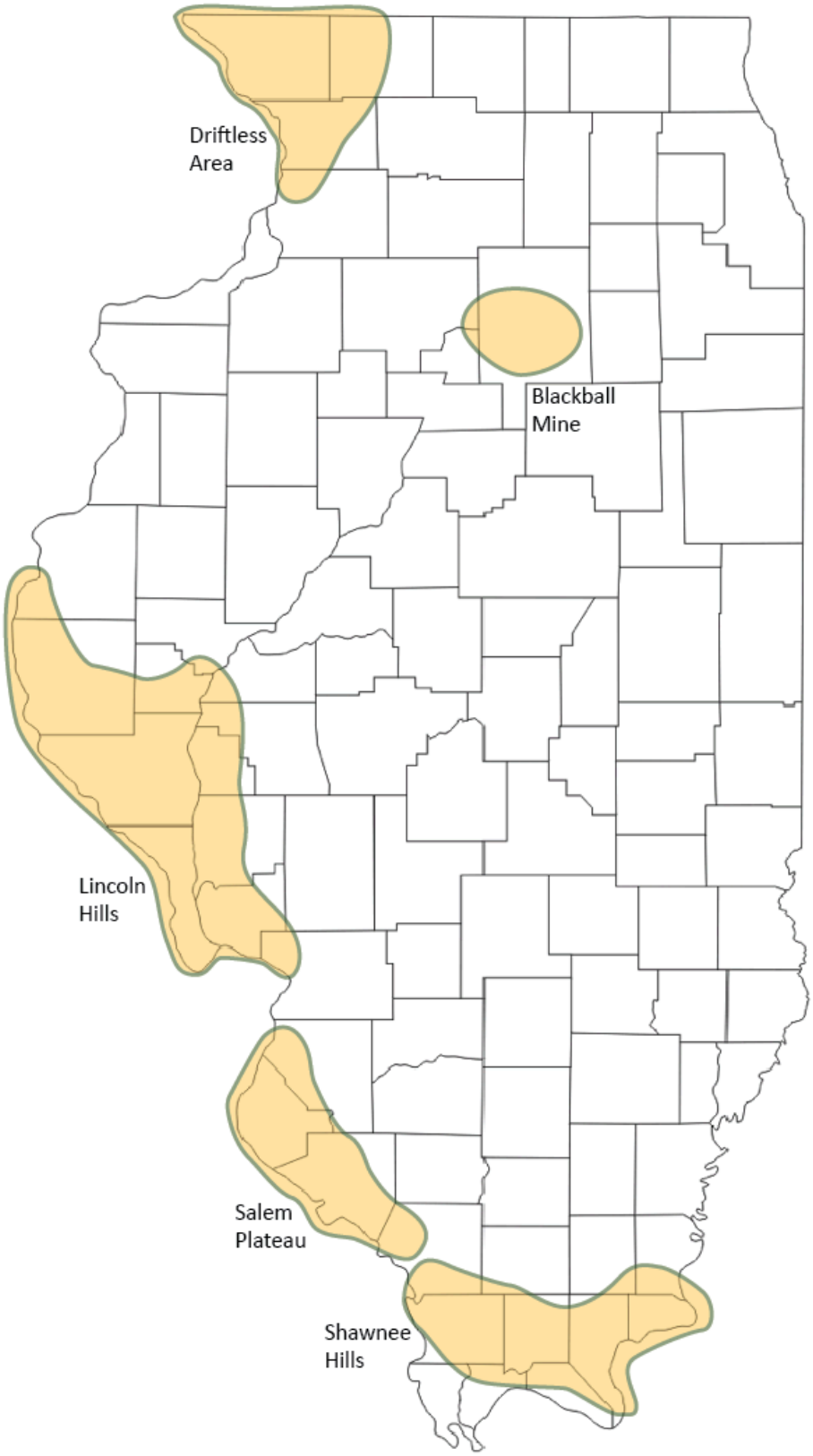

Figure 4. Distribution of four karst areas in Illinois where most of Illinois' caves are found. The approximate area where Blackball Mine is located is also indicated. See also Table 1.

Table 1. White Nose Syndrome in Illinois study, potential hibernaculum sampling sites. Legend: (County) [Priority for Sampling: 1-High, 2-Medium, 3-Low] {ownership}. See also Figure 4.

Lincoln Hills

1. Burton Cave – (Adams) [2] {IDNR}
2. Twin Culvert Cave – (Pike) [2] {TNC}
3. Brainerd Cave – (Jersey) [2] {IDNR}

Salem Plateau

4. Fogelpole Cave – (Monroe) [2] {IDNR}
5. Illinois Caverns – (Monroe) [3] {IDNR}

Shawnee Hills

6. Cave Spring Cave – (Hardin) [2] {Mining company (TNC & USFS for Eidelmann farm?}
7. Ellis Cave – (Pope) [**1**] {Illinois Audubon Society}
8. Toothless Cave – (Jackson)[**1**]{private}
9. Griffith Cave – (Hardin) [3] {?private?}
10. Rich's (Hunsaker's) Cave – (Union) [2] {USFS}
11. Guthrie Cave – (Union) [3] {IDNR}
12 Brasher Cave – (Pope) [2] {USFS}
13. Equality Cave – (Saline) [2] {USFS}

    Unimin Corporation silica mines complex:

14. Magazine Mine – (Alexander) [**1**] {USFS, Unimin Corp.}
15. Mine #30 – (Alexander) [2] {USFS, Unimin Corp.}
16. Other mine(s) – (Alexander) [3] {USFS, Unimin Corp.}

Driftless Area

17. Various copper mines – (Jo Daviess, Carroll) [3] {various}

Other Areas

18. Blackball Mine – (La Salle) [**1**] {IDNR}