

Cumberland Piedmont Network

National Park Service
Inventory and Monitoring Division



Standard Operating Procedure 2

Pre-field Sampling and Safety—Version 1.3

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Summary

This standard operating procedure (SOP) provides checklists and describes general preparations for field work in/at caves; safety (including a Job Hazard Analysis); and scheduling monitoring of cave-roosting bats and associated cave meteorological parameters at four park units in the Cumberland Piedmont Network (CUPN).

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #
December 2015	Steven Thomas	Changed to require within-year revisits for summer bat data collection in order to use a multiple-measures (hierarchical modeling) analytical approach.	Response to external peer review comments. Minor edits also made following external peer review.	1.1
April 2020	Steven Thomas	Minor edits—multiple throughout document.	Minor edits made following 2019 annual review of protocol	1.2
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Overview

Sampling design is presented first to orient the reader. This standard operating procedure (SOP) also describes additional precautions taken to reduce disturbance of hibernating bats and sensitive habitats, with particular consideration for the anthropogenic spread of White-nose Syndrome (WNS). Prior to conducting field sampling each year, all field personnel involved must read and sign the related Job Hazard Analysis (JHA), as well as the sections of this SOP that deal with WNS and disturbance of hibernating bats. The project leader should revise any sections of this SOP based on lessons learned from the previous field seasons that year.

A summary of the sampling dates and effort for methods used in this protocol is presented in Table 1. This table also indicates the sampling design for various methods in the protocol.

Table 1. A summary of the monitoring methods and sampling dates used to monitor cave roosting bats and associated cave meteorological parameters at four parks in the Cumberland Piedmont Network.

Park Name	Bat Monitoring Method—Summer Emergence Counts	Bat Monitoring Method—Biennial Winter Bat Counts	Cave Meteorology Method—Biennial Grab Sampling (in winter roosts only)	Cave Meteorology Method—Continuous Sampling (in winter and summer roosts)
Chickamauga and Chattanooga National Military Park	May 15–July 31	Jan 1–Feb 28	Jan 1–Feb 28	continuous
Cumberland Gap National Historical Park	May 15–July 31	Jan 1–Feb 28	Jan 1–Feb 28	continuous
Mammoth Cave National Park	May 15–July 31	Jan 1–Feb 28	Jan 1–Feb 28	continuous
Russell Cave National Monument	May 15–July 31	Jan 1–Feb 28	Jan 1–Feb 28	continuous

General Sampling Approach

Summer Cave Roost Sampling

Monitoring of bats at 40 summer cave roosts will follow a split panel revisit design at each selected CUPN cave; with one fixed panel of caves monitored at least twice every year, and one set of panels of caves rotating such that each cave in that panel set is monitored at least two times during one-out-of-every-four years (Table 2). A complete cycle of monitoring of selected CUPN caves will be finished every four years. The collection of bat emergence count data at summer cave roosts will take a minimum of 21 days and a maximum of 37 days to complete each year and will occur between May 15 and July 31 (Table 1). Counts at known bat maternity caves will occur between May 25 and June 15 during the period of maximum adult colony size (between late pregnancy and early lactation) (Table 3). Specific sampling dates for each summer cave roost will be scheduled as close as possible

to the same dates each revisit year, and within-year revisits will occur as closely as possible to each other (i.e., a short interval such as 1 to 4 days) to minimize inter- and intra-annual variation and minimize adding unaccounted-for uncertainty to the abundance estimate.

Table 2. Startup of the split panel revisit design used for monitoring summer cave-roosting bats via nocturnal bat exit counts at selected cave entrances among four Cumberland Piedmont Network Parks.¹

Panel	2014	2015	2016	2017	2018	2019	2020	2021	2022
1	X	X	X	X	X	X	X	X	X
2	X	–	–	–	X	–	–	–	X
3	–	X	–	–	–	X	–	–	–
4	–	–	X	–	–	–	X	–	–
5	–	–	–	X	–	–	–	X	–

¹Caves in Panel 1 are monitored annually. Caves in Panels 2–5 are monitored on a four-year rotation (1 year on followed by 3 years off). The number of panels sampled each year is constant (i.e., 2 panels per year). Although not shown, every cave is sampled at least two times within a short “index” period (i.e., as short an interval as possible between samples such as one to four days apart) in the scheduled sampling year.

Summer-roosting bats at either 20 or 21 selected caves will be counted each year. Fourteen caves will be monitored every year (Table 2, Panel 1), seven caves will be monitored each revisit year in Panels 2 and 5, and six caves will be monitored in Panels 3 and 4. Field sampling will normally be performed by one to four persons, depending on cave-specific factors (e.g., human safety, size and number of entrances at roost, colony size, sampling methods being used). During each sampling event the team will perform all steps described in SOP 3 *Summer Cave Roost Sampling*—Version 2.3 (CUPN 2023a) at each of the selected cave entrances. All sampling tasks at a cave entrance are expected to take about two hours to complete; this includes set-up and take-down time, plus 1.25 hours for the emergence count. Total travel time between office or lodging site and the cave entrance should range from 10 minutes to 3.25 hours (average is 1.5 hours).

Winter Cave Roost Sampling

Monitoring of bats in winter hibernacula will occur each year using a panel revisit design that will result in each of the 29 selected hibernacula being censused biennially (i.e., once every two years). The field data-collection elements in winter cave roosts will take approximately 10 field days to complete each year (i.e., 9 days for years ending in even numbers and 11 days for odd years). Sampling will occur between January 1 and February 28, with a narrower sampling frame (15 January to 15 February) designated for nine CUPN caves with federally endangered Indiana bats (USFWS 2007; Table 1). The wider sampling window provides more time to monitor bats in the 20 caves without Indiana bats. Specific sampling dates for each winter cave roost will be scheduled as closely as possible to the same dates each revisit year, to minimize inter-annual variation. Fifteen hibernacula will be censused in years ending with an odd number (e.g., 2017, 2019)—including nine caves with federally listed Indiana bats, and 14 hibernacula will be monitored in years ending with an even number (e.g., 2016, 2018; Table 4). Field sampling will normally be performed by a team(s) of

two to four persons, depending on cave-specific factors (e.g., human safety, size and complexity of the hibernaculum, distance from the entrance to the most-distal roosting bats, colony size, and sensitivity of bat species to disturbance). After the initial census of any given hibernaculum, each subsequent field crew for that hibernaculum should include at least one member who participated in the original or most recent survey. During each sampling event the team will perform all steps described in SOP 4 *Winter Cave Roost Sampling*—Version 1.2 (CUPN 2023b) in each of the caves. All sampling tasks within a cave are expected to take from 30 minutes to 7 hours to complete—primarily depending on the size and complexity of the hibernaculum and the number/location of bats present. Total travel time between office or lodging site and the cave entrance should range from 10 minutes to 2.25 hours (average is 1.3 hours).

Cave Meteorological Sampling

Monitoring of cave meteorological data in CUPN bat roosts will employ two sampling methods—opportunistic grab sampling and continuous sampling.

Opportunistic Grab Sampling

Opportunistic grab sampling of cave air/rock temperature and relative humidity (RH) at selected hibernacula will occur each year (between 1 January and 28 February) using the same panel revisit design as winter bat censuses because opportunistic grab sampling will be done in conjunction with hibernacula censuses (Table 1). Thus, the sampling schedule, number of days to complete, and number of personnel needed will mirror winter monitoring of bats in hibernacula (see above). During each field sampling event the team will perform all procedures described in the Opportunistic Grab Sampling section of SOP 4 (CUPN 2023b) in each of the caves.

Continuous Sampling

Continuous sampling of cave air temperature and RH at selected hibernacula and summer bat roosts will occur throughout the year using automated data loggers that continuously collect data at a programed interval (Table 1). Annual field sampling activities associated with continuous sampling (i.e., data logger deployment, data collection, replacement, and removal) will occur during mid-November through mid-March, either in conjunction with hibernacula censuses (i.e., winter counts) or during special field trips to summer roost caves during the winter when bats are gone. Annual field activities associated with continuous sampling of cave temperature and RH data at 14 or 15 selected hibernacula will be completed while onsite for bat monitoring, so additional time required for cave meteorological sampling will be negligible. Of the 40 summer cave roosts monitored, only 20 will require occasional special field trips focused on data logger sampling activities during mid-November–mid-March; because 19 summer cave roosts are also used as hibernacula, the data loggers at those 19 summer cave roosts will be deployed, data will be collected, or loggers will be replaced during scheduled winter bat counts. The 20 monitored summer cave roosts that require special field trips focused on data logger sampling activities during mid-November–mid-March will follow a panel revisit design that will result in each cave being visited every other year. Similar to hibernacula censuses, special field trips focused on data logger sampling activities will be performed by a team(s) of two to three persons, depending on cave-specific factors (e.g., human safety, size and complexity of the hibernaculum, distance from the entrance to the most-distal bat roosting section, number of

data loggers to deploy/collect data/replace/remove). It will take approximately five days to complete these field trips focused on data logger sampling activities at 10 caves each year. During each field sampling event the team will perform all steps described in SOP 5 *Cave Meteorological Sampling*—Version 1.2 (CUPN 2023c) in each of the caves.

White-nose Syndrome

White-nose Syndrome (WNS) is a disease that has resulted in unprecedented mortality of hibernating bats in North America and has been confirmed in multiple caves at all four CUPN parks. The syndrome is caused by the fungus *Pseudogymnoascus destructans* (*Pd*), and affected bats often display white fungal growth on their skin (primarily the muzzle, ears, and wings) and exhibit uncharacteristic behavior including frequent winter arousals. Loss of energy reserves, dehydration, and wing damage are among the effects of WNS and often lead to death. Because *Pd* is a psychrophilic (cold-loving) fungus, it is unlikely for disease transmission to occur during the warm summer months; however, *Pd* is known to grow and persist for years in cold and damp environments such as those favored by hibernating bats. While bat-to-bat spread is the primary means of disease transmission, the chance for anthropogenic spread does exist through contaminated caving gear (including footwear, clothing, and sampling equipment). To reduce the risk of inadvertent transport of *Pd* spores to healthy bats or habitats by field personnel working inside caves or at summer bat roost caves, it is recommended that only “dedicated gear” be used in hibernacula or by personnel who enter the entrance areas of summer bat roost caves. Dedicated gear is caving gear that is used only in park units in an area where bat counts and cave meteorological sampling are being conducted. After use at a park unit, all gear that entered a cave (or came into contact with such gear—like a backpack or jacket) and all gear that entered the entrance area of a summer bat roost must be thoroughly decontaminated and properly stored following the latest national guidance available at <https://www.whitenosesyndrome.org/> (WNSRT 2023) and on the CUPN server.

Disturbance to Bats

Minimizing disturbance to hibernating bats is a critical element of conducting counts and meteorological sampling in bat roost caves. Disturbance can disrupt the natural arousal cycle of bats and force them to burn essential energy reserves. Further, repeated disturbances may even cause bats to abandon a hibernaculum. To minimize disturbance, field personnel must remain as quiet as possible while in the presence of hibernating bats. Approaching bats will be done only when necessary to confirm species identification, to conduct an accurate count of a cluster, or to read the number on a bat band; in many cases, binoculars or camera with a zoom lens can be used in place of approaching bats. Handling bats should only be done in limited circumstances (e.g., to read an easily accessible band number, to confirm species identification, to euthanize a mortally injured bat, to collect a dead bat) and by individuals who have an up-to-date rabies pre-exposure prophylaxis (vaccination). See details on handling bats in SOP 4 (CUPN 2023b) and in the section on handling bats in Table 5. In general, observers will attempt to minimize the amount of time spent in the cave, while recognizing that additional time may be needed to move safely and carefully through caves, to deploy or collect data from equipment, and to ensure count quality while searching for bats. If possible, data will not be collected from loggers in close proximity to roosting bats—rather, each data logger will be moved to a safe location that is removed from bats for data collection, then

carefully returned to the spot it was previously. To minimize disturbance to summer-roosting bats, data loggers will be deployed and data will be collected during the winter (i.e., mid-November–mid-March) inside each summer bat roost cave that is not also on the list of monitored winter bat roost caves. All censuses and cave meteorological sampling should be done with a minimum crew size, balancing human safety, possible damage to sensitive cave features (e.g., such as speleothems or artifacts), sampling efficiency, and disturbance to bats (Kunz et al. 1996; Tuttle 2003; Kunz et al. 2009; Hayes et al. 2009).

The ease at which bats arouse from torpor varies among species and even within species (depending upon such factors as cluster density, distance from observers, and ambient roost temperature). For example, species such as gray bats (*Myotis grisescens*) and Rafinesque’s big-eared bats (*Corynorhinus rafinesquii*) in general, tend to arouse from torpor more quickly during censusing than tri-colored bats (*Perimyotis subflavus*), big brown bats (*Eptesicus fuscus*), or Indiana bats (*M. sodalis*). In contrast, Rafinesque’s big-eared bats which hibernate in a particularly cold cave (e.g., Hickory Flat Cave at Mammoth Cave National Park [MACA]) where midwinter roost air temperatures are typically -2°C to 5°C are slow to arouse from torpor while being counted. Experienced field crew leaders (and field crew members, when available) and consistency in sampling effort (by following instructions in the field sampling SOPs in this protocol), along with advance planning, should help address many of these monitoring challenges and ensure that data loggers are properly deployed, maintained, and replaced, and counts are as precise and accurate as possible.

Schedule

Variable weather and personnel workloads preclude the scheduling of sampling events to specific annual dates. Thus exact sampling dates and field personnel will be scheduled and logistics (e.g., lodging, vehicles) organized at least two weeks in advance of sampling trips. Backup dates will also be scheduled in advance. Flexibility is encouraged when scheduling because the project leader may want to schedule opportunistically to take advantage of periods of cold/stable weather, as bats are more likely to be in deep torpor during this time, reducing the potential for disturbance to cause arousal during sampling. To minimize inter-annual variation, sampling dates for each cave will be scheduled as closely as possible to the same dates each scheduled year. The project leader is responsible for contacting potential field personnel to schedule specific sampling (and backup) dates.

Bat caves (listed by CUPN park unit) and sampling panel/year and sampling dates for summer (see Appendix G in a Supplemental Materials package available on the Cumberland Piedmont Network internal server, or by request to the network) and winter cave roost monitoring are given in Tables 3 and 4, respectively.

Table 3. List of bat caves by CUPN park, maternity cave status, sampling panel number, sampling dates, and co-located cave vital signs for **summer** cave roost monitoring. Panel 1 is sampled annually. Panels 2-5 are done once every four years. Panel 2 started in 2014, panel 3 started in 2015, and so on. NA means not applicable [CHCH—Chickamauga and Chattanooga National Military Park; CUGA—Cumberland Gap National Historical Park; MACA—Mammoth Cave National Park; RUCA—Russell Cave National Monument].

Park Name	Cave Name	Maternity Cave (Y/N/Unk)	Sampling Panel #	Sampling Date	Co-located Cave Vital Sign
CHCH (Six caves)	27 Spiders Cave	N	3	June 16–June 30	NA
	Chambliss Cave	Unk	1	June 16–June 30	NA
	Lapp Hole	N	2	June 16–June 30	NA
	Lookout Mountain Battlefield Pit #1	N	5	June 16–June 30	NA
	Lookout Mountain Battlefield Pit #2	N	5	June 16–June 30	NA
	Neeld's Well	Unk	4	June 16–June 30	NA
CUGA (Five caves)	Big Salt Cave	N	2	July 1–July 15	NA
	Gap Cave	N	1	July 1–July 15	Cave Aquatic Biota
	Grassy Springs Cave	N	3	July 1–July 15	NA
	Olde Formation Pit	Unk	4	July 1–July 15	NA
	Taylor Cave	Unk	5	July 1–July 15	NA
MACA (27 caves)	Bat Cave	N	2	June 16–June 30	Allegheny woodrats
	Colossal Entrance	N	1	July 16–July 31	NA
	Dixon Cave	N	1	July 1–July 15	Allegheny woodrats
	Historic Entrance	N	1	July 16–July 31	Allegheny woodrats and Cave Crickets
	Lee Cave	N	1	July 16–July 31	NA
	Long Cave	N	1	July 16–July 31	Allegheny woodrats
	Anarchy Shelter	Unk	5	June 16–June 30	NA
	Blight Cave	Y	1	May 25–June 15	NA
	Blood Cave	Y	2	May 25–June 15	Allegheny woodrats
	Blue Spring Hollow Sandstone Shelter	Y	4	May 25–June 15	NA
	Boundary Cave	Unk	2	July 16–July 31	NA
	Cathedral Cave	Y	1	May 25–June 15	NA

Park Name	Cave Name	Maternity Cave (Y/N/Unk)	Sampling Panel #	Sampling Date	Co-located Cave Vital Sign
	Coke Cave	Y	1	May 25–June 15	NA
	Currie Cave	Unk	2	May 15–May 31	NA
	Deceptive Cave	Unk	4	May 15–May 31	NA
	Dynamite Rock Cave	Unk	1	May 15–May 31	NA
	Evening Cave	Unk	3	June 16–June 30	NA
	Hemlock Cave	Unk	5	June 16–June 30	NA
	Hickory Flat Cave	Unk	3	July 1–July 15	NA
	Larkin Davis Cave	Unk	4	June 16–June 30	NA
	Luna Cave	Y	1	May 25–June 15	NA
	Misty Hole Cave	Y	1	May 25–June 15	NA
	Mossy Root Cave	Unk	3	May 15–May 31	NA
	Saucer Cave	Y	5	May 25–June 15	NA
	Stacked Rock Cave	Unk	3	June 16–June 30	NA
	Temple Hill Shelter	Unk	4	July 1–July 15	NA
	Wilson Hollow Pit	N	2	June 16–June 30	NA
RUCA (2 caves)	Picnic Entrance	Unk	1	June 16–June 30	Cave Aquatic Biota
	Main Entrance	N	2	June 16–June 30	Cave Aquatic Biota

Table 4. List of bat hibernacula by CUPN park, biennial sampling year, sampling dates, and co-located cave vital signs for **winter** cave roost monitoring [CHCH—Chickamauga and Chattanooga National Military Park; CUGA—Cumberland Gap National Historical Park; MACA—Mammoth Cave National Park; RUCA—Russell Cave National Monument].

Park Name	Cave Name	Sampling year Ending in Odd or Even Number?	Sampling Dates	Co-located Cave Vital Sign
CHCH (Six caves)	27 Spiders Cave	even	January 1–February 28	NA
	Chambliss Cave	even	January 1–February 28	NA
	Ha-Ha Cave	even	January 1–February 28	NA
	Lapp Hole	even	January 1–February 28	NA
	Lookout Mountain Battlefield Pit #1	even	January 1–February 28	NA
	Lookout Mountain Battlefield Pit #2	even	January 1–February 28	NA
CUGA (Eight caves)	Big Salt Cave	odd	January 15–February 15	NA
	Cliff Cave	odd	January 1–February 28	NA
	Gap Cave	odd	January 1–February 15	Cave Aquatic Biota
	Grassy Springs Cave	odd	January 15–February 15	NA
	Indian Cave	odd	January 1–February 28	NA
	Little Saltpeter Cave	odd	January 1–February 28	NA
	Olde Formation Pit	odd	January 1–February 28	NA
	Skylight Cave	odd	January 1–February 28	NA
MACA (12 caves)	Bat Cave	odd	January 15–February 15	Allegheny woodrats
	Colossal Entrance	odd	January 15–February 15	NA
	Dixon Cave	odd	January 15–February 15	Allegheny woodrats
	Historic Entrance	odd	January 15–February 15	Allegheny woodrats
	Lee Cave	odd	January 15–February 15	NA
	Long Cave	odd	January 15–February 15	Allegheny woodrats

Park Name	Cave Name	Sampling year Ending in Odd or Even Number?	Sampling Dates	Co-located Cave Vital Sign
	Wilson Cave	odd	January 15–February 15	NA
	Currie Cave	even	January 1–February 28	NA
	Haunted Cave	even	January 1–February 28	Allegheny woodrats
	Hickory Flat Cave	even	January 1–February 28	NA
	J.T. Cave	even	January 1–February 28	NA
	Wildcat Hollow Sink	even	January 1–February 28	Allegheny woodrats
RUCA (3 caves)	Picnic Entrance	even	January 1–February 28	Cave Aquatic Biota
	Ridley Cave	even	January 1–February 28	NA
	Main Entrance	even	January 1–February 28	Cave Aquatic Biota

Staffing

The cave bats monitoring protocol will, in most cases, be implemented by two to five persons (typically one field crew leader and one to four crew members) covering 9 to 11 days between 1 January and 28 February; by two to three persons for about five days from mid-November to mid-March; and by one to four persons for a minimum of 21 and a maximum of 37 days between 15 May and 31 July. Field crews will consist of CUPN staff, volunteers, park staff, state/federal cooperators, university interns, SCA members, American Conservation Experience (ACE), or similar cooperators. It is the network program manager's responsibility to obtain field assistants each year through various cooperative agreements available to the Cumberland Piedmont Network. At least the field crew leader should possess good identification skills for local bat species and have experience in winter bat counting methods. Field personnel must also be adept at traveling through caves, including crawling, descending/ascending, and climbing where necessary. Caving skills are important to ensure that field personnel can safely access caves and maneuver through passages without causing resource damage or sustaining injury, while remaining quiet to reduce bat disturbance potential. Implementation of the protocol will also require use of cameras, GPS units, radios or satellite communicators, and other field equipment.

Communication and Coordination with Parks

A National Park Service (NPS) research permit will be obtained for each park scheduled for monitoring of cave-roosting bats. The permits should be completed in November of each year (if possible, permits should be requested for two or more years to cut down on the amount of paperwork from year to year). Some parks allow multi-year permits to cover long-term monitoring projects,

while others require annual renewal. The status of cave bats monitoring research permits and applications for new permits is available at the NPS Research Permit and Reporting System website (<https://irma.nps.gov/RPRS/>). The project leader will ensure that each park has the current protocol for monitoring bats at cave roosts (previously reviewed by each park) and a list of sampling locations so that any compliance issues can be addressed. The project leader will be responsible for year-end reporting requirements for each permit. Entry into hibernacula during the hibernation period to census federally listed bats will require authorization under the Endangered Species Act in the form of a permit from the U. S. Fish and Wildlife Service (USFWS). At a minimum, one person on the team during each sampling trip into such protected hibernacula must be named on a current USFWS permit (or equivalent authority at the state level) which specifically allows performing this activity on this/these listed bat species. The project leader will be responsible for obtaining and maintaining the required USFWS permit.

In addition to permits, the project leader will email the key park contact at each park at least two weeks prior to each sampling trip to provide a trip plan with the tentative dates and planned sites where bat monitoring field work is scheduled to take place. The trip plan will also include a list of the field crew (with mobile phone numbers) and a list of the vehicles (with descriptions and license plate numbers). When possible or when requested by park staff, the sampling crew should stop by the park resources management office for brief introductions and to meet any logistical needs such as picking up keys, vehicle hang tags, etc. If required by a park, the project leader will fill-out a cave entrance request form for each cave to be sampled during that trip and obtain proper approval signatures. Brief follow-up Trip Reports will be completed within two weeks after each sampling trip. However, because sampling at Mammoth Cave National Park occurs throughout the summer, a single Trip Report for that park will be completed within two weeks after the end of the sampling season.

Logistics

Once the specific dates (including backup dates) for each sampling trip have been selected, the project leader will reserve a CUPN or rental vehicle for transport to and within parks. Sampling at Chickamauga and Chattanooga National Military Park (CHCH), Cumberland Gap National Historical Park (CUGA) and Mammoth Cave National Park (MACA) often requires a 4-wheel drive vehicle.

The project leader will attempt to reserve in-park lodging where available, as soon as specific field sampling dates are selected each year. If no in-park lodging is available, nearby commercial lodging with government rates will be pursued by the project leader.

Safety

The Cumberland Piedmont Network considers the occupational health and safety of its employees, cooperators, and volunteers to be of utmost importance, and is committed to ensuring that all field crews receive adequate training on NPS safety procedures, incident reporting, and emergency

response prior to field work. Working in a cave environment can present some particular safety hazards, and certain activities (e.g., vertical caving) necessitate specialized training and experience.

Job Safety

An important tool used to promote safe conduct is the job hazard analysis (JHA; formerly called a job safety analysis). This approach is consistent with NPS Directors Order 50B (<https://www.nps.gov/policy/DOrders/50B.htm>; last accessed 30 March 2020) and Reference Manual 50B ([Reference Manual 50B: NPS Occupational Safety and Health Program](#); last accessed 30 March 2020) for Occupational Health and Safety. The JHA process is to (1) identify hazards associated with field and laboratory settings, as appropriate, and (2) develop approaches to mitigate those hazards. Prior to conducting cave bats sampling each year, all field personnel involved must read and sign the related JHA (Table 5). Prior to each cave bats multi-event sampling trip (e.g., four consecutive days of sampling at CHCH), all participating field personnel must review the related JHA (Table 5) and agree to follow all safety guidelines during sampling. In addition to the JHA, all NPS staff must read the entire CUPN Safety Plan. Prior to participating in field work all NPS staff must complete NPS Operational Leadership training.

Responding to an Incident

Life-Threatening Medical Emergency

1. **Call 9-1-1 or park emergency number. When available, use park radios or a phone to contact dispatch.** Administer first aid to the best of your knowledge, ability and training. If appropriate, transport to emergency room. Directions to the nearest hospital from each park and emergency numbers will be updated and printed every January, prior to field sampling, by the project leader or designated field crew leader (Table 6). Copies of the hospital directions and emergency numbers are included as items on the supplies and equipment checklists (Table 7, Table 8, or Table 10) used before each field event.
2. As soon as it is practical to do so, inform your supervisor and the park's emergency contact.
3. For injured NPS staff and volunteers, complete workers' compensation paperwork. For contractors and cooperators, follow your organization's procedures for documenting accidents.

Non-Emergency Incidents

1. For a non-emergency incident that may require medical attention, contact supervisor immediately after incident. If the supervisor cannot be reached, inform the park's emergency contact.
2. Seek medical attention, if needed.
3. For injured NPS staff and volunteers, complete workers' compensation paperwork (should be done within 48 hours of incident). For contractors and cooperators, follow your organization's procedures for documenting accidents.

Job Hazard Analysis for Monitoring Cave-Roosting Bats in Cumberland Piedmont Network Parks

Date of last update:

5 July 2016

NPS Division with primary responsibility for this JHA:

Inventory and Monitoring Division for the Southeast Region

Last updated by:

S. Thomas

Reviewed by:

Teresa Leibfreid, Rickard Olson, Steven Thomas, Rickard Toomey

Approved by:

Teresa Leibfreid

Required standards & general notes:

If required, cave entry permits must be obtained and approved prior to any caving activity. Surface contact person (aka “surface watch”), detailed trip plan for the day, and call-in time must also be established prior to the trip; surface contact person should be informed of party exiting each cave ASAP (e.g., via cell phone, two-way radio, or satellite communicator). Always bring two reliable and fully charged communication devices (e.g., a radio and satellite communicator, or two cell phones if cell service is reliable) to the cave entrance. Inform LE of trip plan when conducting surveys in remote sections of cave. Trip leaders must be appropriately trained and prepared for the type of trip they are leading. Each team member must be prepared for the type of trip and familiar with first aid kit locations (if any) along the nearest travel route. All PPE will be inspected and tested prior to using, and all equipment will be adequate for the type of trip. Always enter a cave with a party appropriate to the planned activity and cave area; caving alone is usually not appropriate

Personal protective equipment:

UIAA approved helmet with four-point suspension chin strap; three reliable independent light sources; knee-pads (as needed); elbow-pads (as needed); gloves (needed when handling bats); treaded boots with good soles and ankle support; coveralls with hood, gloves, and eye protection (required for non-rabies vaccinated participants when there is medium to high bat-human contact potential); sufficiently warm clothing; chemical heat pack; compact first aid kit; insect repellent and poison ivy treatment; and bee sting kit (required if allergic to insect stings).

Typical tools, equipment & supplies:

Side-mounted pack, adequate drinking water, adequate quick-energy food supply, extra batteries, watch, cave maps, compass, hand-line.

Table 5. Potential hazards and recommended actions encountered in monitoring of cave-roosting bats in CUPN parks.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
Planning Cave Trip and Communication	Not being prepared and not following plan/itinerary. Lack of leadership and communication. Failing to establish a reliable surface contact person and reasonable call-in time. Planning a caving trip that will exceed the abilities of any team member. These abilities include physical condition, technical skills, and psychological aspects	One person for each trip will be designated as the trip leader. This person is responsible for providing leadership and clear communication concerning safety, minimizing impact to the cave resource, and achieving the trip goals. Ensure that trip plans are within the range of all team members. Discuss trip plans with team members and make sure each member understands the trip plans and is prepared to meet the challenges of the trip in terms of physical condition, technical skills, and psychological aspects. Gather appropriate maps, GPS data, and route information so that the team can efficiently find caves they are going to and meet their objectives within the caves. Establish a reliable surface contact person and reasonable call-in time. Provide surface contact person with a detailed trip plan, Field Information Sheet(s), travel route map(s), a list of all team members and emergency contact phone numbers, and whom/when to notify (i.e., the response lead) in the event the crew does not return (or call-in) on time and after attempting to contact the crew. Instruct surface contact person to monitor weather channels/radar for approaching severe weather and to alert the field crew with adequate time to take safe action. Always carry at least two methods of communication among team members with full charges. Ensure designated surface contact person and law enforcement are informed when conducting surveys in remote sections of cave. Check expected weather and stream conditions for day and sites.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
Emergency Preparedness	Not knowing emergency procedures.	Know who to contact and how to reach them in the event of a life-threatening or non-life-threatening emergency. Have current CPR and first aid certification and know the certification status of co-workers.
Preparing Equipment	Not bringing proper equipment to achieve the planned objectives.	Trip members will make sure they have the proper personal equipment for the trip. Trip leader will supply protocol-specific checklist of necessary equipment.
	Equipment worn, broken or inoperable due to lack of proper maintenance.	Each trip member is responsible for regularly checking, cleaning, and ensuring their caving equipment is in proper working order.
	Team member not knowing how to properly use caving equipment.	All team members will have the training and knowledge as to proper usage of each piece of equipment used for their specific trip.
Entering Cave	Entrance zone animals	While in the entrance area of a cave all team members should be alert and aware that skunks, venomous snakes, spiders, and other potentially hazardous animals may be found. Avoid treading on accumulated guano or middens.
	Rock fall	Due to high fluctuation in temperature and moisture near cave entrances, some entrance areas can be particularly prone to loose rocks. Move carefully and thoughtfully so as not to dislodge rocks.
Horizontal Caving (in general)	Getting lost	Caves can be confusing, and route finding in the cave can be tricky. As you travel to the area(s) where you will be working, pay attention to the route you take. Each person on the party should be able to find his/her way out of the cave. It helps to look back at junctions as you travel through them; doing this gives you a look at what the junction will look like when you come back. If needed, removable flagging can be used to mark junctions; permanent markers, like arrows, should not be placed in the cave without specific permission.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
	Exposed climbs	Always use three points of body contact on cave surfaces to minimize risk of falling. Where feasible, use a hand-line or belay.
	Slippery surfaces/Falling	Everyone will wear footwear with good traction and a caving helmet with a chinstrap. Everyone should move in a careful, controlled manner to avoid falling. When climbing, test all holds to ensure that they can withstand the force being placed upon them.
	Low/small areas	Trip leaders should ensure all members are able to negotiate low/small areas on caving route. Remaining calm and thinking through what one must do to get through low/small areas is key. Team members will not travel head-first through low/small areas that slope steeply downward.
	Exertion/Exhaustion	Each team member must have adequate knowledge of the length and duration of trip prior to heading into the cave and should have cave-specific physical conditioning. People in good physical condition need less water and are less prone to injury. Push your endurance limit in gradual increments. Avoid overloading your pack; be creative to reduce weight and bulk. Prior to the trip, the trip leader should inquire about people with known physical conditions and treatment needs. Groups should avoid overexertion and should stop at least every hour to eat and drink. Group speed should be tailored to the slowest person on the team. Should the trip become too much for one trip member, the whole trip plan will be modified to achieve a safe trip.
	Temperature related issues	Ensure team members are appropriately dressed for continued movement—a lightweight long-sleeved shirt and lightweight, durable pants are usually sufficient and prevent overheating.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
Horizontal Caving (in general, continued))	Overdue party	Ensure team members have adequate cold-weather clothing in their packs such as a balaclava and long-sleeved polypropylene shirt. Explain to team members about the colder temps while not moving and the necessity of wearing these items to prevent hypothermia. Keeping clothing dry is important. Trip leaders must always establish a reliable surface contact person prior to embarking on a trip. This person must be briefed on what time to expect the team to return (or call-in) and what to do if the team does not call-in on time. A detailed trip plan for the day with order of caves to be visited, travel route map(s), parking location(s), and names and emergency contact information for each participant will be provided to the surface contact person. Trip leaders will allow a reasonable amount of time for the team to exit the cave prior to the pre-established "surface watch" call-in time. If the team becomes lost, team members will remain where they are and wait for the contact person to notify search and rescue.
	Dehydration	All team members will be properly hydrated before entering the cave and drink sufficient water or electrolyte replacement drinks during the trip to maintain a proper hydration and avoid cramps.
	Minor injuries	Self-rescue using compact first aid kit in pack or in caches.
	Major Injuries	When possible, at least one team member stays with injured party while other team member(s) goes for help. Roaring River (ROR), one of the more remote sampling locations at MACA, has access to a telephone at the Snowball Dining Room; cell phone # of LE Ranger on duty or dispatch phone # should be known beforehand.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
	Rockfall	Cavers should locate themselves in places where they will not be exposed to rockfall from team members above them. Cavers will move carefully and thoughtfully so as not to dislodge rocks. Should a team member accidentally dislodge a rock or drop equipment they will clearly yell "Rock!" to inform team members below of the impending danger. Team members below should be alert and step away (not look up). All team members will wear a caving helmet with a chinstrap. This helmet should not be removed when in an area with a potential for rockfall.
Wading or snorkeling. Additional required equipment: Thermal protection in water (such as wetsuit or drysuit, neoprene shorts, neoprene shirt, neoprene socks, exposure suit as appropriate for specific condition), mask and snorkel, fins (if snorkeling), inflatable kayak/boat, paddle.	Total submersion	When possible, monitoring in cave streams and rivers should be performed during the dry season so that water levels and flooding potential are low (and visibility high). Always check weather reports before performing monitoring in cave streams or rivers. Be aware of antecedent conditions: consider current soil saturation. If there is a high chance of heavy rain in the surrounding area the trip should be postponed. Always work in areas with adequate air space between the water surface and the cave ceiling. Know alternative exit routes. Personal flotation devices are unnecessary when snorkeling because wetsuits or exposure suits (which are needed due to temperature) make the individual positively buoyant and so they will float on the surface.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
	Hypothermia	When possible, monitoring in cave streams and rivers should be performed during the dry season so that water levels and flooding potential are low (and visibility high). Always check weather reports before performing monitoring in cave streams or rivers. Be aware of antecedent conditions: consider current soil saturation. If there is a high chance of heavy rain in the surrounding area the trip should be postponed. Always work in areas with adequate air space between the water surface and the cave ceiling. Know alternative exit routes. Personal flotation devices are unnecessary when snorkeling because wetsuits or exposure suits (which are needed due to temperature) make the individual positively buoyant and so they will float on the surface.
Vertical caving Additional required equipment: Rope of adequate length, harness outfitted with standard (or preferred) ascending and descending gear, and Quick Attachment Safety.	Miscommunication resulting in someone entering the rockfall zone while another team member is in a position to dislodge rocks or while another team member is still on rope.	Clear signals will be used to avoid miscommunications. "On Rope!" will be clearly shouted when entering the rockfall zone with the intent to rappel or ascend a rope. "Off Rope!" will be clearly shouted after getting off rope and exiting the rockfall zone. A clearly shouted "OK!" from the other team members should acknowledge either of these commands.
	Ropes and or rigging materials worn or damaged.	All ropes and rigging materials will be inspected for wear or damage before use. If necessary damaged or worn materials will be retired.
	Unsafe Rigging.	All rigging will be inspected before use to ensure that it is safe. If determined not to be safe, the rigging will be modified if possible or the trip halted until the rigging can be made safe. During rigging, a figure eight knot will be tied at the end of the rope prior to the first rappel to prevent accidental "short-ropeing".
	Not conducting a thorough check prior to rappelling.	All vertical caving participants will go through a pre-rappel checklist, often called "Checking the Chain".

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
	Rope damage encountered while on rope.	A butterfly knot will be used to eliminate the damaged section of rope from the life supporting rope. A note will be left both at the top and bottom of the rope informing cavers of the situation.
	Incident occurs where caver is forced to change over to ascent while descending or to descent while ascending.	Everyone participating in vertical caving will be required to have the equipment, training, and knowledge to perform changeovers from ascent to descent and descent to ascent.
	Object becomes jammed in rappel device.	Everyone participating in vertical caving will be required to have the equipment, training, and knowledge to safely lock off their rappel device and remove the jammed object without using a knife.
	Difficulty in passing a rebelay, traverse, or other complex rigging situation.	All persons traveling to sections of cave with complex riggings will be required to have the equipment, training, and knowledge to safely negotiate these complex riggings.
	Caver becomes exhausted, unconscious or injured resulting in immobilization on rope.	When someone becomes immobilized on rope, it is critical to remove that person from rope as soon as possible, usually by talking them through the problem or lowering them to the ground. Ideally every trip should have at least one person knowledgeable of small-party vertical rescue techniques. Single-rope pickoffs are a last resort.
	Unsafe use of cable ladders	Cable ladders are often convenient for short pitches (< 30 feet; 9.1 meters), however, they can be tricky to use. People using cable ladders should have knowledge and experience in their use. A belay should be used when either descending or ascending on cable ladders.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
Handling bats, Exposure to bats	Unsafe use of ladders	Although they are not used very frequently, hard sided ladders (such as extension ladders, step ladders, collapsible ladders, or sectional ladders) may be used for some types of vertical caving. Be sure that ladders are appropriately secured. It may be appropriate to belay climbers on ladders, depending on mounting and exposure. With collapsible ladders, be sure that ladder is locked, to prevent collapse while climbing. For sectional ladders, be sure sections are locked together and that ladder is used with an appropriate rise/run ratio. Be aware of (and clean off) mud on rungs to prevent slipping on the ladder.
	Bats can transmit rabies to humans.	All people handling live and freshly dead bats must have up-to-date rabies pre-exposure inoculations. If bitten, clean wound and seek medical attention for appropriate post-exposure treatment. Bats should be handled with gloves that will prevent penetration of bites. Freshly dead bats are less dangerous. However, they should also be handled with appropriate PPE (such as gloves).
	Bats can transmit other diseases to humans.	Always wash your hands after handling bats. Appropriate gloves can reduce the risk of exposure and should be worn for handling live and freshly dead bats. Take care in handling bats to reduce the risk and severity of bites and scratches which may transmit disease. Eye protection should be worn when handling bats, as long as wearing such eye protection does not in itself create a safety hazard.
	Bites and Scratches	Live bats will readily bite and scratch when handled. Handle bats carefully to minimize their ability to bite or scratch. Wearing appropriate gloves will reduce the ability of the bats to penetrate skin when biting. If bitten, clean wound and seek medical attention for appropriate rabies post-exposure treatment.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
	Parasites with ability to transmit diseases	Bats may have parasites such as fleas and ticks which may transmit diseases. Be sure to watch for parasites attempting to colonize you while you are handling bats. Wearing appropriate gloves reduces parasite exposure.
	Difficult locations	Bats may roost in areas that are difficult to access. Use care when reaching up (or climbing to get) bats off walls or ceilings.
	Fatigue	Some bat work is performed at night. Be aware of the potential to fall asleep and only perform work when you can maintain concentration and alertness.
	Euthanizing bats with anesthetics	Euthanizing bats with anesthetics, such as isoflurane, must only be performed by approved people with appropriate training. Euthanization should take place in a well-ventilated area in a way that does not expose the practitioner or others to anesthetic fumes.
	Inadvertent bat-human contact	For caves in which bats are known to arouse from hibernation and swarm in flight, all non-vaccinated (rabies) field personnel will wear additional PPE (e.g., disposable coveralls with hood, gloves, eye protection).

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
General foot travel (on surface)	Falling or tripping due to stream crossings, wading, wet areas, poor footing, uneven terrain, loose/rolling rocks, heavy pack, navigating at night, falling into an abandoned well or vertical cave entrance, becoming lost.	Use caution at all times. Walk carefully, watching footing. Wear appropriate boots for conditions, especially stream wading. Stay aware of your feet. Address blisters and hot spots promptly. Avoid carrying excessive weight or unbalanced loads. When walking on a steep slope, lean upslope. Ensure that stems and vines are alive and can support your weight before relying on them. Use extreme caution traversing wet rocks, streams, steep slopes or blowdown areas. Proceed cautiously, test footing carefully, and use a sturdy pole or walking stick for balance. Some field work will involve traveling from cave entrance to vehicle or lodging site after dark. Navigate using the CUPN GPS unit(s) that GIS specialist previously uploaded parking location coordinates into. Select a navigator and stick together. Additionally, place small reflectors on cave-side of trees using tacks (e.g., "bright eyes", "Fire Tacks") in appropriate places along route. If the team becomes lost, team members will remain where they are, notify the contact person of their coordinates (if possible) or approximate location, and wait for the contact person to notify search and rescue.
Working outdoors during storms	Severe weather. Being struck by falling trees or branches.	Listen to the weather forecast each morning (park radio or internet). Plan or adjust field work to avoid being out in thunderstorms. Postpone work if safety will be compromised by storm conditions. Instruct surface contact person to monitor weather channels/radar for approaching severe weather and to alert the field crew with adequate time to take safe action.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
	Being struck by lightning.	If you have cell phone service, use a lightning tracker application (e.g., "My Lightning Tracker" for iOS) to alert you of lightning in the area. If you see or hear a thunderstorm coming, retreat from high ground and exposed areas. Go inside a sturdy building, vehicle, or cave, if possible. If you can't get inside and if you feel your hair stand on end, lightning is about to strike. Make yourself the smallest target possible and minimize contact with the ground. Crouch down on your pack on the balls of your feet and keep your feet close together. Place your hands on your knees and lower your head. During a thunderstorm members of the crew should stay separated by at least ten feet.
Poisonous Plants (specially poison ivy)	Contamination/toxicity from contact with poisonous plants.	Learn to identify poison ivy in its many growth forms. Wear long sleeves and pants. Be aware of poison ivy and avoid coming in direct contact with it. Thoroughly wash hands, equipment, and clothes with Tecnu or similar specialized soap after working in areas with poison ivy.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
Bee, wasp, or yellow-jacket stings	Multiple stings from disturbing or stepping into nest areas.	Be alert to hives in brush, ground holes, or hollow logs. Watch for insects traveling in and out of one location. If you or anyone you are working with is known to have allergic reactions to bee stings, tell the field crew leader at a minimum. Make sure you carry emergency medication with you at all times and that at least the field crew leader knows where you keep it. Wear long sleeve shirts and pants, tuck in shirt. Bright colors and metal objects may attract bees or wasps. If you are stung, a cold compress may bring relief. If stinger is left behind, scrape it off of skin. Do not use tweezers as this squeezes the venom sack, worsening the injury. If the victim develops hives, asthmatic breathing, tissue swelling, or a drop in blood pressure, seek medical help immediately.
Bites from mosquitoes, no-see-ums, and chiggers	Itchy reactions to multiple bites.	Avoid sitting on the ground or on logs, especially in dry sunny grassy areas. Use insect repellants. Do not apply Permethrin, Permanone, or greater than 30% DEET directly to skin, only to clothing. Wear long sleeves and pants. Carry after-bite medication to reduce skin irritation.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
Venomous snakes	Being bitten by a venomous snake.	Wear snake gaiters when in known snake habitat. Do not work alone at sampling sites with recent history of snake activity. Be alert for snakes in thick vegetation and rocky habitats. Look before putting hands or feet in places out of immediate view. Treat all bites as if envenomation has occurred. Seek medical attention immediately and/or call 9-1-1 for help. Keep the person calm and move as little as possible to reduce spread of the venom. Immobilize the bitten area and keep it at or below the level of the heart. Remove rings, watches, shoes, etc. before swelling begins in earnest. Monitor the person's vital signs—temperature, pulse, rate of breathing, and blood pressure—if possible. If there are signs of shock (such as paleness), lay the person flat, raise the feet about a foot, and cover the person with a blanket. Do NOT use tourniquets or suction devices. Do NOT cut the area around the bite. Do NOT apply ice or flush the wound with water. Do NOT give the person stimulants or pain medications unless a doctor tells you to do so. Do NOT give the person anything by mouth. <i>[compiled from NIH, JAMA, and American College of Emergency Physicians]</i>

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
Ticks	Contracting diseases transmitted from ticks.	Use tick avoidance precautions, such as pre-treating clothing with permethrin, tucking pants into socks and shirt into pants. Avoid sitting directly on the ground, especially in leaf litter and check packs for ticks before putting them on. Wear clothes (including pants and long-sleeved shirts) that are light colored and check for ticks on clothing periodically throughout the day. Conduct a thorough tick check every evening after completing field work. Know how to identify tick life forms and the symptoms of tick-borne diseases.
Walking through thick vegetation	Cut, scratched, or bruised by vegetation; eye or ear injuries.	Shield your eyes and face with your hands, glasses, or hat when moving through tall thick brush. Keep your head and eyes pointed somewhat downward so your head hits obstacles before your eyes. Wear pants and long-sleeved shirts to protect bare skin. Look before you grab vegetation to avoid grasping thorny stems. Do not follow closely behind others to avoid branches snapping back at you.
Working in heat, humidity, or cold	Heat exhaustion, sunburn, dehydration, hypothermia.	Evaluate the weather forecast each morning and plan field work accordingly. Carry and drink plenty of water. Take extra breaks during extreme weather events. Adjust the work routine to minimize exposure to extreme heat and humidity. Take adequate garments for all possible weather conditions. Choose clothing that will keep you warm even if it gets wet.
Hazard trees	Being struck by falling trees or branches.	Look up. Be alert for “widow-makers” (storm-damaged trees with large broken limbs), and unstable standing dead trees. Do not spend extended time in an area with hazard trees. Do not attempt to tag or measure unstable snags.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
High water stream crossings	Injuries from falling or drowning.	Thoroughly investigate area to find safest crossings. Wear appropriate foot gear for stream crossings. It is safer to wade through high water, rather than rock hop across a stream trying to keep your boots dry. Unbuckle your pack and be prepared to jettison gear should you lose your balance or fall in. Use a sturdy pole or walking stick for balance.
Carrying a pack and other equipment	Injuries from improper packing, adjustment, and lifting of backpacks. Injuries from improper carrying of gear.	Learn how to properly pack, adjust, lift, and carry a pack. When hand-carrying gear, keep one hand free. If carrying long equipment, be aware of other people and never swing around quickly. Avoid allowing a long piece of equipment to project up and behind you, where you cannot see it.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
General operation of a vehicle	Injuries from vehicle accident; damage to vehicle.	Perform pre-operational check of vehicle (oil, tire pressure, tire condition, fluids, wipers, brakes, lights, gas, etc.). Report all needed repairs to the crew leader or supervisor promptly. Do not use the vehicle if it is unsafe. Wear seat belts with shoulder harnesses whenever vehicle is in motion. (E.O. 13043 4-16-97) Do not use cell phones or text while driving. Only NPS employees, volunteers, or authorized cooperators and contractors are allowed to operate or ride in a government vehicle. Ensure full visibility from all windows and mirrors. Clean windshield regularly. Always ride inside the vehicle. Properly store and secure all tools, equipment, and cargo so that they will not shift during sudden starts or stops. Plan your travel before you start. Know your route. Practice defensive driving; be alert to potential hazards. Obey all traffic laws and speed limits. Adjust speed to changing weather or traffic conditions. Allow adequate following/stopping distance. Avoid distractions like eating or adjusting navigation/GPS units while driving. Be alert for pedestrians or bicyclists using roadways. Be watchful for wildlife crossing roads, especially at early morning, dusk, and after dark. Do NOT drive if fatigued. Stay alert! Do NOT exceed the 12 hour limit for driving/work hours.

Activity	Potential Hazards	Recommended (unless otherwise stated) Safe Action or Procedure
Driving on gravel, dirt, or un-maintained roads	Injuries from vehicle accident; damage to vehicle.	Maintain a slow and safe speed for changing road conditions, such as loose gravel, large potholes, washed out road, fallen trees or rocks, etc. Be alert on narrow roads for oncoming vehicles and log trucks. Be prepared to slow down, pull over, or stop with little notice. Many roads require 4-wheel drive or high-clearance vehicles for safe passage. Use the appropriate vehicle for the terrain. Do not exceed the capacity of your vehicle or driving ability. When in doubt, turn around or back out. Use spotters to assist in navigating obstacles and assessing water depth at stream crossings. Assure there is a tow rope in good condition in the vehicle before departing for the field and that at least one person in the vehicle has received training on the proper use of a tow rope with a vehicle.
Handling batteries	Electric shock, burn from overheated metal.	Carefully (without rushing) pack/unpack 12-volt batteries and associated equipment for transport to/from the field. Assure that no metal items are in direct contact with the battery terminals—<u>especially</u> the metal bar used for mounting external IR lights and the NV video camera to a tripod. When not in use, keep the battery terminals covered with an insulator such as thick cloth, rubber, plastic, electrical tape, Teflon, vinyl, etc.

Participant Accountability Form

I certify that I have read and I am familiar with the Job Hazard Analysis for Monitoring Cave-Roosting Bats in Cumberland Piedmont Network parks (*in SOP 2, Pre-Field Sampling and Safety—Version 1.3 [CUPN 2023d).*

Print Name	Signature	Date

Field Information Sheets and Section Maps

For hibernacula and summer roost caves to be monitored, the development and maintenance of Field Information Sheets describing conditions at each site will help orient new crew members, increase efficiency, and greatly improve the consistency of counts through time. The Field Information Sheet template in Figure 1 provides an outline of the types of information that will be included. Additional information can be included (e.g., recommended sampling schedule, gate status, bat species which use cave, maternity status). A Field Information Sheet will initially be developed for each cave prior to the first sampling event and maintained in a Microsoft Access database application (see example in Appendix E in a Supplemental Materials package available on the Cumberland Piedmont Network internal server, or by request to the network). Before leaving the field, each information sheet will be reviewed, and at the office the project leader will revise any sections based on lessons learned from the sampling event that just concluded.

For each hibernaculum to be censused, Cave Section Maps were created and will be used as a means of including a spatial component to the counts in order to assess within-cave distribution. The spatial resolution for most sites is coarse, as sections were defined by obvious, in-cave features that are easy to recognize (e.g., passage junctions, steep slopes or pits, dramatic changes in ceiling height); however, the systematic collection of data by sections should allow changes in bat habitat use to be tracked over time. It is critical that sections are well-documented and integrated with the Field Information Sheet. The Cave Section Maps were also created and will be used for plotting and labeling the locations of HOBO data loggers and permanent landmarks during cave meteorological field sampling at all selected roost caves. Figure 2 provides an example of a hibernaculum section map. After each sampling event, the project leader will update the Cave Section Map (if necessary) by plotting the approximate locations of any fresh guano piles in summer bat caves that are entered during the winter or newly established data logger or landmark locations. Boundaries of extant sections on the map should not be altered. The steps in the process used to create the Cave Section Map shown in Figure 2 are described below.

1. Adobe software was used to crop the original .pdf map file to the area to be surveyed (because the whole map was too large to save) and it was saved as a .jpg file.
2. The file was opened in Microsoft Paint, the file was cropped to the part of the cave to be used in the bat monitoring, the scale and north arrow were moved by the cropped area, and the file was saved as a .png file.
3. The cropped map was printed and the project leader drew the locations of the 5 cave sections and the three HOBOS and three permanent landmarks on the paper map to be created as shapefiles in ArcMap.
4. In ArcCatalog, the shapefiles were created in the Bat Cave folder by right-clicking in the folder, selecting “new,” then “shapefile.” The first shapefile was named Bat_Cave_Section_1, and “polygon” feature type was selected. The same process was repeated for the second through fifth sections.

5. In ArcMap, the .png file and the five section shapefiles were added to the data frame. For each shapefile, under “properties,” under the display tab transparency was changed to 50%. In the Editor toolbar, “start editing” was selected and “create features” was selected. Bat_Cave_Section_1 was highlighted in the create features box and was then drawn on the map as a polygon. The lines were drawn within the cave wall boundary line so that there was no white space between the polygon and the cave wall and so the polygon did not completely cover up the cave wall line. When the polygon was completed, “save edits” was chosen under the Editor toolbar. Each section was completed with the same process.
6. When the last shapefile was created, “stop editing” was selected. In the data frame box, contrasting colors were selected for each shapefile, with no outline chosen.
7. In layout view, the map was enlarged to fill up as much of the page as possible in portrait orientation and the data frame line was removed by right-clicking on it, selecting “properties,” and under the frame tab changing the border to none. In the data frame box, the shapefile names were changed to Section 1, etc. so they could be added to the legend.
8. To create the legend, under the Insert tab, legend was selected and only the sections were included in the legend. The legend was titled “Bat Survey Section,” given a 1.5 pt. border and a grey 30% drop shadow with a gap of 10. The legend was placed to the left of the map and the map was then exported as “Bat_Cave_Shapefiles.png” with a 400 dpi resolution to the Bat Cave folder.
9. In Microsoft Paint, the map was further enlarged to fill the page, leaving room on top for the map title and information. Each section was labeled using the text feature, and the label was placed in an easy-to-read location near the center of each section.
10. A text box was then added to the bottom of the map, reading “Modified from CRF 2008, H. Barton, Cartographer.”
11. For the map title, a solid black line was placed across the top of the page using the line feature. Above the line the title reads “Bat Cave: Hibernaculum Cave Section Map” in a large bolded font centered above the line. Under the line, to the left side of the page reads “Mammoth Cave National Park.” Under that reads “January 2014” in smaller text, and to the right side of the page read “Unique Cave ID#: 027.”
12. HOBO and landmark locations were added to the map for three HOBO data loggers. A red star feature in Microsoft Paint was used to mark the locations, and text feature was used to label them. A straight line feature was used to connect the text to the stars when needed.
13. The completed map was saved as “Bat_Cave_Section_Map_Final.png” in the Bat Cave folder. A subfolder was created in the Bat Cave folder called Bat Cave Files, and all files except the final map were placed into the subfolder (for easier access to the final map).

All Field Information Sheets and Cave Section Maps will be printed on waterproof marine paper/Rite-in-the-rain paper (8.5 × 11-inch) using a color LaserJet printer. Field forms and maps filled out in pencil or permanent ink can be disinfected after surveying by immersion in an appropriate solution following current national decontamination protocols. Other non-permanent ink may smear during disinfection, so be sure to use permanent ink. While some print cartridges use permanent ink, others do not, so we will experiment with locally printed forms prior to field sampling. Because they contain sensitive information (e.g., cave location coordinates), extra copies of Field Information Sheets and Cave Section Maps will be maintained by the project leader with the secure project files.

Fake Cave: Cave Bats Monitoring Field Information Sheet	
Bat Torpor National Park Date (month, year)	Access Keys Needed: _____
Description of Bat Use / Bat Location List bat species and roost type (e.g., hibernaculum, maternity, bachelor, transient). Describe the locations where bats are commonly encountered and areas of high bat density.	
Cave Location Map The cave entrance location should be overlaid on a USGS topographical map, with roads, trails, and park boundaries included. This will aid in navigating to the entrance. [print on back of sheet, if blank] GPS coordinates: X= _____ Y= _____	
Parking Location Describe where to park to begin hiking to the cave. This may be a designated trailhead, or a more obscure location, such as a specific spot along a road shoulder. GPS coordinates: X= _____ Y= _____	
Directions to Cave / Travel Time (round-trip from parking location) / Survey Time Give directions from the office (or place of lodging) to the parking location and then to the cave entrance. Indicate the approximate time required to complete round-trip travel only. Use a conservative time range estimate to reflect differences in hiking speeds. Separately record the approximate time required for each of the various sampling events that are scheduled to occur at this site (e.g., winter bat census, special trip in winter for HOBO data logger activities, summer bat count). Approximating the survey time required will aid planning and logistics, especially when conducting multiple counts in the same day.	
Field Crew Size Indicate the recommended number of personnel based on safety, efficiency, cave size and complexity, number and size of entrance(s), and disturbance considerations, for example: best = 3, minimum = 2, maximum = 4 [winter in-cave monitoring] best = 2, minimum = 1, maximum = 5 [summer emergence monitoring]	
Special Equipment Needed List any non-standard equipment necessary for the survey, for example: ▪ cave access gear: climb-down on north side of pit ✓ 50' handline to be rigged to live oak tree ▪ wide-angle lens for thermal infrared video camera system for recording emergence	
Overview/Sampling Instructions Describe the cave and recommended sampling route, method, or equipment / observer placement (provide a sketch). Include obstacles or safety hazards like climbs or drops. Indicate any special considerations that may affect the count. For summer emergence caves include the local start / end times and sampling dates.	
HOBO Data logger Information For each temp / RH data logger provide: cave section number, location and landmark names, descriptions of location and landmark (& plot on Cave Section Map), and siting info (e.g., azimuth, inclination, dist.).	
Entrances / In-cave Section Descriptions List and describe cave entrances (if more than one) and established sections inside cave to aid surveyors in recognizing section transitions. ▪ Section 1 – Entrance Area. Begins at entrance drip line and ends at start of crawl. ▪ Section 2 – 50' Crawl. Begins at entrance to crawl and ends at opening to first room.	

Figure 1. Sample Field Information Sheet for monitoring of cave-roosting bats in CUPN parks.

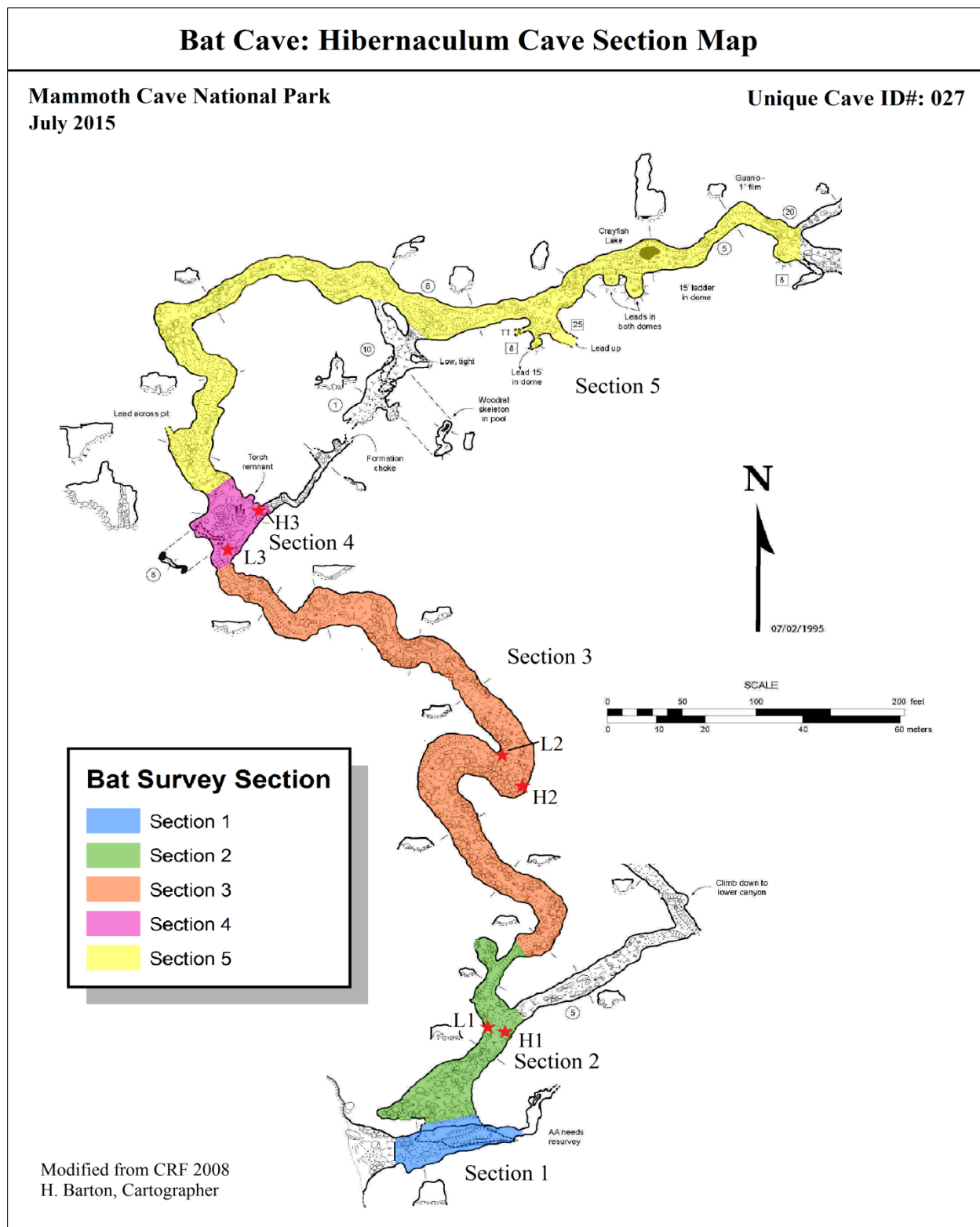


Figure 2. Example of a hibernaculum Cave Section Map for monitoring cave-roosting bats in CUPN parks. The locations of continuous HOB0 data loggers and permanent landmarks are indicated by red stars and labeled with “H” for HOB0 and “L” for landmark used to locate the HOB0 location.

GPS Setup

Using DNRGarmin (free) or similar software, the GIS specialist will upload cave location and parking location coordinates into the CUPN GPS unit(s) or handheld device. Immediately after uploading the plot coordinates, it is critical to check the GPS unit's map page to ensure that the cave locations are shown correctly and are in the correct projection. One easy way to check that the points loaded properly is to navigate manually to the park in the GPS unit's map function and see if the points line up approximately with where they should be based on the cave location map in the Field Information Sheet.

Communication and Crew Oversight

Prior to each trip (i.e., multiple days sampling at a park, or periodically at MACA), a trip plan will be filed with a CUPN contact (i.e., someone in the office during the trip) and the park (Figure 3). A trip plan will include items such as trip purpose, sampling dates and times, daily check-in/check-out procedure, field crew members, contact information, and sampling sites.

When available, the field crew should carry a cell phone plus a NPS radio or satellite communicator when traveling in remote areas at Chickamauga and Chattanooga National Military Park (CHCH), Cumberland Gap National Historical Park (CUGA), Mammoth Cave National Park (MACA), and Russell Cave National Monument (RUCA). In all situations, crew members will comply with park policies regarding the use of radios while conducting field work. Remember, radios, cell phones, and satellite communicators do not work inside caves. Radios must be programmed to the appropriate frequencies for each park. Crew members should know which frequencies to use, how to contact park radio dispatch, and be familiar with proper radio etiquette. If available, crew members should be familiar with proper use of a satellite communicator. In areas with cell phone coverage, crew members will be encouraged to carry a cell phone in the field for safety and to call the project leader concerning protocol questions, although this is not required. It is essential for the crew to maintain regular contact with the project leader throughout the field season. Establish a regular weekly telephone call time between the field crew leader (or crew member, as appropriate) and project leader to review the week's work. The update should cover questions or problems related to caves, protocol, logistics, and scheduling.

CUMBERLAND PIEDMONT NETWORK (CUPN) TRIP PLAN

Cave Bat Monitoring

PARK: Cumberland Gap National Historical Park (CUGA)

DATES: Week of February 6, 2017

ESTIMATED TIME: The field crew anticipates arriving at the park on Tuesday, February 7 at approximately 1:00 pm (EST). They will check-in with a representative of Resource Management Division. Field activities will likely occur between the hours of 9:00 am and 7:00 pm and should be completed by Saturday, February 11. The crew will check-out with staff at the Visitor Center.

PURPOSE: To conduct winter bat population monitoring and service/deploy cave air temperature and relative humidity dataloggers inside selected caves.

DAILY PROCEDURE: A surface contact person ("surface watch") will be established before each trip to a cave. Clearly established with the contact person will be: 1) the time to expect the crew to return (or call-in after exiting the cave), and 2) whom and when to notify (i.e., the response lead) in the event the crew does not contact on time and after attempting to contact the crew. The contact person will be given a copy of this trip plan, as well as, travel route maps (surface and subsurface) for each cave to be visited.

VEHICLE: Ford Explorer (white), license plate: I515510

FIELD CREW:

NAME	MOBILE PHONE
Steve Thomas (CUPN)	270-792-XXXX
Rick Reynolds (VA Dept. G&IF)	540-430-XXXX
Will Orndorff (VA Dept. of Cons & Rec)	540-430-XXXX

CONTACT INFO:

NAME	OFFICE PHONE	MOBILE PHONE
Jenny Beeler (CUGA)	606-246-XXXX	865-850-XXXX
Amy Settles (CUGA)	606-246-XXXX	606-670-XXXX
Cumberland GAP Tunnel	606-248-XXXX	N/A
Teresa Leibfreid (CUPN)	270-758-XXXX	270-784-XXXX

SITES: [in no particular order]

Skylight Cave	Cliff Cave	Gap Cave
Indian Cave	Grassy Springs Cave	Olde Formation Pit
Big Salt Cave	Little Saltpeter Cave	Taylor Cave

Figure 3. Example of a trip plan to be filed with a CUPN contact and a park prior to monitoring cave-roosting bats in CUPN parks.

Summary of Yearly Staff Roles

Timing and staff roles for primary tasks are presented in Table 6.

Table 6. List of major protocol tasks, responsible staff, and schedule for monitoring cave-roosting bats in CUPN parks.

Task	Staff	Timing
Acquire the appropriate permits (i.e., NPS, FWS).	Project Leader	November
Prepare, repair, or purchase supplies and equipment (using an inventory/inspection file) for winter and summer sampling.	Project Leader/Field Crew Leader	November–December
Establish and refine annual and seasonal budgets.	Project Leader/Network Program Manager (NPM)	October–January
Assure final electronic data sets from previous sampling year are archived and backed-up following NPS guidelines. Post public data set and annual reports to IRMA.	Data Manager/Physical Scientist	December
Assure archives from previous sampling year are processed as per NPS guidelines.	Curatorial Specialist	December
Finalize winter sampling dates for field crews.	Project Leader/Field Crew Leader	December
Reserve in-park housing for winter sampling field crews (if available).	Project Leader/Field Crew Leader	December
Prepare field data forms/notebooks, Field Information Sheets, Cave Section Maps, and equipment/gear (using an inventory/inspection file) for winter sampling. Check for updates to emergency numbers list for each park and print copies along with directions to hospitals.	Project Leader/Field Crew Leader	December
Coordinate directly with park resource managers when conducting winter field sampling (email at least two weeks in advance to confirm field work dates to arrange for logistical support [e.g., in-park lodging, keys, unlocking gates]).	Project Leader/Field Crew Leader	December–February
Collect and upload air temperature and RH data from automated HOBO loggers to network server and rename data files.	Project Leader/Physical Scientist/Field Crew Leader	Mid November–mid March
Upload cave location and parking location coordinates into CUPN GPS unit(s). Print maps, if necessary.	GIS Specialist	December
Arrange and conduct field crew training for winter sampling (if new crew members) or refresher for experienced crew members absent from field sampling for a substantial length of time. Distribute field sampling and safety SOPs to field crew at least one week beforehand.	Project Leader/Field Crew Leader	January
Email trip plan to park contacts at least two weeks in advance of field work.	Project Leader/Field Crew Leader	January–February
Participate in winter field sampling and oversee field crew during field season, providing logistic and administrative support as directed by Project Leader.	Project Leader/Field Crew Leader/Field Crew Member	January 1–Feb. 28

Task	Staff	Timing
Scan, name, and update Cave Section Maps after each winter field sampling trip. Decontaminate field data forms. Download, sort, and rename photo files from cameras.	Field Crew Leader/Field Crew Member	January–Mid March
Submit brief winter sampling Trip Reports to park contacts within two weeks after each trip.	Project Leader/Field Crew Leader	January–Mid March
Ensure sampling work meets quality standards.	Project Leader/Field Crew Leader	Ongoing
Ensure sampling work is done in a way that addresses safety hazards, disturbance to bats, and transmission of WNS.	Project Leader/Field Crew Leader	Ongoing
Ensure effective communication between park staff, field crew, and other CUPN staff.	Project Leader/Field Crew Leader	Ongoing
Submit Investigators Annual Reports to permit reporting system summarizing the previous year's activities for each active permit.	Project Leader	March
Conduct analysis of winter bat cluster photos.	Project Leader/Field Crew Leader/ Crew Member/Data Intern	February–April
After post-processing is complete, enter all winter sampling data and HOBO data from hardcopy forms into working database.	Field Crew Leader/Crew Member/Data Intern	March–May
Conduct Operational Review of winter bat sampling.	Project Leader/Field Crew Leader/Crew Members	March-May
Upload HOBO air temp/RH data files to Aquarius and process/assess completeness/DQ flag/validate data.	Physical Scientist	March-September
Conduct data verification on 100% of forms once data are entered into database.	Data Manager/Crew Members/ Data Intern	April–May
Complete all validation/DQ flagging/DPL steps for winter data. At minimum, this should be completed before summer sampling begins.	Project Leader	April–May
Scan/name field data forms.	Data Intern/Crew Member	April-May
Finalize summer sampling dates for field crews.	Project Leader/Field Crew Leader	April
Reserve in-park housing for summer sampling field crews (if available).	Project Leader/Field Crew Leader	April
Prepare field data forms, Field Information Sheets, supplies, and equipment (using an inventory/inspection file; including all external hard drives) for summer sampling. Place updated Field Information Sheet, travel route map, and cave entrance photo(s) for each scheduled cave on external hard drive where videos are stored.	Project Leader/Field Crew Leader	April

Task	Staff	Timing
Coordinate directly with park personnel when conducting summer field sampling (email at least two weeks in advance to confirm field work dates and to arrange logistical support [e.g., in-park lodging, keys, unlocking gates]).	Project Leader/Field Crew Leader	April–June
Upload summer cave location and parking location coordinates into CUPN GPS unit(s). Print maps, if necessary.	GIS Specialist	Early May
Arrange and conduct field crew training for summer sampling (if new crew members or refresher for experienced crew members absent from field sampling for a substantial length of time). Distribute field sampling and safety SOPs to field crew at least one week beforehand.	Project Leader/Field Crew Leader	May–June
Email trip plan to park contacts at least two weeks in advance of field work.	Project Leader/Field Crew Leader	May–July
Participate in summer field sampling and oversee field crew during field season, providing logistic and administrative support as directed by Project Leader.	Project Leader/Field Crew Leader/Field Crew Members	May–July
Decontaminate field data forms after each summer field sampling trip (if necessary). Download, sort, and rename photo and video files from cameras.	Field Crew Leader/Field Crew Member/Data Intern	May–July
If necessary, update monitoring protocol documents after writing final Operational Review of winter bat sampling and submit to regional program manager.	Project Leader	July
Submit brief summer sampling Trip Reports to park contacts within two weeks after each trip.	Project Leader/Field Crew Leader	Late May–Mid August
Conduct analysis of bat emergence video footage.	Project Leader/Crew Members/Data Intern	May–October
After post-processing is complete, enter all summer sampling data from hardcopy forms into working database.	Crew Member/Data Intern	June–October
Inventory the condition of all equipment and prepare a list of required repairs/replacements.	Project Leader/Field Crew Leader	August
Submit the volunteer total hours worked on each park to CUPN (and each park's) Volunteer Coordinator.	Project Leader/Field Crew Leader	July–September
Conduct Operational Review of summer bat sampling.	Project Leader/Field Crew Leader/Crew Members	September–October
Conduct data verification on 100% of forms once data from hardcopy forms are entered into database	Data Manager Crew Members/Data intern	October
Conduct data validation/DQ flagging/DPL steps for summer data.	Project Leader	October
Scan/name field data forms.	Data Intern/Crew Member	October

Task	Staff	Timing
Data analysis and report writing.	Project Leader/Physical Scientist/Data Manager/Quantitative Ecologist	October-December
If necessary, update monitoring protocol documents after writing final Operational Review of summer bat sampling and submit to regional program manager.	Project Leader	November

Pre-departure Preparation

1. File trip plan with CUPN contact and the park contact two weeks ahead (Figure 3).
2. Obtain proper approval signature on cave entrance request form for each cave to be entered that day (if required by park). Give copy to surface contact person.
3. Obtain keys to vehicle(s), cave gates/doors, and road gates in advance.
4. For each sampling site, determine whether the field crew will survey the entire cave together, or if the team will split and survey sections or entrances separately.
5. For each cave/entrance that will be monitored that day, obtain previously-printed field data form(s) or obtain a pre-printed notebook (multiple copies of each, if splitting by sections).
6. Print a Field Information Sheet (Figure 1 or Appendix E in a Supplemental Materials package available on the Cumberland Piedmont Network internal server, or by request to the network) and applicable Cave Section Map (Figure 2) for the cave(s). Study the information sheet(s) to become familiar with the caves and determine if any special equipment is needed for the recommended sampling method. For summer sampling, plan to arrive at the cave entrance **no later than** 19:00 hours (7:00 p.m.) at Mammoth Cave National Park and Russell Cave National Monument (central time zone) for setup and by 20:00 hours (8:00 p.m.) at Chickamauga and Chattanooga National Military Park and Cumberland Gap National Historical Park (eastern time zone). The count will start **exactly** (to the second) 45 minutes later.
7. Assemble all caving gear and sampling supplies/equipment. Complete and sign/date a copy of the appropriate checklist (Table 7 for summer sampling, Tables 8 and 9 for winter bat and cave meteorological sampling, and Table 10 for cave meteorological sampling at summer bat roosts conducted during winter field trips).

8. For summer bat sampling, synchronize (to the nearest second) the internal clock of the NV video camera with the watch or time mechanism (e.g., smartphone or cell phone; remember—reception may be limited at cave entrances) that will be used to determine the count start and end times. The TIR video cameras currently used by the Cumberland Piedmont Network do not have an internal clock to record the time on the video file like the NV video camera does.
9. All field crew members will review (and sign/date—if not previously done that field season) the JHA (Table 5) and follow proper backcountry field work and safety procedures.
10. Establish surface contact person, what time to expect the crew to return (or call-in), and whom/when to notify (i.e., the response lead) in the event the crew does not return (or call-in) on time after attempting to contact the crew. Give the contact person a copy of the detailed trip plan, Field Information Sheet, travel route maps (surface and subsurface) for each cave to be visited, as well as a list of all crew members and emergency contact phone numbers.
11. Sign out field crew with destination, vehicle(s), surface contact person, and approximate return time on park/office message board (if required by park).
12. Project leader or designated field crew leader conducts pre-field sampling briefing for crew member(s) to cover such things as the sampling plan, any potential safety hazards/concerns (e.g., weather, check-in time, particular hazards expected), and to gage how the crew is doing (SOP 1 *Training Sampling Crew*—Version 1.2 [CUPN 2023e]).

Supplies and Equipment

Below is a summary of sources for checklists of required equipment and supplies for monitoring:

1. Summer cave-roosting bats (Table 7).
2. Winter cave-roosting bats and cave meteorological parameters at winter bat roosts (Tables 8 and 9).
3. Cave meteorological parameters at summer bat roosts (Table 10).

Equipment should be organized and maintained in good working condition. The checklists provided below should be printed out and used to assemble caving gear and sampling supplies/equipment and calibrate all necessary equipment prior to departure for each sampling event. The project leader or field crew leader should sign and date a copy of the supplies and equipment checklist (Table 7, Table 8, or Table 10) used before each sampling event.

Table 7. Supplies/equipment checklist for monitoring summer cave-roosting bats in the Cumberland Piedmont Network.

Check Box	No. of Items Needed	Summer Cave Roost Monitoring Supplies/Equipment Checklist for 1 Field Sampling Crew (at 1 cave entrance)
☐	1	Pre-printed data form or notebook on Rite-in-the-rain paper (Figure 1, SOP 3 [CUPN 2023a])
☐	1	Pre-printed Field Information Sheet for cave to be visited (on Rite-in-the-rain paper)
☐	1	Copies of NPS, USFWS, and state permits (if required)
☐	1	Clipboard with storage compartment
☐	1	Digital camera, battery, memory card (for optional photos of site or setup)
☐	1–4	Folding chair (<i>optional</i> ; 1 per crew member)
☐	2	Digital thermometer, temperature probe, thermo-hygrometer, or Kestrel (includes backup)
☐	≥ 1	Infrared (IR) illuminator kit (2 illuminators, cords, connectors, mounting bar, 5Ah 12v rechargeable battery, 2 spare 3A fuses) or IR Pelican™ light (quantity is site dependent)
☐	2	Night vision goggles (backup pair of goggles; four AA batteries total)
☐	1	Thermal IR video camera system, memory card (with at least 3GB of space available)
☐	1	Digital night vision video camera synchronized to smartphone or watch to be used during the count, memory card (with at least 14GB of space available)
☐	≥ 2	Tripod (quantity is site dependent)
☐	2–4	Handheld tally counter (“clicker”)
☐	2	Mechanical pencil and black ultra-fine point permanent marker (“sharpie”)
☐	1	Equipment bag or backpack (Waterproof, as necessary)
☐	1	Magnetic compass
☐	1	Smartphone, watch or time mechanism synchronized to the NV video camera’s clock to the second; smartphone application (auto-chimes every 5 mins.) or count-down timer device
☐	?	Extra batteries for all battery-operated equipment (i.e., one digital camera battery, six AA cells, one 9-volt battery, rechargeable batteries for 2 video cameras and IR lights)
☐	1	GPS unit with all cave entrance waypoints and parking locations pre-loaded (two AA batteries)
☐	1	Water bottle and food (as necessary)
☐	1	Small cooler with water and/or sports drinks (or packets of electrolyte powder) for the crew
☐	1	Headlamp

Check Box	No. of Items Needed	<i>Summer Cave Roost Monitoring</i> Supplies/Equipment Checklist for 1 Field Sampling Crew (at 1 cave entrance)
☐	1	Backup headlamp or handheld flashlight for back up light source
☐	≥ 25	Small reflectors with tacks (e.g., “Bright Eyes”, “Fire Tacks”) for nighttime navigation
☐	1	First Aid kit. Printed copy of directions to nearest hospitals and emergency numbers
☐	2	Two-way radio, cell phone (with weather radar and lightning tracker applications), or satellite communicator
☐	1	Disinfectant wipes (transfer several to zip-lock bag for ease of transport) and spray bottle of isopropyl alcohol
☐	1	Golf umbrella & stake with tape for securing umbrella (cover cameras during rain)
☐	1	Insect/tick repellent and poison ivy treatment (as necessary)

Crew Leader's Signature/Date _____

Table 8. Supplies/equipment checklist for monitoring winter cave-roosting bats and cave meteorological monitoring in CUPN parks.

Check Box	No. of Items Needed	<i>Winter Cave Roost Monitoring and Cave Meteorological Monitoring</i> Supplies/Equipment Checklist for 1 Field Sampling Crew
☐	?	Pre-printed data forms (1 for each cave section for bat roost counts, and 1 for each HOBO data logger location) or notebooks on Rite-in-the-rain™ paper (see Field Information Sheet for cave to be visited to determine quantity needed)
☐	1	Pre-printed Field Information Sheet and Cave Section Map for cave to be visited on Rite-in-the-rain paper
☐	1	Copies of NPS, USFWS, and state permits
☐	1	Clipboard with storage compartment
☐	1-2	Digital camera with zoom lens, Pelican™ case, battery, 2 memory cards, flash assembly (quantity and type of camera are site dependent)
☐	2	Laser pointer
☐	2	Laser thermometer (calibrated) (includes a backup unit)
☐	2	Calibrated digital thermometer, temperature probe, thermo-hygrometer, or Kestrel (includes a backup unit)
☐	1-4	Pre-launched HOBO Pro v2 data loggers as replacements (quantity is site dependent)
☐	2	Recently re-launched (done in office in order to update the shuttle's date and time to a computer that is set to local standard time—remember to adjust computer clock to eastern standard time for CHCH and CUGA) HOBO data shuttle for offloading temp/RH data from data loggers (1 shuttle each for Pro H8 and Pro v2 models—Note: they are different shuttle types)
☐	1	Block of modeling clay for use as a barrier between cave surface and loggers
☐	1	Small clean rag or piece of cloth for cleaning HOBO data loggers
☐	1	Silicone grease for lubricating o-rings on HOBO data loggers
☐	1	Coil of wire for hanging data loggers on cave wall or ceiling
☐	1	Wire cutters for cutting wire used to hang data loggers (<i>optional</i> —needed if wire cannot be cut by hand using a repeated back-and-forth motion)
☐	1	Binoculars or spotting scope
☐	≥ 1	Spotlight (quantity is site dependent)
☐	1	Hand lens or magnifying glass (to read band numbers, etc.)
☐	1	Black ultra-fine point permanent marker (“sharpie”)

Check Box	No. of Items Needed	Winter Cave Roost Monitoring and Cave Meteorological Monitoring Supplies/Equipment Checklist for 1 Field Sampling Crew
☐	2	Mechanical pencil
☐	1	Equipment bag (Waterproof, as necessary)
☐	1	Magnetic compass
☐	1	Telescoping or PVC pole ($\geq 2\text{m}$) with plastic cup taped to end (to capture banded bats)
☐	1	Watch
☐	1	50m measuring tape (<i>optional</i>)
☐	1	Laser range finder or Disto
☐	?	Extra batteries for all battery-operated equipment (i.e., one battery per digital camera, ten AA cells, one 9-volt battery, HOBO temp/RH data logger batteries—refer to Field Information Sheet for number of HOBO locations, two HOBO shuttle batteries)
☐	1	GPS unit with all cave entrance waypoints and parking locations pre-loaded (two AA batteries)
☐	1	First Aid kit. Printed copy of directions to nearest hospitals and emergency numbers
☐	2	Two-way radio, cell phone, or satellite communicator
☐	1	Disinfectant wipes (transfer several to zip-lock bag for ease of transport) and spray bottle of isopropyl alcohol
☐	4	Large plastic garbage bags (contaminated clothing/gear storage)
☐	1	Small roll of duct tape for miscellaneous repairs

Crew Leader's Signature/Date _____

Table 9. Individually assigned supply/equipment checklist for a day in the field monitoring winter cave-roosting bats or attending to cave meteorological monitoring equipment in CUPN parks.

Check Box	No. of Items Needed	<i>Winter Cave Roost Monitoring or Cave Meteorological Monitoring</i> Individually Assigned Supplies/Equipment Checklist for 1 Crew Member
☐	1	Helmet (UIAA or CE certified) with mounted light source with charged batteries
☐	1	Pair knee pads (<i>optional</i>)
☐	1	Pair elbow pads (<i>optional</i>)
☐	1	Pair hiking boots or rubber “muck boots” with sturdy soles
☐	1	Water bottle and lunch (as necessary)
☐	1	Extra quick-energy food supply
☐	1	Pair work gloves or disposable rubber gloves (as necessary)
☐	1	Backup headlamp with charged batteries
☐	1	Handheld flashlight for additional backup light source with charged batteries
☐	?	Extra batteries (appropriate cell size as needed) for all personal battery operated equipment
☐	1	Sufficiently warm, quiet (avoid “swishy”), and rugged caving clothing
☐	1	Extra caving clothing (jacket, balaclava)
☐	1	Coveralls or change of clothes (including footwear)
☐	1	DuPont Proshield (or similar) disposable coveralls with hood and elastic bands (<i>optional</i>)
☐	1	Caving pack
☐	2	Chemical heat pack
☐	1	≥ 50 ft of 1-inch tubular webbing (for hand line; site dependent)
☐	1	Empty bottle for liquid human waste (site dependent)
☐	1	Vertical caving gear including rope (site dependent)

Crew Leader’s Signature/Date _____

Table 10. Supplies/equipment checklist for deploying/data collecting/replacing/removing cave meteorological monitoring equipment in summer bat caves during the winter in CUPN parks.

Check Box	No. of Items Needed	<i>Cave Meteorological Monitoring (at summer bat roost caves)</i> Supplies/Equipment Checklist for 1 Field Sampling Crew
☐	?	Pre-printed data forms (1 for each HOBO data logger location) or notebook on Rite-in-the-rain paper (see Field Information Sheet for cave to be visited to determine quantity needed)
☐	1	Pre-printed Field Information Sheet and Cave Section Map for cave to be visited on Rite-in-the-rain™ paper
☐	1	Copies of NPS, USFWS, and state permits
☐	1	Clipboard with storage compartment
☐	1	Digital camera with zoom lens, protective case, battery, 2 memory cards, flash assembly (type of camera is site dependent)
☐	1-4	Pre-launched HOBO Pro v2 data loggers as replacements (quantity is site dependent)
☐	2	Recently re-launched (done in office in order to update the shuttle's date and time to a computer that is set to local standard time—remember to adjust computer clock to eastern standard time for CHCH and CUGA) HOBO data shuttle for offloading temp/RH data from data loggers (1 shuttle each for Pro H8 and Pro v2 models—Note: they are different shuttle types)
☐	1	Block of modeling clay for use as a barrier between cave surface and loggers
☐	1	Small clean rag or piece of cloth for cleaning HOBO data loggers
☐	1	Silicone grease for lubricating o-rings on HOBO data loggers
☐	1	Coil of wire for hanging data loggers on cave wall or ceiling.
☐	1	Wire cutters for cutting wire used to hang data loggers (<i>optional</i> —needed if wire cannot be cut by hand using a repeated back-and-forth motion)
☐	1	Binoculars
☐	1	Hand lens or magnifying glass (to read band numbers, if encountered)
☐	1	Black ultra-fine point permanent marker ("sharpie")
☐	2	Mechanical pencil
☐	1	Equipment bag (waterproof, as necessary)

Check Box	No. of Items Needed	Cave Meteorological Monitoring (at summer bat roost caves) Supplies/Equipment Checklist for 1 Field Sampling Crew
☐	1	Magnetic compass
☐	1	50 meter (164 ft) measuring tape (<i>optional</i>)
☐	1	Laser range finder or Disto
☐	1	Watch
☐	?	Extra batteries for all battery operated equipment (i.e., one digital camera battery, six AA cells, one 9 volt battery, HOBO temp/RH data logger batteries—refer to Field Information Sheet for number of HOBO locations, two HOBO shuttle batteries)
☐	1	GPS unit with all cave entrance waypoints and parking locations pre-loaded (two AA batteries)
☐	1	First Aid kit. Printed copy of directions to nearest hospitals and emergency numbers
☐	2	Two-way radio, cell phone, or satellite communicator
☐	1	Disinfectant wipes (transfer several to zip-lock bag for ease of transport) and spray bottle of isopropyl alcohol
☐	4	Large plastic garbage bags (contaminated clothing/gear storage)
☐	1	Small roll of duct tape for miscellaneous repairs

Crew Leader's Signature/Date _____

Literature Cited

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