

Cumberland Piedmont Network

National Park Service
Inventory and Monitoring Division



Standard Operating Procedure 3

Summer Cave Roost Sampling—Version 2.3

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Summary

This standard operating procedure (SOP) provides direction on conducting summer sampling focused on counting several species of bats which roost in caves. These counts are used to assess abundance and infer population trends of bats among sampled caves. Multiple visit and multiple observer methods will be employed to collect summer bat data—this will allow the use of hierarchical models and estimation of detectability. The methods in this SOP focus on annual and four-year rotating nocturnal bat emergence counts conducted by observers or video imagery equipment stationed outside a cave entrance(s). Monitoring procedures were compiled from various published and unpublished sources (see Overview).

This SOP gives step-by-step instructions that field crew leaders and crew members should follow to conduct summer cave roost sampling at four parks 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 <u>and</u> multiple observer methods for summer bat data collection in order to use a multiple-measures (hierarchical modeling) analytical approach.	In response to external peer review comments. Minor edits also made following external peer review and during database development.	2.0
April 2016	Steven Thomas	Minor edits made to field data form and instructions for filling out the form.	To record SOP version # used and name of person counting bats for each specific method.	2.1
April 2020	Steven Thomas	Minor edits—multiple throughout document.	Minor edits made following 2019 annual review of protocol	2.2
June 2021	Steven Thomas	Emphasize that data recorder does not assist with bat counting, and observers do not assist each other (step 19). Encourage consistent start times for cameras (step 22)	Minor edits made following 2020 annual review of protocol	2.3

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Overview

This SOP provides direction on conducting summer sampling focused on counting several species of bats which roost in caves. These counts are used to assess abundance and infer population trends of bats among sampled caves. Multiple visits (at least two per sampling window) and multiple observer methods (two or more independent observers or two or more independent methods) will be employed to collect summer bat (“multiple-measures”) data—this will allow the use of hierarchical models and estimation of detectability. The methods in this SOP focus on annual and four-year rotating nocturnal bat emergence counts conducted by one or more observer or video imagery equipment stationed outside a cave entrance(s). Monitoring procedures were compiled from various published and unpublished sources. In particular, a dual agency draft guidance document for the state of Kentucky (USFWS 2009), an SOP from Lava Beds National Monument (Smith 2011), and a chapter on colony counts from a program plan for the North American Bat Population Monitoring Program (Loeb et al. 2015) were borrowed from greatly.

The relationship between cave meteorological data (i.e., temperature and relative humidity) and summer cave bat abundance estimates will be explored via additive modeling. Automated data loggers will be used to continuously collect cave air temperature (temp) and relative humidity (RH) measurements following methods described in Woodman et al. (2011). These HOBO 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 to minimize disturbance to bats. Therefore, regular summer cave roost sampling will not require the field crew to enter caves, other than a few cave entrance areas. More information about measuring temp and RH using automated data loggers is provided in SOP 5 *Cave Meteorological Sampling*—Version 1.2 (CUPN 2023a).

This SOP gives step-by-step instructions that field crew leaders and crew members should follow to conduct summer cave roost sampling at four parks in the Cumberland Piedmont Network (CUPN). These parks include Chickamauga and Chattanooga National Military Park (CHCH), Cumberland Gap National Historical Park (CUGA), Mammoth Cave National Park (MACA), and Russell Cave National Monument (RUCA).

Step by Step Instructions

Non-intrusive methods will be used for enumeration of bats as they exit caves in the evening. These include: (1) direct or manual emergence counts [with the aid of night vision (NV) goggles (or scopes) and external infrared (IR) illuminators as additional light sources or a thermal infrared (TIR) scope]; and (2) passive or automated emergence counts [with use of a near IR night vision high-definition digital video camera with external IR illuminators and a TIR video camera system]. It is important to minimize the differences in the number/type of methods and specific observers used for each sampling event at a cave entrance—both within- and between-sampling years. This is done to minimize intra- and inter-annual variation because changes in co-variables, such as observer and method, affect detection probability and require more data to accommodate through analytical modeling. The required bat counting methods, recommended number of observers, equipment

arrangement, and observer placement, along with bat demographic information (e.g., species) and roost status (e.g., maternity, bachelor, transient), are provided in the Field Information Sheet (see template in Figure 1 in SOP 2 *Pre-field Sampling and Safety*—Version 1.3 [CUPN 2023b] or example in Appendix E of a Supplemental Materials Package available on the CUPN internal server, or by request to the network) for each cave scheduled for summer monitoring. Bat demographic information and roost status will be periodically assessed via internal surveys or external surveys (e.g., harp trapping, acoustic sampling) to determine if a substantial change has taken place since the Field Information Sheet was last updated. Assessments of bat demographics or roost status will follow methods described in Kunz et al. (2009), and could be triggered by events such as: (1) a request from park staff, (2) a sharp increase in the number of bats counted in a short period (e.g., the count at a cave goes from 2 to 200 bats between sampling events), (3) acoustic sampling indicates a new bat species may be using a cave, (4) an incidental observation (e.g., a non-volant bat seen outside a presumed bachelor cave), or (5) a research finding [e.g., using radio telemetry, researchers track a species (or sex) of bat not previously known to use a particular cave]. Below is a sequential list of major tasks the field crew will complete during each *sampling event* [i.e., one cave entrance counted on one evening].

1. Project leader or designated field crew leader will file a trip plan with a CUPN contact (i.e., someone in the office during the trip) and the park (Figure 3 in SOP 2 *Pre-field Sampling and Safety*—Version 1.3 [CUPN 2023b]) before the trip.
2. Project leader or designated field crew leader will establish a surface contact person (“surface watch”), 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. The contact person will be given a copy of the detailed trip plan, the Field Information Sheet(s), travel route map(s), and a list of all team members and emergency contact phone numbers. The contact person will also be instructed to monitor weather channels/radar for approaching severe weather and to alert the field crew with adequate time to take safe action.
3. Project leader or designated field crew leader will conduct a 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 gauge how the crew is doing (SOP 1 *Training Sampling Crew*—Version 1.2 [CUPN 2023c]).
4. Before leaving office, field crew leader should review the Field Information Sheet and supplies/equipment checklist (Table 7 in SOP 2 [CUPN 2023b]) to help alleviate any confusion in the field.
5. If necessary, use the GPS unit and field map included with the Field Information Sheet to navigate to the entrance of the cave to be sampled. Consider placing small reflectors on cave-side of trees using tacks (e.g., “bright eyes”, “Fire Tacks”) in appropriate places along route to aid return navigation. Plan to arrive at the cave entrance **no later than** 19:00 hours (7:00 p.m.) at Mammoth Cave National Park (MACA) and Russell Cave National Monument

(RUCA; central time zone) for setup and by 20:00 hours (8:00 p.m.) at Chickamauga and Chattanooga National Military Park (CHCH) and Cumberland Gap National Historical Park (CUGA; eastern time zone). The count will start **exactly** (to the second) 45 minutes later.

6. Note the time of arrival at the cave entrance and the data recorder completes the fields from “PARK CODE” through “INTERVAL DURATION” on the Summer Bat Emergence Monitoring Data Form. List the name of the Field Crew Leader (i.e., the field person responsible for all data collected at the entrance during the sampling event) first on the OBSERVERS NAME(S) line.
7. Indicate whether any evidence of recent human disturbance is seen at the cave entrance area.
8. Record meteorological conditions at the start (e.g., sky/weather, wind, temperature), as well as the method used to obtain the temperature (i.e., digital thermometer, laser thermometer on paper, mercury thermometer, nearby weather station, smartphone, or weather radio). *Note:* a count will not be conducted during fog or rain that does not stop within 30 minutes or continues intermittently during the sampling period.
9. Circle the type of methods used to count the bats recorded on the data form. Circle only one type of method for “Method 1” and one type for “Method 2.” If more than two methods are used at a **single cave entrance**, then record “Method 3” followed by the type of method **and** video camera recording start time (hhmmss) in the COMMENTS field—**this is extremely important if the method is TIR**. Record the name of the person counting bats if “NV goggles” is circled for the method (i.e., the first/last name of the person actually using the goggles). If two or more persons are independently counting bats at the same entrance, then each person **MUST** use a separate field data form without discussion (i.e., as if they were alone) (see step 18). If NV video or TIR is circled, then the person who later counts bats in the office using a computer (i.e., digital video analysis) will record their name on the data form. Record the camera recording “Start Time (hhmmss)” if method circled is NV video or TIR; leave blank if method circled is NV goggles.
10. Refer to the Field Information Sheet for a description or sketch of the recommended placement of equipment and observer(s). There will be at least one field crew member counting bats at each entrance, unless, for efficiency, two or more passive sampling methods (e.g., NV video, TIR) are used while the observer(s) count bats at another cave entrance(s).
11. The placement of the individual(s) counting will vary by entrance configuration, but in most cases the best field of view is achieved by either sitting at a 45° angle to the path the bats are expected to fly or in the center of the entrance and at least 2 meters (6.6 feet [ft]) away so as not to impede the flight path. The observer(s) should have an unobstructed view of the entire entrance(s).
12. If possible, position the field data recorder away from the view of the observer so their light does not affect the observer’s view of the bats.

13. The number and placement of external IR lights will vary depending on the size and configuration of the cave entrance and sampling method. Normally, use from one to four IR lights per entrance. Typically one light is placed on each side of the entrance aiming towards the opposite side, with one covering the top portion and the other covering the bottom of the entrance. If helpful, a third light can be aimed directly into the cave to permit an early view of bats before they emerge. It is possible to over-expose an entrance with too many lights—this makes bats difficult to see. Initial placement (before dark) of the lights can be accomplished with the help of another crew member and a handheld flashlight or laser pointer. After dark or after bats begin emerging, lights may need additional adjusting to reduce shadows. If possible, consider having another crew member adjust some IR lights during interval #7 to maximize NV goggle visibility and NV video quality/clarity toward the end of the count (as it gets darker).
14. The placement of a NV video camera and external IR lights will vary by entrance configuration, but in most cases the best field of view is achieved by placing the camera mounted to a tripod 5 to 10 meters (16.4 to 32.8 ft) from the cave entrance. The camera should be positioned so that emerging bats either fly perpendicular to or directly towards the camera's field of view. The field of view must encompass all emerging bats. Two external IR lights may be mounted on the light bar on either side of the camera (also attached to the bar) and the bar mounted to a tripod. Additional external IR lights may be placed/aimed at opposite sides of the cave entrance to eliminate shadows as much as possible.
15. A TIR video camera does not require (and is not adversely affected by) the use of external IR lights. The TIR camera should be mounted on a tripod and must be placed near to the NV video camera, when present, so the two cameras will have similar fields of view (to serve as independent double-counts).
16. The NV or TIR video cameras will record the bat emergence while the observer(s) conduct the direct count (e.g., with NV goggles), or at least two cameras will be started and left unattended while the observer(s) counts bats at another cave entrance(s). If passive (i.e., video cameras) and direct counts are conducted simultaneously **at an entrance** then: (a) the field of view **MUST** be similar for **all** sampling methods (for independent double-sampling purposes); (b) **all** data must be recorded on **one data form** in the field; (c) it is essential that the NV or TIR video camera(s) start recording either a few minutes before or at the exact (to the nearest second) time as the direct count (i.e., NV goggles) starts in the field—not after; (d) it is crucial that the internal clock of the NV video camera is synchronized (**to the nearest second**) with the watch or time mechanism (e.g., smartphone or cell phone) used to determine the count start and end times; (e) it is extremely important to record the time the video camera(s) started recording, to the nearest second, in the “TIR/Video Recording Start Time” field on the data form for each camera method—**especially for the TIR camera** (because the TIR video cameras currently used by CUPN do **not** have an internal clock to record the time on the video file like the NV video camera does); (f) it is important to record the **TIME COUNT STARTED** to the nearest second on the field data form to indicate when

the observer(s) started the direct count [so the **exact** start time of the first 5-minute time interval can be synchronized among the direct count(s) done in the field and video counts done in the office], and; (g) the NV or TIR video camera(s) must stop recording **after** the direct count(s) has ended and the Time Count Ended to the nearest second has been recorded on the field data form. If the NV or TIR video cameras are unattended, then recording may start at any time before the scheduled direct count start time, providing memory and battery life are sufficient to record the entire emergence count. Recording will stop when the observer returns to retrieve the cameras. *Note:* the TIR video cameras currently used by the Cumberland Piedmont Network will not properly save video files longer than approximately 1.5 hours in length.

17. When monitoring at a cave with more than one entrance used by bats, a **separate field data form** will be filled-out (entirely) for each entrance being monitored simultaneously. It is vital that each direct count at each entrance **starts at exactly the same (scheduled) time** (to the nearest second). This will enable the **exact** start time of the first 5-minute time interval to be synchronized among the direct count(s) done in the field and video counts done in the office for all the entrances to the cave. If any for any reason a direct count starts late, it **must** start at the **beginning** of the earliest interval possible (see example in step 24). Ensuring synchrony of start times will be important to the subsequent data analysis process. Count data from the two or more simultaneous events (at two or more entrances) will be combined via a query for the entire cave during analysis. Meteorological data (e.g., temperature, sky/weather conditions) do not need to be obtained independently for each entrance to the same cave if those entrances are within close proximity to each other (≤ 500 meters or $\leq 1,640$ ft apart). The name of the particular entrance **must** be recorded on each data form after “ENTRANCE NAME.” The name of the field crew leader (i.e., the person responsible for the data collected at that entrance) **must** be listed first on the “OBSERVERS NAME(S)” line, and the completed forms will be reviewed and submitted to the project leader as described in SOP 6 *Post-field Sampling*—Version 2.2 (CUPN 2023d). Follow procedures in step 13 for passive counts.
18. If two or more observers are conducting independent counts at the same entrance simultaneously (e.g., for multiple-measures for hierarchical modeling, to determine detectability, for QA/QC purposes), then each person **MUST** use a **separate field data form without discussion** (i.e., as if they were alone) to record direct bat count data, however all other data (**except** PARK CODE, CAVE NAME, ENTRANCE NAME, DATE, and Name of Person Counting Bats) must be recorded on **only one** of the field data forms (use either observer’s form for this). These field data forms will be entered into the database as separate methods within the same sampling event. It is crucial that each direct count **start at exactly the same (scheduled) time** (to the nearest second). This will enable the **exact** start time of the first 5-minute time interval to be synchronized among the direct counts done in the field and video counts done in the office. Follow procedures in step 13 for passive counting methods.

19. Generally, one crew member serves as the counter and is supported by a data recorder/time keeper for each entrance being counted. The data recorder/timekeeper must **never** directly assist the counter with counting bats. Depending on field crew size available, other arrangements are acceptable at certain locations (consult Field Information Sheet). For example, one crew member can count and record bats exiting and entering a cave with a single entrance from which relatively few (< 500) bats typically emerge. Alternatively, two crew members can count—one person **only** counts exiting bats the other only counts entering bats, without assisting each other. In this situation, the crew member counting the (relatively) few bats **entering** the cave should also serve as the data recorder/time keeper using a single field data form.
20. It is important for the field crew to establish roles in advance and maintain good communication to ensure accurate counting. Using clear, agreed upon hand signals is helpful. Eliminate distractions among crew members. Talking should occur only when absolutely necessary and then use a low voice. Use as low light (or red light) as possible for data recording/time keeping and turn auxiliary lights off when not in use.
21. It is anticipated each observer will use third generation NV goggles or scopes and one or two handheld tally counters (“clicker”) for counting bats directly (manually). One clicker may be used to count exiting bats and the other for bats entering the cave.
22. Observer(s) will be at their assigned place and ready to begin at least 5 minutes before the scheduled start of the direct count. An observer or team member will start recording the NV or TIR video camera(s) either a few minutes before or at the exact (to the nearest second) time as the direct count starts in the field. It will help simplify video analysis if the camera recording is started on the minute or 5-minute (e.g., starting at exactly 19:44:00 or 19:40:00 instead of at 19:44:25). Record the time the video camera(s) started recording, to the nearest second, in the “TIR/Video Recording Start Time” field on the data form for each camera method used—**especially for the TIR video camera** (because it lacks an internal clock).
23. Start the interval timer (e.g., smartphone application [auto-chimes every 5 minutes], countdown timer, watch) and the direct count at **exactly** (to the second) **19:45:00** (7:45:00 p.m.) at Mammoth Cave National Park (MACA) and Russell Cave National Monument (RUCa; central time zone) and **20:45:00** (8:45:00 p.m.) at Chickamauga and Chattanooga National Military Park (CHCH) and Cumberland Gap National Historical Park (CUGA; eastern time zone).
24. Record the TIME COUNT STARTED to the nearest second on the field data form. If, for any reason, the count started **after** the scheduled start time (see step 23), then record “NA” on the lines next to the corresponding interval(s) for **both** exiting bats and entering bats for each incomplete interval (i.e., data was collected for less than four minutes out of the 5-minute interval). Start the count at the **beginning** of the earliest interval possible. If for example, due to inclement weather, you were not able to start the NV goggles count at a MACA cave entrance until 19:48:00 (7:48:00 p.m.), then record “NA” on the field data form for interval 1

for both exiting bats and entering bats, start the count at the beginning of interval 2, and record “19:50:00” on the TIME COUNT STARTED line.

25. Record the time, to the nearest minute, when the first bat was seen flying out of the entrance, regardless of whether the bat remained outside or re-entered the cave. This first activity may include a period when bats circle in/out of the cave in what has been called “light-sampling.”
26. Record the time, to the nearest minute, when a bat was first seen exiting but not re-entering the cave entrance. Use a clicker to count this as the first exiting bat. If possible, after each bat exit or entry watch for 3 seconds to make sure the bat either stays out (or in) the cave before counting the bat. If an exiting bat re-enters the cave in less than 3 seconds, then do not count it as either an exit or an entry—vice versa for an entering bat. Any bats that enter the cave before the first exiting bat is counted will be counted as **entering** bats.
27. Continue to count bats as they exit or enter the cave using the two clickers. Alternatively, bat exits and entries can be tallied (e.g., using tick marks in groups of five such as: |||||) by the data recorder on the margin of the data form, depending on rate and amount of emergence. It is not recommended that a running sum of bats be kept in the observer’s head.
28. Count bat exits and entries for the length of the pre-determined sampling interval (5 minutes, unless otherwise specified) recorded in the INTERVAL DURATION field on the data form.
29. When the alarm sounds indicating the end of a sampling interval, record the number of exiting bats counted and the number of entering bats counted on the field data form on the line provided next to the corresponding interval number. This can efficiently and accurately be accomplished by having an extra pair of clickers that have been set to zero by the data recorder during the count. At the sound of the alarm, the data recorder immediately resets and starts the timer (only if necessary, because the preferred timers reset/start automatically) and the observer stops clicking bats, then they exchange one clicker with bat numbers on it for a zeroed clicker. The observer tells the data recorder whether it was the clicker with exiting or entering bats and continues to watch the cave entrance for bats to count during the interval that just started while the data recorder transfers the number from the clicker to the field data form. They exchange the other two clickers as before and the observer continues counting while the data recorder transfers the number from the second clicker. Finally, the data recorder resets the two clickers used during the previous sampling interval to zero, turns off any external light source, and awaits the next alarm. Recording bat numbers for each interval can be accomplished by one trained observer, but it is less efficient, and it is possible that some bats might be missed while the observer briefly looks away to record the numbers and reset the clickers to zero. It is critical to keep each of the sampling intervals the same length of time and not to “drift” away from the equally spaced start time of each time interval. For example, if it takes 3 seconds to stop/reset/restart a watch timer, then after 10 intervals the count will have “drifted” by 30 seconds. This will be avoided in the field by using a smartphone application or count-down timer that automatically resets and restarts when the alarm sounds without any time delay.

30. It is important to record a zero on the line provided next to the corresponding interval number **each** time that no bats are counted exiting or entering the cave. Do not leave any of these lines blank during the entire bat count (i.e., between the first and last intervals sampled). If the direct count is substantially interrupted for some reason (e.g., weather, equipment issues, visitors, potentially hazardous animals), record “NA” on the lines next to the corresponding interval(s) for **both** exiting bats and entering bats for each incomplete interval (i.e., data was collected for less than four minutes out of the 5-minute interval). For example, 14.5 minutes (at 19:59:30 [7:59:30 p.m.]) into the direct count at Mammoth Cave National Park the fuse for the external IR lights blows and everything goes dark. It takes 8 minutes to replace the fuse and prepare to resume counting. On the field data form, record the number of exiting bats and exiting bats from the clickers on the lines next to interval 3 (since bats **were** counted for more than 4 minutes of interval 3, which ended at 20:00:00 [8:00:00 p.m.]), record “NA” on the lines next to intervals 4 and 5 (both of these intervals were not sampled during the light repairs) for both exiting bats and entering bats, record the start and end time and cause of the interruption in the “Comments” field, and resume counting bats at the start of interval 6 (i.e., at 20:10:00 [8:10:00 p.m.]).
31. The data recorder will assist with determining the time when the last bat emerged by writing the time bats emerge on the margin of the data form as the count progresses and the number of exiting bats begins to dwindle. As each bat exits, the data recorder will strike through the earlier time and record the new time and so on until the last bat exits or the count ends. If no data recorder is available to assist, focus on watching the entrance, not on trying to determine the time the last bat emerged—this can later be determined (or corrected) during video analysis. **Note:** as the count progresses, it is possible that the number of entries could exceed the number of exits. That will be accounted for during data analysis.
32. Continue counting and recording bat exits and entries until the alarm sounds at the end of the last time interval that ends the count (**interval 15**, unless otherwise specified). End the count at **exactly** (to the second) **21:00:00** (9:00:00 p.m.) at Mammoth Cave National Park and Russell Cave National Monument (central time zone), and **22:00:00** (10:00:00 p.m.) at Chickamauga and Chattanooga National Military Park and Cumberland Gap National Historical Park (eastern time zone). Stop counting and immediately record the time (to the nearest second) that the alarm sounded in the “TIME COUNT ENDED” field on the data form. Record the bat numbers from the last interval count and stop the timer. If, for any reason, the **count ended before the scheduled end time** (above), then record “NA” on the lines next to the corresponding interval(s) for **both** exiting bats and entering bats for **each** incomplete interval (i.e., data was collected for less than four minutes out of the 5-minute interval) through interval 15, unless otherwise specified.
33. In the “Time Last Bat Emerged” field on the data form, record the time, to the nearest minute, when a bat was last observed flying out of the cave entrance before the count ended.
34. Stop recording with the NV video or TIR camera(s), then power them down.

35. Record meteorological conditions (e.g., sky/weather, wind, temperature) at the end of the count.
36. **Optional step:** The data recorder may sum all the bats recorded **exiting** the cave entrance from start to end of emergence count (i.e., from the first to the last time interval). Record the total number of bats that exited.
37. **Optional step:** The data recorder may sum all the bats recorded **entering** the cave entrance from start to end of emergence count. Record the total number of bats that entered.
38. Record any notes related to the sampling event. Comments may include: evidence of recent human disturbance seen at the cave entrance area; emergence description; unusual bat behavior; backlighting/visibility problems; position of camera; field of view; dead bats; dying bats; bats collected for testing; evidence of recent flooding; instrument problems; interruptions in the count (including the time it started and ended); interesting non-target species or behavior observed (e.g., woodrat, mouse eating crickets).
39. If in the unlikely event a bat mortality or serious injury to a bat occurs, this must be reported to the project leader immediately following completion of the count. All people handling live and freshly dead bats must have up-to-date rabies pre-exposure inoculations and use gloves that will prevent penetration of bites. A freshly dead bat should be double-bagged in two labeled plastic bags for transport to the office where it should be refrigerated while the project leader decides what should be done with it. A mortally injured bat should be euthanized in the field by the project leader. Anyone performing euthanasia must have received NPS training to humanely euthanize bats. Mortality or injury to a federally listed species must be reported to the U. S. Fish and Wildlife Service (USFWS) within five calendar days.
40. Secure all road or cave gates and locks as required.
41. Before leaving the cave entrance, all field data forms will be reviewed by someone (usually the project leader or field crew leader) other than the individual who filled them out, if possible. Review the Field Information Sheet and suggest any changes to be considered by the project leader.
42. Follow all applicable gear decontamination procedures as described in the White-nose Syndrome section of SOP 2 *Pre-field Sampling and Safety*—Version 1.3 (CUPN 2023b).
43. Upon arrival at the vehicle, office or place of lodging, immediately contact the designated surface contact person via cell phone, radio, or satellite communicator.

Passive Bat Counting Methods

Summer populations of cave-roosting bats in the selected CUPN parks will be counted using videography alone or videography in conjunction with direct emergence counts. For multiple observer methods, when direct counts are impracticable (e.g., at caves with large numbers of bats), when it is desirable to capture a permanent record that can be analyzed later (manually by a single observer, independently by two or more observers for QA/QC of the data, or automatically), then one (or both) of two passive video imagery techniques will be used: (1) a digital NV camera (near infrared) with external IR illuminators, or (2) a TIR camera system. In most cases, these methods will be coupled with direct counts. However, at a minimum two methods (direct counts, passive counts, or a combination) will be used simultaneously during **each** sampling event at **each** cave entrance.

The placement of equipment will vary depending on the size and configuration of the cave entrance(s). Regardless of which passive technique is used, the camera should be positioned so that emerging bats fly perpendicular to or directly towards the camera's field of view, and the field of view must encompass all emerging bats (Sabol and Hudson 1995; Kunz et al. 2009). Thermal infrared video imaging also requires a temperature contrast between the bats and a uniform background (Sabol and Hudson 1995; Kunz 2003). However, Melton et al. (2005) developed a TIR technique to detect bats against a thermally non-homogeneous background, and without assumptions of the flight behavior of emerging bats.

For a detailed description of the methodology for using a high-resolution NV camera with external illuminators see Elliott et al. (2006). A comprehensive manual for use of a TIR system is provided by Sabol and Melton (2008). A copy of the appropriate technique manual will be reviewed by the project leader or designated field crew leader prior to each field use of a passive bat counting technique, and a copy of each manual will be included with the corresponding camera equipment in the field as a reference.

Filling in the Field Data Form

A detailed list of descriptions for the Summer Bat Emergence Monitoring Data Form (Figure 1) is provided in Table 1 below.

Office Only: scan made by _____ on ____/____/____ CUPN_Cave_Bats_Summer_Data_Form_20190801
 entered by _____ on ____/____/____ validated by _____ on ____/____/____ Protocol Version #: _____

Summer Bat Emergence Monitoring Data Form Cumberland Piedmont Network

PARK CODE: _____ Data recorder initials _____ Reviewed by: _____

CAVE NAME: _____ ENTRANCE NAME: _____

OBSERVERS NAME(S): _____
[list the Field Crew Leader first] (first name last name, first name last name, ...)

DATE (mm/dd/yyyy): ____/____/____ TIME OF ARRIVAL (hhmm, 24-hr format): _____ local DST

HUMAN DISTURBANCE SEEN AT CAVE ENTRANCE AREA? Yes or No (circle one) (if "Yes" is circled, include details in Comments section below)

SKY/WEATHER CONDITIONS AT START: 0 1 2 4 5 8 (circle one)

WIND CONDITIONS AT START: 0 1 2 3 4 5 (circle one)

Sky/Weather Condition Codes: 0=clear or few clouds; 1=partly cloudy/variable; 2=cloudy/overcast; 4=fog/smoke; 5=drizzle; 8=showers

Wind Speed Codes: 0=smoke rises vertically; 1=wind direction shown by smoke drift; 2=wind felt on face, leaves rustle; 3=leaves, small twigs in constant motion; 4=dust rises, small branches move; 5=small trees in leaf sway

TEMPERATURE AT START: _____°C or °F (circle one) Method Used for Temp: _____

External Infrared Lights Used? Yes or No (circle one)

INTERVAL DURATION: _____ minutes (default = 5 minutes)

TIME COUNT STARTED: _____ (hhmmss) Scheduled Start: 19:45:00 MACA/RUCA
20:45:00 CHCH/CUGA

Time First Bat Emerged (hhmm): _____ local DST

Time First Bat Emerged Without Re-entering (hhmm): _____ local DST

Time Last Bat Emerged (hhmm): _____ local DST

TIME COUNT ENDED: _____ (hhmmss) Scheduled End: 21:00:00 MACA/RUCA
22:00:00 CHCH/CUGA

SKY/WEATHER CONDITIONS AT END: 0 1 2 4 5 8 (circle one)

WIND CONDITIONS AT END: 0 1 2 3 4 5 (circle one)

TEMPERATURE AT END: _____°C or °F (circle one)

Method 1: NV goggles NV video TIR (circle one)
TIR/video Recording Start Time (hhmmss): _____
 Name of Person Counting Bats: _____

Method 2: NV goggles NV video TIR (circle one)
TIR/video Recording Start Time (hhmmss): _____
 Name of Person Counting Bats: _____

Exiting Bats: (# of bats during each time interval)
 1) _____ 5) _____ 9) _____ 13) _____ 17) _____
 2) _____ 6) _____ 10) _____ 14) _____ 18) _____
 3) _____ 7) _____ 11) _____ **15)** _____ 19) _____
 4) _____ 8) _____ 12) _____ 16) _____ 20) _____
Total # of bats that exited cave: _____

Exiting Bats: (# of bats during each time interval)
 1) _____ 5) _____ 9) _____ 13) _____ 17) _____
 2) _____ 6) _____ 10) _____ 14) _____ 18) _____
 3) _____ 7) _____ 11) _____ **15)** _____ 19) _____
 4) _____ 8) _____ 12) _____ 16) _____ 20) _____
Total # of bats that exited cave: _____

Entering Bats: (# of bats during each time interval)
 1) _____ 5) _____ 9) _____ 13) _____ 17) _____
 2) _____ 6) _____ 10) _____ 14) _____ 18) _____
 3) _____ 7) _____ 11) _____ **15)** _____ 19) _____
 4) _____ 8) _____ 12) _____ 16) _____ 20) _____
Total # of bats that entered cave: _____

Entering Bats: (# of bats during each time interval)
 1) _____ 5) _____ 9) _____ 13) _____ 17) _____
 2) _____ 6) _____ 10) _____ 14) _____ 18) _____
 3) _____ 7) _____ 11) _____ **15)** _____ 19) _____
 4) _____ 8) _____ 12) _____ 16) _____ 20) _____
Total # of bats that entered cave: _____

COMMENTS : _____

Page: _____ of _____

Figure 1. Example of summer bat emergence monitoring data form.

Table 1. Data form field descriptions for summer cave roost sampling.

Field Name	Field Description
Park Code	Unique 4-letter park acronym (i.e., CHCH, CUGA, MACA, RUCA)
Data recorder initials	Initials of individual filling-out the data form in the field. Occasionally, one or more persons will call out data, while another records.
Reviewed by	Initials of individual who reviewed completed data form for summer bat emergence monitoring elements. Ideally this should be someone other than the individual who filled-out this page of the data form and is intimately familiar with the data forms.
Cave Name	The unique name of the cave being sampled.
Entrance Name	Entrance name (if there is more than one) being sampled. If the cave has only one entrance, then put "NA".
Observers Name(s)	First and last names of all involved in the field data collection at the particular cave entrance being sampled. List the Field Crew Leader (i.e., field person responsible for data collection) first.
Date	The date that data are being collected in mm/dd/yyyy format (e.g., 05/17/2011).
Time of Arrival	The time, to the nearest minute, (using the hour and minute format shown) when crew arrived at the cave entrance. A 24-hours format should be used. All four digits should be filled in. Examples: 0630 (6:30 am) and 1350 (1:50 pm). Use daylight saving time (DST)—make sure to use correct time zone: CHCH and CUGA are in eastern; MACA and RUCA are in central.
Human Disturbance Seen at Cave Entrance Area?	Circle "Yes" if any recent human disturbance is observed around the cave entrance and record details in the Comments section at the bottom of the page. Examples include: damage to gate; missing or damaged lock(s); attempts to circumvent the gate by digging or chiseling; tools for digging, cutting, prying; digging in the vicinity (artifact searching). Circle "No" if none seen.
Sky/Weather Conditions at Start	Circle the National Weather Service Weather Condition Code number that best represents sky/weather conditions at the start of sampling. Codes and descriptions listed in text box. Adapted from USGS Breeding Bird Survey.
Wind Conditions at Start	Circle the Beaufort Scale Wind Speed Code number that best represents wind conditions at the start of sampling. Codes and wind speed indicators are listed in text box.
Temperature at Start	The ambient temperature outside the cave, but not directly influenced by the cave, at the start of sampling. Scale used (i.e., Celsius or Fahrenheit) should be circled. Celsius is preferred.
Method Used for Temp	The method used to obtain temperature readings outside the cave at start and end of sampling. Possible methods used include: digital thermometer, smartphone, nearby weather station, weather radio, laser thermometer on paper, or mercury thermometer.
External Infrared Lights Used?	Circle "Yes" if one or more external infrared (IR) lights (i.e., illuminators) were used during the bat count. Indicate any problems that occurred with the external IR lights during the count in the Comments section. Circle "No" if external IR lights were NOT used during the count.

Field Name	Field Description
Interval Duration	The duration of the counting interval used for this sampling event, in minutes. Use 5 minutes unless otherwise specified by the Project Leader.
Time Count Started	The time, to the nearest second, the count actually started in the field (i.e., started watching the entrance). The hour, minute, second format shown and 24-hours format should be used. All six digits should be filled in. Use daylight saving time (DST). This should be 19:45:00 at MACA and RUCA (central time zone), and 20:45:00 at CHCH and CUGA (eastern time zone). If, for any reason, the count started after the scheduled start time , then record "NA" on the lines next to the corresponding interval(s) for both exiting bats & entering bats for each incomplete interval (i.e., data was collected for less than four minutes out of the 5-minute interval).
Time First Bat Emerged	The time, to the nearest minute, (using the hour and minute format shown) when a bat was first observed flying out of the cave entrance—regardless of whether the bat remained outside or re-entered the cave. A 24-hours format should be used. All four digits should be filled in. Examples: 0630 (6:30 am) and 1350 (1:50 pm). Use daylight saving time (DST) and use correct time zone. <i>Note:</i> if the bat did not re-enter the cave in less than 3 seconds, then the same time will be recorded in the next field as well.
Time First Bat Emerged <u>Without</u> Re-entering	The time, to the nearest minute, (using the hour and minute format shown) when a bat was first observed flying out of the cave entrance and NOT re-entering it for at least 3 seconds. A 24-hours format should be used. All four digits should be filled in. Examples: 0630 (6:30 am) and 1350 (1:50 pm). Use daylight saving time (DST) and use correct time zone. <i>Note:</i> this bat is the first exiting bat counted.
Time Last Bat Emerged	The time, to the nearest minute, when a bat was last observed flying out of the cave entrance and remaining out for at least 3 seconds before the count ended. The hour and minute format shown and 24-hours format should be used. All four digits should be filled in. Examples: 0630 (6:30 am) and 1350 (1:50 pm). Use daylight saving time (DST) and use correct time zone. <i>Note:</i> the time the last bat emerged can later be determined (or corrected) during video analysis.
Time Count Ended	The time, to the nearest second, when observer stopped the sampling event at the cave entrance (i.e., stopped watching the entrance). The hour, minute, second format shown and 24-hours format should be used. All six digits should be filled in. Use daylight saving time (DST). This should be 21:00:00 at MACA and RUCA (central time zone) and 22:00:00 at CHCH and CUGA (eastern time zone). <i>Note:</i> this should occur when the alarm sounds at the end of the last time interval that ends the count (interval #15, unless otherwise specified). If, for any reason, the count ended before the scheduled end time , then record "NA" on the lines next to the corresponding interval(s) for both exiting bats and entering bats for each incomplete interval (i.e., data was collected for less than four minutes out of the 5-minute interval).
Sky/Weather Conditions at End	Circle the National Weather Service Weather Condition Code number that best represents sky/weather conditions at the end of sampling (i.e., the time the count ended). Codes and descriptions listed in text box.
Wind Conditions at End	Circle the Beaufort Scale Wind Speed Code number that best represents wind conditions at the end of sampling (i.e., the time the count ended). Codes and wind speed indicators are listed in text box.

Field Name	Field Description
Temperature at End	The ambient temperature outside the cave, but not directly influenced by the cave, at the end of sampling (i.e., the time the count ended). Scale used (i.e., Celsius or Fahrenheit) should be circled. Celsius is preferred. Use the same method that was used to measure temp at start.
Method 1, Method 2	Circle the type of method being used to count bats. Circle only one type for "Method 1". The three types of methods include: NV goggles; NV Video camera; and TIR. If two or more observers count the bats independently at the same cave entrance simultaneously, then each person MUST use a separate field data form without discussion (i.e., as if they were alone) to record direct bat count data, however all other data (except Park Code, Cave Name, Entrance Name, Date, and Name of Person Counting Bats) must be recorded on only one of the field data forms, and the two data forms will be entered into the database as a single event with two or more NV goggle counts. If only one observer counts the bats and uses one or more passive method(s) (e.g., NV goggles and NV video camera), then the observer MUST complete one field form and circle only one type of counting method for "Method 1" and only one type for "Method 2." If more than two methods are used record "Method 3," followed by the type of method and camera recording start time (hhmmss) in the Comments field— this is extremely important if the method is TIR (because it lacks an internal clock). In the few instances when two or more entrances to the same cave (e.g., Hemlock Cave at MACA, Gap cave at CUGA) are counted simultaneously by two or more observers, two or more separate field forms MUST be filled-out (entirely) and the two or more field forms will be entered into the database as separate events.
TIR/ Video Recording Start Time	Record the camera recording "Start Time (hhmmss)" if method circled is TIR or NV video. This is extremely important if the method is TIR (because it lacks an internal clock). This serves only as a backup for the NV video camera, since it has an internal clock that should have been synchronized with the watch or time mechanism (e.g., smartphone, cell phone) used to determine the count start and end times. Leave blank if NV goggles is circled as the method.
Name of Person Counting Bats	Record the name of the person counting bats if "NV goggles" is circled for the method (i.e., the first and last name of the person actually using the goggles during the count). On rare occasions when two crew members count bats—one only counts exiting bats while the other only counts entering bats (see step #19)—then record the name of the person who counts exiting bats in this field. If "NV video" or "TIR" is circled, then the person who later counts bats in the office using a computer (i.e., digital video analysis) will record their first/last name in this field on the data form.

Field Name	Field Description
Exiting Bats	Count bats as they exit the cave. Sum bats on a handheld counter ("clicker") or other reliable method (e.g., using tick marks in groups of five such as: on the margin of the data form) and record the sums for each time interval (5-minutes, unless otherwise specified) on the line provided next to the corresponding interval number. It is important to record a zero on the line provided next to the corresponding interval number each time that no bats are counted exiting the cave. Record "NA" on the line next to the corresponding interval(s) for exiting bats for each incomplete interval (i.e., data was collected for less than four minutes out of the five-minute interval) due to starting the count late, interruption(s) during the count, or ending the count early. <i>Note:</i> the preferred approach, when two trained observers are present, is to have each conduct independent counts using separate data forms without discussion. However, if two trained observers are present, one can record exiting bats and the other record entering bats. If this approach is taken, before leaving the cave, carefully transcribe entering counts to the data form used by observer recording exiting bats.
Total # of bats that exited cave	Sum of all the bats recorded exiting the cave from start to end of the emergence count (i.e., from the first to the last time interval). This is <i>optional</i> in the field and is not entered into the database.
Entering Bats	Count bats that enter the cave. Sum bats on a handheld counter ("clicker") or other reliable method (e.g., using tick marks in groups of five such as: on margin of the data form), and record the sums for each time interval (5-minutes, unless otherwise specified) on the line provided next to the corresponding interval number. It is important to record a zero on the line provided next to the corresponding interval number each time that no bats are counted entering the cave. Record "NA" on the line next to the corresponding interval(s) for entering bats for each incomplete interval (i.e., data was collected for less than four minutes out of the five-minute interval) due to starting the count late, interruption(s) during the count, or ending the count early.
Total # of bats that entered cave	Sum of all the bats recorded entering the cave from start to end of emergence count (i.e., from the first to the last time interval). This is <i>optional</i> in the field and is not entered into the database.
Comments	Notes related to the sampling event. May include: information on Method 3 (and any additional methods) including when Thermal Infrared (TIR) or Night Vision (NV) video camera was started, evidence of recent human disturbance seen at cave entrance area, emergence description, unusual bat behavior, backlighting/visibility problems, position of camera, field of view, dead bats, dying bats, bats collected for testing, evidence of recent flooding, instrument problems, interruptions in the count (including the time it started and ended), interesting non-target species or behavior observed (e.g., woodrat), etc.
Page ____ of ____	Total number of field data forms used during this sampling event. Recorded <i>in the office</i> by person who completed video analyses for this event.

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