

Integrated Monitoring Protocol for Cave Entrance Communities and Cave Environments in the Klamath Network

Standard Operating Procedure #8: Bats

Version 2017Feb10

Citation:

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To create a new version of this SOP, carefully follow the instructions in SOP #18: Revising the Protocol (<https://irma.nps.gov/DataStore/Reference/Profile/2238840>). Use the Revision History Log below to describe the revisions:

- Populate the top table of the revision history log, providing the previous version date, author of the change, a specific but concise description of the changes made, the footnote number associated with change details, and a new version date.
- In the bottom table, add a footnote and as much text as needed to describe in detail the reasons for and implications of the change.

Revision History Log

Previous Version Date	Author of Change	Changes Made	Footnote #	New Version Date

Footnote #	Detailed Reasons for and Implications of the Changes

1 Introduction and Background

This Standard Operating Procedure (SOP) gives instructions for surveying small colonies (<1,000) of bats using a non-contact method: in-cave counts. These methods can be used any time of year, but are prescribed here for counting during the winter hibernation season at Oregon Caves National Monument and Preserve (ORCA) and at Lava Beds National Monument (LBE) in order to focus on monitoring long-term population trends of the Townsend's Big-eared Bat, *Corynorhinus townsendii*. Secondly, this SOP will yield data on other hibernating bat species, such as *Myotis* species and big brown bats (*Eptesicus fuscus*). Bat monitoring will be the responsibility of each park and will be completed once per year.

LBE also monitors bats during the warm seasons each year for management purposes (e.g., to identify and temporarily close caves with maternity roosts). In addition to the winter counts described here, staff at LBE developed a probability proportional to size (PPS) sampling method to opportunistically survey additional sites in the winter that may harbor hibernating bats. This process includes selecting and surveying a certain number of sites from different caves that are grouped according to their known bat abundance. ORCA also performs additional bat monitoring during monthly critter count surveys (described in the protocol narrative, section 1.2.2); these surveys are independent from this long-term monitoring protocol and detailed in Appendix A: Other Bat Surveys and Monitoring at Lava Beds and Oregon Caves.

Precautions will be taken to prevent the spread of the fungus *Pseudogymnoascus destructans* into park caves. This fungal pathogen is the cause of White Nose Syndrome (WNS), which has infected and devastated populations of hibernating bats in North America. The fungus infects the skin and membranes of bats, likely causing death by increasing the frequency of arousal during hibernation, damaging wing membranes, and disrupting critical physiological functions (Blehert et al. 2011). Many large populations of bats have declined or died out altogether in eastern and midwestern states. In March 2016, WNS was confirmed in the state of Washington, and western parks now have the responsibility of surveilling for WNS in park bat populations and preventing human-mediated spread of WNS into their parks. National guidance on decontamination procedures is found at <https://www.whitenosesyndrome.org/topics/decontamination>, which will serve as the basis for each park's specific WNS protocol. As needed, this SOP will be updated to cite and implement the latest national and park protocols, which are changing as WNS spreads across North America. Currently, park procedures require the use of dedicated field equipment (i.e., gear and clothing used only within the park) or decontaminated equipment from areas not affected by WNS. The latest map of WNS contaminated areas may be found at <https://www.whitenosesyndrome.org/resources/map>.

2 Equipment

- Dedicated and/or decontaminated caving equipment, including: helmet with mounted light(s), backup lights, kneepads, gloves, boots
- Absolutely no gear that has been in a White Nose Syndrome (WNS) affected area is allowed into caves within LBE or ORCA; all other gear must follow park protocol and the most recent decontamination recommendations and standards available

- Caving clothing and equipment that is "quiet" for traveling in cave (e.g., minimize nylon/cordura suits, metal clips, or packs and cases with loud closures)
- Appropriate intensity light for cave ceiling height (may require a spotlight ≥ 3 watts and binoculars)
- Cave zone maps (see site dossiers, referenced in Appendix C)
- Hibernacula Survey Data Sheet (attached at end of this SOP)
- Photo Data Sheet (available from SOP #14)
- Pencils
- Watch
- Laser thermometer (models with greater than ± 2 °F accuracy)
- Kestrel weather meter
- Laser pointers
- Additional gear specific to the site (e.g., keys, ropes) noted in site dossier
- Camera with flash

3 Timing and Location of Surveys

In-cave counts are prescribed for the winter season at ORCA and LABE to measure abundance during the hibernation period. Such hibernacula counts may occur between 1 December and 1 March; however, to provide greater assurance that the bats are in hibernation, the ideal time is between 1 January and 1 March. These counts are performed coincident with winter climate downloads at both ORCA and LABE and at the same time as winter water monitoring at ORCA. In order to reduce the likelihood of double-counting or undercounting (in the case of bats switching sites), all sites at LABE will be visited as close together as possible, preferably within a single 5-day work week. In-cave hibernacula surveys can take place day or night. To avoid unnecessary disturbance of hibernating bats, we do not recommend surveying more than once per season. Disturbance often goes undetected because bats rouse from hibernation slowly and may not be fully active until after surveyors have departed.

In-cave counts for the Klamath Network Inventory and Monitoring (I&M) Program are performed in the winter once per year at 6 sites in LABE (ANGL, BEAC, CGCA, DRHE, INCA, and Sentinel Cave) and 1 site at ORCA (The Cave). As mentioned in the Introduction section of this SOP and in Appendix A of the protocol narrative, these same methods are used to monitor other sites at LABE for hibernating bats, but data from those additional sites are not generated as part of this protocol.

Weather conditions affect bat behavior and surveyor safety, both of which should be considered when planning survey dates and timing. While bats often select hibernacula sites that have relatively stable environmental conditions relative to aboveground conditions, conducting surveys during consistent cold weather is generally best because 1) bats are more likely to be in deep torpor during this time, reducing the potential for disturbance and bat arousal, and 2) bats in deep torpor are less likely to move among sites, thus reducing the chances of survey error due to bat movement. Scheduling and timing of hibernacula surveys must also consider surveyor safety. Extreme cold, deep snow, ice, and other conditions associated with prolonged extreme cold may limit the ability of surveyors to access sites or safely conduct field work, and under these circumstances, it may be prudent to conduct surveys in more moderate conditions.

4 Conducting Surveys

The objective of this SOP is to count the number of hibernating bats observed under conditions (e.g., level of survey effort) as similar to previous years as possible. Given the high level of variation introduced by different numbers of surveyors and skill levels, it is preferable to have the survey at a particular cave conducted each year by the same number of individuals with the same level of experience. At least 1 surveyor must be an experienced bat researcher during cold season in-cave counts. This person (or people) should also be able to, at a minimum, differentiate Townsend's big-eared bat from other bat species; Townsend's Big-eared Bats often tuck their ears down against their bodies during hibernation and may be easily mistaken for other species. During winter surveys, it is critical to minimize disturbance of hibernating bats because awakened bats burn valuable fat reserves that are critical to survival through the winter. Only experienced surveyors may recognize special cues that reflect early stages of disturbance.

Prior to surveying the I&M caves (caves monitored by this protocol) at LABE and ORCA, surveyors should have practiced surveying in non-I&M caves and demonstrated proficiency in visually detecting and identifying hibernating bats in various locations (cave ceiling, wall, in crevices, etc.). Personnel must also be adept at traveling through caves, including crawling and climbing where necessary. Caving skills are important to ensure that surveyors can safely access caves and maneuver through passages without causing resource damage or sustaining injury, while remaining quiet to reduce potential bat disturbance. Approaching bats should be done only when necessary to confirm species identification or to conduct an accurate count of a cluster; in many cases, binoculars can be used in place of being in close proximity to bats. In general, surveyors must always attempt to minimize the amount of time spent in the cave, while balancing the need to move cautiously through the cave and spend adequate time searching to ensure survey quality. During surveys, if bats show signs of disturbance, such as flying or actively unfurling ears, surveyors should proceed with caution and be attentive to increasing levels of disturbance. If a large number of bats begin flying, such that an accurate survey cannot be conducted, the count should be abandoned and surveyors should immediately exit the cave. A resurvey could be attempted later that year in some cases, for example if a particularly warm winter contributed to an unexpectedly active colony, but later the weather cooled down and the Field Lead decided to attempt another survey.

The primary focus of this survey protocol is to detect stationary bats on the cave walls and ceilings. This survey is conducted in one direction only and stop times should reflect when surveyors reach the end of the unidirectional route. Surveyors will use the minimum intensity light needed to accurately count the bats and distinguish species. This typically involves a basic headlamp (usually LED and white in color), but may require a high-powered spotlight and binoculars in caves with high ceilings. Any sites where extra light is required will be indicated as a special gear requirement on the site dossier. Surveyors will also minimize noise and spend as little time as necessary in rooms with roosting bats.

The secondary focus of this survey protocol is to detect potential signs of White Nose Syndrome. Surveyors should be trained to notice abnormal bat behavior, visual signs of fungal infection on the nose and wings of bats, and, potentially, UV light diagnosis of histopathologic wing scarring.

4.1 Team Roles

Caves in this protocol are divided into search zones, and zone maps for each cave are in the cave site dossiers, which are referenced in Appendix C: Examples of Cave Site Dossier Materials. Team members should familiarize themselves with cave-specific maps and documentation before embarking on surveys.

Survey roles should be established in advance, and to prevent possible confusion in the cave, all surveyors need to clearly understand their role and responsibilities prior to beginning the survey. Only 1 surveyor should be designated as the data recorder. This person carries the clipboard with the datasheets, and in general, also the maps and site dossiers. Therefore, navigating and coordinating the search strategy also falls on the data recorder. Additionally, when splitting data collection by zones, the data recorder is responsible for keeping track of zone boundaries. For complex surveys, the data recorder should be an experienced surveyor capable of directing the team. For simple surveys, any team member can act as the data recorder. Other surveyors serve as spotters and counters. Surveyors split the passage and thoroughly search walls, ceilings, cracks, alcoves, etc. When bats are encountered, species identification and counts are relayed to the data recorder. The data recorder should maintain a central position to facilitate communication with all team members. This position should also allow the data recorder to oversee the search effort and run quality control by assessing whether any areas have been missed or duplicated. This position should also monitor the start/stop times on the datasheets to be certain that the search effort is not over-represented by including time it takes to perform other tasks, such as downloading data loggers, measuring water levels, etc. One of the counters should also be assigned cave climate duties. This person is responsible for downloading and replacing HOBO climate data loggers according to SOP #5: Climate. In some cases, surveyors may separate from each other to split up sections of a cave. This is most common when braided passages are present. The team should decide on a case-by-case basis whether additional datasheets are required to record data when team members separate. In most cases, a surveyor can quickly search a side passage or alcove and report back to the data recorder upon reuniting.

4.2 Team Size

Surveys can be conducted by as few as 1 surveyor (if cave conditions and safety assessment allow) and up to a maximum of 3 surveyors. Solo surveys are only recommended for small caves with no

significant hazards (pits, loose rock, etc.), which can be quickly surveyed by a single, experienced surveyor. In this case, it is best to have another team member waiting on the surface. Team size should balance workload needs (based on cave size and complexity), disturbance potential (small teams preferable when appropriate), safety considerations, and previous survey effort. The number of surveyors and the total survey time are important factors to record because total survey effort (i.e., number of survey hours) may be correlated with number of bats observed. Efforts should be made to be consistent in the number and experience level of surveyors at each site from year to year. That is, if cave X is surveyed by 2 experienced individuals in 2016, the cave should be surveyed by 2 experienced individuals in 2017 (versus 1 individual, or 1 experienced plus 1 inexperienced individual). At LABE, all bat caves except CGCA have been surveyed by 2 individuals. If a third individual (e.g., trainee) accompanies the surveyors, that person should be noted on the datasheet as a Non-counting Observer rather than a surveyor and that person's observations of bats are not included in the survey.

4.3 Communication

It is important for the survey team to establish roles in advance and maintain good communication in the cave to ensure accurate counting. Using clear communication is critical to achieving quality survey results and efficiently moving through the cave without unnecessary confusion. Talking should occur only when necessary for the survey, such as reporting counts to the data recorder, asking for assistance with a cluster count or species identification, determining appropriate travel routes, and pointing out conservation or safety concerns. When talking, use a low voice but avoid whispering, which can produce high frequency sounds that may increase disturbance potential. Counters should clearly communicate to the data recorder when bats are observed, allowing the data recorder to ensure that all bats are being counted and no duplicates are being recorded. Use laser pointers to assist communication by clearly indicating which bat or cluster of bats is being counted or pointed out.

4.4 Preparing for the Survey

1. Develop a survey schedule for the day, attempting to maximize travel efficiency based on where sites are located.
2. Based on sites chosen for the day, determine the appropriate number of surveyors for each site (refer to "Team Size" section above); surveys may be conducted by a single person or up to 3 personnel.
3. For each site, determine whether the team will survey the entire cave together, or if the team will split and survey zones separately.
4. For each cave that will be surveyed, print a cave map and a datasheet (or multiple datasheets if splitting by zones).
5. If applicable, print site dossiers and zone maps. Study the site dossiers to become familiar with the sites and determine if any special equipment is needed.
6. Assemble all caving gear and survey equipment.

7. Follow proper backcountry travel and safety procedures (establish a point of contact, carry a radio, etc.).

4.5 Conducting the Survey: Counting Bats

1. Near the entrance, suit up with caving gear and prepare the survey equipment.
2. Refer to cave maps, zone maps, and/or site dossiers to navigate through the cave and determine the most efficient survey route.
3. Enter the cave, moving cautiously and staying as quiet as possible.
4. If multiple surveyors are present, split the passage evenly and communicate to the other surveyor(s) when bats are identified to avoid double-counting in potentially overlapping areas. If surveying solo, proceed down and across passages to ensure that all areas are checked.
5. Traveling through the cave, stop often to thoroughly search the ceilings and walls. It is often necessary to turn around and scan the ceiling from different directions in order to see into alcoves and cracks.
6. Report all bats to the data recorder. Use laser pointers to point out bats and clusters as they are counted.
7. Record each bat or bat cluster separately on the datasheet, in the appropriate zone. Clusters are defined by bat-to-bat contact. A solitary bat is recorded as a “cluster” of 1. Use tally marks to record solitary bats, and record cluster sizes as legible numerals separated by commas. It is important to use commas between clusters to avoid misinterpreting 2 single-digit cluster sizes (e.g., 2 & 7) as a double-digit cluster size (e.g., 27).
8. Whenever possible, use binoculars instead of approaching bats to confirm species identifications and conduct cluster counts. Binoculars are also helpful at close range to ensure accuracy of cluster counts.
9. For clusters that are large enough that an accurate count is difficult (usually 20+), use a camera with flash to capture a photo of the cluster. If necessary, use a spotlight to help illuminate bats for photography. Attempt to take photos that look straight on at the faces of the bats, which makes photo counting easier. Indicate each photo on the datasheet (in the proper zone) by estimating the cluster size and drawing a square around the number recorded.
10. When the survey is complete, exit the cave as quickly as possible while still moving cautiously for safety. Bats are only counted in one direction through the cave. That is, if surveyors must travel the same passage to return to the entrance, they will not record any additional bats seen on their return trip. Alternatively, additional bats on the return trip may be noted in the Comments section as bats observed outside the official survey period.

4.6 Conducting the Survey: Cave Climate Data

1. Download and replace the entrance, middle, and deep zone HOBO climate data loggers during or after the bat survey.
2. In addition, record ceiling and air temperature up to 3 times per bat monitoring zone (this may or may not coincide with the entrance, middle, and deep climate zones). Record temperatures to the nearest tenth of degree Celsius (X.X °C). Use the infrared thermometer to measure ceiling temperatures adjacent to a bat cluster, being careful not to touch bats with the laser. To measure air temperature, use the infrared thermometer on a sheet of paper held away from surveyors' bodies to avoid artificial temperature increase due to body heat. Wave the paper around for several seconds to allow it to reach ambient air temperature.

4.7 Data entry and total site counts

Site count totals can be calculated by manually adding all the cluster counts on the datasheet. An independent calculation may be achieved by entering survey data in the LABE bat database. For quality control, we recommend that manually summed totals and automatically calculated database totals be compared to ensure they match.

If photography is used to verify estimated counts of larger clusters, these cluster counts need to be determined by analyzing the photos. The recommended method for counting a photographed cluster (refer to Figure 8-1) uses ArcGIS with the following steps:

1. Open ArcMap and add a cluster photo to the dataframe.
2. Create a "point" shapefile or feature class, and start an editing session for that layer.
3. Using the "create new feature" tool, click each individual bat to create a new point. Focus on the noses of the bats when possible.
4. After clicking each bat, open the attribute table for the layer to view the number of points created; this number is the cluster count.
5. Repeat the above steps for each cluster photo. The points created on the previous photo can simply be deleted, and the blank point layer will then be ready for the new photo.

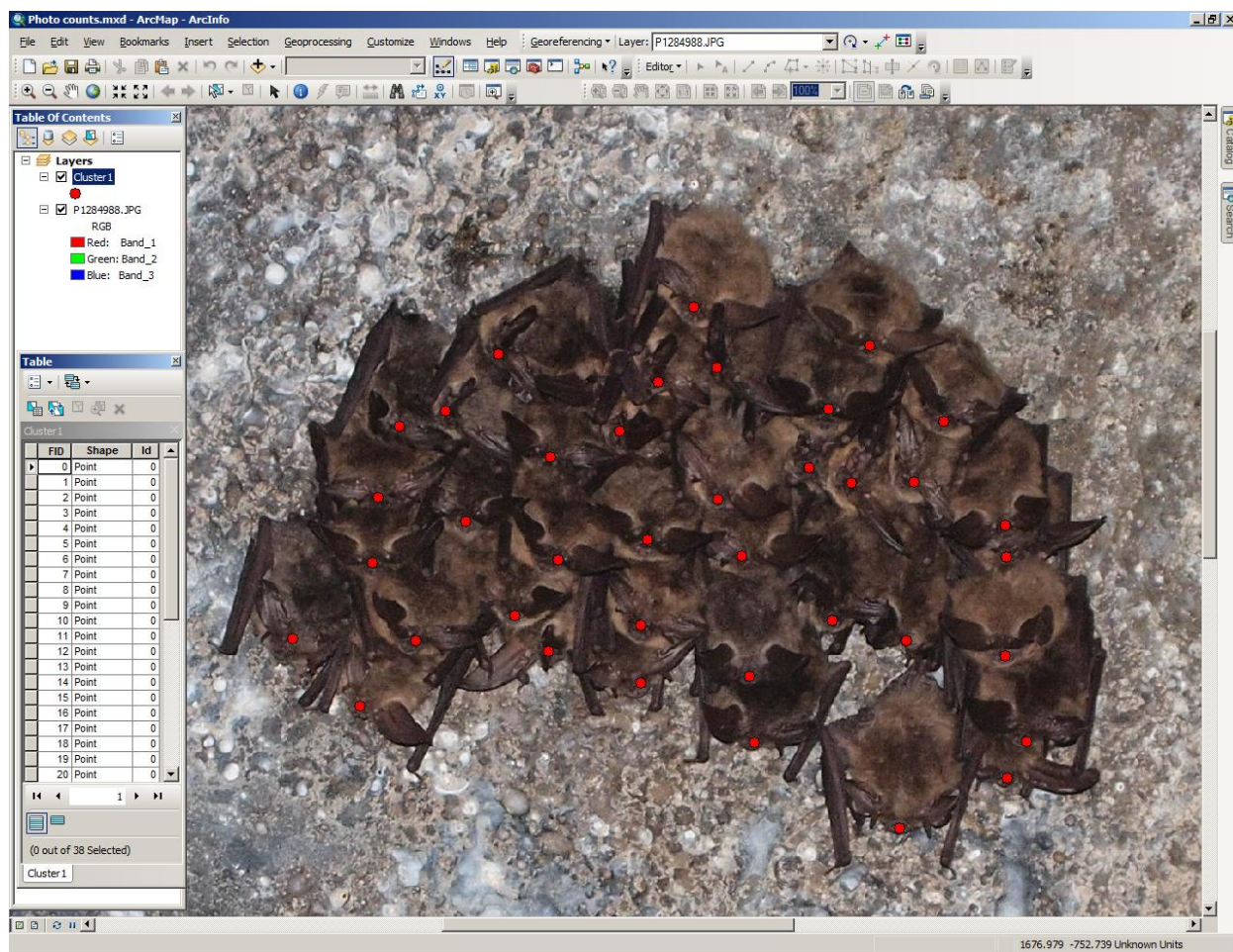


Figure 8-1. Screen capture illustrating use of ArcGIS for counting cluster photos (38 bats).

5 Literature Cited

Blehert, D. S., J. M. Lorch, A. E. Ballmann, P. M. Cryan, and C. U. Meteyer. 2011. Bat white-nose syndrome in North America. *Microbe* 6:267-273.

6 Datasheets

Bat Hibernacula Survey Data Sheet

(single site with zones)

Cave: _____ Surveyors: _____ Date: _____

Start time: _____ Stop time: _____ RH (%): _____

Comments: _____

*Record each solitary bat using tally marks (e.g., |||| ||). Record cluster counts separately (e.g., 2, 5, 7, 4, 2, 19, 3, 8).**Draw a square - □ - around estimated counts of photographed clusters. Use notes to indicate dead or flying bats.*

	COTO (<i>Corynorhinus townsendii</i>)	MYSP (<i>Myotis</i> spp.)	Other species (list below)	UNKN (unknown species)
Zone __	Solitary bats:			
	Clusters:			
Zone __	Solitary bats:			
	Clusters:			
Zone __	Solitary bats:			
	Clusters:			

(For additional Zones, use reverse side of data sheet.)

Record temperature up to three times per zone. Measure temperature in association with bat clusters, when present.

	Zone __			Zone __			Zone __		
Cluster size									
Ceiling temp (°C)									
Air temp (°C)									

Bat Hibernacula Survey Data Sheet

(single site with zones)

	COTO <i>(Corynorhinus townsendii)</i>	MYSP <i>(Myotis spp.)</i>	Other species (list below)	UNKN (unknown species)
Zone __	Solitary bats:			
	Clusters:			
Zone __	Solitary bats:			
	Clusters:			
Zone __	Solitary bats:			
	Clusters:			

	Zone __			Zone __			Zone __		
Cluster size									
Ceiling temp (°C)									
Air temp (°C)									

Bat Hibernacula Survey Data Sheet

(multiple sites, no zones)

Cave: _____ Surveyors: _____ Date: _____
 Start time: _____ Stop time: _____ Air Temp (°C): _____ Ceiling Temp (°C): _____ RH (%): _____
 Comments: _____

Record each solitary bat using tally marks (e.g., |||| ||). Record cluster counts separately (e.g., 2, 5, 7, 4, 2, 19, 3, 8).

Draw a square - □ - around estimated counts of photographed clusters. Use notes to indicate dead or flying bats.

COTO (<i>Corynorhinus townsendii</i>)	MYSP (<i>Myotis spp.</i>)	Other species (list below)	UNKN (unknown species)
Solitary bats:			
Clusters:			

Cave: _____ Observers: _____ Date: _____
 Start time: _____ Stop time: _____ Air Temp (°C): _____ Ceiling Temp (°C): _____ RH (%): _____
 Comments: _____

Record each solitary bat using tally marks (e.g., |||| ||). Record cluster counts separately (e.g., 2, 5, 7, 4, 2, 19, 3, 8).

Draw a square - □ - around estimated counts of photographed clusters. Use notes to indicate dead or flying bats.

COTO (<i>Corynorhinus townsendii</i>)	MYSP (<i>Myotis spp.</i>)	Other species (list below)	UNKN (unknown species)
Solitary bats:			
Clusters:			