

U.S. Department of the Interior
National Park Service

**A Protocol for Monitoring Allegheny Woodrats
(*Neotoma magister*) at Mammoth Cave National Park**

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Important Note: This sampling protocol includes both this narrative section, and the accompanying Standard Operating Procedures (SOPs):

SOP 1: Training of Field Personnel
 SOP 2: Pre-Sampling
 SOP 3: Establishment and Location of Sampling Sites
 SOP 4: Collection of Field Data
 SOP 5: Post-Sampling
 SOP 6: Data Management
 SOP 7: Data Analysis
 SOP 8: Reporting
 SOP 9: Revising the Protocol

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I. Background and Objectives

Issues Being Addressed and Rationale for Allegheny Woodrat Monitoring

The Allegheny woodrat, *Neotoma magister*, is a native small mammal of interest on Mammoth Cave National Park (MACA) and across the Eastern USA, due, in part, to recent dramatic population declines. Woodrats are frequent visitors to the cave ecosystem and are important importers of organic matter, in the form of nesting materials, food caches, and fecal and urine deposition, into caves. These organic nutrients are known to support a specialized invertebrate cave community (Richards 1989, 1990). Cave management and visitor activity may impact or inhibit woodrat access into and use of caves through imposition of physical barriers, such as cave doors, and various disturbance factors (noise, lighting, etc.). Woodrats, as surface foragers feeding on a wide variety of plant materials and parts (e.g., fruit, nuts and seeds, fungi, leaves, etc.) also relate to the terrestrial ecosystem, and may reflect larger-scale changes in vegetation communities through long-term changes in population performance and structure. The combination of being relatively widespread, important to the cave ecosystem, potentially sensitive to cave management and visitation impacts, and a strong dependent relationship with surface vegetation-based ecosystem performance make woodrats a useful indicator for park-level monitoring.

Allegheny woodrats are an endemic forest-dwelling species associated with cliffs, rock outcrops, talus slopes, and caves. Because woodrats are limited to rocky habitats for dens and to forests for food (especially nuts and acorns), they are vulnerable to disturbance both within caves and in the surrounding forest. Due to dramatic population declines along the northern and western peripheries of the species' range over the past 30 years, they now occur on more state endangered and threatened species lists than any other rodent in the U.S. The Allegheny woodrat is currently monitored by the Natural Heritage Program as a G3/G4 species (i.e., "vulnerable"/"apparently secure", and is considered a "species of concern" (formerly called "Category 2 candidate") by the U.S. Fish and Wildlife Service.

Several hypotheses have been proposed to account for the decline, they include: 1) inbreeding (Beans 1992); 2) reduced winter forage (Hicks 1989, Beans 1992, McShea and Schwede 1993); 3) infection with the raccoon roundworm (*Baylisascaris procyonis*) (McGowan 1993, Stone et al. 1993); 4) increased exposure to an increasing number of predators (Hassinger et al. 1996); 5) habitat (forested) fragmentation (Hassinger et al. 1996); 6) climate/weather changes (Linzey 1990); 7) human disturbance (Linzey 1990); and 8) synergistic affects of two or more causes of decline (Linzey 1990).

Specific threats to woodrats at MACA include cave entrance modification, direct visitor disturbance, cave lighting impacts, raccoon roundworm parasite (lethal to woodrats), impacts to food resources [from pests/pathogens (hard mast species), ozone, acid deposition, and fire], habitat fragmentation/loss (adjacent land use), in-cave modifications, and an increase in predators (e.g., feral cats, skunks, owls) on the park.

Woodrat population parameters ranked third in the Cave Nutrients functional "pathway" (ecosystem "sub-model") at the end of the MACA Prototype Long-term Ecological Monitoring program's ecosystem attribute ranking and prioritization process. The Cave Nutrients pathway ranked second in importance among 18 ranked pathways on the park. This ranking established

the significance of monitoring woodrat park-wide abundance and population structure, and use of managed caves on MACA.

Historical Development of Allegheny Woodrat Monitoring at MACA

Recognizing the special management status (Category 2 species) and key role woodrats play in supporting cave invertebrate communities, long-term monitoring of woodrats at MACA was put forth as a component in a 1993 proposal which resulted in MACA being selected as a prototype monitoring park for the cave/karst biome (A Proposal 1993).

Development of the MACA Allegheny woodrat monitoring protocol is based on the preliminary five-year woodrat monitoring study initiated at MACA in 1997 and completed in 2002 (Thomas 2003). Limited methods testing continued through 2003. Design and sampling methods revision, field testing of revised design, and initial database development took place primarily in 2004. A pilot test of the sampling methodology and designs was performed on “highly managed” caves and “unmanaged” caves (on the South side of the Green River only—due to the ferry being out of operation) in November 2004. The data have been entered into a MS Access database and analysis will be performed in early 2005. The sampling methods described in the preliminary study are utilized in the MACA woodrat monitoring protocol.

Measurable Objectives

Two general questions will be simultaneously assessed in woodrat monitoring: (1) what are the trends in woodrat population structure, abundance, and distribution on the park over time, and (2) are woodrats using “highly managed” and visited (tour) caves?

The specific **monitoring questions** that will be addressed by this protocol include:

- What is the status of Allegheny woodrat populations [abundance estimates, distribution among caves, and structure (age class ratios, sex ratios)] using “unmanaged” (i.e., natural) caves on the park?
- What is the trend over time in population abundance, distribution among caves, and structure (age class ratios, general health, reproductive status, sex ratio) of the Allegheny woodrat population associated with “unmanaged” caves across the park?
- How do trends in Allegheny woodrat population structure differ between “highly managed” (i.e., with lighting systems, cave doors, block houses, tours, etc.) and “unmanaged” caves on the park?
- What is the current pattern (status) in use of “highly managed” caves by Allegheny woodrats on the park?
- What is the change in the pattern (trend) of use of “highly managed” caves by Allegheny woodrats on the park?

The specific **monitoring objectives** for this protocol are:

1. Determine current population structure and cave-use status and long-term trends in Allegheny woodrat populations in “unmanaged” caves on the park.
2. Establish current use-levels and determine trends in use of “highly managed” caves by Allegheny woodrats on the park.
3. Determine if trends in Allegheny woodrat population status and structure differ between “highly managed” and “unmanaged” caves within the park.

II. Sampling Design

Rationale for Selecting this Sampling Design over Others

Two general questions will be simultaneously assessed in woodrat monitoring: are woodrats using “highly managed” and visited (tour) caves, and what are the trends in woodrat population structure and abundance on the park over time? Both questions will be assessed using a standard live trapping methodology which provides for collection of sex, body weight, reproductive and general health states, ectoparasite load, and tracking of marked individuals. Sampling will occur in two temporally-overlapping designs using the same sampling methodology. One sampling design will address assessment of woodrat use of “highly managed” caves, the other, assessment of population status and trends across the park over time. The differences between the designs include: 1) numbers of sites (caves) being sampled, 2) intensity of sampling at each site, and 3) frequency of sampling over the year. Both designs use the same exact trapping, handling and marking methods, and both base upon a standardized 3-day sampling session (setup on day 1, check traps AM of days 2 and 3, for 2 trap-nights per session). In the “use of managed caves” design, nine (9) “highly managed” caves will be sampled bimonthly (6 sessions per year). In the “park-wide” design, 50 “unmanaged” caves will be sampled hemi-annually (2 sessions per year). Sampling for both designs will be temporally coincident on two of the 6 bimonthly sessions scheduled for “highly managed” cave use assessment. Data from the temporally-overlapped sessions will be used in combined analysis that examines woodrat population status and trends using a “cave management-level” stratification factor. The “unmanaged” or natural caves being sampled for “park-wide” population status and trends are distributed unequally on the North and South sides of MACA, as defined by a natural barrier, the Green River. This distribution pattern will be used as a geographic stratification factor in analysis of data from the “park-wide” design.

Managed caves will be sampled with higher intensity than are the natural caves. Sampling within “highly managed” caves will be accomplished with 4 traps per cave per trap-night, while “unmanaged” caves will be sampled with 2 traps per trap-night. This reflects the fact that “highly managed” caves have a variety of entrance structures that may require trap locations to be distributed within partitioned or otherwise grossly modified entrance areas, as well as deeper into the cave entrance (≤ 50 m from outside), in order to adequately sample for woodrats. Natural cave entrance areas, in contrast, are typically open to access by woodrats, and may be adequately sampled for visitation with only 2 traps per cave. Also, in terms of logistics, more traps can be placed in the limited number ($n=9$) of “highly managed” cave entrances than in the large number ($n=\pm 50$) of “unmanaged” caves]. Sampling “sessions” will run for 3 consecutive days each and will consist of several sampling “events” (a sampling “event” is defined as one project crew’s sampling on one date; roughly equivalent to the data collected and recorded by one crew on a field data form on one date).

This design provides maximum ability to assess use of managed caves by woodrats. The “unmanaged” cave component (~ 50 caves) provides unequal stratification across the park’s major natural barrier, the Green River. Using separate sampling schedules in natural versus managed caves improves potential detection through enabling larger natural cave N within the defined sampling run period. Further efficiency is gained through use of a distance-from-road limit factor in selecting natural caves- sampled caves will be located within 0.3 km of accessible roads to reduce hike-in site access times, which allows inclusion of more caves within the available time.

Site Selection

Following a review of cave location maps and park information, potential sampling sites (caves) were selected with respect to four selection criteria: (1) the question being assessed (Are woodrats using “highly managed” caves? or What are the trends in woodrat population abundance and structure on the park?), (2) location relative to the Green River (i.e., north or south), (3) distance from an accessible road, and (4) road distance (= travel time) from the staff office (i.e., sampling “hub”). The steps followed during the initial sample site selection process which used the four criteria, and rationale for each, are describe below:

- *Criterion #1.* All “highly managed” caves (n=9) on the park were auto-selected by definition as woodrat monitoring sites in order to provide maximum ability to assess use of “highly managed” caves by woodrats. “Highly managed” caves were defined as those having entrances with physical structures such as doors and block houses, or which have electric lighting, or which receive regular visits by tours.
- *Criterion #2.* To assess trends in woodrat population abundance and structure, approximately 50 “unmanaged” or natural caves were selected, roughly equally distributed North and South of the Green River. This is because natural caves are distributed unequally across MACA, on the North and South sides, as defined by a natural barrier, the Green River. “Unmanaged” caves do not have doors (although some have bat-friendly, angle iron gates), block houses, lights, and are off limits to public visitation.
- *Criterion #3.* The approximately 50 “unmanaged” caves were initially selected from the group of caves (n=133) located within 0.3 km from a vehicle-accessible road as determined by straight-line measurement using GIS. This design was chosen to reduce site access times, which allows inclusion of more caves within the available time. This group of caves was considered a semi-random sample of caves on the park because we have no evidence to assume the distribution of roads at MACA affects the distribution of caves. Since fewer caves naturally occur north of the Green River than south, all North side caves (n=25) that met the distance-from-accessible-road criterion were selected as potential sampling sites. The South side caves (n=108) were reduced in number by sorting them by distance from an accessible road, and then selecting the 70 caves closest to a road as potential sampling sites.
- *Criterion #4.* South side caves selected as potential sampling sites were further selected (from the 70 caves closest to a road) based on road distance (=travel time) from the staff office. This serves to increase sampling efficiency by decreasing drive-time to/from caves. The most distal caves were later dropped due to being located a longer road distance from the sampling “hub” (i.e., the staff office).

The final list of “unmanaged” caves on both the north (n=25) and south (n=25) sides were selected from among the potential sites based on safety considerations. Caves which were either unsafe for sampling personnel (e.g., a vertical pit entrance requiring ropes and gear to safely access) or for woodrats (e.g., no safe/sheltered spot in entrance to place traps) were omitted from consideration.

Allegheny Woodrat Sampling Locations

Approximately 59 permanent sampling sites (caves) have been established as a one-time task with respect to the process described in the previous section. However, due to the sensitive nature of cave location data, no information that could be used to determine the location of any

cave at MACA can be disclosed (Cave Resources Protection Act of 1988). Therefore, for review purposes, only a general sampling site locations map is provided (Figure 1). Copies of the approved protocol for internal use only will contain detailed maps and cave location information. Map locations data are elements of the project database (locations tables) established within the CUPN-MACA Data Management System.

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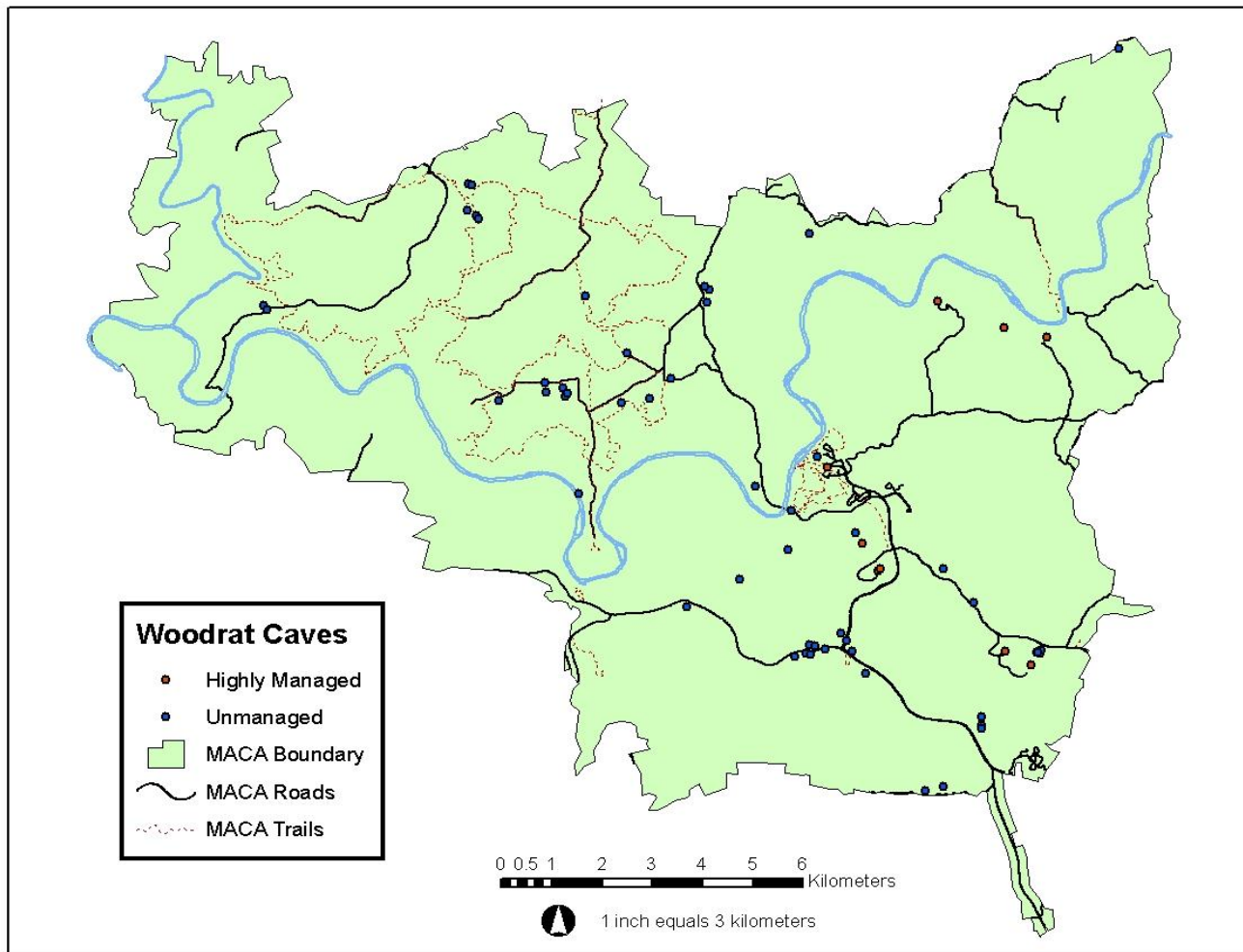


Figure 1. Locations of “unmanaged” and “highly managed” caves for Allegheny woodrat monitoring at Mammoth Cave National Park, Kentucky. **Note:** Due to the sensitive nature of cave location data, cave names have been omitted and all points are approximate while this protocol is under review. In-house copies of the approved protocol will contain information obscured here.

Sample Frequency and Replication

Initially, monitoring of “unmanaged” caves will be accomplished using two three-consecutive-day “sampling sessions” (consisting of at least six “sampling events” total). Sessions are currently scheduled to occur during spring (first two weeks of May) and fall (first two weeks of November). If the number of sampling sessions per year decreases to one, this sampling session will likely be scheduled during November. This is based on previous woodrat monitoring at MACA (Thomas 2003), where annual peaks in trapping success occurred in November four out of five years. The greatest number of juvenile woodrats was captured during May at MACA (Thomas 2003). Marking and recapturing juveniles can provide information on longevity and dispersal. Approximately 20 to 25 “unmanaged” caves will be sampled north of the Green River and 20 to 25 caves will be sampled south of the Green River simultaneously during each session.

Sampling “sessions” in “highly managed” cave entrances are currently scheduled to occur within the first two weeks (see Section III below) of every-other month beginning in January (between 01 and 14 January, March, May, July, September, and November). A maximum of nine caves, all south of the Green River, will be sampled. After a woodrat is captured in a given cave, the frequency of sampling at that cave will decrease to two times per year, with sampling to occur in May (spring) and November (fall) of each year. Managed cave sampling will include a set of alternative follow-up actions that will depend on initial and year-long sampling outcomes for that cave (i.e., if no rats are trapped within 1 year at initial sites, a new, deeper-in-cave array may be developed within the cave). Managed-cave sampling will be scheduled to occur as close to park-wide sampling as possible, to provide comparison within a similar time period and average seasonal condition.

III. Field Methods

Field Season Preparations, Field Schedule, Site-Check, and Equipment Setup

Prior knowledge of sampling procedures and locations is essential for efficient and consistent sampling efforts. Therefore, project crew leaders and crew members should be trained and refreshed (SOP #1 “Training of Field Personnel”), particularly if new personnel join the sampling crews or if intervals between sampling sessions are $\geq$ six months.

Three-consecutive-day sampling sessions will be scheduled by the project leader into 2-week blocks within given sampling months by 31 December for the upcoming calendar year. A two-week window allows for inclement weather, personnel workloads, etc. Initially, woodrat sampling sessions in “unmanaged” caves are scheduled to occur during spring (first two weeks of May) and fall (first two weeks of November). Sampling sessions in “highly managed” cave entrances are initially scheduled for the first two weeks of every-other month beginning in January (between 01 and 14 January, March, May, July, September, and November). Managed-cave sampling will be scheduled to occur as close to park-wide sampling as possible. Sampling routes (sampling order) for each crew will be finalized one or two days beforehand (incorporating information obtained during the site-check of caves described in the next paragraph) in order to maximize efficiency and minimize travel times.

A day or two before the scheduled sampling event a project crew leader and/or a crew member should conduct pre-sampling site-checks of all remote cave entrances (SOP#2 “Pre-Sampling”,

Site-Check of Sampling Sites). The purpose of these checks is to confirm that all sampling sites can be located and accessed (i.e., no safety hazards or roads blocked). Also, particularly difficult to locate caves can be temporarily marked with a piece of colored survey ribbon placed in the vicinity ($\geq 15\text{m}$) of the cave entrance to enable easy location of the cave during sampling. Upon return from the field, the crew leader/member will give a copy of any written notes that may impact sampling logistics to the project leader, and discuss options with the project leader. Based on outcomes of the discussion, appropriate adjustments will be made prior to the next sampling session.

In order to reduce lost time and perhaps lost data, a pre-event checklist is provided (SOP#2 “Pre-Sampling”, Table 2.01.1). The crew leader must check each item on the list, particularly supplies, at least one week before sampling, in case supplies are needed, and again the day before the event for final details. All of the equipment and supplies listed in this checklist should be organized and made ready for each trip into the field, and copies of the field data form (SOP #4 “Conducting Field Sampling”, Appendix A) should be made. Most equipment maintenance and repair/replacement is routinely performed as a post-sampling task—this check serves as an assurance of current readiness. As the crew leader prepares to depart for the field, the list should be checked again and reconciled against supplies and equipment being loaded up to assure nothing is being left behind.

Sampling Methods

Park-wide abundance and population structure will be assessed by live-trapping for woodrats in approximately 50 “unmanaged” caves distributed across the park. Initial design will use a North-South stratification based on the rough bisection of the park by the West-running Green River, with 20 to 25 caves on each side of the river. Two live traps will be placed within each cave for 2 consecutive nights in each sampling session, in 2 sampling sessions per year. Each sampling session will be performed by a minimum of two 2-person crews (one crew leader and at least one crew member). Day 1 of each session will consist of each crew locating approximately 20 to 25 caves (each site located within a 5-minute hike from a drivable road) and setting the two live traps in the entrance area. Beginning early in the morning of Day 2, each trap will be checked, all captured woodrats processed and released, and traps rebaited and reset as necessary. Starting early in the morning of Day 3, each trap will be checked, all captured woodrats processed and released, and traps removed and placed in the vehicle.

Use of “highly managed” caves will be assessed by placing four live traps within the first 50 m of each of 9 managed caves proximal to the main entrance. Trapping will be performed for 2 consecutive nights each sampling session, in 6 sessions in the first sampling year. After a woodrat is captured in a given cave, the frequency of sampling at that cave will decrease to two times per year, with sampling to occur in May (spring) and November (fall) of each year. Managed caves will be sampled by a single two-man crew (one crew leader and at least one crew member). Day 1 will consist of accessing each cave and setting the four live traps in the entrance area. Days 1 and 2 will proceed the same way as described for “unmanaged” caves (above).

Captured woodrats will be transferred from the trap to a cotton mesh handling bag for processing. A woodrat will be processed following these steps:

1. Visually inspect woodrat for presence of tattoo
2. Make-ready tattooing supplies and equipment if woodrat is unmarked
3. Zero scale
4. Transfer woodrat from trap to handling bag
5. Weigh woodrat
6. Determine sex
7. Determine age class
8. Determine reproductive condition
9. Determine ectoparasite load (e.g., fleas, ticks, bot fly larvae)
10. Assess physical condition
11. Tattoo previously unmarked woodrat
12. Release woodrat at site of trap

A detailed description of procedures, listed in the order they should occur, for: (1) operating live traps; (2) handling a woodrat; (3) weighing a woodrat; (4) differentiating between woodrat sexes; (5) assessing reproductive condition; (6) differentiating among woodrat age classes; (7) assessing woodrat measures of “health”; (8) marking a woodrat, and (9) filling in the field data form is provided in SOP #4 “Conducting Field Sampling”.

IV. Data Management

Overview of Database Design

Following the lead of the National Park Service (NPS) and the Inventory and Monitoring (I&M) Program, CUPN-MACA Monitoring Program has adopted MS Access XP (2002) as its desktop database standard and ArcGIS as the GIS standard.

Rather than developing a single, integrated database system, CUPN-MACA relies upon modular, standalone project databases that share design standards based on the I&M Program’s Natural Resource Database Template (NRDT) with links to shared lookup tables housed in a centralized database. This and other protocol databases developed by CUPN-MACA share certain design standards. This is important given the often unpredictable ways in which datasets may be aggregated and summarized. Each protocol database is developed using the following primary components:

It should be noted the current database model for this protocol was developed using the NRDT, phase II tables and structure, where possible. However, recent (December 2004) proposed changes (phase III) to the NRDT will likely result in significant changes to the data model presented in SOP #6, as the sampling methodology and data model are further developed.

1. *Common lookup tables* – Links to entire tables that reside in a centralized database, rather than storing redundant information in each database. These tables contain information that is not project-specific (e.g., lists of parks, personnel, and species).

2. *Core tables and fields based on CUPN-MACA and national templates* – These tables and fields are used to manage the information describing the “who, where and when” of project data. Core tables are distinguished from common lookup tables in that they reside in each individual project database and are populated locally. These core tables contain critical data fields that are standardized with regard to data types, field names, and domain ranges.
3. *Project-specific tables and fields* – The remainder of database objects can be considered project-specific, although there will typically be a large amount of overlap among projects. For example, a time field will require similar data types and domain values.

A noteworthy deviation from the NRDT for this and other cave-related protocols is the development of a “tlu_Cave_Locations” table. It is a common lookup table shared by all cave protocols. While this table contains the exact structure and fields found in the NRDT, phase II table “tblLocations”, it also contains additional cave-specific fields. The decision to break out cave location information in this manner was made in large measure due to its recognized sensitivity level. The project-specific data tables for this protocol include:

- tblCaveObservation – Contains cave level observational information such as woodrat sign and cave notes.
- tblTrapObservation – Contains trap level observational information such as trap condition and trap notes.
- tblOccupant – Contains observational information for each woodrat capture such as sex and weight of the trap occupant.

Data Entry

Extensive use of programmatic data validation has been incorporated to greatly reduce the number of operator entry errors. Rather than direct database table entry, customized forms are being designed and tested that provide a natural flow of data entry into the database and validate the entered data before allowing them to be written to the database. Where possible, data are entered via the use of dropdown lists (i.e., built into the form or separate lookup tables) or by typing the beginning characters of the value, thus eliminating a large proportion of potential operator entry errors.

For other data fields, validation controls prevent impossible values to be entered (e.g., a negative number for woodrat weight) and data entry alert messages are provided any time a datum is entered that is not realistic (e.g., weight greater than 600 g). The user is offered a chance to reenter the data or keep the abnormal data. If the user accepts the abnormal data, a log file will be generated listing pertinent information about the out-of-range data (e.g., sample number, fields, entry operator, sample collector, etc.). The log file is submitted to the project leader.

Data Verification and Editing

In addition to data verification accomplished by the computer program, the data will also be manually verified shortly after data entry. This process involves checking the accuracy of

computerized records against the original source. To minimize transcription errors, our policy is to verify 10 percent of the records to their original source by staff familiar with project design and field implementation.

The primary goal of data entry verification is to determine where errors are being introduced into the database. Each error found will, of course, be corrected, but will additionally be cataloged to find methods for eliminating that specific type of error during subsequent collection periods.

Metadata Procedures

While the importance of metadata is universally accepted within the data management community, the approaches for collection and levels of detail are varied (sometimes referred to as the “101 ways”). A primary component of our dataset documentation approach is the I&M Program’s Dataset Catalog. Dataset Catalog provides a means whereby CUPN-MACA can organize, maintain, and disseminate brief metadata on its dataset holdings. In addition, staff can identify and prioritize datasets for which formal metadata will be developed and identify the status of metadata documentation for a particular dataset (i.e., planned, in work, or complete).

A Dataset Catalog record will be entered by the data manager, based on information provided by the project leader. It is the shared responsibility of the data manager and project leader to ensure this record is accurate and remains up-to-date. The decision to develop Federal Geographic Data Committee (FGDC) compliant metadata, utilizing the FGDC Biological Data Profile, for the tabular dataset produced by this protocol will be based upon (1) its level of use in analysis, (2) the amount of requests received for data sharing, (3) and staff workloads. All GIS layers generated from this project will be documented with applicable FGDC and NPS metadata standards.

Data Archival Procedures

This and other monitoring protocols will have variable long-term data archiving requirements. Modifications to protocols will typically require complete datasets to be archived before modifications are implemented. Archived datasets or subsets destined for long-term archiving will be saved in their native formats. To ensure the capability of accessing the data the application software will be maintained. If it is not possible to archive or support the application software, the data will be stored in ASCII text files.

Versioning of archived datasets is handled by adding a three digit number to the file name, with the first version being numbered 001. Each subsequent version is assigned a sequentially higher number.

Tabular datasets destined for archiving will be stored locally within an object-oriented file structure established on the MACA file server. Currently this server is backed up to an HP Superstore Autoloader nine tape carousel using DLT tapes. All backups are performed and monitored by MACA IT system administrators. Currently GIS files are maintained and archived separately by the GIS specialists.

V. Analysis and Reporting

Data Analysis

The monitoring questions and subsequent analysis of the supporting data can be divided into two categories, based on time scale in analysis. The first category includes questions of status (population structure and relative abundance), natural distribution across the park, and management—influence on population status and use of caves, measured at the within-a-year and annual scales. The second category includes these same questions, considered over multi-year scales. Both categories of questions will be addressed using a combination of summary and descriptive statistics, graphic analysis, and multivariate comparative and correlative analysis. Additional analytic approaches will be employed to evaluate woodrat population parameters in a comparative and correlative model with park-level weather trends and spatial dynamics and movement of woodrats among sampled caves.

Data analysis with respect to use of “highly managed” caves by woodrats will be performed sequentially as data are collected and analyzed in bimonthly sampling sessions. Each session’s data will be evaluated using a suite of descriptive and summary statistics. Annual and longer-term trends analyses will use separate bimonthly data sets (for “highly managed” caves), hemi-annual, and derived, cumulative annual data to evaluate longer-period trends and patterns, both for “highly managed” and “unmanaged” caves.

The development of basic queries and summary reports in MS Access will be utilized to automate and thus streamline the data analysis and reporting workload, as appropriate. In consultation with the project leader, the data manager will develop queries (and accompanying summary reports) that will address basic statistical questions. It is anticipated the results of these queries will be relied upon heavily for annual reporting.

In instances where the statistical questions become increasingly complex, data will need to be exported out of the relational MS Access database to commercial off-the-shelf statistical packages for higher level statistical analyses (i.e. t-tests and ANOVA). In general, these data will be formatted based on parameters provided to the data manager via a make-table query in MS Access. The generated table will be exported in comma delimited ASCII text format for import into the appropriate statistical analysis software.

Reporting

There will be two main categories of reports produced from woodrat monitoring at MACA. The first is an annual status report. The second type of report will be used to summarize long-term trends and will become available after multiple years (~5) of monitoring have been completed. Annual status reports will address the same basics questions as long-term summary reports, just at different time scales.

In an effort to disseminate findings in a timely manner, annual reports should be completed by March 31 of the year following data collection. A brief (2-3 paragraphs) summary of sampling

activities, preliminary results, and any public interest highlights that occurred during each federal fiscal year will be written by October 15 for inclusion in the CUPN-MACA Monitoring program's Annual Administrative Report. More extensive summary reports (long-term trend reports) should be completed every five years. Summary reports may be used in place of annual reports for the year in which the last data are collected.

VI. Personnel Requirements and Training

Roles and Responsibilities

Implementation of this protocol requires an overall project leader and a minimum of two 2-person project crews. The project leader oversees and directs project operations, including training of personnel. Each crew consists of one project crew leader and at least one project crew member. The project crew leader has site familiarity, woodrat sampling/handling techniques expertise, and is responsible for team tasks. The project crew member has varied and less expertise, and is responsible for assisting the crew leader with data collection.

The project leader is the principal ecologist for implementing this monitoring protocol and is supervised by the MACA Prototype coordinator. The project leader will be responsible for training, data collection, filing trip reports with the data manager, some data entry, data verification, data validation, data summary, analysis, and reporting. Trained NPS scientists will serve as crew leaders and will be responsible for preparation of supplies/equipment, conducting pre-sampling site-checks, some training, project crew oversight, data collection, data recording, post-sampling equipment inspection and storage, and some data entry. Crew members, will be responsible for assisting with pre-sampling site-checks, some data collection and some data entry. Data management will be shared responsibilities among the project leader and data manager. The data manager and project leader will develop automated data entry forms and database features as part of the quality assurance process. The data manager is ultimately responsible that adequate QA/QC procedures are built into the database management system. The data manager, project leader, prototype coordinator are jointly responsible for ensuring data handling procedures are followed.

Qualifications and Training

An essential component for the collection of credible, high-quality woodrat data is well-trained and experienced project crew leaders. Therefore, new crew leaders should be thoroughly familiar with SOP #4 "Conducting Field Sampling" and should be given hands-on training by the project leader, or an experienced crew leader designated by the project leader, for each of the items detailed therein. Because of the time and effort required to fully train a crew leader, it is recommended that only permanent staff scientists be trained as crew leaders. The overall project leader should be a permanent staff member as well.

Special qualifications and training for crew members is not required because the tasks assigned to them can be easily taught and rehearsed in less than 1-hour during a pre-sampling "training and handling preparation" meeting on Day 1 of a sampling session. Due to the need for underground travel and in environments with some surface relief all project crew should be free of claustrophobia and relatively physically fit.

VII. Operational Requirements

Annual Workload and Field Schedule

In the initial year-long test of the protocol, woodrat monitoring of “highly managed” caves will occur on a bimonthly basis beginning in January (between 01 and 14 January, March, May, July, September, and November). Sampling sessions in “highly managed” cave entrances are scheduled for the first two weeks of each sampling month. A two-week window allows for inclement weather, personnel workloads, etc. Monitoring efforts in “highly managed” caves will require one two-person crew. Woodrat sampling sessions in “unmanaged” caves are scheduled to occur during the first two weeks of May and the first two weeks of November. Monitoring efforts in “unmanaged” caves will require at least two 2-person crews. Based on the pilot test, the nine “highly managed” caves can be sampled by one two-person crew in less than six hours per day (for a total sampling staff field time of about 12 staff-hours per day). Sampling “unmanaged” caves should take each two-person crew approximately eight hours per day to complete (approximately 32 staff-hours per day total).

Facility and Equipment Needs

The nature of woodrat sampling work does not require special facilities beyond normal office space and equipment storage needs. Table 2.01.1 in SOP #2 “Pre-Sampling” contains a list of field equipment needs for one crew. Since two crews will work simultaneously, equipment requirements will increase accordingly.

Startup and Monitoring Costs

Personnel expenses for field work are based on two crews of two people—an NPS scientist to oversee the sampling session (project leader) and/or act as crew leader, plus a transient individual to act as a crew member. The initial year-long test of the protocol will involve: (1) four people doing four full days of field work twice a year (one day of pre-sampling site-check plus the 3-day sampling session of “unmanaged” caves) for approximately 32 field-days per year, and (2) two people doing three half-days of field work six times a year (for “highly managed” caves) for approximately 18 field-days per year. Therefore, woodrat monitoring is estimated to require a total of 50 field-days to implement. Field costs will vary somewhat from year to year based on the skill level and size of the crew. Further, the permanent sampling schedule may decrease after the year-long test of the protocol. Data management personnel expenses will include staff time of student interns, the project leader, the data manager, and other NPS staff. We are currently analyzing personnel expenses including staff time of student interns, full-time employees, the project leader, and data manager. There are no anticipated startup costs for implementing this protocol, since all items on the list of supplies and equipment (SOP #2 “Pre-Sampling”, Table 2.01.1) have already been purchased. Annual supplies and equipment costs should be minimal ($\leq$ \$200), since the most expensive items on the list (i.e., two-way radio and GPS unit) are shared among multiple projects.

Procedure for revising the Protocol and Archiving Previous Protocol Versions

No protocol can be expected to remain unchanged over the long term. The Allegheny woodrat protocol, although well researched and defined, is no exception. We anticipate the foundation,

the logic and rationale of program design, to remain as written over the term of the program. However, there will come a time when program logistics, such as sample locations, methods, and reporting criteria may require updating. Careful documentation of changes to the protocol are essential when people, years from now, are examining data trends for example, to know exactly what conditions the data were gathered. All woodrat monitoring data will be entered into a project-specific MS Access database, which within is a field that denotes the protocol version under which the data were collected. Each protocol version will be properly archived to ensure future retrieval.

The rationale for dividing a sampling protocol into a Protocol Narrative with supporting SOPs is based on the following:

- The Protocol Narrative is a general overview of the protocol that gives the history and justification for performing the work as well as sampling methods. It does not contain all methodological details which are found in the accompanying SOPs. The Protocol Narrative is changed only if major revisions are necessary.
- The SOPs, in contrast, are specific detailed instructions for performing given tasks and are expected to be revised more frequently than the Protocol Narrative.
- When a SOP is revised, in most cases, it will not require modification to the Protocol Narrative, unless they affect the Narrative direction or rationale.
- All versions of the Protocol Narrative and SOPs will be archived in the MACA Prototype protocol library and referenced to the resulting Woodrat data.

Steps for changing the Protocol Narrative or SOPs are detailed in SOP #9 “Revising the Protocol”. Each SOP contains a Revision History Log that will be filled out each time a SOP is changed.

VIII. References

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A Protocol for Monitoring Allegheny Woodrats (*Neotoma magister*) at Mammoth Cave National Park

Standard Operating Procedure (SOP) # 1

Training of Field Personnel

Version 1.0 (December 2004)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Implementation of this protocol requires an overall **project leader** and a minimum of two 2-person project crews. The project leader oversees and directs project operations, including training of personnel. Each crew consists of one **project crew leader** and at least one **project crew member**. The project crew leader has site familiarity, woodrat sampling/handling techniques expertise, and is responsible for team tasks. The project crew member has varied and less expertise, and is responsible for assisting the crew leader with data collection.

An essential component for the collection of credible, high-quality woodrat data is well-trained and experienced project crew leaders. This cannot be overemphasized. Therefore, new crew leaders should be thoroughly familiar with SOP #4 “Conducting Field Sampling” and should be given hands-on training by the project leader, or an experienced crew leader designated by the project leader, for each of the items detailed therein. Many procedures require little time to reach an adequate level of proficiency (e.g., locating sampling sites, operating traps, and sexing woodrats), while others may take several sampling events and handling several woodrats to become fully competent (e.g., assessing woodrat reproductive condition, determining age class, and properly marking a woodrat). Because of the time and effort required to fully train a crew leader, it is recommended that only permanent staff be trained as crew leaders. The overall project leader should be a permanent staff member as well. Several crew leaders should be trained (and should participate in sampling on a regular basis) from among permanent Mammoth Cave National Park (MACA) staff in case primary crew leaders are unavailable for particular sampling events. Proper adherence to SOP #2 “Pre-Sampling” should serve to refresh and “recalibrate” the crew leaders’ abilities to prepare for sampling; locate sampling sites; identify woodrat sex, reproductive condition, age class, and measures of overall “health”; and properly record the information—which ensures integrity of the data being collected.

Transient personnel (e.g., student interns, short-term or seasonal employees, volunteers, etc.) should serve as project crew members (i.e., field assistants). While review of SOP #4

“Conducting Field Sampling” for crew members is encouraged, it is not essential because the tasks assigned to crew members can be easily taught and rehearsed in less than 1-hour during a pre-sampling “training and handling preparation” meeting on Day 1 (e.g., carrying traps, placing polyester fiber fill in traps, slicing apples, baiting traps, setting traps, checking traps, holding a woodrat, etc.). In this meeting, the project leader (or designated crew leaders) also reviews member roles, steps in the sampling process, the particular safety Job Hazard Analyses, and two-way radio use. A checklist to assist the training and preparation meeting facilitator is provided (Table 1.01.1).

Table 1.01.1. Pre-Sampling training and handling preparation meeting checklist for Woodrat Monitoring. Meeting conducted by either overall project leader or project crew leader(s) designated by the project leader.

Item	Description
Pre-Event Training Meeting Checklist	
☐ 1.	Demonstrate how to operate a live trap; including inspection, correct setup, baiting, placement of fiber fill, setting, and folding process (see SOP #4 “Conducting Field Sampling”).
☐ 2.	Discuss risk of woodrat bites and describe how to handle a woodrat; including transfer of woodrat from trap to handling bag, and holding and releasing a rat (see SOP #4 “Conducting Field Sampling”).
☐ 3.	Review roles of project crew leader and crew member(s) (see SOP #1 “Training of Field Personnel”).
☐ 4.	Review steps in the field sampling process (see SOP #4 “Conducting Field Sampling”, Appendix B).
☐ 5.	Review appropriate Job Hazard Analyses (JHA’s) (see SOP #4 “Conducting Field Sampling”, Appendix C).
☐ 6.	Demonstrate proper use of the park’s two-way radios (including radio call #’s).

Since the Allegheny woodrat (*Neotoma magister*) is the only woodrat species known to occur at MACA and is easily distinguished from other rodents on the park, expertise in woodrat identification is not required for project crew.

A Protocol for Monitoring Allegheny Woodrats (*Neotoma magister*) at Mammoth Cave National Park

Standard Operating Procedure (SOP) # 2

Pre-Sampling

Version 1.0 (December 2004)

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This SOP gives procedures for (1) general sampling preparation and (2) conducting pre-sampling site-checks of cave entrances, as well as (3) a brief description of how woodrat monitoring should be scheduled at Mammoth Cave National Park (MACA), and (4) how to organize supplies and equipment. In order to reduce lost time and perhaps lost data, a pre-event checklist is provided (Table 2.01.1). All of the equipment and supplies listed in this checklist should be organized and made ready for each trip into the field, and copies of the field data form (SOP #4 “Conducting Field Sampling”, Appendix A) should be made. This SOP describes tasks to be performed prior to Day 1 of a sampling session. Therefore, the crew leader should not simply peruse the checklist the morning before the sampling session. The crew leader must check each item on the list, particularly supplies, at least one week before sampling, in case supplies are needed, and again the day before the session for final details (such as keys, road closures, batteries for lights/GPS units, etc). Finally, as the crew leader prepares to depart for the field, the list should be checked again and reconciled against supplies and equipment being loaded up to assure nothing is being left behind.

I. General Preparation And Review

Procedures:

1. Copies of field data forms from recent surveys should be reviewed to identify any unique events or hazards that may be encountered. Trip reports are based on information recorded on field data forms, so it is imperative that they are clearly organized for ease of field note entry. Thus, uniform field data forms printed on “Rite-in-the-Rain” paper will be used by project crew leaders in an effort to standardized field data entries between sampling crews (SOP #4 “Conducting Field Sampling”, Appendix A).

2. Prior knowledge of sampling procedures and locations is essential for efficient and consistent sampling efforts. Therefore, project crew leaders and crew members should be trained and refreshed (SOP #1 “Training of Field Personnel”), particularly if new personnel join the sampling crews or if intervals between sampling sessions are greater than or equal to six months.

II. Site-Check of Sampling Sites

Procedures:

1. A day or two before the scheduled sampling session, a project crew leader should obtain a hard copy of the **map** (i.e., from the project leader’s file cabinet in the office, or print a new copy from the GIS subfolder in the woodrat project Images folder on the shared drive on write-in-the-rain paper) with the appropriate cave locations and cave numbers. Also, obtain a hard copy of the appropriate **cave locations field list** (i.e., ordered route list) (i.e., from the project leader’s file cabinet in the office, or print a new copy from the “Docs” subfolder in the “Woodrats” project folder on the shared network drive on write-in-the-rain paper) for “unmanaged” caves (e.g., SOP #3 “Establishment and Location of Sampling Sites”, Table 3.01.1) or for “highly managed” caves (e.g., SOP #3 “Establishment and Location of Sampling Sites”, Table 3.01.2) with written directions to the vehicle access parking location and to each cave from the vehicle, and geographic coordinates in Universal Transverse Mercator (UTM), utilizing the North American Datum 1983 (NAD83) projection, for parking and cave entrance locations. Review map and cave locations field list, and become familiar with route and directions to each cave prior to departing for the field.
2. The GIS specialist will download the most current geographic coordinates for each cave entrance scheduled for sampling into the GPS unit to be utilized by the respective field crews. Note: It is the responsibility of the project crew leader to schedule this task with the GIS specialist in advance and provide the GPS unit to the GIS specialist. If the waypoints have not been erased from the GPS unit since the last time the cave entrances were visited, simply confirm that the waypoint for each cave is there. Note: sampling site waypoints can be stored on GPS units between sampling sessions. However, if caves are added or removed from the list of sampling sites for monitoring, the waypoint list must be updated and unneeded cave entrance location information should be erased from the GPS unit.
3. Following the written directions in the appropriate cave locations field list (e.g., SOP #3 “Establishment and Location of Sampling Sites”, Table 3.01.1 or Table 3.01.2) and GPS unit if necessary, the crew leader and/or a crew member should drive a field vehicle to the designated parking spot (point on a road that is closest to the first cave entrance). Safely park the vehicle and locate the cave entrance on foot using the “Navigate” or “Go To” feature on the GPS unit (see operations manual for unit) in conjunction with the written directions and the map.
4. Confirm the correct entrance has been found by locating the permanent numbered brass marker (“cap”) anchored to a rock in the entrance, and/or the cave entrance description information. Note: presently, not all cave entrances have been permanently marked. The current permanent mark status for each cave should be noted on the cave locations field list.
5. Visually inspect cave entrance for new hazards (e.g., recent entrance collapse, unstable rocks in entrance, tree blocking entrance, flooding, ice in entrance, access road blocked or

impassible, etc.). Make written notes regarding any such hazards and initial recommendations for later discussion with the project leader.

6. Temporarily mark all non-permanently marked caves with a piece of colored survey ribbon placed in the vicinity ($\geq 15\text{m}$) of the cave entrance to enable easy location of the cave during sampling. Note: special care should be exercised to remove the ribbon on the last day of the 3-day sampling session in order not to compromise site “security”.
7. Continue as above to the second cave on the route until all cave entrances have been located. Note: it is not necessary to conduct a pre-sampling site-check of the 5 “highly managed” cave entrances that receive daily visitation (i.e., Carmichael, Historic, Frozen Niagara, New, and Violet City); since all hazards will be reported by other NPS staff and resolved quickly.
8. Immediately give a copy of any written notes that may impact sampling session logistics to the project leader and discuss options with the project leader.
9. Based on outcomes of the discussion in procedure #8, adjustments [e.g., the sampling route (order), number of caves to sample, which caves to sample] are made and a new cave locations field list (i.e., ordered route list) is produced (on write-in-the-rain paper), necessary changes to the GPS waypoint list are made, and the GPS unit and hardcopies are placed with the rest of the supplies/equipment, assembled for the ensuing sampling session. Note: Caves on the cave locations field list should be arranged according to the order they will be encountered following the most time-efficient route.

III. Scheduling Field Work

Procedures:

1. Three-consecutive-day sampling sessions will be scheduled by the project leader into 2-week blocks within given sampling months by 31 December for the upcoming calendar year. A two-week window allows for inclement weather, personnel workloads, etc. Initially, woodrat sampling sessions in “unmanaged” caves are scheduled to occur during spring (first two weeks of May) and fall (first two weeks of November). If the number of sampling sessions per year decreases, monitoring will likely be scheduled during November. Monitoring sampling sessions in “highly managed” cave entrances are initially scheduled for the first two weeks of every-other month beginning in January (between 01 and 14 January, March, May, July, September, and November). *Rationale*: Based on previous woodrat monitoring at MACA (Thomas 2003), annual peaks in trapping success occurred in November four out of five years. The greatest number of juvenile woodrats was captured during May at MACA (Thomas 2003). Marking and recapturing juveniles can provide information on longevity and dispersal. *Background Information*: Sampling routes (sampling order) for each crew will be finalized one or two days beforehand (incorporating information obtained during the site-check of caves detailed in the previous section) in order to maximize efficiency and minimize travel times. Based on results from the pilot test, the nine “highly managed” cave entrances can easily be sampled by one crew in less than six hours per day.

IV. Organizing Supplies and Equipment

Procedures:

1. The crew leader should check each item on the supplies and equipment checklist (Table 2.01.1) to organize and make everything ready one week in advance of a sampling session. This allows time to make needed repairs, check batteries and purchase supplies, if necessary. The following is a list of field supplies and equipment needs for one sampling crew, along with a pre-event logistical checklist. Note: most equipment maintenance and repair/replacement is routinely performed as a post-sampling task—this check serves as an assurance of current readiness.

Table 2.01.1. Logistical and field supplies/equipment checklist for Woodrat Monitoring.

Number Required	Description
Pre-Event Logistical Checklist	
☐ 1.	Schedule monitoring crews with caves and ordered routes in advance
☐ 2.	Reserve appropriate number and type of vehicles in advance
☐ 3.	Go through supplies/equipment checklist
☐ 4.	Check all appropriate equipment for battery (including two-way radios) condition—replace as needed
☐ 5.	Pre-sampling “site-check” to locate & visually inspect each remote cave ent.
☐ 6.	Crew member(s) assemble, inspect, and place fiber fill in traps.
☐ 7.	Fill out Cave Entrance Request Form for all non-artificially lighted caves and file one copy with Ranger Division---Project leader keeps originals in file
☐ 8.	Obtain keys to cave gates/doors and road gates (<i>list will be provided here, but it is hidden in this draft protocol for security purposes</i>)
☐ 9.	Perform general pre-event vehicle inspection (check: first aid kit, fuel level, oil level, tires, spare tire and changing equipment, lights, and wipers)
☐ 10.	Establish surface watch
☐ 11.	Sign out crew with destination, vehicle, and approximate return time on dry erase board in office
Supplies/Equipment Checklist (<u>Per</u> Crew)	
<i>“Unmanaged” Caves Monitoring (per crew, 2 crews needed):</i>	
☐ 50	Live traps [Tomahawk brand #102 (rigid) or #201 (collapsible)]
☐ ~100	Cover boards (8” x 16” x 1/8”) for covering top and one side of each trap
☐ ~55	Apples

“Highly Managed” Caves Monitoring (per crew, 1 crew needed):

- ☐ ≤ 36 Live traps [Tomahawk brand #102 (rigid) or 201 (collapsible)]; place 4 traps per cave, if all 9 caves scheduled to be trapped then 36 traps needed; if 8 caves, then 32 traps needed; 7 caves = 28 traps; and so on
- ☐ ≤ 72 Cover boards (8” x 16” x 1/8”) for covering top and one side of each trap (fewer boards needed if less than 36 traps set); use ~2 boards per trap
- ☐ ≤ 40 Apples (fewer apples needed if less than 36 traps set); calculations based on about 1.1 apples per trap

Both “Unmanaged” and “Highly Managed” Caves Monitoring (per crew):

- ☐ 1 Pesola brand scale (500g or 600g)
- ☐ 1 Cotton mesh bag (the type found at natural food/produce stores for customers to carry fruit in works well) with a boot lace threaded through the holes around the perimeter of the bag’s mouth; tie around trap door for handling woodrats
- ☐ 1 Polyester fiber fill (5 lb bag/box)
- ☐ 1 Tattoo pliers (Model 3080 from Stone Mfg. and Supply Co., Kansas City, MO)
- ☐ 1 Container (pill box) with tattoo letters/numbers (#300 tattoo digit)
- ☐ 1 Bottle of black ink for marking male woodrats
- ☐ 1 Bottle of green ink for marking female woodrats
- ☐ 10 Disposable latex or vinyl gloves in ziplock bag for applying ink to woodrat ears
- ☐ 10 Alcohol wipes stored in ziplock bag to clean woodrat ears prior to tattooing
- ☐ 1 Copy of woodrat trapping history report from database (*optional*).
- ☐ 1 Covered clipboard for field data forms
- ☐ 1 Field data forms for two sampling days (on write-in-the-rain paper)
- ☐ 2 Pencils and/or Permanent markers (“Sharpies”)
- ☐ 1 Backpack and/or “fanny” pack to hold equipment
- ☐ 2 Work gloves
- ☐ 2 Helmets with lights
- ☐ 2 Hand-held flashlights for backup
- ☐ ~10 Extra AA batteries for lights and GPS unit
- ☐ 1 Hard copy of map with cave locations (on write-in-the-rain paper)
- ☐ 1 Hard copy of appropriate (“unmanaged” or “highly managed”) cave locations field list with written directions to each cave (on write-in-the-rain paper)

- ☐ 1 GPS unit with all cave entrance waypoints pre-programmed
- ☐ 1 Needle-nose pier for adjusting and repairing traps
- ☐ 1 ~0.5 meter-long section of cotton string for repairing handling bag
- ☐ 1 Pocket knife for cutting string and apples
- ☐ 6 Trash bags to keep bedding dry while transporting to caves during rain and for soiled bedding and other trash (e.g., disposable gloves, used alcohol wipes)
- ☐ 1 Two-way radio (operational and fully charged)
- ☐ 1 First Aid kit

Crew Leader's Signature: _____ Date: _____

IV. References

Thomas, S. C. 2003. Allegheny woodrat monitoring in Kentucky final report. Cooperative Agreement No. G553002001 between the National Park Service, Mammoth Cave National Park and the Kentucky Department of Fish and Wildlife Resources. 76pp.

A Protocol for Monitoring Allegheny Woodrats (*Neotoma magister*) at Mammoth Cave National Park

Standard Operating Procedure (SOP) # 3

Establishment and Location of Sampling Sites

Version 1.0 (December 2004)

Revision History Log:

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This SOP explains the procedures used for establishing (i.e., selecting) and locating permanent sampling sites (i.e., cave entrances) that should be followed by all project crews both: (1) prior to sampling (if an additional site is to be added) and (2) during sampling events.

I. Establishment of Sampling Sites

Approximately 59 permanent sampling sites (caves) have been established as a one-time task. If necessary, additional sites may be selected following the 4-step procedure outlined below. The distance from accessible road parameter should be incrementally increased by 0.1 km until a satisfactory list of potential sampling caves is obtained.

Procedures:

1. Cave location maps and park information was reviewed to locate sampling sites with respect to four selection criteria. Potential sampling sites (caves) were selected based on: (1) the question being assessed (Are woodrats using “highly managed” caves? or What are the trends in woodrat population abundance and structure on the park?), (2) location relative to the Green River (i.e., north or south), (3) distance from an accessible road, and (4) road distance (= travel time) from the staff office (i.e., sampling “hub”). *Rationale:* Criterion #1—All “**highly managed**” caves (n=9) on the park were auto-selected by definition as woodrat monitoring sites in order to provide maximum ability to assess use of “highly managed” caves by woodrats. Therefore, no additional such caves should be added to the list of monitoring sites unless park managers prescribe a management action like those contained in the definition which follows. “Highly managed” caves were defined as those having entrances with physical structures such as doors and block houses, or which have electric lighting, or which receive regular visits by tours. Criterion #2—To assess trends in woodrat population abundance and structure, approximately 50 “**unmanaged**” or natural caves were

selected, roughly equally distributed North and South of the Green River. *Rationale:* Natural caves are distributed unequally across MACA, on the North and South sides, as defined by a natural barrier, the Green River. Note: “Unmanaged” caves do not have doors (although some have bat-friendly, angle iron gates), block houses, lights, and are off limits to public visitation. Criterion #3—The approximately 50 “unmanaged” caves were initially selected from the group of caves (n=133) located within 0.3 km from a vehicle-accessible road as determined by straight-line measurement using GIS. *Rationale:* This design was chosen to reduce hike-in/out site access times, which allows inclusion of more caves within the available time. Since fewer caves naturally occur north of the Green River than south, all North side caves (n=25) that met the distance from accessible road criterion were selected as potential sampling sites. The South side caves (n=108) were reduced in number by ordering them by straight-line distance from a vehicle-accessible road, and then selecting the 70 caves closest to a road as potential sampling sites (which effectively “squeezed” the distance-from-road boundary down from 0.3 km to 0.2 km). Note: we have no evidence to assume the distribution of roads at MACA affects the distribution of caves. Therefore, this group of caves was considered a semi-random sample of caves on the park. Criterion #4—South side caves selected as potential sampling sites were then further reduced (from the 70 caves closest to a road) based on road distance (=travel time) from the staff office. This serves to increase sampling efficiency by decreasing drive-time to/from caves. The most distal caves were later dropped due to being located a longer road distance from the sampling “hub” (i.e., the staff office).

2. The 40 nearest caves on the South side were visited to assess whether or not they were safe to use as a permanent site. The final list of “**unmanaged**” caves on both the north (n=25) and south (n=25) sides were selected from among the potential sites based on safety considerations. Caves which were either unsafe for sampling personnel (e.g., a vertical pit entrance requiring ropes and gear to safely access) or for woodrats (e.g., no safe/sheltered spot in entrance to place traps) were omitted from consideration. Caves which could not be located were also omitted from consideration.
3. The proposed list of sites was adjusted to create the final list.
4. GIS was informed, and maps and tables were created for cave locations (e.g., Figure 3.01.1, Table 3.01.1, and Table 3.01.2).

II. Location of Sampling Sites during a Sampling Event

Procedures:

1. On Day 1 of a sampling event, obtain the current/revised sampling locations map and cave locations field list (i.e., ordered route list, with written driving and walking directions) on write-in-the-rain paper described in procedure #9 in “Site-Check of Sampling Sites” (SOP#2 “Pre-Sampling”). Review map and field list, and become familiar with route and directions to each cave prior to departing for the field. Note: Caves on the cave locations field list should be arranged according to the anticipated order they will be encountered following the most time-efficient predetermined route.
2. Following the written driving directions in the appropriate cave locations field list (e.g., Table 3.01.1 or Table 3.01.2) and GPS unit if necessary, the crew leader and crew member(s) should drive the field vehicle to the designated parking spot (point on a road that is closest to

the first cave entrance). Safely park the vehicle and locate the cave entrance on foot using the “Navigate” or “Go To” feature on the GPS unit (see operations manual for unit) in conjunction with the written directions and the map. The temporary piece of colored survey ribbon placed in the vicinity (≥ 15 m) the previous day (or two) during the pre-sampling site-check (SOP #2 “Pre-Sampling”, Site-Check of Sampling Sites) should aid in locating the entrance.

3. Confirm the correct entrance has been found by locating the permanent numbered brass marker (“cap”) anchored to a rock in the entrance, and/or cave entrance description information. Note: presently, not all cave entrances have been permanently marked.
4. Visually inspect cave entrance for new hazards (e.g., recent entrance collapse, unstable rocks in entrance, tree blocking entrance, flooding, ice in entrance, access road blocked or impassible, etc.) since the pre-sampling site-check a day or two earlier. Record notes regarding any such hazards in the “Cave Notes” field of the field data form (SOP#4 “Conducting Field Sampling”, Appendix A) for that cave.
5. Continue as above to the next cave on the route until all cave entrances have been located.
6. Repeat the above steps to locate sampling sites on Day 2 and Day 3 of the sampling session. Note: Remember to remove the temporary ribbon placed at selected “hard to find” cave entrances on Day 3 of the sampling session in order not to compromise the “sensitivity” of these locations.

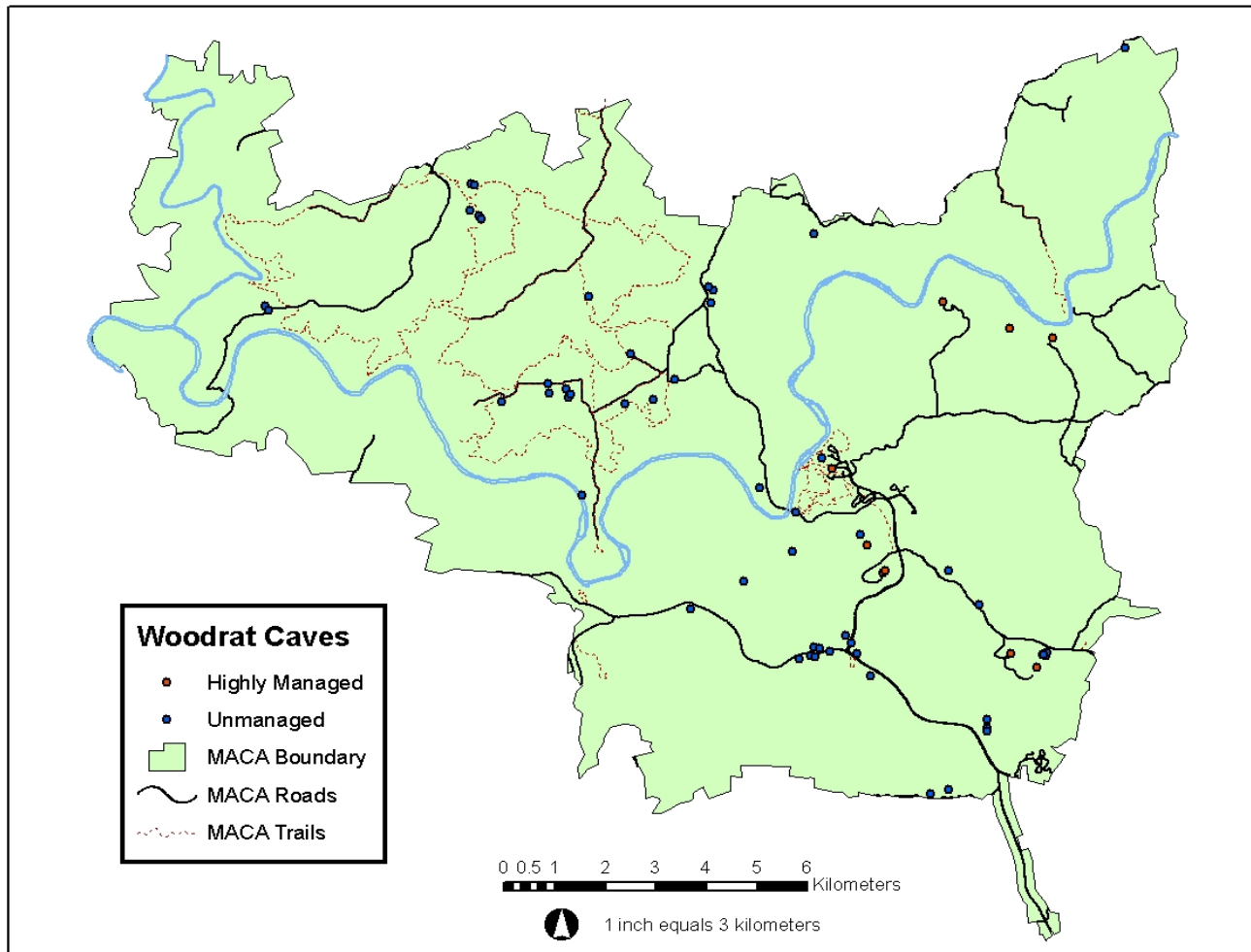


Figure 3.01.1 Locations of “unmanaged” and “highly managed” caves for Allegheny woodrat monitoring at Mammoth Cave National Park, Kentucky. **Note:** Due to the sensitive nature of cave location data, cave names have intentionally been omitted and all points are approximate while this protocol is under review. In-house copies of the approved protocol will contain information obscured here.

Table 3.01.1. Driving and walking directions, and UTM coordinates for woodrat monitoring of “unmanaged” caves, at Mammoth Cave National Park, Kentucky. **Note:** Cave names, directions, and coordinates have intentionally been omitted from this table while the protocol is under review due to the sensitive nature of these data. In-house copies of the approved protocol will contain information withheld here.

Cave #	Cave Name	Directions from SRM Office to Vehicle Parking Location	Vehicle Parking X Coordinate	Vehicle Parking Y Coordinate	Directions from Vehicle Parking Location to Cave Entrance	Cave Entrance X Coordinate	Cave Entrance Y Coordinate
<i>“Unmanaged” Cave Location List—<u>South</u> Side of Green River</i>							
0025	Cave Name Hidden	<Example> Drive 3.5 miles to Little Hope Cemetery on South Entrance Road and park on N. side of road 0.1 miles west of cemetery.	000000.000000	0000000.0000000	<Example> Follow old road bed (just west of drainage that is just east of cemetery) south for 95 meters. Cave entrance is on west side of road bed.	000000.0000000	0000000.0000000
040	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
041	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
043	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
077	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
080	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
102	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
104	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
105	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
134	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
143	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
149	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
156	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
170	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
197	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
202	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
207	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
212	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
214	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
216	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
217	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
265	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
266	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000

278	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
280	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
281	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
286	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000

“Unmanaged” Cave Location List—North Side of Green River

009	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
027	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
057	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
058	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
117	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
118	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
172	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
173	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
176	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
177	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
178	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
179	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
224	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
242	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
248	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
293	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
298	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
311	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
324	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
334	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
335	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
336	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
339	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
346	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000
350	Cave Name Hidden	000000.000000	000000.000000	000000.000000	000000.000000

Table 3.01.2. Driving and walking directions, and UTM coordinates for woodrat monitoring of “highly managed” caves, at Mammoth Cave National Park, Kentucky. **Note:** Cave names, directions, and coordinates have intentionally been omitted from this table while protocol is under review due to the sensitive nature of these data. In-house copies of the approved protocol will contain information withheld here.

Cave #	Cave Name	Directions from SRM Office to Vehicle Parking Location	Vehicle Parking X Coordinate	Vehicle Parking Y Coordinate	Directions from Vehicle Parking Location to Cave Entrance	Cave Entrance X Coordinate	Cave Entrance Y Coordinate
“Highly Managed” Cave Location List							
0001	Cave Name Hidden	<Example> Drive 1.0 miles to service road behind hotel. Unlock gate and proceed down hill on paved road to entrance on right.	000000.0000000	0000000.0000000	<Example> N/A—Park vehicle at entrance and walk down stairs.	000000.0000000	0000000.0000000
001a	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
001b	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
001c	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
001d	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
001e	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
005a	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
0007	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000
0032	Cave Name Hidden		000000.0000000	0000000.0000000		000000.0000000	0000000.0000000

A Protocol for Monitoring Allegheny Woodrats (*Neotoma magister*) at Mammoth Cave National Park

Standard Operating Procedure (SOP) # 4

Conducting Field Sampling

Version 1.0 (December 2004)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) gives step-by-step instructions that project **crew leaders** and **crew members** should follow to conduct a woodrat sampling event at Mammoth Cave National Park (MACA). The SOP describes procedures, listed in the order they should occur, for: (1) operating live traps; (2) handling a woodrat; (3) weighing a woodrat; (4) differentiating between woodrat sexes; (5) assessing reproductive condition; (6) differentiating among woodrat age classes; (7) assessing woodrat measures of “health”; (8) marking a woodrat, and (9) filling in the field data form (Appendix A). A checklist summarizing the steps is provided in Appendix B.

Prior to conducting a woodrat monitoring event all personnel involved should review the related Job Hazard Analyses (JHA's) and follow all safety guidelines (Appendix C), and review SOP #2 “Pre-Sampling”.

General Sampling Approach

- **Monitoring “unmanaged” caves:** monitoring of “unmanaged” caves will be accomplished using two three-consecutive-day “**sampling sessions**” (consisting of at least six “**sampling events**” total) initially scheduled to occur during spring (May) and fall (November) (see “Scheduling of Field Work” in SOP #2 “Pre-Sampling”). Approximately 20 to 25 caves will be sampled north of the Green River and 20 to 25 caves will be sampled south of the Green River simultaneously during each session. Each sampling session will be performed by a minimum of two 2-person crews (one crew leader and at least one crew member). Day 1 of each session will consist of each crew locating approximately 20 to 25 caves (each site located within a 5-minute hike from a drivable road) and setting two live traps in the entrance area and should take approximately eight hours (each crew's work is considered a separate “sampling event” on Day 1). Beginning early in the morning of Day 2, each trap should be checked, all captured woodrats processed and released, and traps

rebaited and reset as necessary. Depending largely on the number of woodrat captures (especially unmarked individuals), Day 2 could take from four to eight hours to complete (each crew's work is considered a separate "sampling event" on Day 2). Starting early in the morning of Day 3, each trap should be checked, all captured woodrats processed and released, and traps removed and placed in the vehicle (each crew's work is considered a separate "sampling event" on Day 3). Like Day 2, Day 3 could take from four to eight hours to complete.

- **Monitoring "highly managed" caves:** three-consecutive-day "sampling sessions" (consisting of three "sampling events") are scheduled for every-other month of the year beginning in January (see "Scheduling of Field Work" in SOP #2 "Pre-Sampling"). A maximum of nine caves, all south of the Green River, will be sampled by a single two-man crew (one crew leader and at least one crew member). After a woodrat is captured in a given cave, the frequency of sampling at that cave will decrease to two times per year, with sampling to occur in spring (May) and fall (November) of each year. Day 1 will be considered a "sampling event" and will consist of accessing each cave and setting four live traps in the entrance area (within the first 50 meters) and could take up to six hours. In the morning of Day 2, each trap should be checked, all captured woodrats processed and released, and traps rebaited and reset as necessary. Depending on the number of caves sampled and the number of woodrat captures (especially unmarked individuals), Day 2 (the second "sampling event") could take from two to six hours to complete. In the morning of Day 3 (the third "sampling event"), each trap should be checked, all captured woodrats processed and released, and traps removed and placed in the vehicle. Like Day 2, Day 3 could take from 2 to 6 hours to complete.

I. Operation of Live Traps

Procedures:

Pre-Departure Setup and Preparation (steps to be performed at the MACA-SRM office)

1. Rigid traps (e.g., Tomahawk brand #102) will require no assembly. Consult the instructions sheet (Appendix D) for proper setup of collapsible traps (e.g., Tomahawk brand #201). Inspect the trap for any damage which would prevent it from operating correctly (e.g., door bent so won't close fully, hook missing from rear of collapsible trap, trigger hook bent so door doesn't stay open, large hole in trap, etc.). Check the proper operation of the trap by setting and tripping it twice.
2. Hold the trap door open with one hand and place 3 slices of apples with skin up (to keep apple juices from soaking into bedding and to minimize chewing of bait by rodents from outside trap) in the back of the trap. Note: it is critical that bait remain beyond the trip pan ("treadle") because the door will not close properly if an apple slice becomes lodged underneath the pan.
3. Set the trigger on the trap (Appendix D) so the door remains open. Place about a softball-sized ball (when gently squeezed) of clean polyester fiber fill in the back of the trap above the apple slices. Close the trap door to ready for transport. The fiber fill is for use as bedding material by a woodrat during periods of cold weather (outside air temperatures predicted to be < 60 degrees Fahrenheit) or in breezy or "drippy" cave entrances. Note:

When properly placed, the fiber fill will not interfere with proper operation of the treadle and will actually hold the apple slices in place.

4. Place checked and baited traps into vehicle for transport to cave sites.

At Sampling Site

1. Place each baited trap inside the cave entrance in the most sheltered spot available. Near woodrat sign (e.g., food cache, midden, latrine) is especially good. Don't place a trap less than 1 meter from a fresh-looking nest, since woodrats tend to disturb traps placed too close to their nests. Ideally the spot should be free from water sources (e.g., dripping from overhead, flooding, flowing along floor of cave, blowing in from outside), especially if there is a chance of rain during the sampling event. Since woodrats are primarily nocturnal, spots that offer shelter from light sources (i.e., electric lights in "highly managed" caves or sunlight in "unmanaged" caves) should reduce stress on the captured animal. The use of 1 to 3 "cover boards" (8" x 16" x 1/8" hardboard) per trap is strongly recommended, and when placed on top and along side a trap, can provide shelter from water and light, as well as discourage accessing the bait from outside of the trap rather than through the door. When used, cover boards should be placed in a way which will not prevent the trap door from operating correctly. If available, a flat rock can be placed on top of the cover board placed on top of the trap, and another rock leaned against the cover board alongside the trap to stabilize both the trap and boards. Note: before placing cover boards on the trap, make sure the fiber fill and apple slices do not interfere with the treadle.
2. Properly set the trap (Appendix D). Make sure that: a) the trap door is open, b) the back door on a collapsible trap is secured with the hook provided, and c) nothing is likely to prevent the door from closing properly (e.g., an obstacle such as a stick, nut, rock or cover board is in the way of the door; an apple slice or stick is underneath the treadle; or the trigger hook which holds the door open is wedged against the rock wall). See Figure 4.01.1 for example of a correctly set trap.

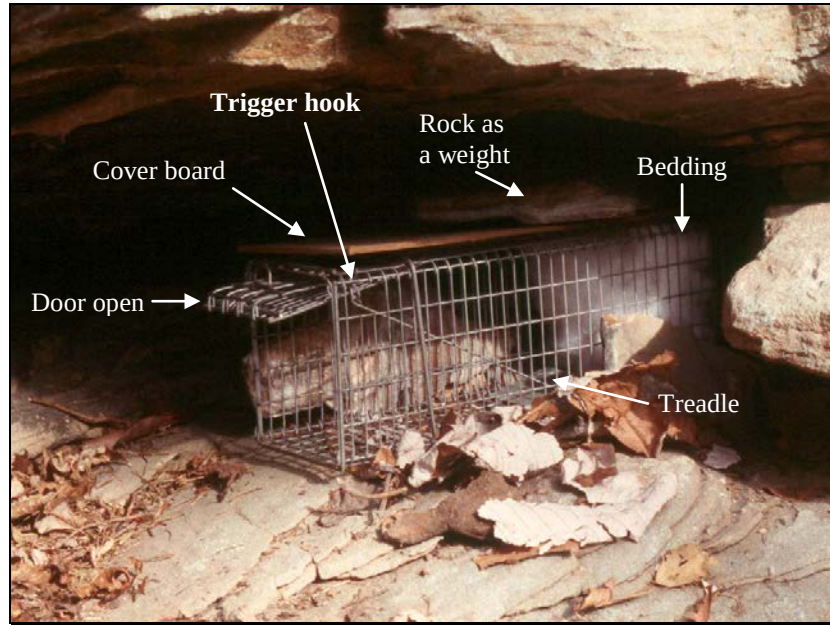


Figure 4.01.1. A set live trap. Board covering side has been temporarily removed to show position of bedding. Apples are underneath fiber fill bedding material towards rear of trap. Ideally trap should be placed further back in cave entrance for added shelter from outside elements.

Trap Inspection

When checking a set trap on day 2:

1. Note whether or not the door is shut and any disturbance that is evident.
2. Use a light source to check the condition of the bait and fiber fill.
3. If the bait appears to have been chewed by a rodent (or is missing), replace the chewed apple slices and reset trap. Reposition any fiber fill that has been moved.
4. If the bait and fiber fill appear to be undisturbed, leave the trap alone for the second night.
5. Carefully release any non-target species captured, replace the bait and fiber fill and reset the trap. It is not necessary to replace the trap with another trap because woodrats have been captured in traps the day following capture and release of skunks and other species, as well as conspecifics (other woodrats). **If a woodrat is captured**, process the animal following section “II. Handling a Woodrat” (below), and replace the bait and fiber fill, and reset the trap. Note: prior experience indicates several (non-target) species may be captured, including skunks, snakes, chipmunks, opossums, juvenile raccoons, gray squirrels, weasels, and pregnant mice (too large to escape).
6. Before leaving the baited, set, and covered trap, visually check it (see procedure #2 in “At Sampling Site”, above).

When checking traps on Day 3 of a sampling session, steps 1, 2, and 5 (above) apply. After recording trap condition, retrieve trap, bedding, bait, and cover boards.

II. Handling a Woodrat

Procedures:

Notes about Risk of Bites

Even though woodrats are hardy and relatively easy to handle, care should be used not to add unnecessary stress to the animal and not to be bitten by the animal. Whether or not to use gloves while handling a woodrat is a matter of preference. It is difficult to find a glove that provides both the dexterity needed for holding and manipulating a woodrat and protection from a full force bite. With practice, an observer can learn how to avoid being bitten by using the handling bag to direct a woodrat's mouth away from his hand. Being rather docile animals, woodrats only tend to bite when greatly provoked.

Processing a Woodrat

1. To process a captured woodrat, use the cotton mesh handling bag provided to receive the woodrat from the trap and to control the animal during measurement and assessment. Before transferring a woodrat from the trap to the handling bag, the scale must be zeroed with the empty bag attached (see procedure #1 in section III. "Weighing, Sexing, Aging, and Assessing Reproductive Condition of a Woodrat" below). Note: Before using the bag, thoroughly inspect it to ensure there are no holes large enough to allow escape. Repair any enlarged holes with cotton string and re-zero the scale before using the bag.
2. Look at the woodrat while still in the trap to determine if it has been tattooed. If not, assemble all tattooing supplies and equipment prior to transferring the unmarked woodrat from the trap to the handling bag (see procedure #1 in section V. "Marking a Woodrat").
3. Open the bag and place it over the trap entrance and secure the bag with the attached boot lace. Reach through the handling bag and hold the door open with one hand and spread the bag out with the other hand. Forcefully blow on the woodrat and direct it out of the trap and into the bag. Once the woodrat is entirely out of the trap, close the door and use the hand that was holding the bag out to cinch the bag closed near the trap entrance to contain the woodrat in the bag. Next, use the hand that once held the trap door open to untie the boot lace and carefully remove the bag from around the trap. Finally, tie the handling bag mouth shut with the boot lace using an overhand knot and a bow for security. Note: while transferring a woodrat from trap to handling bag, place the bag on a clean, dry surface (e.g., a cover board) so the bag does not pick up moisture, dirt, leaves, sticks, etc. which can affect its weight.
4. A woodrat in a handling bag is best held by tightly pinching the fur and skin behind the neck and between the shoulder blades right through the handling bag. A woodrat can be further immobilized, such as when tattooing the animal (see V. "Marking a woodrat"), by wrapping it up in the handling bag. Note: woodrats tend to be less active, and therefore easier to handle, when the bagged woodrat doesn't come into contact with the ground or a rocky surface. Either suspend the bag in the air, such as when weighing the animal, or place the bag and woodrat on your lap.
5. Once a woodrat has been fully processed, it should be released at the point of capture (i.e., by the trap) by untying the boot lace and opening the handling bag mouth. Shake any dirt and debris out of the bag. Note: always hold on to the handling bag while releasing a woodrat because sometimes a hind foot can become entangled in the mesh and the animal might take the bag with it.

III. Weighing, Sexing, Aging, and Assessing Reproductive Condition of a Woodrat

Procedures:

For each Woodrat:

1. Zero the scale. Attach the handling bag to the hook at the bottom of the scale, and hold the scale up and suspend it from the ring at the scale top. If available, use a fixed object (e.g., cave wall or ceiling, tree branch) to steady your hand while zeroing or using the scale. Check the scale for a “zero” reading while the empty handling bag is attached. Adjust or reset zero, if needed. After zeroing the scale proceed to transfer the woodrat from the trap to the handling bag for weighing (see above procedures for “Processing a Woodrat” in section “II. Handling a Woodrat”).
2. **Weigh** the woodrat while it is in the handling bag. Woodrats should be weighed to the nearest 1 gram. Since the Pesola scale only displays in 5-gram increments, you will need to interpolate to achieve the 1-gram level. Wait until the woodrat has stopped moving before reading the scale. Re-weigh the animal at least once or until the same weight is obtained twice consecutively.
3. Determine the **sex** of the woodrat in the handling bag. An adult woodrat is much easier to sex than a juvenile. The elongated penis sheath and lack of mammae (teats) are readily apparent on an adult male woodrat. The relatively shorter urethral papilla (projection) and mammae (normally 4) visible in the inguinal (groin) region are usually obvious on an adult female—especially around a period of lactation (Figure 4.01.2). First, part the fur in the inguinal region by blowing or using a finger or other probe and search for small mammae. Second, assess the distance from the sheath/papilla to the anal opening. This distance is greater in males (approximately same as length of penis sheath) than in females.
4. Assess the **reproductive condition**, if possible. Juvenile woodrats usually have nonscrotal testes (males) or imperforate vaginal openings (females). **Adult male woodrats** can have either nonscrotal testes or scrotal testes, depending on breeding condition. During the breeding season, the enlarged testes lie in a shallow body cavity depression (temporary scrotum) on either side of the anus (Swartz and Swartz 1981). Testes of woodrats generally are less-prominent than those of typical laboratory rats (*Rattus rattus*). Thus, visual assessment alone is usually insufficient to determine scrotal status, and palpation of the testes is required. Only with experience will an observer develop the ability to distinguish between the two categories. **Adult female woodrats** can have either imperforate (closed) or perforate (open) vaginal openings, depending on breeding condition. During breeding season, a perforate vaginal opening will appear as a fleshy (moist and swollen during estrus) vertical slit at the base of the urethral papilla. At other times, the slit will be closed and usually will have a crusty or flaky appearance. Imperforate juvenile females do not have this crusty appearance. Pregnant females have enlarged bellies and pups can often be felt by palpation. Lactating females have elongated, baggy, often pinkish mammae that are missing hair around the bases of one or more, so they are highly visible (Figure 4.01.2). The mammae of post-lactating females are often orange and crusty (dried). They may be elongated and hair may be missing around the bases, but they are not baggy and pink. After the breeding season (February-September), adult mammae tend to decrease in size, remain “crusty”, and hair grows around the bases of each one...partially obscuring them.

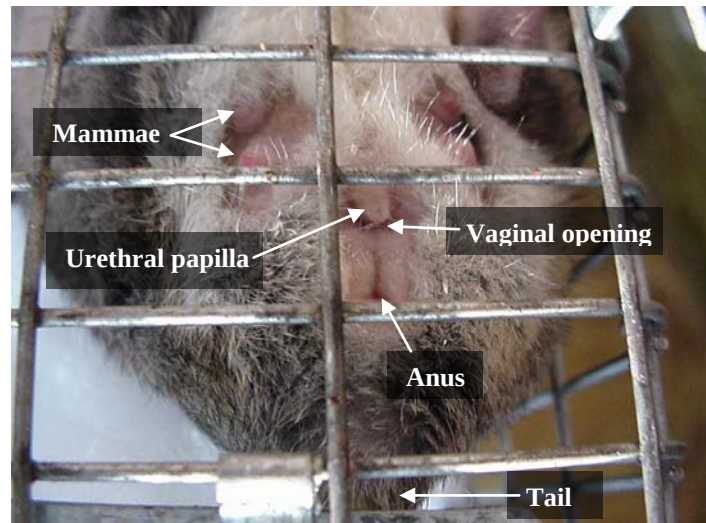


Figure 4.01.2. Lactating adult female Allegheny woodrat. Note pink, baggy mammae with hair missing around their bases. Mammae have similar appearance during late stages of pregnancy.

5. To increase certainty and decrease subjectivity, this protocol will initially differentiate only two **age classes**; adults and juveniles. A woodrat will be considered an adult if one of the following primary criteria is met: (a) at least six months has passed since the woodrat was first captured (thus ensuring that, unless captured as a neonate, the woodrat is at least 7 to 8 months old) (Rainey 1956); or (b) the woodrat displays evidence of sexual maturity, namely, it is a scrotal male, or a female with a perforate vaginal opening or shows signs of lactation or pregnancy. In the future, use of secondary criteria, such as weight and pelage (fur) color, will be used [and possibly other age classes reliably differentiated (e.g., subadults)] as additional keys to age class determination are developed specifically for the MACA population (e.g., Figure 4.01.3). These characteristics must be evaluated on a local basis for effective use. *Rationale:* Differentiating among woodrat age classes can be difficult. The difficulty lies not in obtaining the information upon which to make a determination, but the high degree of variability associated with some of the data. It is a particular challenge to discern age at the border between age classes. Generally, three age classes have been recognized: (1) adult, (2) subadult, and (3) juvenile. For Allegheny woodrats, these have traditionally been distinguished mainly by weights reported from Virginia by Mengak (1991) (i.e., adult: $\geq 225\text{g}$; subadult: $175\text{--}224\text{g}$; juvenile: $<175\text{g}$). However, in a five-year study of woodrats in Kentucky, Thomas (2003) found average weights of adult woodrats were almost 50 grams less for males and nearly 30 grams less for females than reported from Virginia by Mengak (1999). Thomas (2003) also captured known adult (based on capture history or known to have produce a litter) woodrats that weighed less than 200 grams, as well as woodrats with very little gray pelage (i.e., subadult-like pelage) that weighed less than 175 grams.

Key to Determine Age Class at Mammoth Cave National Park, Kentucky (<u>Note</u> : under evaluation)	
<u>Primary Criteria:</u>	
1.	a). If time between 1 st capture and recapture is ≥ 6 months, then it is considered an <u>adult</u> . b). If this is 1 st capture or if time between 1 st capture and recapture is < 6 months, then see #2.
2.	a). If male woodrat is scrotal, or if female has a perforate vagina or is lactating, post-lactating, or pregnant, then it is considered an <u>adult</u> . b). If woodrat does not show signs of sexual maturity as in a), then see #3.
<u>Secondary Criteria:</u>	
3.	a). If male woodrat weighs ≥ 250 grams, then it is considered an <u>adult</u> . a'). If female woodrat weighs ≥ 225 grams, then it is considered an <u>adult</u> . b). If male woodrat weighs less than 250 grams, then see #4. b'). If female woodrat weighs less than 225 grams, then see #4.
4.	a). If woodrat weighs less than 175 grams, then see #5. b). If woodrat weighs between 175 and 224 grams, then see #6.
5.	a). If woodrat weighs less than 175 grams <u>and</u> has predominately ($\geq 75\%$) soft gray pelage on sides and dorsal, then it is considered a <u>juvenile</u> . b). If woodrat weighs less than 175 grams <u>and</u> has some ($< 75\%$) soft gray pelage (but fur is mostly, gray-brown—sides and gray-black—dorsal), then it is considered a <u>subadult</u> .
6.	a). If male woodrat weighs 175 – 249 grams, then it is considered a <u>subadult</u> . b). If female woodrat weighs 175 – 224 grams, then it is considered a <u>subadult</u> .

Figure 4.01.3. Key to determine Allegheny woodrat age class (under evaluation).

IV. Assessing the “Health” of a Woodrat

Procedures:

Several measures can be used to assess the relative health of a woodrat. These include: a) injuries, b) general physical appearance, and c) ectoparasite load, and are collected while the woodrat is in the handling bag and being held by the nape of the neck.

1. Search the woodrat for any evidence of major or obvious injuries. Examples of injuries include large gashes; open wounds; missing or severely torn ear; blind or damaged eye; some or all of tail missing; missing digit or limb; and broken limb.
2. Visually assess the general physical appearance of the woodrat. Look for evidence of disease or malnutrition such as eye infection, large patches of fur missing, disorientation, lethargy, a growth or tumor, and emaciation.
3. Visually scan the woodrat for ectoparasites. **Fleas** found on MACA woodrats have been identified as *Orchopeas sexdentatus pennsylvanicus*, a subspecies that specializes in

woodrats as hosts. Obviously, the longer a woodrat is handled, the more likely a flea is to be observed, if it is present. Only record fleas observed during this assessment period (for consistency between marked and unmarked woodrats)—DO NOT record fleas seen later, as in tattooing step. **Ticks** (*Ixodes woodi* or *I. kingi*) can be found on the ears and muzzle of woodrats and occur less frequently than fleas. Subcutaneous **bot fly larvae** can be found on the cervical (throat) region of a woodrat (Figure 4.01.4) and leave a **scar** that is visible for several weeks following emergence. *Rationale:* During a five-year study at MACA, the flea infestation rate (total # of infested woodrats/total # of captures x 100) was over 22% with little intra-annual variation (Thomas 2003). Tick infestation rates at MACA were just below 3%, and didn't vary by season (Thomas 2003). Bot fly larvae (*Cuterebra americana*) were found to occur less frequently than ticks, with an infestation rate of less than 1% at MACA over 5-years (Thomas 2003). Thomas (2003) found as many as five larvae present on a woodrat at one time (the two woodrats were recaptured months later with no visible deleterious effects).



Figure 4.01.4. Woodrat with four subcutaneous bot fly larvae (*Cuterebra* sp.) in cervical region.

V. Marking a Woodrat

Tattooing will occur after weight, sex and age class has been determined, and general “health” assessed. Woodrats are marked for permanent recording and tracking over time. Woodrats in this monitoring project will be permanently marked on their first capture with a letter or number (except zero, 9 and W) tattoo in one ear. *Rationale:* During two years of a capture-recapture study in Kentucky, almost 24% of woodrats marked with two Monel brand #1 ear tags lost one or more tags, and almost 10% lost more than one ear tag (Thomas 2003). Subsequently, all individual woodrats marked with tattoos were able to be identified.

Each woodrat will be given a unique 3-digit identifier that will follow a code based on the tattoo mark applied (Appendix E). *Rationale:* The first digit refers to the ear that is marked. The capital letter “R” for right ear and the letter “L” for left. The second digit refers to the color ink

used. The capital letter “B” for black ink and the letter “G” for green. The third and final mark refers to the particular mark itself; either a capital letter or number (except zero, 9 and W). For example, the woodrat identified as “RBA”; its Right ear has a Black letter “A” in it. To increase the possible combinations, either introduce another ink color (e.g., red), or tattoo both ears using the same color and capital letter or number initially. If the latter is done, the identification code could remain 3-digits long if a B” (for Both ears) was used in the first digit. Obviously, after a reasonable length of time since the last capture, say eight years, an individual woodrat can be assumed dead and the identification code reused.

All male woodrats will be marked using black ink and all females with green ink. *Rationale:* For ease of distinguishing sex of individual woodrats inside a trap, or if a marked individual is sighted outside a trap, as well as increasing the possible number of unique marks. This also follows the marking convention used during the woodrat study at Mammoth Cave National Park from 1999-2003 (Thomas 2003).

Procedures:

For each Woodrat:

1. Assemble all tattooing supplies and equipment prior to transferring an unmarked woodrat from the trap to the handling bag. Specifically, a disposable glove should be put on one of the observer’s hands; the correct letter or number (Appendix E) should be placed in the tattoo pliers and secured with the rotating bar and thumb screw; an alcohol wipe packet should be opened and the tattoo letter/number prongs cleaned; and the correct color (see procedure #3 below) tattooing ink should be removed from its ziplock bag, the top removed and the ink flow started (for roll-on applicator this can be accomplished by holding the bottle upside down, squeezing it, and rolling the ball along your thumb covered with the disposable glove or along a cover board). Proceed to section III. “Weighing, Sexing, Aging, and Assessing Reproductive Condition of a Woodrat”, and section IV. “Assessing the ‘Health’ of a Woodrat” before tattooing a woodrat (detailed in the steps below).
2. Prepare the weighed, sex, aged, and reproductive condition- and “health”-assessed woodrat for tattooing by having a crew member “immobilize” the animal by wrapping it up in the handling bag and tightly pinching the fur and skin behind the neck and between the shoulder blades through the handling bag. Gently pull the appropriate ear to be marked (Appendix E) through one of the holes in the handling bag. Apply alcohol from the wipe packet to both sides of the ear and allow it to dry. Drying time can be shortened by blowing on the ear. Apply tattooing ink to thumb and index finger of gloved hand and gently rub ink on to both sides of ear. Before the ink dries, spread the ear out with gloved hand and position pliers with letter or number in the middle of the wide, flat portion on the front side of the ear. Note: it is important not to miss some of the ear with the tattoo or to have the ear folded when tattooing because the mark may not be readable. Quickly squeeze and release the pliers making sure the pins on the letter or number made contact with the cork on the pliers on the back side of the ear. It is not necessary to completely puncture the ear with the pins, only the outer layer of skin must be penetrated for ink to enter. It is better to squeeze too hard with the pliers than not hard enough. Note: an ear tattoo must be applied only one time otherwise

the mark will be indiscernible. If a tattoo is later found to be unreadable, mark the other ear and consider it an individual new to the marked population.

3. After squeezing the pliers to mark the woodrat, apply fresh ink to thumb and index finger of gloved hand and gently rub ink into both sides of ear by taking the ear between the thumb and index finger and massaging with a circular rubbing motion. Continue rubbing ink into the marked area on the ear for 15 to 20 seconds, up to 1 minute if the ear is bleeding.
4. Alternately tattoo ears of same sex woodrats marked the same day in close proximity (≤ 1 km) to each other or (if too many unmarked individuals of a particular sex are captured in close proximity) also mark the untattooed ear with a permanent marker using the same capital letter or number placed in the tattooed ear to distinguish recaptured woodrats on Day 2 of the sampling session. *Rationale:* Because the tattoo will not be legible for a month or two, you will not be able to read the mark on any woodrats marked on Day 1 if recaptured on Day 2 of the sampling session.
5. Unwrap the woodrat from the handling bag and the woodrat is ready to be released (see procedure #3 in section II. “Handling a Woodrat”).

VI. Filling in the Field Data Form

Procedures:

One type of field data form will be used in woodrat monitoring for both “unmanaged” caves and “highly managed” caves (Appendix A). The data fields on the form are arranged into the following 4 levels that proceed from general to specific: (1) sampling event data, (2) cave data, (3) individual trap data, and (4) individual woodrat data.

1. Make sure you have blank copies of the form before leaving the office on Days 2 and 3 of the sampling session.
2. On Day 3 of the session, make sure you take a photocopy of the data form completed on Day 2 for making field comparisons for quality control. Only “blind” comparisons should be made in order to minimize bias. That is, only compare what was recorded for any particular field on Day 2 with Day 3 after recording the Day 3 data. **For example**, on Day 2 the observer recorded that a particular woodrat had two ticks. If the same woodrat is recaptured (indicated by entering a “Y” for “Yes” in the “Caught Yesterday?” field) on Day 3, do not look at the data form from Day 2, instead process the woodrat normally, but before releasing it, compare the two data forms to see if they differ. If, continuing the example, only one tick was recorded on the Day 3 form, then re-examine the woodrat to see if there is only one tick (the other may have fallen off) or if there are two (indicating the observer missed the second tick the during initial exam).
3. When the sampling crew arrives at the first trap on Day 2 the individual assigned to record data (usually the crew leader, for consistency) should record the following information on the form:

Sampling Event Level Data

Event Date (mm/dd/yyyy): Record the month (2 digits), day (2 digits), and year (4 digits) in the format shown. Include the forward slash. An example is 05/02/2002.

Area: Record the side of the Green River the crew is sampling this event. Enter **s** for south side and **n** for north side.

Weather: Write a narrative description of the general weather conditions starting with last night's weather and including the conditions during the day (this may need updating if the conditions change dramatically as the day progresses). An example is "Clear but windy overnight, low in the mid 40s; cloudy and upper 60s while checking traps". Detailed weather parameters can be obtained electronically from the park's weather station during future analysis if necessary. Thus, this entry is not intended to be exhaustive, but rather, provide a brief snapshot.

Crew Leader and Crew Member(s): List the three initials of the crew leader and the primary crew member. If there is more than one crew member, then list the full names of all additional crew member(s) in the "Event Notes" field (the next field). In the database these, initials will correspond to the full name and contact information for that person. Examples are SCT for Steven C. Thomas or BJM for Bill J. Moore.

Event Notes: Record any special notes regarding the sampling event (day). For example, crew leader WSM got sick in the middle of the event and was replaced by crew leader SCT.

Start Time (hhmm): Enter the time the crew departed the office to begin the sampling event (day). Since all field work should be conducted between 6:30 am and 6:30 pm, regular 12 hours format should be used. Fill in all four digits. Examples are 0630 (6:30 am) and 0150 (1:50 pm). Only use central time zone.

End Time (hhmm): Enter the time the crew returned to the office after completing the sampling event (day). Since all field work should be conducted between 6:30 am and 6:30 pm, regular 12 hours format should be used. Fill in all four digits. Examples are 0630 (6:30 am) and 0150 (1:50 pm). Only use central time zone.

Cave Level Data

Cave #: Record the unique 3-digit cave identification number in the space provided. Note: A few caves are identified by a 3-digit number followed by a lowercase letter (e.g., "001a") instead. For monitoring "highly managed" caves only, use the unique cave number corresponding to the popular cave entrance name in the list provided, and place an up arrow (↑) in the cell below (i.e., first cell on the next row) to indicate the next two traps (#'s 3 and 4) are in the same cave. Note: It is critical that the correct number be recorded for each cave. Before recording cave number, double-check the map, written descriptions, and locate the permanent numbered brass marker ("cap") anchored to a rock in the entrance, if one exists.

Arrival Time at Cave (hhmm): Record the time to the nearest minute when you arrived at the cave entrance using the hour and minute format shown. Since all field work should be conducted between 6:30 am and 6:30 pm, regular 12 hours format should be used. Fill in all four digits. Examples are 0630 (6:30 am) and 0150 (1:50 pm). Only use central time zone.

Visible Sign: Using the codes provided, circle any woodrat sign observed at the cave that has not been previously recorded this sampling session [**on** = old nest, **fn** = fresh nest, **ov** = old vegetation, **fv** = fresh vegetation (greenery), **ol** = old latrine, **fl** = fresh latrine, **wb** = woodrat bones/skull/teeth, **lw** = live woodrat]. Note: Can select more than one. Additional notes related to woodrat sign (e.g., species of fresh vegetation observed, number of fresh nests, etc.) should be recorded in the “Cave Notes” field (see below).

Cave Notes: Record any notes related to the cave itself [e.g., new hazards such as recent entrance collapse, unstable rocks in entrance, tree blocking entrance, flooding, ice in entrance, access road blocked or impassible)], visible woodrat sign, etc.

Individual Trap Level Data

Trap #: Record the trap number. Follow numerical sequence for the next record (e.g., 1...2...3...4). To provide an example, the trap numbers have been pre-printed on the form for the first cave—these correspond to the first two traps placed at the cave. Note: Traps are numbered as they are encountered while entering from outside. The first trap encountered is #1, the second is #2, and so on. If two traps are encountered simultaneously (i.e., they are equidistant to the outside), the one on the right facing into the cave is given the lower number and the one on the left is given the higher number. **For example,** you enter a “highly managed” cave entrance and encounter a single trap on your left; this is trap #1. You continue on and encounter two traps approximately the same distance from the outside, one on your right and one on your left; the trap on your right is trap #2 and the trap on your left is trap #3. The last one you encounter is #4.

Trap Cond.: In the space provided, record the condition the trap was in when you encountered it. Use the following codes: **ud** = trap undisturbed; **udch** = trap not sprung, but bait was chewed by a rodent (or bedding pulled on/out) or piece of bait missing; **sp** = trap sprung, but bait and bedding not disturbed by a rodent; **spch** = trap sprung and bait was chewed by a rodent (or bedding pulled on), but no animal in trap; **mal** = malfunction of trap (e.g., apple under treadle so door couldn’t shut, door caught on rock which prevented closer, door didn’t close completely or at all when treadle was depressed, etc.); **malch** = malfunction of trap and bait was chewed by a rodent (or bedding pulled on), but no animal in trap; **rat** = woodrat(s) in trap; **chipmunk** = chipmunk in trap; **opossum** = opossum in trap; **skunk** = skunk in trap; **gray squirrel** = gray squirrel in trap; **weasel** = weasel in trap; or **mouse** = mouse caught in trap. Note: Record one of the above codes for each trap in every cave.

Trap Notes: Record any special notes regarding the trap (e.g., trap was flipped upside down, trap moved outside cave, trap missing, cover boards removed from trap, all bedding pulled outside of trap, all bait gone).

Individual Woodrat Level Data

Weight (g): Record the weight of the woodrat (not including the weight of the handling bag) to the nearest 1.0 gram.

Sex: Record the determined sex of the woodrat. Use **m** for male and **f** for female. Use **u** for unknown. A comment should be made in the “Woodrat Notes” field if code **u** is utilized.

Age Class: Record the age class of the woodrat as determined by the crew leader. Use **a** for adult, **j** for juvenile, and **u** for unknown.

Repro.: Record the reproductive condition of the woodrat as determined by the crew leader. For females use a 3-digit code. The first digit refers to the state of the vaginal opening, either **i** for imperforate vaginal opening, **p** for perforate vaginal opening, or **u** for unknown. The second digit refers to the state of the mammae regarding lactation; enter **n** for nonlactating, **l** for lactating, **p** for post-lactating, or **u** for unknown. The third digit refers to whether or not the woodrat is pregnant; enter **n** (no) for not pregnant, **y** (yes) for pregnant, and **u** for unknown. For male woodrats, use **n** for nonscrotal and **s** for scrotal.

Tag #: Record the unique 3-digit identification code for the woodrat. The tattoo should be read by the crew leader and the identification code determined by the crew leader. The first digit refers to the ear that is marked. The capital letter “R” for right ear and the letter “L” for left. The second digit refers to the color ink used. The capital letter “B” for black ink and the letter “G” for green. The third and final mark refers to the particular mark itself; either a capital letter or number (except zero, 9 and W). For example, the woodrat identified as “RBA”; its Right ear has a Black letter “A” tattooed in it (Appendix E).

Caught Yesterday?: Always enter **n** (no) on Day 2 of a 3-day sampling session for each woodrat captured. On Day 3, enter either **n** (no), **y** (yes), or **u** (unknown) depending on whether the woodrat was captured (anywhere) the previous day of the sampling session.

Injured?: Circle the correct letter to indicate whether or not the woodrat shows any sign of injury **n** = no injury observed, **y** = injury observed, or **u** = unknown. Note: Describe any injury observed in the “Woodrat Notes” field.

General Physical Condition: Record the general physical condition of the woodrat using the following four choices: **good** = no visible diseases or injuries, or evidence of only very slight injury; **fair** = several signs of injury but not severe, or some hair missing, or signs of mild illness or disease; **poor** = many signs of injury or serious injury, or much hair missing, or very sick, or disease-ridden; **dead** = dead; or **unknown**.

Ectoparasites:

- (1) **Fleas (F=)** [write in: **0** = none observed, or **f** = few (1-5), or **m** = many (>5)]
- (2) **Ticks (T=)** [write in: **0** = none observed, or **1** = one, or **2** = two, or...**6** = six]
- (3) **Bot fly larvae (BFL=)** [write in: **0** = none observed, or **1** = one, or **2** = two, or...**6** = six]
- (4) **Bot fly larval scars (BFS=)** [write in: **0** = none observed, or **1** = one, or **2** = two, or...**6**=six]

Woodrat Notes: Record any special notes regarding an individual woodrat [e.g., pelage (fur) is predominately ($\geq 75\%$) gray on sides and dorsal, pelage is mostly ($\geq 75\%$) gray brown on sides and gray black on dorsal, missing tail, collected tissue sample from right ear, animal appeared disoriented, left ear split in two, etc.].

VIII. References

- Mengak, M. T. 1991. Woodrat population status and distribution. Virginia Fed. Aid Proj. EW-2-2, Study No. 1, Job No. I-A & I-B. 14 pp.
- , 1999. Status and distribution of the Allegheny woodrat (*Neotoma magister*) in Virginia. Final Report. Nongame and Endangered Wildlife Program Research Contract: ED0918MM_078, 4 pp.
- Rainey, D. G. 1956. Eastern woodrat, *Neotoma floridana*: Life history and ecology. University of Kansas Publications of the Museum of Natural History **8**:535-646.
- Schwartz, C. W. and E. R. Schwartz. 1981. The wild mammals of Missouri. University of Missouri Press, Columbia.
- Thomas, S. C. 2003. Allegheny woodrat monitoring in Kentucky final report. Cooperative Agreement No. G553002001 between the National Park Service, Mammoth Cave National Park and the Kentucky Department of Fish and Wildlife Resources. 76pp.

Appendix A. Field data form for recording data for Allegheny woodrat monitoring of caves. This form will be used in woodrat monitoring for both “unmanaged” caves and “highly managed” caves. (*next page*)

DRAFT

Field Data Form -- Allegheny Woodrat Monitoring of Cave Entrances at Mammoth Cave National Park

Event Date (mm/dd/yyyy): ____/____/____ Area: N or S (circle one)

Weather: _____

Crew Leader: _____ Crew Member(s): _____

Event Notes: _____

Start Time (hhmm): _____ End Time (hhmm): _____

Cave #	Time	Arrival		Cave Notes	Trap #	Trap Cond.	Trap Notes	Wt(g)	Sex	Age Class	Repro.	Tag #	Caught Yesterday?	Woodrat Notes		
		Visible Sign	Sign													
		on	fn		1									Injured?: n y u Physical Cond:_____		
		ov	fv											Fleas: 0 f m Ticks: __ BFL:__ BFS:__		
		ol	fl		2										Injured?: n y u Physical Cond:_____	
		wb	lw												Fleas: 0 f m Ticks: __ BFL:__ BFS:__	
		on	fn											Injured?: n y u Physical Cond:_____		
		ov	fv											Fleas: 0 f m Ticks: __ BFL:__ BFS:__		
		ol	fl												Injured?: n y u Physical Cond:_____	
		wb	lw												Fleas: 0 f m Ticks: __ BFL:__ BFS:__	
		on	fn											Injured?: n y u Physical Cond:_____		
		ov	fv											Fleas: 0 f m Ticks: __ BFL:__ BFS:__		
		ol	fl												Injured?: n y u Physical Cond:_____	
		wb	lw												Fleas: 0 f m Ticks: __ BFL:__ BFS:__	
		on	fn											Injured?: n y u Physical Cond:_____		
		ov	fv											Fleas: 0 f m Ticks: __ BFL:__ BFS:__		
		ol	fl												Injured?: n y u Physical Cond:_____	
		wb	lw												Fleas: 0 f m Ticks: __ BFL:__ BFS:__	

KEY:

Area: North or South of Green R. Managed Cave #s: 001 SomeCave 001a SomeCave 001b SomeCave 001c SomeCave 001d SomeCave 001e SomeCave 005a SomeCave 007 SomeCave 032 SomeCave	Visible Sign: <u>on</u> = old nest <u>fn</u> = fresh nest <u>ov</u> = old veg. <u>fv</u> = fresh veg. <u>ol</u> = old latrine <u>fl</u> = fresh latr. <u>wb</u> = woodrat bones or teeth <u>lw</u> = live woodrat	Trap Condition: <u>ud</u> = undisturbed <u>udch</u> = not sprung yet bait or bedding was disturbed, chewed, or missing <u>sp</u> = trap sprung but bait and bedding not disturbed <u>spch</u> = trap sprung and bait was chewed by a rodent (or bedding pulled on) but no animal in trap <u>mal</u> = mechanical malfunction of trap <u>malch</u> = malfunction of trap and bait chewed by rodent (or bedding pulled) or write in specific animal(s): <u>rat</u>, <u>chipmunk</u>, <u>opossum</u>, <u>skunk</u>, <u>squirrel</u>, <u>weasel</u>, <u>mouse</u>	Sex: <u>Male</u>, <u>Female</u>, or <u>Unknown</u> Age Class: <u>Adult</u>, <u>Juvenile</u>, or <u>Unknown</u> Reproductive Condition: Females have 3-digits: 1) vaginal opening: <u>Imperforate</u>, <u>Perforate</u>, or <u>Unknown</u>. 2) <u>Nonlactating</u>, <u>Lactating</u>, <u>Post-lactating</u>, or <u>Unknown</u>, 3) Pregnant? <u>Yes</u>, <u>No</u>, or <u>Unknown</u> Males: <u>Nonscrotal</u> or <u>Scrotal</u>	Tag #: has 3-digit code: 1) ear marked: <u>Right</u>, <u>Left</u> or <u>Both</u> ; 2) ink: <u>Black</u> or <u>Green</u>; 3) capital letter or number of the mark (not 0, 9 or W) Caught Yesterday?: was woodrat captured yesterday (anywhere)? <u>Yes</u>, <u>No</u>, or <u>Unknown</u> Physical Condition: <u>good</u> = no visible diseases, no injuries, or evidence of only very slight injury, <u>fair</u> = injuries but none severe, some hair missing, signs of mild illness or disease <u>poor</u> = many signs of injury, serious injury, much hair missing, very sick, or disease-ridden <u>dead</u> = dead <u>unknown</u> = unknown	Fleas: <u>0</u> (zero), <u>Few</u>(1-5), <u>Many</u>(>5), For Ticks, Bot fly larvae (BFL), and Bot fly larval scars (BFS) use actual counts of <u>0</u>, <u>1</u>, <u>2</u> ... <u>6</u>. BEFORE LEAVING CAVE ENTRANCE CHECK FIELD FORM FOR COMPLETENESS AND ACCURACY.
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Appendix B

Sequence of Steps for Woodrat Monitoring at Mammoth Cave N.P.

Step	Procedure
1.	Read and follow SOP #1 “Training of Field Personnel” and SOP #2 “Pre-Sampling” procedures.
2.	One week prior to sampling session, crew leader(s) check each item on pre-event checklist and purchase any supplies/equipment. (see SOP #2 “Pre-Sampling”)
3.	One week prior to sampling session, GIS Specialist is assigned task to load all site location waypoints for appropriate sampling session on GPS unit(s). (see SOP #3 “Establishment and Location of Sampling Sites”)
4.	One or two days prior to sampling session, conduct sampling “site-check” to locate & visually inspect each remote cave entrance. (see SOP #3 “Establishment and Location of Sampling Sites”) (crew leader and/or crew member)
5.	One day prior to sampling session: Crew member(s) assemble, inspect, and place fiber fill in traps. (see SOP #2 “Pre-Sampling”)
6.	Day 1: Crew member(s) cut bait and place it underneath fiber fill in traps. (see SOP #4 “Conducting Field Sampling”)
7.	Day 1: Conduct a ≤ 1 -hour long pre-sampling “training and handling preparation” meeting (see SOP #1 “Training of Field Personnel”)
8.	Day 1: Crew leader(s) check each item on pre-event checklist before departing to the field. (see SOP #2 “Pre-Sampling”)
9.	Day 1: Locate sampling caves using map, directions, and/or GPS. (see SOP #3 “Establishment and Location of Sampling Sites”)
10.	Properly place, cover, set, and inspect live traps (2 per cave for “unmanaged” caves and 4 each for “highly managed” caves). (see SOP #4 “Conducting Field Sampling”)
11.	Day 2: Check traps, process woodrats, rebait and reset traps as needed. (see SOP #4 “Conducting Field Sampling”)
---	<i>All following steps are described in SOP #4 “Conducting Field Sampling”:</i>
12.	Woodrat in trap: visually inspect woodrat for presence of tattoo
13.	Woodrat in trap: make ready tattooing supplies and equipment if unmarked
14.	Woodrat in trap: zero scale
15.	Woodrat in trap: transfer woodrat from trap to handling bag
16.	Woodrat in bag: weigh woodrat
17.	Woodrat in bag: determine sex
18.	Woodrat in bag: determine age class
19.	Woodrat in bag: determine reproductive condition
20.	Woodrat in bag: determine ectoparasite load
21.	Woodrat in bag: assess physical condition
22.	Woodrat in bag: tattoo previously unmarked woodrat
23.	Woodrat in bag: release woodrat at point of capture
24.	Upon return to office review field data forms for completeness and accuracy
25.	Day 3: Check traps, process woodrats (steps 12 - 22 above), and retrieve traps.
26.	Upon return to office review field data forms for completeness and accuracy
27.	Day 3 or 4: Project crew leader and member(s) check and repair/replace all needed supplies and equipment prior to storage.(see SOP #5 “Post-Sampling”)
28.	Project Leader is responsible for filing a field report with the Data Manager. (see SOP #5)
29.	Follow SOP #6 “Data Management” for data flow following sampling session.

Appendix C

Job Hazard Analyses (JHAs) Related to Conducting Woodrat Monitoring

JOB HAZARD ANALYSIS
MAMMOTH CAVE NATIONAL PARK

DATE: 9/20/2002 JOB TITLE: Field work in backcountry JOB LOCATION: Backcountry FILENAME: fldbackcountry.jha.doc		PREPARED BY: Kurt Helf TITLE: Invertebrate Ecologist DATE WORK IS PLANNED TO START:	
APPROVED BY: (Division Chief) Mark DePoy		DATE:	CONCURRED BY:
SAFETY ITEM	PROCEDURE		RESPONSIBILITY
Biological Hazards (e.g., ticks, stinging insects, poisonous plants and animals)	Be aware of surroundings, be able to identify and avoid contact with hazardous organisms. Carry small first aid kit with proper treatments. Bring medication if severely allergic to hazardous organisms.		Individual and immediate supervisor.
Accidents	Observe speed limits at all times. Assemble backcountry gear including boots, required specialized gear, park radio or cell phone, compass, water, food, and maps. Ensure ranger activities and surface watch is aware of activity location. No 'self rescue' or assist is allowed; all transport must be performed by responding medical service.		
Rough terrain (e.g., excessive slope, etc.)	Wear proper footwear.		
Hazardous Weather	Check weather forecast for expected time involved. Wear proper clothing against expected weather.		
Getting Lost	Ensure some knowledge of orienteering of group member. Know area to be traveled and bring maps.		

JOB HAZARD ANALYSIS
MAMMOTH CAVE NATIONAL PARK

DATE: 9/20/2002 JOB TITLE: Driving in backcountry JOB LOCATION: Backcountry FILENAME: drbackcountry.jha.doc		PREPARED BY: Kurt Helf TITLE: Invertebrate Ecologist DATE WORK IS PLANNED TO START:	
APPROVED BY: (Division Chief) Mark DePoy		DATE:	CONCURRED BY:
SAFETY ITEM	PROCEDURE		RESPONSIBILITY
Vehicle Failure	Check vehicle's oil, water, spare tire, tire pressure, and fuel level.		Driver and immediate supervisor.
Deer and other animals in front of vehicle. Other Drivers and Vehicles.	Observe posted speed limits at all times. Be aware of surroundings.		
Hazardous Weather	Check weather forecast for expected time involved.		
Getting Lost and Injury	Know the area to be traveled and carry map. Ensure vehicle has first aid kit and emergency equipment (i.e., fire extinguisher, flashlight, blanket, radio). Set up a surface watch.		

JOB HAZARD ANALYSIS
MAMMOTH CAVE NATIONAL PARK

DATE: 9/20/2002 JOB TITLE: Field work in caves JOB LOCATION: Caves FILENAME: fldwrkcv.jha.doc		PREPARED BY: Kurt Helf TITLE: Invertebrate Ecologist DATE WORK IS PLANNED TO START:	
APPROVED BY: (Division Chief) Mark DePoy		DATE:	CONCURRED BY: DATE:
SAFETY ITEM	PROCEDURE	RESPONSIBILITY	
Loss of light and hypothermia	Bring at least three separate sources. An LED flashlight will outlast you. Carry and extra layer of wool or high tech material, and a balaclava in your helmet liner. A garbage bag, a small piece of foam pad, and chemical heater you are ready for a bivouac.	Individual and immediate supervisor.	
Accidents	Far from entrances or developed trails, cave in teams of at least four people. Team members must be reasonably matched in skills and fitness. In case of accident leave one party member with affected person, and send other two for help. Ensure ranger activities and surface watch is aware of activity location. No 'self rescue' or assist is allowed. All transport must be done by responding medical service. Carry compact first aid kit.		
Passages with vertical exposure	Inspect ropes and slings for wear; replace sooner than you think is absolutely necessary (all fibers in webbing are exposed to abrasion, unlike kernmantle ropes). Inspect teeth of mechanical ascenders for wear; keep a prussik 'quick draw' in case of ascender failure. Cross a drop unsecured only if you are sure that the moves needed are well within your skill level; make sure nobody is below.		
Flooding/storms	Check weather forecast. Base level passages, shaft drains, and even shafts can become impassable or unlivable in a matter of minutes to hours. Consider soil saturation levels in concert with weather forecast. Take note of upper level refuges from flood along lower level routes. Cave entrances can be prone to lightning; if waiting out a storm then stay hundreds of feet in and periodically check storm status.		
Fatigue	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.		

Appendix D

Woodrat Live Trap Assembly and Setting Instructions

Assembly instructions are for collapsible Tomahawk brand (model #201) live traps only.

1. Release roll hook which holds trap in collapsed position. Open to square position.
2. Important: If it does not open fairly easily do not force it, but look for something that may be catching.
3. Swing the U-bar down over the front of the live trap to a straight up and down position.
4. Secure the rear door by clipping roll hook over lower cross wire of door.
5. It is important not to force the live trap in any way. If it is not caught on itself, it opens and sets up easily.
6. To fold trap place trap before you with roll hook located at top, nearest you. Swing U-bar back to folding position. Raise both end doors up against roof and fold away from you. Hook roll hook over one leg of U-bar to hold trap closed.
7. When folding, be sure to fold the trap so the trigger mechanism is in the middle of the collapsed trap.
8. Important: Do not force trap to collapse. If it doesn't collapse easily, check carefully for something left hooked or you are possibly folding it the wrong way.

Setting a Trap:

Place trap before you with trip rod on the side nearest you. Press safety door (spring) back and raise complete door unit up against the top. Press trigger forward so small brass roller on door rests on trigger.

**A Protocol for Monitoring Allegheny Woodrats
(*Neotoma magister*) at Mammoth Cave National Park**

Standard Operating Procedure (SOP) # 5

Post-Sampling

Version 1.0 (December 2004)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure explains procedures that all field observers using the Allegheny Woodrat Monitoring Protocol for Mammoth Cave National Park (MACA), Kentucky should be familiar with and follow after the field season is completed.

Procedures:

1. Organize field data forms and check that they have been filled out completely. As a rule, all data forms need to be reviewed for completeness and accuracy immediately upon returning from the field (SOP #6 “Data Management”, Data Flow). However, because of the number of caves involved and crew members, some deficiencies in data recording may not be identified until all data forms have been organized and reviewed as a group (e.g. when arrival time for a particular cave has inadvertently been missed by a sampling crew). Once the data forms have been reviewed, and the data entered into the database, verified and validated, the project leader will make photocopies to serve as backups, and have originals submitted to the appropriate archive (SOP #6 “Data Management”; Data Entry, Data Verification, and Data Validation).
2. Check and repair/replace all non-consumable supplies and equipment prior to returning them to their proper storage areas in the attic of the Maple Springs Research facility house (traps and cover boards), each NPS staff member’s office (helmet with light, GPS unit), and the Science and Resources Management (SRM) biology laboratory (all supplies and equipment not previously mentioned). Inspect each trap for any damage which would prevent it from operating correctly (e.g., door bent so won’t close fully, hook missing from rear of collapsible trap, trigger hook bent so door doesn’t stay open, large hole in trap, etc.). Check the proper operation of each trap by setting and tripping it twice. Use needle nose pliers to adjust trigger hook if door either won’t stay open or won’t close. If trap condition is questionable, repair or replace the damaged ones.
3. All reference manuals should be re-shelved on their appropriate bookshelf. Other reference materials (e.g., field maps, field sampling locations lists and directions) and extra field data

forms need to be filed in their appropriate filing cabinet. Clean the insides and outsides of all vehicles used in the field.

4. Identify and obtain ancillary data. It is of critical importance that these data be incorporated into the woodrat monitoring efforts. First and foremost, knowledge of management efforts inside and outside caves for that year (e.g., controlled burns) will be used to assess the effects of these efforts on woodrat population structure and dynamics. Second, because cave woodrats obtain food from outside caves, the quality and quantity of their food supply can be affected by surface weather patterns. For example, drought conditions limit plant growth and thus reduce food availability for woodrats. Therefore, annual climate data will be obtained from the park weather station or from the National Park Service Air Resources Division.
5. At the end of each field sampling session, crew leaders complete a narrative trip report outlining hours worked, field crew members and their responsibilities on the project, and any unique situations/hazards encountered. This information will be used to document the dataset and may be important for data analysis (i.e., it may be the only source of information identifying causes for discrepancies and inconsistencies in the data). The project leader is responsible for ensuring field trip reports are completed and filed in the appropriate folder within the established protocol file structure (i.e., X:\CUPN_MACA IM Projects ...Woodrats).

Post-Trip Logistical Checklist

- ☐ 1. Inform surface watch of return
- ☐ 2. Erase crew sign out from dry board in office
- ☐ 3. Return keys to appropriate individuals
- ☐ 4. Review field data forms for completeness and accuracy
- ☐ 5. Remove apples from traps and discard at least 0.5 km from cave entrances
- ☐ 6. Remove soiled bedding from traps and discard in trash; remove clean bedding and store for future use if/when dry; traps do not need to be hosed out nor sanitized (*hantavirus* not a concern at present)
- ☐ 7. Examine all non-consumable supplies and equipment for damage or loss; repair or order replacements
- ☐ 8. Remove all batteries from battery-operated equipment if storage will be ≥ 6 mos
- ☐ 9. Store equipment in proper place (see SOP#5 "Post-sampling", procedure #2)
- ☐ 10. Photocopy field data forms to serve as backups
- ☐ 11. Project Leader is responsible for filing a field report with the Data Manager
- ☐ 12. Designated personnel enter data from field forms into database using data entry forms

Crew Leader's Signature: _____ Date: _____

A Protocol for Monitoring Allegheny Woodrats (*Neotoma magister*) at Mammoth Cave National Park

Standard Operating Procedure (SOP) # 6

Data Management

Version 1.0 (December 2004)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Introduction

Purpose

This SOP provides instructions for the development, maintenance and distribution of monitoring data associated with the protocol for monitoring Allegheny woodrats in Mammoth Cave National Park Prototype (MACA). The woodrat protocol is one of 17 identified vital signs monitoring protocols currently slated for development by the Cumberland Piedmont Network (CUPN)-MACA Monitoring program. Per national IM Program guidance, Microsoft Access XP (2002) is the primary software environment being utilized for desktop database applications. Data and data products will be archived, backed-up, and distributed per the guidance contained in the CUPN-MACA Data Management Plan (DMP). It is the responsibility of the data manager to be thoroughly familiar with the standards and procedures within the DMP and ensure this SOP is updated to reflect any substantive changes made to the DMP. All proposed changes to this SOP must be routed through the data manager for approval. QA/QC guidelines in this document are based on the general concepts defined in Chapter VI of the DMP.

Expected Audience

This SOP is written specifically for the protocol data manager, protocol project leader, and project crew leaders and crew members. In all cases, it is intended that this SOP will reduce the overall time required to accomplish required tasks performed by each type of reader. To accomplish this goal:

- Protocol data managers will want to read the entire SOP like a text book and be familiar with all aspects of the document. Data managers should be looking for ways to improve the system, but must first know the system being used.
- Protocol project leaders may want to only skim the document, paying particular attention to the data flow and handling procedures. Project leaders are responsible for

understanding and fulfilling the data stewardship tasks assigned their role, as well as ensuring that anyone under their supervision understands and fulfills their assigned responsibilities. Data stewardship roles and responsibilities can be found in Chapter II of the DMP and its associated appendix (Appendix B, Data Stewardship Roles and Responsibilities). Appendix C of this SOP contains a list of pertinent data stewardship roles for this protocol as defined in the DMP.

II. Woodrat Database - Metadata

Metadata, or data about the data, include two basic categories: 1) the data structure information or data dictionary, and 2) data that describe the environment surrounding the purpose of the study. The data dictionary includes information such as field name, field type, field length, etc. The second category of metadata would include, for example, the contact information of the sample collector (name, address, phone number, etc.), or information about the location where the woodrat was captured. These are metadata. The “real” data may be, for example, the attributes of the captured woodrats--that are of no value whatsoever unless accurate metadata are associated with the woodrat capture data. The importance of accurate metadata cannot be overemphasized.

Because of the importance of metadata, much effort has been exerted both by the NPS and the developers of this project to insure useful metadata. NRDT tables and data structures were used as the foundation of the database. Woodrat detail data and metadata tables and relationships were developed specifically for this project and are discussed in the following section. The project leader will complete a basic metadata survey form for inclusion in the data manager’s project file. The data manager will utilize this information to create a Dataset Catalog record. Dataset Catalog, which was developed by the National Park Service’s Inventory and Monitoring Program (I&M), provides a means whereby CUPN-MACA can organize, maintain, and disseminate brief metadata on its dataset holdings. As such, it is the shared responsibility of the project leader and data manager to ensure this record is accurate and up to date. The Dataset Catalog report tool can be used to generate output in the text-based FGDC-compliant metadata format that can then be imported into ArcGis for documentation of associated GIS layers. All sample locations will be documented via a GIS layer created from `tluCave_Locations` fields. GIS layers will be documented with appropriate FGDC compliant metadata.

III. Woodrat Database - Data Model

The general data model for Allegheny woodrat monitoring consists of metadata described above and field collection data. Proper linking of these datasets is critical to effective long-term monitoring and analysis of woodrat population abundance and structure and use of “highly managed” caves, and provides park managers and policy makers with information necessary to make correct decisions regarding the use and conservation of the park’s natural resources. It should be noted that recent (December 2004, i.e., NRDT Phase III) proposed changes made to the Natural Resource Data Template (NRDT) will likely result in significant changes to the data model presented in this SOP, as the sampling methodology and data model are further developed.

Standardized Naming Convention

To help manage the data model a standardized naming convention has been adopted, using the NRDT (i.e., phase II) tables and structure where possible. For other tables and forms within MS Access, the naming convention of the NRDT database is generally followed. For example, the table that contains the location data for this protocol is called “tluCave_Locations” and has the exact structure as the NRDT table, tblLocations, but with additional “cave specific” fields. The decision to “break out” cave location information from other locations was made in large measure due to its recognized sensitivity.

Woodrat Data Model

Figure 6.01.1 includes the core tables and project- specific tables used to store the collected data for this woodrat monitoring protocol. The project-specific table, tblOccupant, contains specific characteristic information about each woodrat capture, while tblCaveObservation and tblTrapObservation store cave and trap level information. It should be noted, there are additional common lookup tables within the data model, such as tluProjects and tluObservers which are not included in Figure 6.01.1. For a discussion on the distinctions between the three table “types” utilized in each CUPN-MACA protocol database (i.e., common lookup, core, and project-specific) the reader is referred to Section IV.3.1 (Project Database Structure) of the DMP.

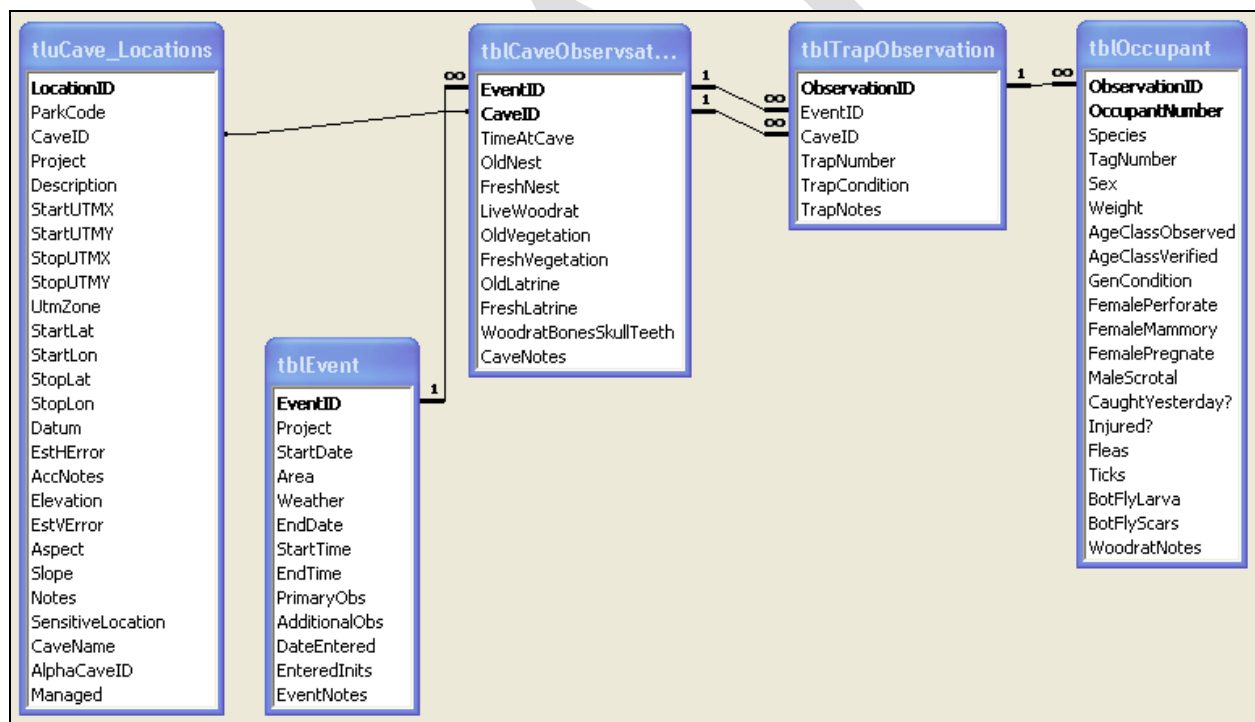


Figure 6.01.1. Allegheny Woodrat Data Model

IV. Data Flow and Data Entry

Data Flow

Periodically (as detailed in the “General Sampling Approach” section of SOP #4 “Conducting Field Sampling”) observers will set woodrat traps at specific cave locations and on the next two consecutive days return to the traps locations checking for and recording trap condition. Immediately upon returning from the field, observers will recheck their field data forms for completeness and accuracy. After rechecking the data forms for accuracy, field data for each park are entered into an MS Access database form. The data will then be checked by the project leader using queries designed to find erroneous entries. After certifying the validity of the data content for that collection period, the project leader will export the data from the database and send it to the data manager who will certify the format and overall reliability of the data. The dataset will then be stored as read-only in the DBMS_Master subfolder of the Woodrats folder (Figure 6.01.2). Archived and fully documented datasets and associated metadata can be uploaded to the NR-GIS Metadata and Data Store, once this system becomes fully operational. The general flow of data and QA/QC is presented in Appendix B.

Data Entry

Extensive use of programmatic data validation has been incorporated to greatly reduce the number of operator entry errors. Rather than direct database table entry, customized forms are being designed and tested that both provide a natural flow of data entry into the database and validate the entered data before allowing them to be written to the database. Where possible, data are entered via the use of dropdown lists or by typing the beginning characters of the value, thus eliminating the possibility of operator entry error. Look-up tables contain project-specific data and prohibit entry of data into a field if a corresponding value is not included in the lookup table. For these fields, only valid names or measures may be entered and spelling mistakes are eliminated.

For the remaining data fields, validation controls prevent impossible values to be entered (e.g., a negative number for woodrat weight) and data entry alert messages are provided any time a datum is entered that is not realistic (e.g., weight greater than 600 g). The user is offered a chance to reenter the data or keep the abnormal data. If the user accepts the abnormal data, a log file will be generated listing pertinent information about the out-of-range data (e.g., sample number, fields, entry operator, sample collector, etc.). The log file is sent to the project leaders.

V. Data Verification

In addition to data verification accomplished by the computer program, the data will also be manually verified shortly after data entry. This process involves checking the accuracy of computerized records against the original source, usually paper field records. While the goal of data entry is to achieve 100 percent correct entries, this is rarely accomplished. To minimize transcription errors, our policy is to verify 10 percent of the records to their original source by staff familiar with project design and field implementation.

The primary goal of data entry verification is to determine where errors are being introduced into the database. Each error found will, of course, be corrected, but will additionally be cataloged to

find methods for eliminating that specific type of error during subsequent collection periods. For example, if data entry of a certain field is more prone to entry errors, a more stringent computer verification method will be created to eliminate that error from occurring. Once the computerized data are verified as accurately reflecting the original field data, the project leader can submit original field forms for archival. The electronic version of the data is used for all subsequent data activities.

VI. Data Validation

In addition to the computerized data validation process described above, manual data validation is performed during the manual verification process. The project leader will validate the data after verification is complete. Validation procedures seek to identify generic errors (e.g. missing, mismatched, or duplicate records and comparison of QA/QC data with corresponding sample data). Again, because of the design of the database and entry form table relationships and linkages, most of the generic errors should have already been eliminated.

During the entry, verification, and validation phases, the project leader is responsible for the data. The project leader must assure consistency between field data forms and the database by noting how and why any changes were made to the data on the original field forms. In general, changes made to the field forms should not be made via erasure, but rather through marginal notes or attached explanations. Once validation is complete, the dataset is turned over to the data manager for archiving and storage.

VII. Database Administration

Data Maintenance

Datasets are rarely static. They often change through additions, corrections, and improvements made following the archiving of a dataset. There are three main caveats to this process:

- 1) Only make changes that improve or update the data while maintaining data integrity.
- 2) Once archived, document any changes made to the dataset.
- 3) Be prepared to recover from mistakes made during editing.

Any editing of archived data is accomplished jointly by the project leader and data manager. Every change must be documented in the edit log and accompanied by an explanation that includes pre- and post-edit data descriptions.

Data Organization

The data are organized based on an object-oriented framework rather than the structured framework. That is rather than grouping files based on function, files are grouped by object. For example rather than placing the data for all vital signs in the same folder and all the narratives in another folder, the object-oriented paradigm suggests that placing all folders concerning an object, that is, a vital sign, be placed together. Global objects such as Admin and GIS Layers have their own top-level folder.

Within the Woodrat object, Shared Data and Shared Docs are also considered independent objects. Within the Allegheny woodrat vital sign there are subfolders corresponding to each aspect of the protocol: DBMS_Master (validated and archived datasets), DBMS_BE (active tables), DBMS Forms, Documents, Images, etc. Figure 6.01.2 displays the general folder located on the MACA Science and Resources Management Division's shared directory (i.e., X-drive) and the expanded folder structure for the woodrat monitoring protocol.

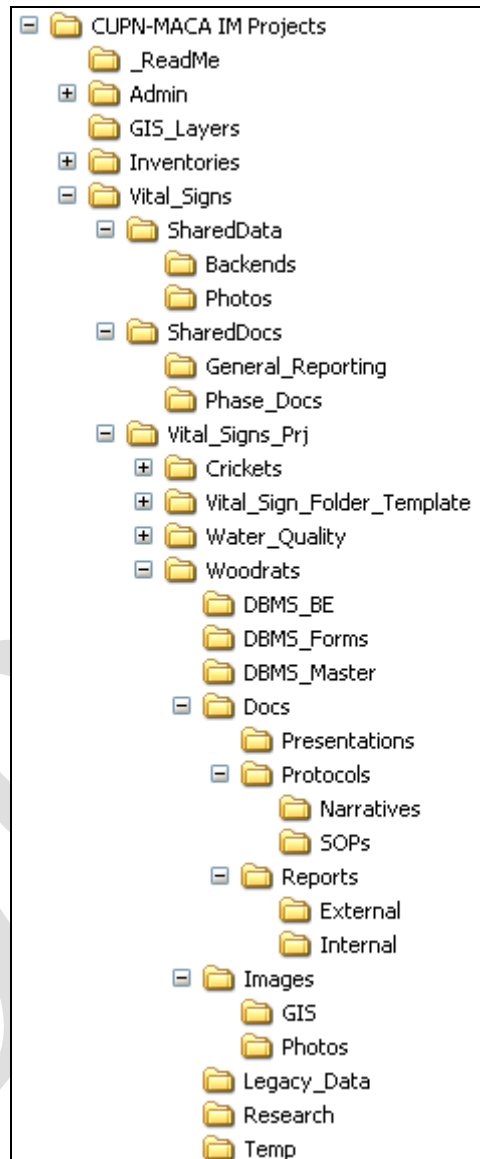


Figure 6.01.2. Folder structure for the Allegheny Woodrat Monitoring Protocol.

Data Security and Integrity

As many different users will be accessing the database, it is imperative that the data remain secure. Although MS Access provides a means for allowing User-Level Security to different groups of users, the data managers have determined that it will be more effective to create user groups within the local area network operating system that will have different security levels.

Generally, three levels of users will be given different sets of permissions. CUPN-MACA data managers will have all permissions, including insert, delete, and modify for all folders in the folder structure. Project leaders/program coordinators, will have the same permissions as program data managers except for read-only permission to the shared data tables and archived data. Those entering the data will have insert-only permission to the observation data and read-only permission to the lookup and shared data tables.

Version Control

Prior to any major changes of a dataset, a copy is stored with the appropriate version number. This allows for the tracking of changes over time. With proper controls and communication, versioning ensures that only the most current version is used in any analysis. Versioning of archived datasets is handled by adding a three digit number to the file name, with the first version being numbered 001. Each new version is assigned a sequentially higher number. Frequent users of the data are notified of the updates, and provided with a copy of the most recent archived version.

Data Logs and Backups

Once the data are archived, any changes made to the data must be documented in an edit log. From this point forward, original field data forms should not be altered. Field forms can be reconciled to the database through the use of the edit log. Secure data archiving is essential for protecting data files from corruption. Once a dataset has passed the QA/QC procedures specified in the protocol, the data manager will make a formal entry in the I&M Dataset Catalog. Subsequently, an electronic version of the dataset is maintained in a read-only format on the program server. Backup copies of the data are maintained at the MACA Prototype office, and an additional digital copy will be forwarded to NPS I&M annually. Incremental or differential tape backups of all project databases are made nightly with a full tape backup being made every weekend. Once per month, a CDROM copy is placed into permanent archive.

VIII. Data Availability

In addition to the “standardized” data dissemination strategies noted in Chapter IX of the DMP, data will be made available for research and management applications on request (per the framework established in the DMP). Data can be transferred using ftp. Data requests should be directed to the MACA Prototype Coordinator.

IX. Tables, Forms, Reports, and Queries

Current detailed table structure information such as field type, length, description, primary keys, and linking fields may be found in the MS Access database file Woodratxxx.mdb where xxx is the database version. This file is located in the appropriate woodrats folder under vital signs project folder. Specific form, report, and query information are stored within the same folder structure. Most protocols within this vital signs monitoring program share common data such as observers, park codes, project codes, etc.

X. Literature Cited

Appendix A

Sample Data Entry Form for the MACA Woodrat Monitoring Database

Woodrat Entry Form									
EventID	WOODRAT_04DEC04_A			EnteredInits	RRB	DateEntered	12/10/2004	Next Event	
Project	WOODRAT	Event Date	12/4/2004	Area	A	Event Notes		Prev Event	
Weather	stormy, heavy winds, some hail			Crew Leader	WDM	Lost a PDA on the way to the first cave.			
			Crew Member	TSL					
StartTime	6:58	EndTime	17:45						
Cave Observation Data									
EventID	WOODRAT_04DEC04_A	Cave #	001a	Arrival Time At Cave	7:20	☐ Old Nest	☒ Fresh Nest	Next Cave	
Cave Notes	Cave entrance was partially blocked by a fallen tree.				☒ Old Veg.	☐ Fresh Veg.	Prev Cave		
				☐ Old Latrine	☐ Fresh Latrine				
				☒ Bones/Skull	☐ Live Woodrat				
Trap Observation Data									
ObservationID	13	Cave #	001a	Trap#	1	TrapCondition	SPCH	Next Trap	
Trap Notes	This trap was nearly crushed and there were large panther tracks all around the trap.							Prev Trap	
Occupant Data									
Occupant#	1	Weight	257	Sex	M	Age Class	A		
Vaginal Opening	/	Lactation State	/	Pregnant?	/	Scrotal?	S	TagNumber	EBN01
Injured?	U	GenCondition	POOR	Fleas	M	Ticks	4	BotFlyLarva	2
								BotFlyScars	1
WoodratNotes	The woodrat was barely alive and looked to be in complete shock.				Species	555661	Next Occupant		
							Prev Occupant		

Appendix B

QA/QC Process Flow for Woodrat Monitoring at Mammoth Cave National Park

<u>QA/QC Procedure Name</u>	<u>Schedule</u>	<u>Description of Procedure</u>	<u>Responsible Entity</u>	<u>Response</u>
Immediate Verification	Before releasing occupant or leaving trap	Crew members will verify all data on their field forms pertaining to the current occupant or trap before releasing the animal or proceeding to the next location	Crew Members	If there are blank or incorrect entries they will be corrected immediately. If a procedural change or new datasheet format could prevent future mistakes, the suggestion will be annotated in the notes.
Field Notes Review	Immediately after returning from the field	After the Crew returns from the field the Crew Leader will assure that all field data forms are accounted for and complete.	Crew Leader	Make sure all data have been entered and all data sheets are accounted for.
Field Notes to Computer Form verification	As entered	The person who enters the data into the computer from the field datasheets explicitly compares the paper datasheet with the data on the computer screen to verify correct data entry	Data Technician	Make corrections immediately and, if the errors could have been prevented by changing a process or computer form tell the data manager.
Hardcopy-to-Digital Verification	As soon as practicable, following previous step	10% of hardcopy records are compared to digital	Project Leader	Date and error types will be tracked using a standard form. Corrections will be made at time of check.
Data Validation	As soon as practicable, following previous step	Run validation queries and/or visual inspections. Once validation is complete save dataset as a read-only in "DBMS_Master"	Project Leader and Data Manager	Record any inconsistencies and import error messages. Correct problems and/or change process as needed. Provide feedback to data technicians and crew members as appropriate.
National level database rollups	Annually	Ensure dataset is fully documented and sensitive information is flagged	Data Manager and I&M Data Manager(s)	

Appendix C

Data Stewardship Roles for Woodrat Monitoring at Mammoth Cave National Park

This appendix contains a list of pertinent data stewardship roles for this protocol as defined in the DMP. For a comprehensive list of responsibilities assigned to each role refer to Appendix B, “Data Stewardship Roles and Responsibilities”, of the DMP.

Role	Individual(s)/Entities	Duty Station / Title	Contact
Project Crew Member	Kurt Helf	MACA / Prototype Ecologist	(270) 758-2145
	Lillian Scoggins	MACA / Prototype GIS Specialist	(270) 758-2149
	Johnathan Jernigan	MACA / Prototype Physical Scientist	(270) 758-2146
	TBD	MACA / WKU Biology Dept. Student Intern #1	(270) 745-
	TBD	MACA / WKU Biology Dept. Student Intern #2	(270) 745-
Project Crew Leader	Bill Moore	MACA / Prototype Ecologist/Data Manager	(270) 758-2161
	Steve Thomas	MACA / MACA Prototype Coordinator	(270) 758-2144
Information Technology Specialist	Pat Price	MACA / Supervisory IT Specialist	(270) 758-2130
Project Leader/Resource Specialist	Steve Thomas	MACA / MACA Prototype Coordinator	(270) 758-2144
GIS Specialist	Lillian Scoggins	MACA / MACA Prototype GIS Specialist	(270) 758-2149
Data Manager	Bill Moore	MACA / Prototype Data Manager	(270) 758-2161
Curator	Brenda Bacon	MACA / Curatorial Assistant	(270) 758-2134
USGS Ecologist (term position)	Bob Woodman	MACA / USGS-BRD Ecologist	(270) 758-2148
Prototype Coordinator	Steve Thomas	MACA / MACA Prototype Coordinator	(270) 758-2144
Data Manager (National Level)		Fort Collins, CO / -	(970) 225-
End Users (managers, scientists, publics)	Multiple Entities	Multiple	Multiple

A Protocol for Monitoring Allegheny Woodrats (*Neotoma magister*) at Mammoth Cave National Park

Standard Operating Procedure (SOP) # 7

Data Analysis

Version 1.0 (December 2004)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP outlines the data flow and expected analyses of Allegheny woodrat monitoring data collected within Mammoth Cave National Park (MACA). The monitoring questions and subsequent analysis of the supporting data can be divided into two categories, based on time scale in analysis. The first category includes questions of status (population structure and relative abundance), natural distribution across the park, and management—influence on population status and use of caves, measured at the within-a-year and annual scales. This category focuses on detection of salient natural patterns in population characteristics, and detection of significant or dramatic influence on use of caves by woodrats due to both planned management activities, such as cave modification, and variable disturbance from cave tours. The sampling design provides a bi-monthly assessment of management impact on cave usage, and a hemi-annual assessment of natural population status. The second category includes these same questions, considered over multi-year scales. This category focuses on detection of multiple-year trends and natural patterns in woodrat populations, and on detection of possible cumulative management effects on cave use levels and patterns that may manifest themselves only after many years. Both categories of questions will be addressed using a combination of summary and descriptive statistics, graphic analysis, and multivariate comparative and correlative analysis. Management impact classes are a key factor in short-term (1-year scale) analyses. Both management impact and time are the key grouping and stratification factors in the long-term, repeated-measures analyses of the several categories of woodrat data (age and sex structure in the population, apparent reproductive rates exhibited by the population, relative health and ectoparasitism levels, cave-use, distribution across the park, and abundance). Additional analytic approaches will be employed to evaluate woodrat population parameters in a comparative and correlative model with park-level weather trends and spatial dynamics and movement of woodrats among sampled caves.

Data analysis with respect to use of “highly managed” caves by woodrats will be performed sequentially as data are collected and analyzed in bimonthly sampling sessions. Each session’s data will be evaluated using a suite of descriptive and summary statistics. Annual and longer-term trends analyses will use separate bimonthly data sets (for “highly managed” caves), hemi-

annual, and derived, cumulative annual data to evaluate longer-period trends and patterns, both for “highly managed” and “unmanaged” caves.

The protocol was designed to answer the following monitoring questions:

1. What is the status of Allegheny woodrat populations [abundance estimates, distribution, and structure (age class ratios, sex ratios)] using “unmanaged” caves on the park?
2. What is the trend over time in population abundance, distribution and structure (age class ratios, general health, reproductive status, sex ratio) of the Allegheny woodrat population associated with “unmanaged” caves across the park?
3. How do trends in Allegheny woodrat population structure differ between “highly managed” (i.e., with lighting systems, cave doors, block houses, tours, etc.) and “unmanaged” caves on the park?
4. What is the current pattern (status) in use of “highly managed” caves by Allegheny woodrats on the park?
5. What is the change in the pattern (trend) of use of “highly managed” caves by Allegheny woodrats on the park?

I. Data Flow

The data manager will work with the project leader to ensure that data are regularly verified and rolled up into a master copy of the dataset in the “DBMS_Master” folder for this protocol (i.e., X\CUPN-MACA IM Projects...\Woodrats\DBMS_Master). This folder is reserved for datasets that have already been validated, will no longer change, and with the exception of the data manager, is available to Cumberland Piedmont Network-MACA Prototype (CUPN-MACA) staff with read-only access privileges. This ensures that once data are validated, the dataset remains accessible to staff while being secure from accidental or undocumented changes. This copy of the dataset, which is in .mdb format, should be utilized by CUPN-MACA staff for all analyses.

The development of basic queries and summary reports in MS Access will be utilized to automate and thus streamline the data analysis and reporting workload, as appropriate. In consultation with the project leader, the data manager will develop queries (and accompanying summary reports) that will address basic statistical questions including:

- Number of woodrats captured at “unmanaged” caves per age class per sampling session per year
- Number of woodrats captured at “unmanaged” caves per sex class per sampling session per year
- Number of woodrats captured at “unmanaged” caves per general physical health class per sampling session per year
- Mean percent of “highly managed” caves used by woodrats per sampling session per year
- Number of woodrats captured per cave per cave management class per sex class per sampling session per year
- Number of woodrats captured at “highly managed” caves per cave ID# per sampling session per year

These are basic questions which the project leader anticipates asking on an irregular, but frequent basis in order to provide various “snapshots” of the current dataset. It is anticipated the results of these queries will be relied upon heavily for annual reporting requirements to the parks, as well as internal reports generated for CUPN-MACA staff and cooperators. The data manager will construct these queries and reports within the front-end of the current version of the protocol’s MS Access database stored in the X:\CUPN-MACA IM Projects . . . \Woodrats\DBMS_Forms folder, which can be linked to the appropriate data tables on the MACA server. Note: This front-end database can be copied to the project leader’s workstation in order to increase performance. However, the working and master back-end databases should remain on the MACA server in their respective folders at all times.

In instances where the statistical questions become increasingly complex, such as the long-term effects of management actions on park woodrat population structure and dynamics, data will need to be exported out of the relational MS Access database to commercial off-the-shelf statistical packages. CUPN-MACA staff primarily utilize SigmaStat, Systat, and SigmaPlot for frequency distribution plots, test for normality, analysis of variance, time series analysis, etc. In these instances, the data manager will work with the USGS ecologist, project leader, and other CUPN-MACA staff to format data for export. In general, these data will be formatted based on parameters provided to the data manager via a make-table query in MS Access. The generated table will be exported in comma delimited ASCII text format.

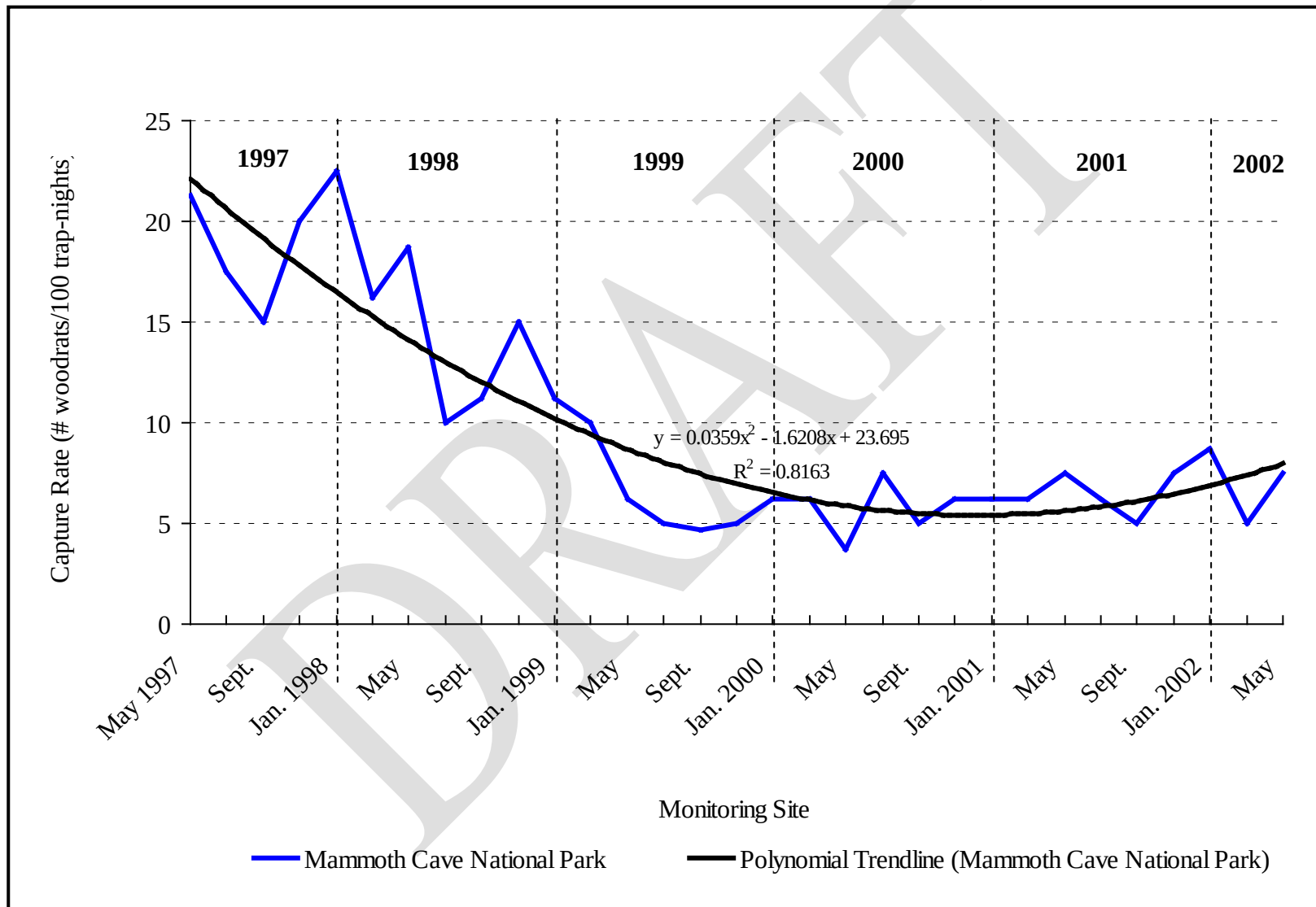
II. Data Analysis

Data in comma delimited ASCII text format are readily imported into statistical analysis software used at CUPN-MACA (e.g., SigmaStat and SigmaPlot). The sequence of steps for data import within SigmaStat and SigmaPlot are:

1. Launch SigmaStat or SigmaPlot.
2. Click on File to view the File menu.
3. Select Import from the File menu.
4. A window will open in which the user can select the appropriate file type and the file to be imported. There will be a drop-down list from which the appropriate file type may be selected. Select “Plain Text.” Then, navigate to the appropriate folder and select the desired file.
5. Now, a new window is launched in which the field format must be indicated. Select “Delimiter” and the comma from the associated drop-down list. Click on “Import.”

We anticipate that analyses will explore the behavior of woodrat sample parameters over time. Of particular interest are variability in sex ratios, age class ratios, and general health indices. Data managers will provide make-table queries within the database or, upon request, data tables that include means for these parameters. These data will be imported into SigmaStat or SigmaPlot for higher level statistical analyses (i.e. t-tests and ANOVA). An example of a time-series graph of capture rates is shown in Figure 7.01.1.

Figure 7.01.1. Example of a time-series graph of woodrat capture rates over time (fitted with a polynomial trend line) from bimonthly sampling at a series of trapping sites along a transect on Mammoth Cave National Park, May 1997- May 2002.



A Protocol for Monitoring Allegheny Woodrats (*Neotoma magister*) at Mammoth Cave National Park

Standard Operating Procedure (SOP) # 8

Reporting

Version 1.0 (December 2004)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP gives step-by-step instructions for reporting on Allegheny woodrat population abundance and structure, and woodrat use of “highly managed” caves data collected at Mammoth Cave National Park (MACA). This SOP describes the procedure for formatting a report, the report review process, and distribution of completed reports. Efficient reporting on monitoring results is critical in assisting park resource managers with management decisions. Therefore, a reporting schedule is given with key reporting dates identified. Timely production of appropriate reports is the responsibility of the project leader and the program coordinator.

I. Report Format

General

Reports should be produced on high quality white paper, 215 x 280 mm in size. Font size of all text should be 12 point unless smaller font aids in fitting information on tables. Times New Roman font should be the standard font utilized. However, other text fonts are acceptable if used consistently throughout the document. Text is left justified with 3-cm margins on all sides. Words should not be hyphenated on the right side of text.

Page numbers and headers should be placed in the upper-right corner of each page starting with page two of the report. One exception to page numbering and headers is with figures (including pictures and illustrations), if a separate figure title page is used, place number and heading on these pages and leave them off pages containing the figures. Headers should contain an abbreviated version of the report title.

Bolding and underlining should be used minimally in the body of the text unless used on section headings and subheadings. Use italic font for scientific names of species. When using both common and scientific names, list scientific name with first mention of common name only.

Three levels of section headings may be used. First-level headings are all upper-case letters, bolded and left-justified with a sequenced whole number to its left. Second-level headings are bolded and left justified similar to first-level headings with sequenced numbers to the first decimal place. However, only the first letter in each word is capitalized. Third-level headings are indented five spaces and the first letter in each word is capitalized. Third-level headings are not bolded, underlined or numbered. Third-level headings may be italicized followed by a period and two hyphens or bulleted.

Reports should be direct and concise, avoiding superfluous wording. Refer to CBE Style Manual (CBE Style Manual Committee 1994) or Writing with Precision, Clarity and Economy (Mack 1986) for aids in writing. Also see Strunk and White (1979), Day (1983), and “Notes on Writing Papers and Theses” (Lertzman 1995) for help in structuring sentences and paragraphs for clarity.

Tables

Tables should be placed within the text of a report or immediately following the literature cited section. Tables should be numbered in sequence regardless of where they are located. Table headers are placed at the top of a table. Horizontal lines are used to separate the table heading from column headings, column headings from the table and to signify the end of the table. Vertical gridlines lines should not appear on a table.

Figures

Figures should be placed within the text of a report or immediately following tables behind the literature cited sections. Figures should be numbered in sequence regardless of where they are located. Figure captions are placed below the figure if it is included in the text or on a separate sheet of paper preceding the figure if included after the literature cited section. Both tables and figures should contain information not presented in the body of the text. Also, tables and figures should not duplicate information already presented in the body of the text.

Pictures

Treat as figures.

Report Outline

TITLE PAGE

- Title
- Author(s)
- Institutions
- Prepared for
- Date

TABLE OF CONTENT PAGE (optional)

EXECUTIVE SUMMARY PAGE (abstract)

1.0 INTRODUCTION

1.1 Background

1.2 Justification for Study

1.3 Objectives

2.0 METHODS

2.1 Study area(s)

2.2 Field method(s)

2.3 Analytical method(s)

3.0 RESULTS

4.0 DISCUSSION

5.0 MANAGEMENT IMPLICATIONS

6.0 ACKNOWLEDGEMENTS

7.0 LITERATURE CITED

(See Section IV, Literature Cited for format examples)

APPENDICES (optional)

II. Review Procedure

Internal Review

Annual reports on woodrat monitoring will be written by the project leader, and/or crew leader(s) under the direction of the project leader. One or more internal reviews for grammatical soundness will be sought prior to submitting the report to MACA Management and Cumberland Piedmont Network (CUPN) Management. Internal review by MACA Prototype or CUPN personnel skilled in technical writing for clarity and directness should fulfill this review requirement. Internal reviews will be conducted by MACA Prototype staff and/or other persons sought out for their language skills.

If reports are written to update findings only and they do not deviate significantly from previously reviewed and distributed reports then the review process may stop here. However, review by park staff and subsequent external reviews must be sought for new reports or those that deviate significantly from previously reviewed and distributed reports. Also, if management activities within a park are not clearly understood, then park review should be sought for a report to clarify results and management implications.

Park Review

Park staff, generally Resource Managers, are in a unique position in that they can supply details about management activities that may influence findings presented in a report. Also, they will be the ones applying management recommendations to their park. Therefore, review by park staff is vital to the interpretation of findings and the assessment of proposed management implications. Review by park staff should be conducted before a report is submitted for external review.

External Review

External review by two or more experts in woodrat monitoring should be sought for the first report in a series of annual reports. In addition, analytical methods employed on data presented in the report need to be reviewed by one or more statisticians. If a report updates a previously reviewed and distributed report then external review is not required. However, external reviews must be sought for new reports or those that deviate significantly from previously reviewed and distributed reports. In order to conserve reviewer time, external reviews must follow the internal and park review process.

All review comments must be addressed, be it their inclusion in the report or reason for excluding them from the report. The responsibility to edit a report falls to the senior author of the report or their designee.

III. Distribution Procedure

Identifying Stakeholders

The primary stakeholder in our woodrat monitoring efforts is the National Park Service management staff at MACA. Additional stakeholders include the CUPN, and any of the national park units with cave/karst resources and/or woodrat populations. Potential stakeholders include state and federal wildlife agencies, universities and the general public.

Distributing Reports

Annual reports will be provided to resource managers at MACA, where woodrat monitoring was performed. Additionally, a copy will be kept on file with the CUPN office of the National Park Service, Mammoth Cave, Kentucky and made available to all interested parties upon request.

All data collected by the MACA Prototype is of course, public property and is subject to requests under the Freedom of Information Act (FOIA). The data management plan for the CUPN-MACA Monitoring program (Moore et al. 2004) describes appropriate procedures to respond to FOIA requests, including the protection of sensitive data such as cave and endangered species locations. Reports containing non-sensitive data will be disseminated through the CUPN-MACA Monitoring program's website. Through the website, those requesting information will be asked to provide information to document by whom and for what purpose the report is being used. By documenting requests, users can be informed when updated reports are available. Users requesting paper copies will be documented also.

In an effort to disseminate findings in a timely manner, annual reports should be completed by March 31 of the year following data collection. A brief (2-3 paragraphs) summary of sampling

activities, preliminary results, and any public interest highlights that occurred during each federal fiscal year will be written by October 15 for inclusion in the CUPN-MACA Monitoring program's Annual Administrative Report. More extensive summary reports (long-term trend reports) should be completed every five years. These reports will be centered upon Allegheny woodrats, but will also synthesize findings among several vital signs being monitored at MACA that display cross correlation. Summary reports may be used in place of annual reports for the year in which the last data is collected.

IV. Literature Cited

- Moore, W. J., R. Byrd, and T. R. Leibfreid. 2004. Draft- data management plan for the Cumberland Piedmont Network and Mammoth Cave National Park Prototype Long Term Ecological Monitoring Program.
- CBE Style Manual Committee. 1994. Scientific style and format: the CBE manual for authors, editors, and publishers. Sixth edition. Council of Biology Editors, Cambridge University Press, New York, New York, USA.
- Day, R. A. 1983. How to write and publish a scientific paper. Second edition. ISI Press, Philadelphia, Pennsylvania, USA.
- Lertzman, K. 1995. Notes on writing papers and theses. Bulletin of the Ecological Society of America **76**:86-90.
- Mack, R. N. 1986. Writing with precision, clarity, and economy. Bulletin of the Ecological Society of America **67**:31-35.
- Strunk, W. Jr., and E. B. White. 1979. The elements of style. Third edition. Macmillan, New York, New York, USA.

**A Protocol for Monitoring Allegheny Woodrats
(*Neotoma magister*) at Mammoth Cave National Park**

Standard Operating Procedure (SOP) # 9

Revising the Protocol

Version 1.0 (December 2004)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure explains how to make changes to the Allegheny woodrat monitoring Protocol Narrative for Mammoth Cave National Park (MACA) and accompanying SOPs, and how to track these changes. Any changes in the Allegheny woodrat monitoring protocol will adhere to the guidelines contained in this SOP. Observers asked to edit the Protocol Narrative or any one of the SOPs need to follow this outlined procedure in order to eliminate confusion in how data is collected and analyzed. All observers should be familiar with this SOP in order to identify and use the most current methodologies, and should see the revision history log attached to each SOP.

Procedures:

1. The woodrat monitoring protocol for MACA and (Narrative and accompanying SOPs) has attempted to incorporate the most sound methodologies for collecting and analyzing data. However, all protocols regardless of how sound require editing as new and different information becomes available. Required edits should be made in a timely manner and appropriate reviews undertaken.
2. All edits require review for clarity and technical soundness. Oversight of the revision process for all protocols is the responsibility of the MACA Prototype coordinator. When a potential modification to a protocol is identified, the project leader consults with the prototype coordinator, who then decides whether the change should be considered “small” or “significant”. Small changes or additions to existing methods will be reviewed in-house by MACA Prototype staff designated by the prototype coordinator. However, if a substantial change, such as a change in methods is sought, then an outside review may be required. The need will be determined by the protocol coordinator and project leader. Reviewers will be selected based on the type of change (i.e., changes in sampling sites versus changes in sampling design or sampling analysis). Regional and National staff of the National Park Service, as well as the U.S. Geological Survey-Biological Resource Discipline, with

familiarity in ecological research and data analysis will be utilized as reviewers. Also, experts in small mammal monitoring, research, and statistical methodologies outside of the National Park Service will be utilized in the review process, as needed.

3. Document all edits and protocol versioning in the Revision History Log that accompanies the Protocol Narrative and each SOP. Log changes in the Protocol Narrative or SOP being edited only. Version numbers increase incrementally by hundredths (e.g. version 1.01, version 1.02, ...etc) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 ...etc). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.
4. Depending upon the magnitude and nature of a proposed change, it could have significant implications for data management. The database may have to be edited by the data manager to accompany changes in the Protocol Narrative and SOPs. The database may have to be edited by the data manager to accompany changes in the Protocol Narrative and SOPs. Thus the data manager must be consulted prior to implementing changes to protocols. Immediately after the changes to the Protocol Narrative or SOP(s) have been made, inform the data manager, so the new version number can be incorporated in the metadata of the project database.
5. Post new versions on the Internet and in the “Narratives” or “SOP” subfolder for the project. Forward copies to all individuals with a previous version of the effected Protocol Narrative or SOP. Archive a copy of each previous version in the MACA curatorial facility.