Tropical Ecology, Assessment & Monitoring Network

TERRESTRIAL VERTEBRATE (CAMERA TRAP) PROTOCOL IMPLEMENTATION MANUAL

Version 3.0

April 2008

Cite as: TEAM Network. 2008. Terrestrial Vertebrate Protocol Implementation Manual, v. 3.0. Tropical Ecology, Assessment and Monitoring Network, Center for Applied Biodiversity Science, Conservation International, Arlington, VA, USA.

TEAM NETWORK

TROPICAL ECOLOGY ASSESSMENT AND MONITORING

Acknowledgments

This protocol and all other TEAM protocols are collective works. They were developed and reviewed by numerous scientists, but in this case, especially by Tim O'Brien, The Wildlife Conservation Society; Leandro Moraes Scoss, Fundacion Biodiversitas; Wilson Spironello, Instituto Nacional de Pesquisas de Amazonia, Johanna Hurtado, Organization for Tropical Studies; James D. Nichols, United States Geological Survey; Roland Kays, New York State Museum; and Jan Schipper, Conservation International.

Jorge A. Ahumada, Technical Director, Tropical Ecology, Assessment and Monitoring Network, Center for Applied Biodiversity Science, Conservation International, compiled and wrote the TEAM Implementation Manual.

Series Editor, TEAM Protocol Implementation Manuals is Sandy J. Andelman, Vice President, Tropical Ecology, Assessment and Monitoring Network, Center for Applied Biodiversity Science, Conservation International.

Graphics and layout by Lorena Garica Bustos, Tropical Ecology, Assessment and Monitoring Network, Center for Applied Biodiversity Science, Conservation International.

The TEAM Monitoring Protocols are published by:

The Tropical Ecology, Assessment and Monitoring (TEAM) Network

Conservation International

2011 Crystal Drive, Suite 500

Arlington, VA 22202

703.341.2400

TEAM Network online: www.teamnetwork.org

Conservation International online: www.conservation.org

Conservation International is a private, nonprofit organization exempt from federal income tax under section 501(c)(3) of the Internal Revenue Code.

CONTENTS

1. INTRODUCTION

This manual describes in detail all the steps and procedures needed to implement the TEAM Terrestrial Vertebrate Monitoring (formerly, camera trap) Protocol. The methods described here are based on the collective experience of many field biologists with experience in using camera traps to estimate the abundance of a range of terrestrial mammal and bird species. The detailed justification for the sampling design and the basics of the analytical approach are presented in the Terrestrial Vertebrate Scientific Protocol (in preparation).

Figure 1 shows the general implementation workflow[1] for the Terrestrial Vertebrate Monitoring Protocol. Each step in the process is thoroughly described in this document. Some steps may occur only during the first year the protocol is implemented (e.g., sampling design, deployment plan, and first year field deployment). The workflow contains three main sections, each of which is separated by conditional (i.e., Yes/No) decision steps:

1. Sampling design, preparation, and submission of the deployment plan.

2. First-year deployment, which includes measuring the spatial locations of all sampling points, first-year sampling, and analysis to determine a minimum number of camera trap points.

3. Field deployment in subsequent years, data recovery, data processing, and data upload.

The details involved in the first-year deployment and deployment in subsequent years are shown in Figures 3 and 4.

The integrity of the data resulting from the TEAM Terrestrial Vertebrate Monitoring Protocol strongly depends on proper functioning equipment. The protocol uses digital camera traps. Each digital camera trap stores many photographs and requires minimal post-processing but adequate care and maintenance. Successful implementation of this protocol also depends on the expert judgment of the deployment crew. The crew determines, on the basis of the protocol, where to place the camera traps and how to set them up. Because of the high equipment cost and the time lag involved in repairing damaged camera traps, it is imperative that staff maintain the equipment well, and promptly report damaged equipment to the TEAM site manager, regional manager, and Terrestrial Vertebrate Protocol manager by e-mail.

Become thoroughly familiar with this document and strictly follow all the steps to ensure that all data from the field site are properly standardized with all other data for this protocol from the TEAM Network. Consult Box 1 for a description of the roles and responsibilities of all individuals involved with the TEAM Terrestrial Vertebrate Monitoring Protocol. Direct any questions, comments, or proposed revisions to the TEAM Terrestrial Vertebrate Monitoring Protocol manager (TEAMVertebrates@conservation.org).

1.1 Key Technical Terms

The Glossary (Section 9) contains complete definitions of all technical terms used in this manual; however, for clarity, some key terms, an understanding of which is essential, are defined in Box 1 and Box 2.

[1] *A workflow is a diagram that divides a complex process into simpler tasks, showing the relationship between them as well as the duration of steps, branching points when decisions need to be made, and steps that need to be repeated several times (loops).*

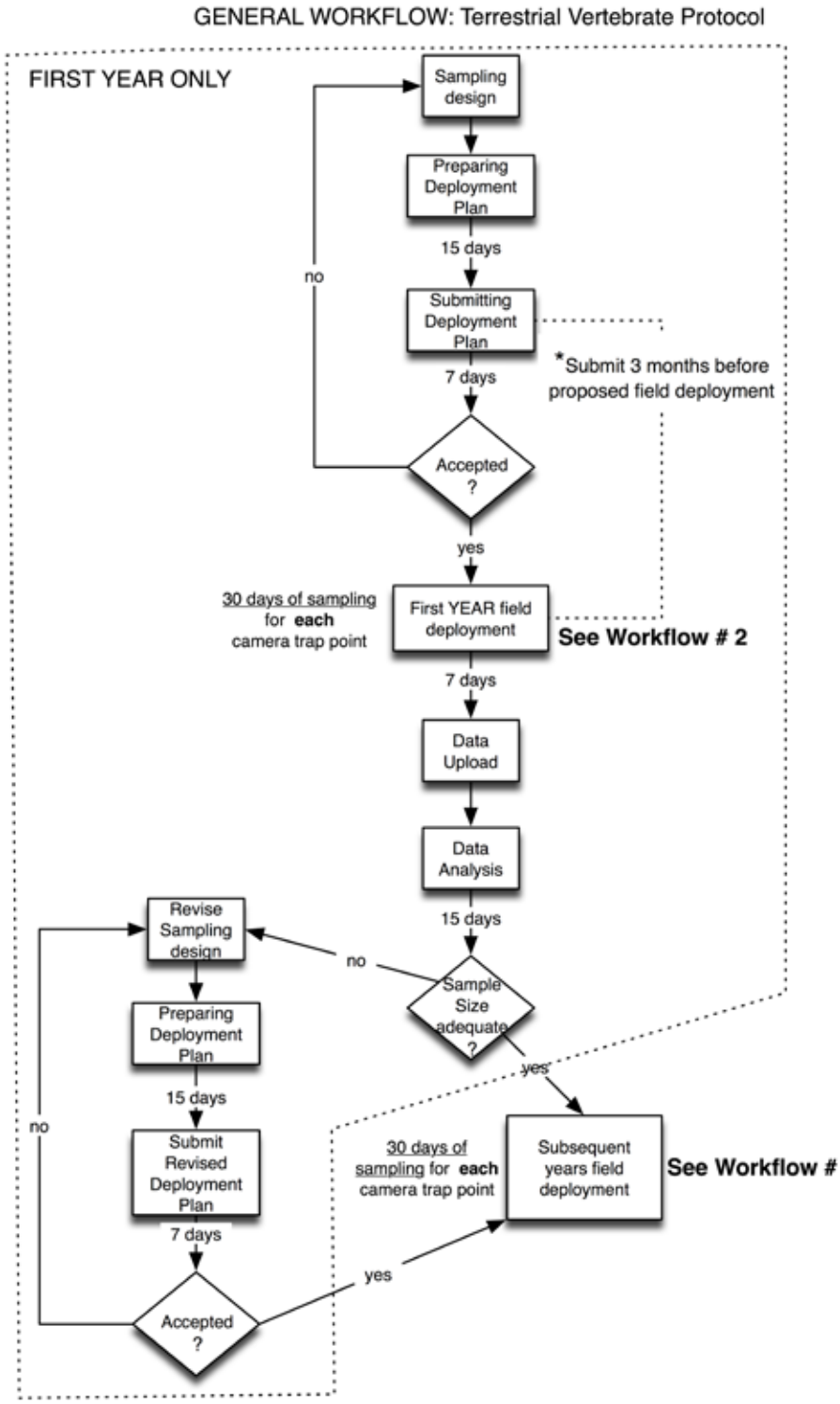


Figure 1. General Workflow illustrating the implementation of the TEAM Terrestrial Vertebrate Monitoring Protocol. Events that happen during Year 1 are enclosed in dotted box.

BOX 1: Key terms describing the statistical design and deployment plan

• **Camera trap point.** A particular spatial location (latitude and longitude) where the camera trap is located during sampling.

• **Camera trap block.** A set of camera trap points (usually 20–30) distributed locally as specified in the deployment plan.

• **Deployment plan.** A plan describing when, where, and how the protocol will be implemented at a specific TEAM site. The plan must contain the proposed sampling design, including the proposed geo-spatial location of each camera trap block, potential locations of the camera trap points within each block, relevant geographic information system (GIS) layers (shape files) for each block (e.g., topography, access, water drainages), and a detailed chronogram of activities.

• **Sampling design.** The framework and rules that specify how the sampling is performed. This includes the number of camera trap points, the guidelines that determine how the camera trap points are placed in space, the number of days each camera trap point is actively sampled in a year, and the season in the year when the sampling occurs.

• **Sampling period.** A data collection effort occurring within a specified period of time (e.g., week, month, climatic season). The TEAM Terrestrial Vertebrate Monitoring Protocol has only one sampling period per year (during the dry season, see below).

BOX 2: Key terms describing protocol implementation and equipment

• **Camera trap**. A piece of equipment installed in the field to automatically take photographs of animals passing in front of it. The camera trap consists of the camera, a control unit, a sensor and a memory card.

• **Camera trap point identification (ID)**. A unique code, assigned on the basis of a standard convention to a particular camera trap point (i.e., the location, not the camera trap itself). See Section 4.3.3 (and the Data Management Protocol) for the specific convention TEAM uses to label camera trap point IDs.

• **Control unit.** An electronic board with a small central processor unit that turns the camera on and off in response to a signal provided by the sensor. The control unit can be programmed by a user to specify the level of sensitivity to movement, the number of photographs the camera takes when it is activated, etc.

• **Memory card.** A small electronic card that stores the photographs taken by the camera. The memory card must be installed inside the camera or the camera will not record photographs; however, it can be temporarily removed from the camera so that photographs can be transferred to the TEAM Information Management System.

• **Motion/Heat sensor.** A small device mounted in front of and on the outside of the camera trap that detects movement or heat within the area in front of the camera. Signals from the sensor travel to the control unit, which in turn, controls the camera.

1.2 Standard Conventions Used Throughout This Document

The following conventions will be used throughout this document:

• Bold text used throughout the document emphasizes critical points. Sometimes entire paragraphs appear in bold. This means that this information is critical and needs to be considered carefully. Sometimes bold text is underlined; this is an additional level of emphasis stronger than bold alone.

• Complicated procedures are often divided into discrete steps. These are numbered with a brief description of the step in bold. Sometimes, steps are divided into sub-steps, indicated with lower-case letters (e.g., a, b, c, etc).

• Icons denoting different contexts in the protocol (e.g. administrative step, GIS required, field work, etc.) are placed along the margins to help guide the reader. Definitions for each of these icons are found in BOX 3 below.

• Names of TEAM standard field forms or Microsoft Excel templates appear in italics (e.g. Camera Trap Point Form).

• The names of particular variables in field forms or Excel templates are underlined (e.g., Latitude). Usually, in the text, the name of the field form or Excel template where this column is located is referred to at the end of the sentence and in parentheses [e.g. "Fill in the columns labeled Year, Month, Day, Time, and First Name of the Person Taking the Reading (Camera Trap Spatial Form)"].

BOX 3: Description of icons found along the text.

Important: a critical step/process that requires special attention.

Data upload: a step or section describing upload of data to the TEAM data repository

Field work: a step describing collection of field data or field work in general (e.g. Setup of camera trap points in the field).

Data entry: series of steps describing transcription of data from field forms to Excel templates in the computer.

GPS: a step were a spatial location (latitude and longitude) needs to be taken with the use of a Geographical Positioning System.

Administration: a step or section describing a required TEAM administrative step (e.g. Deadlines for submitting proposal, required times for data upload, etc.).

Equipment preparation: a step or section describing the preparation (or calibration) of equipment, supplies and forms, usually before going to the field.

GIS expertise: a section or steps, which require a person with technical expertise in Geographical Information Systems.

2. SAMPLING DESIGN

The sampling design for the TEAM Terrestrial Vertebrate Monitoring Protocol—that is, the number of camera traps, their locations (spatial distribution), the time of year and frequency of successive sampling periods (temporal distribution), and the length of time the cameras are deployed in the field during each sampling period (effort), has been carefully specified to maximize the probability of photographing an adequate sample of tropical forest terrestrial mammal and bird species. It is intended to monitor **changes in the community of ground-dwelling, terrestrial vertebrates, and not to monitor the abundance of individual species.** This is an important distinction. As such, the sampling design represents a compromise between the level of effort required to detect species that range over large areas (>100 km^2), such as elephants, tigers, and jaguars and the effort required to detect species with smaller home ranges (~1 km^2), such as terrestrial birds and smaller carnivores. The design also accounts for sampling constraints in the field, which may vary in different parts of the world, and for the logistical tradeoffs of cost versus effort.

A TEAM camera trap sample consists of **60–90 camera trap points, distributed among two to three camera trap arrays.** Each point is sampled over a **30-day period, once a year,** during the **dry season** and **no bait is used** to attract animals to the points. Ideally, all 60–90 points should be sampled simultaneously; however, this is precluded by cost and logistical constraints. Therefore, the sampling points have been divided into two or three (depending on the particular site) camera trap arrays. Each camera trap array contains **20–30 camera traps at a density of one trap per 2 km2. Each** array is **sampled sequentially**, not simultaneously; however, **all arrays must be sampled within the same dry season.** This means that the first array of camera traps is deployed and remains in the field for 30 days. Immediately thereafter, the camera traps are picked up, the batteries and memory cards are replaced, and the replenished camera traps are immediately moved to the second array, remain there for 30 days, etc. (see Figure 2).

The specific spatial layout of the points for camera trap placement in each array is flexible, but the **camera trap density must equal one camera trap per 2 km2**. In very exceptional cases (e.g., where access to a site is very limited or the study area size is too small) camera traps might be placed at a density of one camera trap per 1 km^2. This is a very exceptional situation and needs to be thoroughly justified in advance by the TEAM site manager and approved by TEAM technical director.

Figure 2 illustrates some examples of potential spatial layouts for a TEAM camera trap array. The specific design chosen for a particular site will depend on local conditions at the site such as elevation gradients, topography, ease of access, physical barriers such as rivers, and other logistical constraints. A GIS is needed to design the precise configuration of points for each array. The design must be submitted by the site and approved by the TEAM technical director before field implementation (see Section 3). During deployment, the camera traps are placed as close as possible to these idealized locations. In the best case, the camera traps are placed in the exact idealized location; however, in some instances, the camera traps will need to be placed not at the exact location, but at the nearest possible feasible location where

animals are likely to travel. In sites with obvious elevation gradients, camera trap arrays should be oriented along the elevation gradient from lowest to highest (Figure 2). If this scheme is followed, the spatial distribution of the camera trap points should be sufficient to ensure adequate sampling of the ground-dwelling, terrestrial mammal and bird communities at the site.

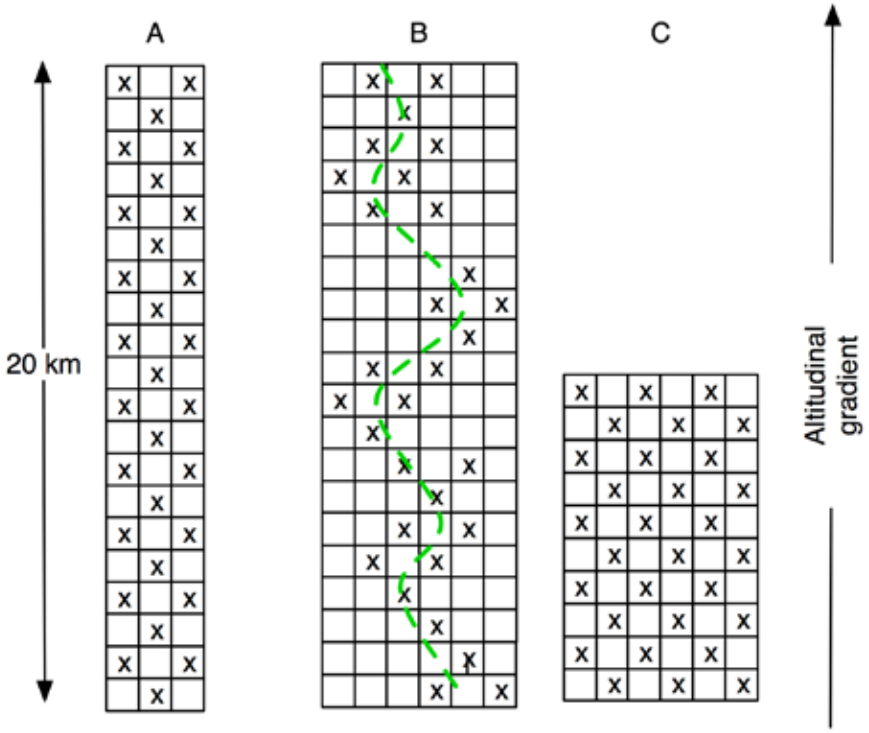


Figure 2. Examples of potential TEAM camera trap block designs. Each small square is one kilometer on a side and the X represents the ideal location of a camera trap. A) 20 x 3 km block with camera traps placed regularly along the block. B) Camera traps are located close to an access trail (broken green line) but placed at the predetermined density of 1 camera per 2 km2. C) 10 x 6 km block with camera traps placed regularly. In places were there is an altitudinal gradient, the blocks should be oriented along the altitudinal gradient.

3. YEAR 1 DEPLOYMENT PLAN

Using the sampling design principles and guidelines (Section 2), the site manager develops a Protocol Deployment Plan, which must be approved before any sampling is implemented. The site manager will need to collaborate with a GIS technical expert (from the site institution or the TEAM Network office if required) to map the site, assemble the various spatial layers, and generate the camera trap points. The Deployment Plan should be submitted to the TEAM Terrestrial Vertebrate Protocol manager at least 3 months before camera traps are deployed in the field. The required steps for developing the Deployment Plan are as follows:

1. Map the site. Use the map of the core study area as the basis for selecting suitable locations for the camera trap points. The map will display the anthropogenic, administrative, land use/land cover, and natural characteristics of the site. The core study area identifies where sampling will occur. The area will have been selected on the basis of multiple criteria. Potential problem areas such as rocky outcroppings, steep slopes, edges, seasonally inundated areas, and large streams will have been

identified and omitted. All access routes, including rivers and trails, should be identified in the core study area.

2. Generate regularly spaced points or grid cells. To identify potential camera trap blocks and points it is necessary to first generate regularly spaced points or grid cells over the core study area. Follow the steps outlined in Section 5 of *Generation of the Sampling Design for All Protocols* to generate regularly spaced points or regularly shaped mesh grid cells in a GIS at a density of (a) one point per 2 km^2 or (b) one grid cell per 2 km^2 over the entire core study area (if using a modified study area the points or mesh grid cells will be generated over this extent instead). These regularly spaced points or grid cells provide the basis for the location of the camera trap points within the camera trap blocks.

3. Determine access points to sample arrays. Use the map and local knowledge to identify access points. Access points are defined as places were the field crew can access a array of camera trap points from a road, river, trail, or any other access way. These access points should include recognizable landmarks such as a mileage post, a dock, or a geographic positioning system (GPS) waypoint. Enter these into the GIS.

4. Identify potential camera trap arrays and points. Once the various access points within the core study area have been identified, select 2–3 arrays of 20–30 points or grid cells to represent potential camera trap points such that (1) they sample a representative portion of the core study area; (2) they are accessible using the access points identified above; (3) they will be accessible year round; (4) they are not located along river banks or other edges; and (5) if possible, they are located in areas with existing trail systems to minimize disturbance and the need to blaze new trails. The points should be placed at the center of the cells.

5. Extract the camera trap points from the GIS. Once 2–3 arrays of 20–30 points or grid cells have been identified (see Point 2 above), use the GIS system to produce a list of latitude and longitudes, one for each point, in decimal degrees using the WGS84 datum. If mesh grid cells have been used up to this point, a center point per cell will first need to be extracted. Remember that these latitude and longitude locations represent only estimates of the **potential location**s and not the final locations for the camera trap points. Program these points into a GPS unit to take to the field.

6. Conduct a reconnaissance survey. With the list of potential locations for the camera traps loaded into the GPS unit, the site manager should visit the proposed sampling area to estimate how many camera trap points the deployment crew will be able to deploy in a day. This number will vary depending on the habitat structure at the site; in particular, the structure and density of the understory and the local topography at the site. Where the understory is relatively open and the terrain is even, more camera trap points can be visited in a day than sites with a dense understory and hilly terrain. To obtain a rough estimate of the number of camera trap points that can be visited (deployed) in a day select a subset of 5–10 points in the array and attempt to visit the selected subset the same day with the help of the GPS unit without blazing any new trails. Using the number of points that could be visited in a day, the site manager should be able to roughly approximate the number of camera trap points that can be deployed by day. With this information, the site manager should be able to realistically plan the deployment of camera trap points, including the order in which

points will be deployed, the locations of temporary camps to optimize travel time to potential points, and the schedule (see below).

7. Preparation of the deployment plan. After completing the reconnaissance survey, the site manager should have in hand all the elements to prepare and submit a deployment plan to implement the Terrestrial Vertebrate Protocol at the site. **Remember that Year 1 deployment plans must include mapped locations for 60 camera trap points distributed in 2–3 sampling arrays.** The deployment plan consists of the following documents or files:

- **Written deployment plan**. Summarize and justify the rationale for the chosen locations of the camera trap arrays and points. Prepare a chronology of activities with proposed occurrence dates. Include the names of personnel who will conduct each activity within the deployment plan (see below for field crew personnel requirements).

- **Maps and shape files.** For each array, submit a map and a shape file containing the locations of the camera trap points together with relevant shape files of each layer (roads, elevation, rivers, vegetation, etc.).

- **Locations of points.** For each array, submit a list of the points with their latitude and longitude.

dThe deployment plan must be submitted to the TEAM Terrestrial Vertebrate Protocol manager (TEAMVertebrates@conservation.org) at least 3 months before the proposed implementation date.

The final number of camera trap points and camera trap arrays to be used in subsequent years will be determined by statistical analysis once the data from the Year 1 implementation are available. The TEAM Terrestrial Vertebrate Protocol manager will perform these calculations and communicate the results to the site.

4. FIRST YEAR FIELD DEPLOYMENT

Once the TEAM technical director has approved the deployment plan the first-year field deployment of camera traps can begin. This process involves 1) assembling an adequate field crew, 2) preparing and calibrating the equipment, 3) traveling to each proposed camera trap point and choosing the best site for each camera trap point, 4) obtaining latitude and longitude readings for each camera trap point, 5) installing the camera trap in the field, 5) leaving each camera trap for 30 days, 6) recovering all camera traps and memory cards, and 7) organizing and uploading all photographs and data according to the TEAM Data Management Protocol.

Figure 3 depicts the major steps in first-year field deployment. The text in this section is structured accordingly.

4.1. Assemble a Deployment Crew

The site manager in consultation with TEAM technical director should assemble a deployment crew consisting of the following individuals:

1. Deployment Crew Leader whose primary responsibility is to guide the other crew members and decide where to set up the camera traps. This person should:

- Have >2 years experience setting up camera traps in the field
- Be prepared to spend several days in the field (including weekends and holidays)
- Be trained by the TEAM remote sensing specialist to read spatial coordinates in the field following the specified standards in the Sampling Unit Placement Protocol found on the TEAM Web site
- Be able to coordinate, manage, and work with field personnel

2. One to three technicians who will accompany and assist the crew leader to set up the camera traps. These technicians should preferably:

- Be local people who live in and are familiar with the area
- Have extensive field experience
- Are prepared to spend several days in the field (including weekends and holidays) without seeing their families

4.2 Equipment Preparation and Calibration

The Terrestrial Vertebrate Monitoring Protocol depends on the equipment being in proper functioning order; thus, adequate care and maintenance of the camera traps is essential. To ensure the highest possible quality and integrity of the data, close attention must be paid to preparing and calibrating the camera traps before they are deployed in the field. Start these preparations 1 week in advance of leaving for the field. The leader of the camera trap deployment crew must follow these steps to ensure this happens.

TEAM requires the use of **Reconyx** digital camera traps model **RM45** (see Section 8, Equipment List). Due to their rapid response time, infrared flash, multifire capabilities and unique design for field conditions, these are the only camera traps approved for the TEAM Terrestrial Vertebrate Monitoring Protocol. **The TEAM Network office does not approve the use of any other equipment to collect TEAM Terrestrial Vertebrate Protocol data.**

4.2.1 Battery preparation

Each camera in the camera trap unit requires six type "C" rechargeable nickel metal hydride (NiMH) batteries to power the camera.

1. Charging the batteries for the first time. If this is the first time the type "C" rechargeable batteries are being used for a given year, **put them in a discharging-recharging cycle (conditioning cycle) at least 48 hours before leaving for the field assignment.** This ensures that the battery "memory" is properly set and prolongs the life of the rechargeable battery. Refer to the battery charger for instructions on how to put the batteries in this **conditioning cycle.** Only use battery charges that have this specification built in (see Section 8, Equipment List). To minimize the amount of time the batteries need to charge, we recommend using four to six battery chargers in parallel, each holding the maximum number of batteries.

3. Do not use these batteries for camera set up. Use only a set of six alkaline type "C" batteries to calibrate the cameras (see next step).

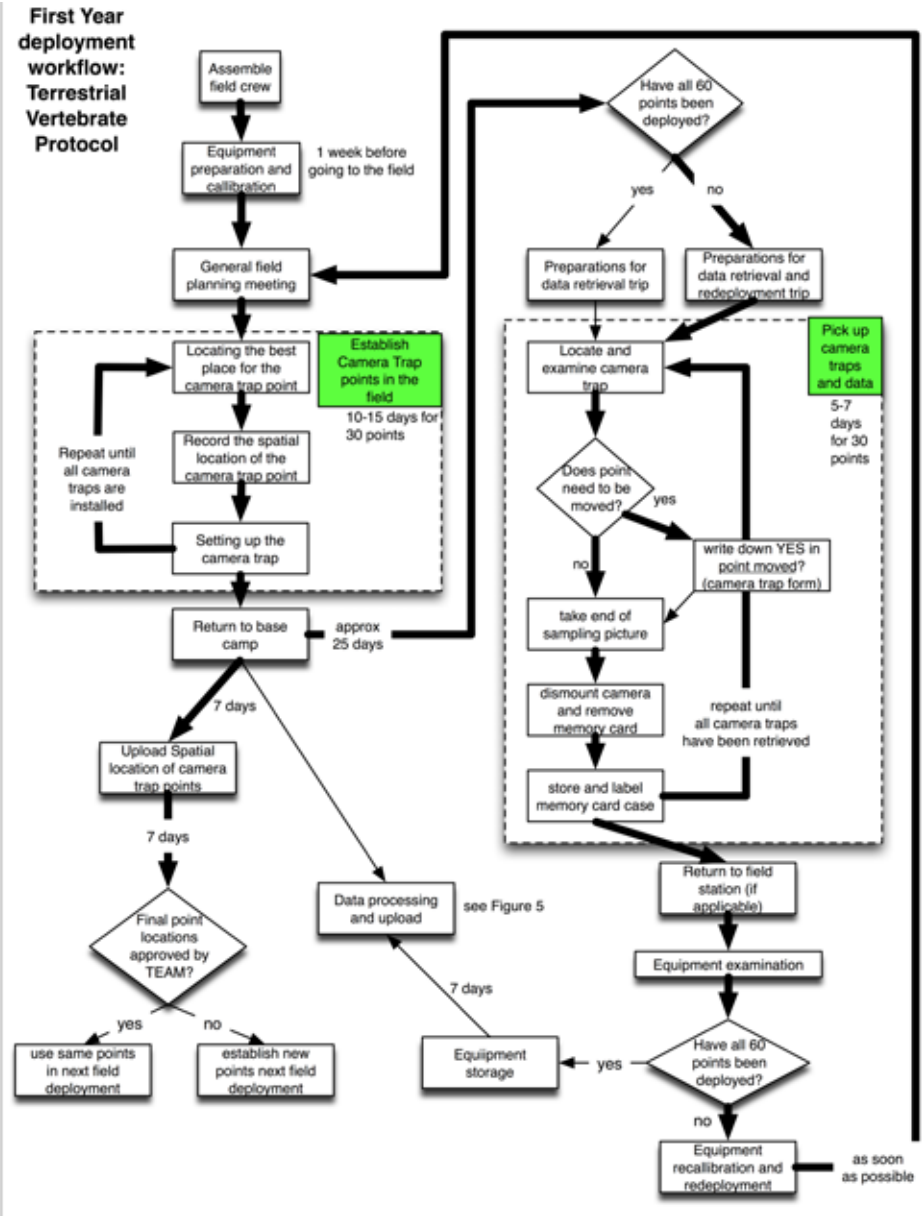


Figure 3. Workflow illustrating the main steps during the first year of deployment of the Terrestrial Vertebrate protocol. The workflow moves from deployment of camera traps to pick-up and redeployment if necessary .The thick arrows show the main steps in the workflow during the first cycle of deployment and pickup of camera traps.

4.2.2 Preparation of the camera trap

It is crucial that all camera traps are set up correctly and with the same settings to ensure standardization of the data being collected. Before taking the camera traps to the field, every single camera trap must be checked, as described below.

Forms needed during these steps:

• *Camera Trap Checklist* (Appendix 2). The *Camera Trap Checklist* needs to be filled out and signed by the team leader (or delegate) and site manager (or delegate). The Site Manager should not authorize the camera traps to go to the field until the *Camera Trap Checklist* has been signed and turned in.

• *Camera Trap Form* (Appendix 3): Use this form to record the serial number of the camera trap and the serial number of the memory card in each camera.

Steps:

1. Wash your hands. Always make sure your hands are clean before handling the camera traps and memory cards. Small bits of dirt may easily become lodged in the contact points resulting in a poor connection to the camera and card failure.

2. Mark the camera trap. Each camera trap should be externally marked with a unique identification number. TEAM recommends using the numbers 01, 02, 03, etc. Clearly write down the number in the back of the camera using a nonerasable, water-resistant pen marker. Write down this number in the Camera Trap Number column on the *Camera Trap Form*.

3. Set the date and time. Remove the front cover of the camera trap and insert six regular or alkaline type "C" batteries (not the rechargeable ones to be used in the field). Turn the camera on using the ON/OFF switch. If this is the first time the camera has been turned on, enter the corresponding year, month, day, hour, and minute, and press the OK button after each step (see Appendix 6, the Camera Trap Manual). To set the time, use the time from a standardized time server such as http://www.timeanddate.com. Enter the name of the city (or closest city) for the field site location to receive the official standardized time.

VERY IMPORTANT!

Date & time settings: images are useless without an accurate date and time stamp.Make sure the correct date and time are set in the camera trap. without this, all resulting photos will be useless!! refer to appendix 5, to learn how to set/verify the current date and time on the camera trap.

4. Record the Serial Number of the Camera Trap: Navigate to the **Camera Info** menu by using the << or >> buttons, and then press the OK button. This will display the Serial Number and Firmware version of the camera. Write down the Serial Number in the Camera Trap Serial Number column in the *Camera Trap Form*.

5. Record information about the Memory Card: Take out a memory card from its case and locate its serial number. The serial number is an 8-9 digit number usually found in the back of the memory card close to the electronic contacts. Write down the serial number in the column Card Serial Number (*Camera Trap Form*) in the corresponding row of the Camera Trap Number column (same form). Insert the memory card in the slot located in front of the panel below the buttons.

6. Set up the camera trap:. Navigate to the **Change Setup** menu of the camera trap and using a combination of the **OK**, <<, and >> buttons, set it up with the following settings (see Appendix 6 for details):

Setting	SET IT TO:
Trigger/Motion Sensor	ON
Trigger/Sensitivity	HIGH
Trigger/Number of photos per trigger	3
Trigger/Interval between pictures	RapidFire
Trigger/Quiet Period	No delay
Time Lapse	OFF
Date/Time	Current date and time, temperature in °C
User Label	Two-letter TEAM Site Code - dash - CT (e.g. CX-CT)(fill other details in the field, see p. 20, section 4.3.3)
Resolution	HIGH

When finished, Check the Correct Date and Time? and Correct Camera Settings? columns (*Camera Trap Checklist*).

7. Erase the memory card: If there are any images in the memory card, erase them. Go back to the **Main Menu** and navigate to **Erase Card** (make sure you are not loosing any valuable information!). Check the Is memory card empty? column (*Camera Trap Checklist*).

8. Replace the batteries: Turn the camera off and remove the six regular C batteries. Replace them with six fully charged C NiMH rechargeable batteries. Check the Camera Batteries Fully Charged? column (*Camera Trap Checklist*).

9. Test the Camera Trap Unit: Turn the camera trap back on, navigate to **Arm Camera** in the main menu, and select OK (the camera will be active in 10 seconds). Place the camera vertically (e.g on a bench) and stand in front of it at a distance of 2 meters; it should take a few pictures (navigate to **Check Status** to see how many pictures were taken). If the shutter clicks, check the column Camera trap working? (*Camera Trap Checklist)*. Otherwise, go back to Step 6 and make sure the camera is set up correctly. This step can be performed with several camera traps simultaneously by placing the camera traps along a bench and walking in front of them.

10. Install Desiccant: Finally, every camera trap case needs to be fitted with a pillow of desiccant or moisture control packets (e.g., Zorb-It, 2 × 2 cm; see Section 8, Equipment List). Place the pillow on top of the LCD screen, turn off the camera trap, and replace its front cover.

4.2.3 Case inspection

With the camera and the control unit programmed and set, the final preparation step is to inspect the camera trap case to make sure it is ready to be deployed to the field. Follow these steps to ensure the case is in proper conditions.

1. Camera trap case seals: Closely inspect the case and look for cracks or other anomalies. Make sure the case is solid and the seals are in good condition to prevent water entry to the interior. Check all the places were water can enter (e.g., junction points where the sensor lens, flash and lens windows, and lock handle touch

the case) to make sure the camera case will withstand wet weather. If junction points seem open or weak, use silicone sealer to seal them. Only after the case and seals are in proper shape check the column Case, Seals and Locking Bracket in Good Condition? (*Camera Trap Checklist*).

2. Prepare locks: In addition to the bungee cord provided, each camera trap should have a corresponding cable lock to fasten it to a tree in the field. Make sure to have the appropriate number of locks and the corresponding keys for each lock (usually, one set of keys will open three different cable locks). Test locks and keys to determine which keys open which locks. Check the column Locks and Keys Marked and Checked? (*Camera Trap Checklist*).

4.2.4 Final review of settings and paperwork

The crew leader should review the Camera Trap Checklist to ensure that for each camera trap all functions are properly set, memory cards are in place, the batteries are functioning, and so on. The crew leader (or his or her delegate) must review, sign, and date the checklist and obtain the signature of the site manager (or the site manager's delegate). The crew leader gives the signed checklist to the site manager who will properly archive it. Without this review and signature, the site manager may not authorize deployment of camera traps to the field. During site visits, the TEAM regional manager or TEAM technical director may request inspection of these forms (or any other forms described in this document).

4.2.5 Other Equipment and Supplies

The following additional field equipment and supplies (in addition to the camera traps themselves) need to be ready and packed before the team leaves for a field assignment:

- **GPS unit.** To ensure the maximum precision possible, the TEAM Network office will arrange for the crew leader to obtain access to a GPS unit with built-in differential correction so that each camera trap point can be geo-referenced. Plan the implementation schedule to allow time access to the differential GPS unit.

- **Aluminum tags.** Take 30–60 aluminum write-on tags to the field (see specifications in the equipment list). Once a camera trap point is established and geo-referenced it needs to be marked (see Section xx).

- **Cutting equipment.** Use light-weight cutting equipment (e.g., garden clippers or a small machete) in case small access trails need to be cleared to access potential camera trap point locations and to clear the vegetation around a camera trap point.

- **Compass and maps.** Take a few compasses and good plasticized maps of the area at the appropriate scale (i.e., block) to help orient the crew in the forest.

- **A small whiteboard.** Take a small whiteboard (e.g., 23 × 35 cm), 2–3 dry-erase pens, and a cloth rag to mark the beginning and end of the sampling period at each camera trap point.

- **One to two open-frame backpacks.** Use these to carry camera traps in the field. Each backpack can hold up to 5–6 camera traps.

- **Field forms.** Bring the following field forms:

    o *Camera Trap Forms* (Appendix 3): Take the forms that were already partially completed during the camera trap setup and preparation steps (Section 4.2.2) with the Camera Trap Number, Camera Trap Serial Number, and Memory Card Serial Number. Record other information on this form when installing the camera trap in the field.

    o *Camera Trap Point Form* (Appendix 1): Take blank copies of this form to complete all appropriate data about the camera trap points (i.e., latitude and longitude, camera trap point identification number, date, time, etc.).

4.2.6 General Field Guidelines

Before leaving for a field assignment, the crew leader should meet with the other crew members to review the deployment plan and schedule. This meeting should explain the setup and movement of temporary camps as the field crew deploys the camera trap points, the order in which various camera trap points will be visited, and other general logistical issues (e.g., water acquisition and food preparation and schedule). These are some general recommendations:

- Use maps of the study area with the expected locations of the camera trap points to explain to the field crew the deployment plan. Each point in the block should have a unique number (between 1 and 30, depending on the number of points in the block). This number will be part of the camera trap point ID used when marking the camera trap location.

- The number and location of temporary camps will depend on the local conditions at the site, but TEAM recommends establishing one or two camps to minimize travel to and from the camera trap points.

- The field crew should be prepared to spend several days sleeping in these temporary camps under sometimes harsh field conditions (high humidity and heat, rain, mosquitoes, etc.).

- TEAM highly recommends establishing temporary camps close to water sources to avoid carrying large amounts of water. Food should be very basic and include mostly nonperishable items.

- Setting up camera traps is hard and arduous work and the field crew should be physically and psychologically prepared to spend all day working in the field over several consecutive days. Spending an entire day in the field is crucial for minimizing the amount of time that camera traps should be deployed. Therefore, each crew member should carry enough water and food for the working day. Going back to the camp for lunch is inefficient and will waste valuable time.

- When packing the camera traps to take in the field **do not store them with food** or any other substances that might attach odors to the camera trap. Food or other smells might attract animals to the camera trap in the field, biasing the estimates of detection probability.

• When carrying camera traps in the field use an open backpack frame to which the camera traps can be strapped using the bungee cords that accompany each camera. **Do not carry camera traps and food in the same bag** to avoid impregnating them with smells that might bias the sampling.

4.3 Field Trip to Establish and Geo-reference Camera Trap Points

The following sections describe the steps for establishing and geo-referencing potential camera trap points and installing the camera traps in the field. Follow these steps carefully, because the successful placement of camera trap points is crucial to the quality and number of photographs expected.

4.3.1 Locating the best place for the camera trap point in the field

Using the Proposed Deployment Plan and a GPS unit, navigate to the proposed camera trap point location where a camera trap is expected to be deployed. This is the **potential location** that was determined during the deployment plan. Once the deployment crew reaches this location, the crew leader needs to find the best possible location as close as possible to the predetermined coordinates. **Choose the exact location to give the highest probability of obtaining useful photographs within 10 meters of the original point.** Often this will be a game trail or ridge top. Different species have unique travel habits, and trail characteristics affect the species that use those trails. Select the location that is likely to yield photos of the largest number of species. DO NOT choose the location on the basis of behavior of any single species. Local knowledge of a species should be used in making the decision. It is the crew leader's responsibility to decide the final location of the camera trap and to have prior experience with camera trapping.

1. Choose a "wildlife-friendly" site. Once in the vicinity of the predetermined coordinates, the crew leader should search for the nearest location such as trails, dirt roads, creek banks, and paths to water that animals use on a regular basis and with a good chance of animal visitation. Look for signs (tracks, scrapes, game trails) nearby.

2. Try to determine the travel path. The crew leader should choose a site where the travel path is limited to the area that the camera trap can photograph (Figure 4, A and C). An open area is a poor choice because animals may cross it at any point and travel in any direction (Figure 4D). A single trail with evidence of use and limited travel alternatives is optimal for placing camera traps (Figure 4C). In some cases it may be necessary to pile brush to restrict the options for movement on a wide trail.

3. Consider the sensor's range and field of view. A wide trail has more places at which wildlife can cross a sensor and thus, the greater the area that must be covered by the sensor's field of view. The maximum distance to the far side of the trail should not be farther than the distance covered by the flash. The distance should also be considerably less than the maximum range of the sensor.

4. Consider the terrain. The ground under the camera trap unit needs to be reasonably level (Figure 4E). Trails with ruts or slopes can result in the ground obscuring a traveling animal from the sensor beam, and might cause the camera trap to miss photograph opportunities. A path with a pronounced slope on one side can result in a sensor beam that is at shoulder height when wildlife walk on the upside of the path, but miss the animal entirely if it walks on the down slope of the path (Figure 4F). Be aware of all the possibilities of travel in front of the camera traps.

If it is impossible to find level terrain then make sure to angle the camera accordingly, so that it is reasonably parallel to the ground.

5. Find a suitable tree in which to set the camera. Finally, find a spot with a suitable tree or post perpendicular to the trail. Affix the camera trap to the tree approximately 30–50 centimeters off the ground and parallel to it. Suitable trees have trunks that are reasonably straight; thin enough to tie a chain or wire around; but not so thin that wind, people, or other animals can shake it excessively. Try to minimize direct sunlight exposure to the camera trap because excessive heat can reduce the sensitivity of the heat sensor. Camera traps should be set back at least 2 meters from the nearest point at which wildlife might travel across the sensor. This allows for clear, focused pictures and a large enough field of detection from the sensor. The longer an animal is in the detection zone, the less chance of missing a photographic opportunity.

6. Set up the "stage" for the camera trap. Occasionally, limitations in terrain or suitable trees hamper complete coverage of a trail. Cut some brush as needed to maximize detection within the field of view of the camera trap. Try not to disturb the trail or lay down too much vegetation to force animals to pass in front of the camera because some animals will turn around if faced with obstructions. Try to keep the stage as natural as possible.

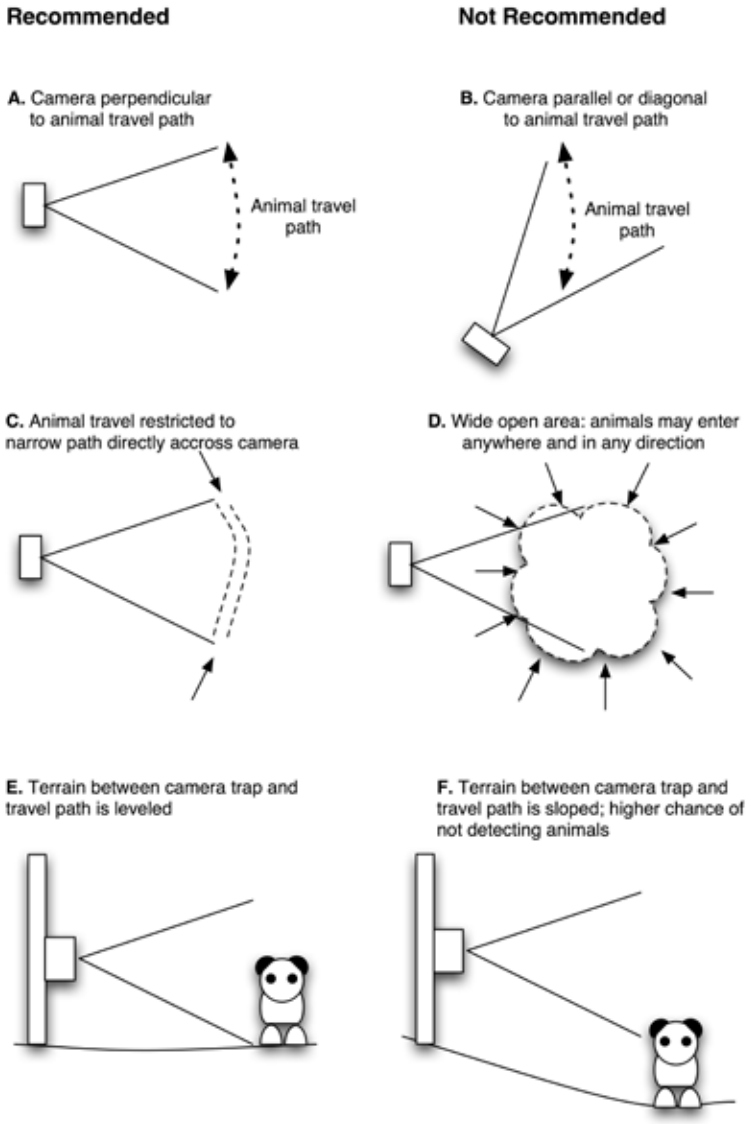


Figure 4. Recommendations for camera trap placement. Camera traps should be placed perpendicular to animal travel paths (A), rather than parallel or diagonal to them (B). Travel paths should be fairly restricted (C) rather than open (D). Terrain between camera trap and travel path should be leveled (E) and not sloped (F).

4.3.2 Record the spatial location of the camera trap point and mark its location

1. Record the spatial coordinates of the location. Once the final location for the camera has been chosen, record the longitude and latitude of the final placement of the camera trap in decimal degrees using a special **differential correction GPS unit**. **It is crucial to take a differentially corrected GPS location for each camera trap point before beginning any sampling.** This location should be as close as possible to the actual tree or post in which the camera will be mounted. Write down the latitude and longitude in decimal degrees with at least six decimal points in the Latitude and Longitude columns (*Camera Trap Point Form*). Fill in the Year, Month, Day, Time, First name of the person taking the reading, Last name of the person taking the reading, GPS Make and Model, and Number of Points columns (*Camera Trap Point Form*).

2. Mark the location where the camera trap will be set. Mark an aluminum tag with the camera trap point ID using the TEAM convention:

CT - Site abbreviation – Array number – Point number

The first two letters refer to the protocol (CT for Terrestrial Vertebrates Protocol); the second two letters are the abbreviation for the TEAM site; the third number is the array number, and the final two digits are the point number. For example, when setting up point # 15 in array # 1 at Manaus, use the following camera trap point ID: CT-MN-1-15. **Strictly follow this naming convention for all camera trap points.** Nail the aluminum tag to the tree were the camera trap will be mounted. Fill in the Point ID column in the *Camera Trap Point Form*.

4.3.3 Setting up the camera trap at the location

Once the specific location for the camera trap is geo-referenced and marked, the camera trap can be installed at the camera trap point. Follow the guidelines outlined here and in Figure 4.

1. Roughly calculate the field of view. Although camera traps can in theory detect movement up to 30 meters away, this distance is dependent on the local temperature and humidity. More realistically, and because vegetation in tropical forests tends to be dense, camera traps should be aimed 2–4 meters from animal trails. Because the camera lens has about a 40 degree field of view, the width of the field of view can be roughly approximated as 70% of the distance from the camera trap to the trail. For example, a camera that is about 3 meters away from the trail will capture a field of view of about 2.1 meters (0.7×3) in the trail. See below for a more precise determination of the field of view using the **Walk Test** mode in the camera trap.

2. Clear debris from the camera trap field of view. Clear big leaves and other obstructions between the camera trap location and the travel path. Anything that obstructs the beam reduces the detection ability of the camera and could result in poor quality photographs. Large leaves can result in false triggers when the sun heats up a frond blowing in the wind.

3. Fix the camera trap to the designated tree. Attach the bungee cord through the large handles (ears) of the camera trap and around the previously

marked tree where it will be located. The sensor beam should be approximately shoulder high on wildlife and set approximately 30–50 centimeters off the ground and parallel to it. Use freshly cut sticks and branches to help prop up and secure the camera trap to the tree trunk or other anchor. A well-placed twig between the camera trap housing and the tree trunk can help adjust the angle at which the sensor is pointed. Always use live wood to brace cameras and adjust camera angles because dead wood is too brittle. Try to avoid pointing the camera trap at objects in direct sunlight such as large rocks or sunlit streams that may absorb heat and trigger sensors.

4. Turn the camera on and type in the camera trap point ID. Remove the front cover and turn the switch of the camera to the ON position. Navigate to the **Change Setup Menu** and then to the **User Label Menu.** Using the << and >> keys to type in the camera trap point ID (the same ID in the aluminum tag at the camera trap point; e.g., CT-CX-1-3). All the photos taken by this camera trap will have that identifier in its pictures.

5. Activate the Walk Test mode. Navigate to the **Main Menu** and select the **Walk Test mode**. With this option, the camera flashes an indicator light when an object enters its detection zone without triggering any photos. Test the aim of the camera trap by crossing in front of it. Do this on both the edges and the middle of the path. A human who crawls or crouches while moving is a good imitation of wildlife walking in a relaxed fashion. Make sure that every conceivable angle at which wildlife can pass in front of the camera trap is tested, and that the sensor triggers in each instance (watch the light in front of the camera trap). If necessary, adjust the angle and height of the camera to maximize the field of view in front of the trail. **The camera trap will arm itself after a 2-minute period of no motion in front of the sensor.** This will ensure the camera has been properly set up.

6. Replace the front cover. Once the camera has been satisfactorily positioned, put the moisture control packet back inside and carefully replace the front cover of the camera trap.

7. Secure the camera trap to the tree. Pass the cable lock through the small ears of the camera trap over the front cover and around the tree. Secure the lock and do not leave the key. Write down the number of the key in the Key Number column (*Camera Trap Form*).

8. Prepare the whiteboard for a test/start photo. Take out the whiteboard and write down the following data:

a. The camera trap point ID that corresponds to this particular point (e.g., CT-MN-01-10)

b. The date in ISO standard format (yyyy/mm/dd); write this below the camera trap point ID

c. The time in ISO standard format (hhmm; e.g., 1600,1235)

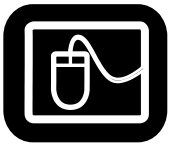
d. Complete first and last name of the responsible field crew team leader (do not use abbreviations, nicknames, or initials)

9. Take a test picture. After 2 minutes of inactivity in front of the sensor the camera will self-arm. As soon as this happens, position yourself 2 meters in front of the camera trap and hold up the labeled whiteboard. **Make sure the camera takes a photograph** (watch for the lens to open and close). The camera trap is set. Fill in the Start Date column (*Camera Trap Form*): year, month, day, hour, and minute (the same date and time that appear on the whiteboard). Also write down the First Name and Last Name of the leader of the crew setting the camera trap (*Camera Trap Form*).

10. Go to the next camera trap point. Walk to the next camera trap point and start the entire process described in Sections 4.3.1, 4.3.2, and 4.3.3. Repeat until all camera traps have been installed.

4.3.4 Return to the base camp/laboratory

After all the camera traps have been deployed at the corresponding camera trap points, each point needs to be sampled for a minimum of 30 days. When returning from the field, the next step is to upload all the spatial



information of the camera trap points to the TEAM Data Repository. The steps below outline this process in detail.

4.4 Upload the Spatial Location of Camera Trap Points

When returning from the field, upload all the spatial location information of the camera traps that have been deployed. It is crucial that this information is uploaded as soon as possible to the TEAM data repository for adequate checking to ensure the quality of the data and that the camera trap points are properly spaced according to the standard sampling design. While in the laboratory or base camp, transcribe all the data in the *Camera Trap Point Form* to the appropriate worksheet in the *Camera Trap Excel Template*. Follow the instructions below.

4.4.1 Transcribe the data from the camera spatial form

Transcribe all the information from the *Camera Trap Point Form* to the *Camera Trap Point Worksheet* (use the Camera Trap Excel Template). If there are problems with the spatial data, the locations will need to be re-established or geo-referenced again in the field by the field crew leader at the TEAM site (see Section 4.3.2).

1. Open the template and save the file using the TEAM standard convention. Open a blank copy of the Camera Trap Excel File. Save the file using the TEAM standard convention:

Site name abbreviation–Protocol abbreviation–From date_To date–NEW.xls

For example, a file from Volcan Barva where camera trap points were measured between January 16 and January 23, 2007, should be named as follows: VB-CT-2007-01-16_2007-01-23.NEW.xls.

2. Transcribe the data. Navigate to the Camera Trap Point Worksheet in the file and enter all the information row by row (record by record). Make sure all the values in each column conform to the standard data dictionary for this form (available at the TEAM Web site). Save the file **EVERY TIME** a new record is entered (by doing so, only one record will be lost if a power failure occurs).

3. Make a backup copy. When finished entering the information or at the end of the day, make a backup copy of the file (ideally, an external removable hard drive). This hard drive should be stored in a different location than the computer.

4.4.2 Upload information to TEAM data repository

Once all the information for a particular camera trap block has been transcribed to the *Camera Trap Point Worksheet* in a corresponding *Camera Trap Excel File*, upload it to the TEAM data repository: http://www.teamnetworkdata.org. You will receive an e-mail confirmation that the file has been uploaded a few days later, and an explanation of whether the data in the file comply with TEAM minimum data standards.

The TEAM remote sensing specialist will evaluate the data only if the data comply with TEAM minimum standards. She or he will communicate within 7 days of ac-

ceptance of the file and approve or reject the spatial data. If the spatial data are approved, then the points just deployed can be used for subsequent sampling. Otherwise, the TEAM remote sensing specialist will discuss with the site manager the problems with the spatial data, and whether a new field trip is required to re-establish and geo-reference camera trap points.

4.5 Data Retrieval and Subsequent Redeployment of Camera Traps

After the first-deployed camera traps have been in the field for at least 30 days, the data (photographs) need to be retrieved and the camera traps moved to new camera trap points if points still remain to be sampled in the season. Remember that in the first year a total of 60 camera trap points need to be sampled for a minimum of 30 days each. Because the number of camera traps at each site is usually between 20 and 30, the camera traps need to be deployed at one set of points, left there for 30 days, moved to the remaining set of points, and left there for another 30 days.

At some TEAM sites it might be possible to retrieve the memory cards, replace the batteries, insert fresh memory cards, and relocate the camera traps without having to return to the permanent base camp or laboratory. At other sites, the field crew might have to bring back all camera traps to the laboratory before redeploying to the remaining set of camera trap points. The site manager can adjust the steps below depending on whether the field crew is expected to return to the laboratory after pickup and before redeployment. However, it is important to minimize the time between picking up the camera traps and redeploying them to a new set of points because all sampling needs to occur within the same dry season, otherwise the sampling period will include dry and wet seasons, which can affect the number of photographs being taken and the quality and comparability of the data with other TEAM sites.

Follow the steps below if the camera traps are to be redeployed almost immediately without their being returned to the field station or permanent base camp. Otherwise, steps 1 and 2 in Section 4.5.1, "Preparations for the data retrieval and redeployment trip" and all steps in Section 4.8, "Redeployment of Camera Traps in the Field" can occur in the base camp before redeployment.

4.5.1 Preparations for the data retrieval and redeployment trip

1. Charge the new batteries. Using Section 4.2.1 as a guide, charge and bring fresh type "C" rechargeable NiMH batteries to replace the ones that have been in the field (a few more than six times the number of camera traps deployed to have some extras). Allow 24 hours to charge the batteries before traveling to the field.

2. Prepare fresh memory cards. Bring new memory cards to insert into the cameras to replace the ones that will be retrieved. Before traveling to the field, make sure each memory card is empty by inserting it into a card-reader drive connected to a computer (any USB drive compatible with the memory card; see Section 8, Equipment List). Pack the memory cards in their original plastic cases to avoid soiling. If the original cases are not available, bring one small, zipper-like plastic bag for each memory card.

3. Keys for the cable locks. Bring all the keys to unlock the cable locks securing the camera traps in the field.

4. Six to 12 type "C" alkaline batteries. Bring some alkaline batteries in case a camera needs to be reprogrammed or reset. Do not use the fresh rechargeable batteries for this to avoid using any of their energy.

5. Replacement camera trap. Bring an extra camera trap in case some have been stolen from the field or need to be replaced because of malfunction. Follow the calibration and preparation steps in Sections 4.2.1 to 4.2.3 before taking it to the field.

6. Small whiteboard and erasable markers. This is crucial for testing the camera trap and documenting the end of the 30-day sampling period.

7. Bring the following forms:

a. The *Camera Trap Form* that was filled out when the cameras in the array were deployed a month ago. This form should already have the first 6 columns filled in. Fill in the remaining columns when the camera traps are picked up in the field.

b. A new blank *Camera Trap Form*, which will need to be filled in when the cameras are redeployed to new locations.

c. A new *Camera Trap Spatial Form* if camera points need to be relocated in the field.

d. A blank Damaged *Camera Trap Form* to log information about camera traps that malfunction.

e. A blank *Camera Trap Checklist* to recheck and recalibrate the equipment before camera traps are redeployed to new locations.

8. Take blank aluminum tags for new camera trap points. Take a few blank aluminum tags in case camera trap points need to be relocated. Use them to mark the location of the new camera trap point.

9. **Pack in a small water canteen and a small towel.** To avoid damaging the contacts of memory cards when picking them up in the field, each crew member should pack a water canteen with a small clean towel and use them to clean their hands before handling memory cards.

4.5.2 Picking up the camera traps and memory cards

To ensure each camera trap is sampled for at least 30 days, the field team must plan to return to each camera trap point to retrieve the memory cards and the camera traps. Follow the steps below to ensure all information is collected in a standardized way.

1. Locate and examine the camera trap. Upon reaching the location where the camera trap was installed, examine it without getting in its line of vision (e.g., from one side) and look for obvious signs of external damage.

a. If the camera is missing write YES in the Camera missing? column and NA in the *Camera working?*, Case damage?, Camera damage?, and Card Damage? columns (*Camera Trap Form*). If the camera is not missing write NO in the Camera missing? column (same form).

b. If the case appears damaged write down YES in the Case damage? column (*Camera Trap Form*), otherwise write NO.

c. If a tree has fallen in the path of vision of the camera trap and it will be difficult to easily remove the camera trap from the line of vision (e.g., without using a saw) then **this camera trap point will need to be moved.** Do not do this now. Instead, write YES in the column point needs to be moved? (*Camera Trap Form*). Explain the reason in the Notes column (same form). Complete all the steps below and do not worry about moving the camera trap point now. This will occur the next time this point is visited for subsequent redeployment next year (see Section 6.2).

2. Prepare the whiteboard for the test/end photograph. Take out the whiteboard and follow the steps outlined in Section 4.3.3, Point #8. The whiteboard needs to be properly labeled with the camera trap point ID, date, time, and first and last name of the camera trap field crew leader.

3. Take a test/end of sampling period photograph. Position yourself about 2 meters in front of the camera trap holding up the previously labeled whiteboard. **Watch to see whether or not the camera takes a photo** (i.e., watch for the lens opening and closing).

a. **If the camera does NOT take a picture**, write NO in the column Camera working? (*Camera Trap Form*). At the end of the day (or back in the field station), follow the steps in Section 4.6 to determine the possible cause of the camera malfunction.

b. **If the camera DOES take a picture**, write YES in the column Camera working? (*Camera Trap Form*).

c. Write the year, month, day, hour, and minute corresponding to the End Date column (*Camera Trap Form*). These values should be the same as those written on the whiteboard.

d. Write down the first name and last name of the person responsible for picking up the camera (i.e., the field crew leader) in the First Name and Last Name—Person picking up the camera columns (*Camera Trap Form*). These values should be the same as those written on the whiteboard.

4. Dismount the camera from the tree. Unlock the cable and dismount the camera from the tree. The camera might take a photo while doing this. Do not worry about this.

5. Clean your hands. Before opening the camera trap and handling any memory cards clean and dry your hands thoroughly using water and a towel to avoid damaging the contacts of the memory card.

6. Open the camera trap case. Open the camera trap and turn the ON/OFF switch to OFF.

7. Retrieve the memory card. Make sure the camera trap is OFF. Pull out the memory card from its slot in the front of the case.

8. Store the memory card in the appropriate case/bag. Store the memory card in the corresponding plastic case previously labeled with the camera trap point ID for that particular camera trap point (e.g., CT-MN-2-04). Double check that the memory card has been stored in the correct case by comparing the **camera trap point unit ID written on the case with the camera trap point unit ID written on the aluminum tag at the camera trap point.** If plastic cases for the memory cards are not available, place the card in a prelabeled, plastic zipper-type bag. You may have dozens of memory cards from 20–30 different camera trap points and it is vital to know precisely which memory card corresponds to which camera trap point.

9. Close the camera trap case. Replace the front cover of the camera trap. Properly pack the camera trap in a bag and go to the next sampling point. Repeat the entire process outlined in Section 4.5.2 until the last camera trap of the day has been picked up.

4.6 Equipment examination

At the end of each day in the field, or if all the camera traps are returned to the main field station or laboratory, examine the camera traps that are believed to be defective and prepare the equipment for redeployment to points that have not yet been sampled. Use the following steps to ensure that by the time the last camera trap is picked up from the current sampling array, most of the equipment will be ready to be redeployed to a new sampling array.

1. Separate functioning camera traps from defective camera traps. Using the results of the photo test at the time of retrieval, separate the camera traps **THAT DO NOT WORK** from the camera traps **THAT DO WORK**.

2. For the cameras that DO NOT WORK:

a. Open the camera trap and replace the rechargeable type "C" batteries in the camera with six regular type "C" batteries. Insert a blank or test memory card. Re-arm the camera trap (**Main Menu/ Arm Camera**).

b. Test the camera trap by walking in front of it. If the camera triggers, open the camera trap and check the display status to make sure the camera took a photo. This means the camera batteries were depleted.

c. If after following Steps a and b above the camera trap does not take a photo, the trap needs to be replaced with a new unit. Fill in all the columns in the *Damaged Camera Trap Form*.

d. Examine the camera trap externally and internally looking for signs of damage (cracks, loose seals, water, etc.). Write down anything unusual in the Notes column of the *Damaged Camera Trap Form*.

e. If new batteries and a memory card were inserted in the camera trap, take them out.

f. Take this camera trap back when returning to the permanent base. Instructions on what to do with these damaged cameras appear below.

3. For cameras that DO WORK:

a. Open the camera trap and take out the rechargeable type "C" batteries.

b. Check the camera trap and camera for any external damage. Write down YES or NO in the column Case damage? as appropriate (*Damaged Camera Trap Form*). If the case appears to be damaged, describe it briefly in the Notes column (*Damaged Camera Trap Form*). If the damage is major (e.g., a large crack) such that water may seep into the camera trap, it needs to be repaired right away (Section X) or taken back to the laboratory and repaired there. In the latter case, replace the camera trap with a spare one. Fill in the column Case damage? in the *Camera Trap Form*.

c. If the case is not damaged, make sure the ON/OFF switch (control unit and sensor) is turned OFF.

d. Store the camera traps in a dry place until redeployment. If the camera traps are not being taken back to the laboratory or permanent base before being redeployed in the field, store them closed in the coolest and driest place available in the temporary base camp.

4.7 Equipment Recalibration

Once all camera traps have been collected from a particular sampling array and examined, they need to be moved to the next sampling array. Before the camera traps are redeployed in the field cameras need to be recalibrated, with new batteries and memory cards installed. Depending on logistical conditions at the TEAM site, this step may occur in a temporary camp in the field before the cameras are redeployed to another sampling array or at the permanent laboratory or field station. In both cases, follow the steps below to ensure this process is standardized.

Field Forms needed: A blank copy of the *Camera Trap Checklist* form.

All camera traps need to be refitted with new batteries and memory cards and re-checked at least 24 hours before field deployment. A new *Camera Trap Checklist* form needs to be filled out and the field deployment team leader (and site manager if this happens at the permanent laboratory or field station) must sign the list before the camera traps can be redeployed. Make sure to follow the requirements in the following sections:

1. Follow Steps 1 and 3–10 in "Preparation of the camera trap" (Section 4.2.2). If a new camera trap is being used to replace a missing or malfunctioning one, be sure to follow Step 2 as well.

2. "Case inspection" (Section 4.2.3).

3. "Final review of settings and paperwork" (Section 4.2.4).

The camera trap settings should not change from one field deployment to the next within the same sampling year. It is important to make sure all the equipment has the same settings to ensure data standardization.

4.8 Redeployment of Camera Traps in the Field

Before returning to the field the crew should meet to review the deployment plan for the remaining camera trap points that need to be established and geo-referenced. Follow the guidelines in Section 4.2.6.

Follow the exact same guidelines in Section 4.3 under "Field Trip to Establish and Geo-reference Camera Trap Points."

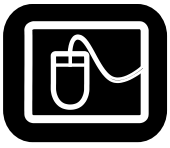
4.8.1 Return to the laboratory/permanent base camp and process damaged cameras

After all camera traps have been redeployed, the field crew will return to the laboratory or permanent base camp. Upon return, process all the memory cards that were collected from the first deployment. The next section explains how to accomplish this. All camera traps that were found damaged need to given to the site manager in conjunction with the *Damaged Camera Trap Form*. If the camera trap is still under guarantee, the site manager must mail it back to the manufacturer for a replacement (see the Reconyx manual in Appendix 5). If the camera is not under guarantee, then the site manager will need to order a replacement and include that cost in the budget for next year.

4.9 Processing and Uploading of Spatial Data

Following the guidelines outlined in Sections 4.4.1 and 4.4.2, transcribe all the new spatial information for the camera trap points that were just deployed and upload it to the TEAM data repository for proper technical evaluation. As described before, a TEAM remote sensing specialist will approve or reject the points within 7 days of uploading. If points are rejected, these points will need to be re-established the next time camera traps are deployed. If the points are accepted then camera traps can be deployed at these points the next field season.

4.10 Processing and Uploading Data from a 30-Day Deployment Cycle



All photos and data from the 30-day camera trap deployment cycle need to be processed and uploaded to the TEAM Web site (http://www.teamnetworkdata.org) **within 7 days of returning from the field. Do not wait until all the sampling for the season has been completed**. Follow the steps below to

ensure this occurs in a standardized and efficient fashion. This process is outlined in Figure 5.

Excel templates needed for this process:

1. *Camera Trap Excel Template* to transcribe all information on the Camera Trap form.

2. *Photo Data Excel Template* to transcribe all information from photos taken by the camera traps in the field.

3. *Damaged Camera Trap Excel* Template to transcribe all information on the Damaged *Camera Trap Form*.

All Excel templates are included in different tabs (or worksheets) within the same Excel template file. The current English version of the Excel template file is named "CT-ET-EN-3.0.xls" and can be downloaded directly from the TEAM Web site. Refer to the Data Management Protocol at the TEAM Web site for an explanation of the naming conventions of the TEAM Excel templates.

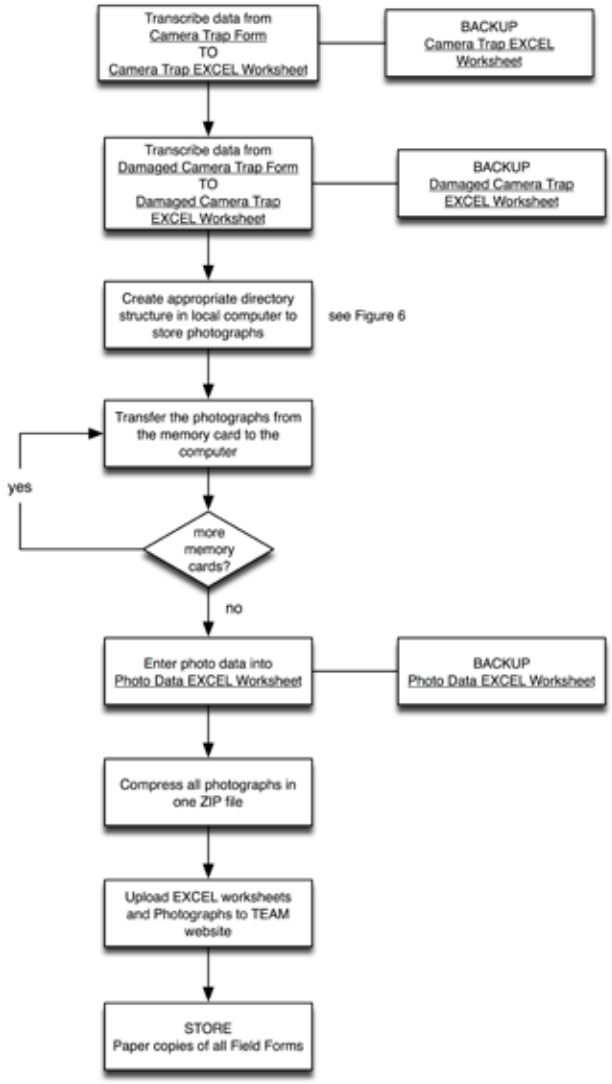
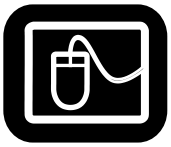


Figure 5. Workflow illustrating data processing, transcription and upload.

4.10.1 Transcribe the data from the Camera Trap Form



Follow these steps to transcribe all the data from the *Camera Trap Form* to the *Camera Trap Excel File*.

1. Open a copy of the *Camera Trap Excel Template*. Open the computer file "CT-ET-EN-3.0.xls." It should contain no data. Navigate to the Camera Trap Worksheet (or tab).

2. Save this template as a new *Camera Trap Excel File*. Save the file with a new name using "Save As." The name of the file should follow TEAM standard convention:

Site name–CT–From date_To date–NEW.xls

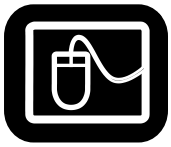
Use the two-letter abbreviation for the TEAM site, the two-letter abbreviation for the protocol name (CT stands for the Terrestrial Vertebrate Protocol), the **from date** in ISO format (yyyy-mm-dd), the **to date** (yyyy-mm-dd), the word NEW (means this is a new file), and the extension (xls).

Example: A file from Manaus, with Terrestrial Vertebrate data collected between January 1 and January 30, 2007, should have the following name: MN-CT-2007-01-01_2007-01-30-NEW.xls

3. Transcribe the data. Transcribe all the information from the *Camera Trap Form* to the *Camera Trap Worksheet* in the *Camera Trap Excel File*, row by row (record by record). Make sure all the values in each of the columns follow the Standard Data Dictionary for this form (the data dictionary for the terrestrial vertebrate monitoring protocol is available at the TEAM Web site). Save the file **every time** a new record is entered (by doing so only one record will be lost if a power failure occurs).

4. Make a backup copy. When all information has been entered (or at the end of the day), make a backup copy of the file (ideally, on an external, removable hard drive). Store this hard-drive file in a location other than on the computer.

4.10.2 Transcribe the data from the Damaged Camera Trap Form



If malfunctioning camera traps or camera traps with damaged cases/seals were returned from the field, transcribe all information from the *Damaged Camera Trap Form* (Section 4.6) into the current *Camera Trap Excel File*:

1. Open the file. Open the current Camera Trap Excel File being used to store the information for this sampling cycle.

2. Transcribe the data. Navigate to the Damaged Camera Trap Worksheet in the file and enter the information row by row (record by record). Make sure all the values in each column follow the standard data dictionary for this form.

3. Save the file frequently. Save the file every time a new record is entered (by doing so only one record will be lost if a power failure occurs).

4. Make a backup copy. When all information has been entered (or at the end of the day), make a backup copy of the file (ideally, on an external, removable hard drive). Store this hard-drive file in a location other than on the computer.

4.10.3 Create the appropriate computer directory structure to store the photographs

Create a directory structure (a series of folders and subfolders nested in a particular way) before transferring photographs from the memory cards to the computer so that photographs from each camera trap point at each sampling period can be easily found. Follow the steps below to ensure this directory structure is standardized.

1. Create a folder for the sampling period. In the folder where the data from the Terrestrial Vertebrate Protocol are usually stored, create a folder with the name of the sampling period. Because the Terrestrial Vertebrate Protocol happens only once a year, the name of this folder should be the year the sampling took place (e.g., 2007).

2. Create a subfolder for the camera trap block number. Inside the sampling period folder create a folder named "Block," followed by the corresponding camera trap block number sampled (e.g., Block 1).

3. Create subfolders for the camera trap points IDs. Inside the Block number folder, create folders named for each camera trap point. For example, folders that will contain photographs from camera trap points 1, 2, and 3 from sampling block 1 in Manaus will be named "CT-MN-1-01," "CT-MN-1-02," and "CT-MN-1-03," respectively.

Figure 6 illustrates this folder hierarchy and shows how the photographs should be stored. **It is intended to serve only as an example**. Use the appropriate abbreviations and numbers depending on the year of sampling and TEAM site.

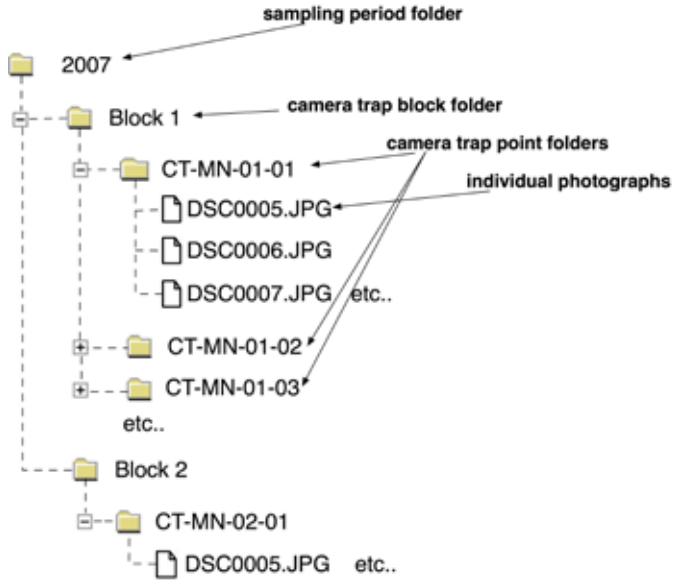
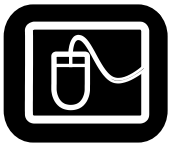


Figure 6. Example of the directory structure created when storing the photos in the computer. The top level is the sampling event folder, the next level is the camera trap block folder, inside these are the camera trap point folders, and inside each of these are the individual photograph files.

4.10.4 Transfer the photographs from the memory card to the computer



Gather all the memory cards that were brought back from the field and put them in an open box or container. Label this box "Cards not transferred." The memory cards should be individually packed in premarked plastic cases or plastic bags with the camera trap point ID from which they came. Label another box or container (it should be empty at this point) "Cards transferred."

1. Connect a card reader to the computer. Connect a card reader capable of reading Compact Flash (CF) cards to the USB port in the computer (see Section 8, Equipment List).

2. Take a memory card with its case from the "Cards not transferred" box. Notice the camera trap point ID written down in the case or bag where the card is stored. This camera trap point ID will be needed when transferring the files to the computer. Open the case (or bag) and take out the card. Do not open other cases/bags at the same time to minimize the risk of mixing up cards from different camera trap points.

3. Insert the memory card in the card reader. Insert the memory card with the metal contacts facing in and down. Pay attention to the orientation of the card; the contact side should be oriented downward.

4. Examine the contents of the memory card. Once the memory card has been properly mounted and read by the computer double-click on the appropriate drive letter to examine the contents of the memory card. Files will have names such as DSC0001.JPG, DSC0002.JPG, etc. Open one or two of these files to make sure these are photographs from the camera trap. **If files do not appear**, the memory card might have been damaged or erased. Follow these steps to determine the problem:

a. Remove the card reader from the computer by using the "Safely Remove Hardware" command in Windows.

b. Reconnect the card reader to the computer and repeat Steps 3 and 4 above.

c. If the contents of the memory card still cannot be examined repeat Step a) above. Go to the next step.

d. Find a camera from a spare camera trap. Insert the memory card in that camera and try to examine the photos in PLAY mode. If photos are still not visible, the memory card might be damaged.

e. Take 2–3 photographs with the camera trap and verify they have been stored in the memory. If they have not, the card is damaged. Go to Step g).

f. If photographs are not visible, there might be a problem with the card reader. Find another card reader. Start again from Step 3 above.

g. Open the *Camera Trap Excel File* used for this 30-day sampling cycle. Navigate to the *Camera Trap Worksheet*, and enter YES in the column Card Damage in the appropriate row for this card. Save the file.

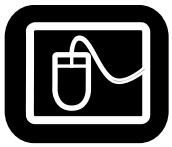
h. If the memory card is damaged, write down "Damaged" on the front side of the card. Return it to the case it came from and store it in a different box labeled "Damaged Memory Cards" to minimize the risk of taking it back to the field and losing valuable information.

5. Copy the files from the memory card to the computer. Select all the photographs from the memory card and copy them into the folder labeled with the same name as the camera trap point ID written on the case or bag. **Be careful! Do not risk mixing up photographs from different camera trap points.**

6. Remove the memory card. Once all photographs have been copied from the card, use Windows Explorer and select the USB drive that corresponds to the memory card. Right click on it and select "Eject" to safely remove the card. **Do not yet erase the photographs from the card.**

7. Place the memory card back in its case. After ejecting the card, INMMEDIATELY return it to the case (or bag) from which it came and drop it in the "Cards Transferred" box.

8. Process another memory card. Repeat Steps 1 through 7 in this section until all photographs from all cards have been transferred to the computer and the "Cards Not Transferred" box is empty. When finished (or at the end of the day) make a backup copy of the entire folder containing all photographs from all camera trap points in a separate drive (ideally, a removable hard drive). Store this drive securely in a place other than where the computer is housed.



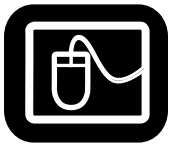
4.10.5 Process the photographs

At this point all photographs should be stored in computer folders that correspond to their camera trap point ID. Several pieces of information now need to be extracted from each photograph and stored in the Photo Data Worksheet in the *Camera Trap Data Excel File*. Follow the steps below to ensure that photographs are processed correctly with all necessary information.

1. Open the Excel file. Open the current *Camera Trap Excel File* used to store all information for this 30-day sampling cycle. Go to the worksheet labeled Photo Data.

2. Locate and open a camera trap point folder. Open the sampling event folder (e.g., 2007) and choose the next subfolder in the list (e.g., CT-CX-01-01) and open it. It should contain all the photographs that were taken at that camera trap point for the 30-day period. Enter the name of the sampling event (e.g., 2007) in the Sampling Period column and the Point ID in the Point ID column in the *Photo Data Worksheet*. All photographs from this folder should have the same Sampling Event and Photo ID.

3. Order the photographs by date. Using Windows Explorer, make sure the photographs are ordered by date from the earliest to the latest.



4. Start entering data. Follow these steps:

a. **Open a photograph file.** Open the next photograph in the list (if not the first one).

b. **Enter date and time.** The bottom right of the photograph contains the date and time the photo was taken. Separately enter the year, month, day, hour, and minute when the photograph was taken in the columns year, month, day, hour, and minute in the *Photo Data Worksheet*.

c. **Enter the name of the file.** Enter the name of the photograph file (e.g., DSC0005.JPG). Enter this name in the Raw Filename column in the *Photo Data Worksheet*. The next column (TEAM Filename) will be completed automatically.

d. **Identify what is on the photograph.** If the photograph contains the image of an animal identify it to genus and species. The Excel spreadsheet will have a drop-down list of all mammal and bird genera and species following the taxonomy given by *Mammals Species of the World* by Wilson and Reeder (2004) (http://nmnhgoph.si.edu/msw/) and *The Sibley/Monroe World List of Bird Names* by Monroe and Sibley (1997) (http://www.ornitaxa.com/SM/SMOrg/sibley4.html). Select the appropriate genus and species in the genus and species columns in the *Photo Data Worksheet*. If the animal can be identified to the subspecies, include the subspecies name with the species name in the same column. The next column in the worksheet (binomial) will be completed automatically. Follow these rules to ensure consistency in how this information is entered:

i. **If a photograph contains more than one animal**, fill in the column number with the number of animals the image contains.

ii. **If a photograph contains more than one species of animal** (this happens very rarely), complete a separate row of data for each species. All the data will be identical EXCEPT for the genus, species, and possibly number.

iii. **If the photograph is a test** to position the camera trap, for example, enter the word TEST in both the genus and species columns.

iv. **If the photograph contains the whiteboard with the start of the sampling cycle information**, enter the word START in both the genus and species columns.

v. **If the photograph contains the whiteboard with the end of the sampling cycle information**, enter the word END in both the genus and species columns.

vi. **If the photograph is of a human** other than a field crew member (e.g., a hunter) enter **Homo** and **sapiens** in the genus and species columns.

vii. **If the photograph contains nothing** (sometimes a camera will take a photo in response to moving vegetation, a falling branch, or a bird quickly flying by), enter BLANK in both the genus and species columns.

e. **Enter the name of the person identifying the photograph.** Type in the first name and the last name of the person who identified the animal in the photograph in the First Name and Last Name columns in the *Photo Data Worksheet*.

f. **Save the file.** Save the file after entering each record (a row). By doing so only one record will be lost if a power failure occurs.

g. **Repeat steps a through g in this section** until the information for each photograph taken at this camera trap point has been entered. Start again at Step 2 (open the folder for a new camera trap point) and again follow all substeps in Step 4.

5. Make a backup copy. After entering all information (or at the end of the day), make a backup copy of the file other than on the current computer (ideally, an external, removable hard drive). Store the hard drive in a different location than the computer.

4.10.6 Upload the information to the TEAM Web site

Once all data for a 30-day sampling cycle have been entered in the computer, these files (Excel templates and photographs) must be uploaded to the TEAM Web site. **Data must be uploaded to the TEAM Web site no later than 7 days after returning from a field assignment.**

1. Prepare the information. The following two files will need to be uploaded:

a. **The Camera Trap Excel file for a specific 30-day sampling cycle.** This includes four worksheets: *Camera Trap Data, Photo Data, Damaged Camera Traps,* and *Camera Trap Point Data*.

b. **A compressed file with all photographs that were taken during the same 30-day sampling cycle.** Using a file compressing utility (such as WinZip, http://www.winzip.com) compress the folder containing all the photographs for that sampling cycle (e.g., folder Array 1 in folder 2007). This will create a much smaller file that can be easily uploaded through the Internet. The compressed file will also preserve the directory structure so that when it is decompressed, the original folder, its subfolders (each with the camera trap point ID), and the photographs in each subfolder will be recreated exactly.

2. Name these files using the TEAM standard convention. Use the convention outlined in the TEAM Data Management Protocol to name these two files:

a. **Camera Trap Excel Template file.** *Site abbreviation–Protocol abbreviation–Start date_End date–NEW.xls*. For example, a file containing data from Manaus collected from July 1 to July 31, 2006, should be named **MN-CT-2006-07-01_2006-07-31-NEW.xls.**

b. **Compressed file with photographs.** *Site abbreviation–Protocol abbreviation–Start date_End date-PHOTOS.zip*. For example, a file containing all photographs from Manaus collected from July 1 to July 31, 2006, should be named **MN-CT-2006-07-01_2006-07-31-PHOTOS.zip.**

3. Upload files to the TEAM data repository. Point the browser to the TEAM data repository Web site (http://www.teamnetworkdata.org), log in, and follow the instructions to upload each file. You will receive a confirmation e-mail.

4.10.7 Backup and store all field forms

After all data have been transcribed and uploaded make copies of all paper field forms and store them in a folder labeled with the name of the sampling period (e.g., TEAM Terrestrial Vertebrate Protocol—2007). Store the originals and copies in different places (preferably in different buildings).

4.11 Last Field Trip of the Season and Camera Storage

Before the end of the last sampling cycle (30 days) of the season, plan one last field trip to return the camera traps and the memory cards to the laboratory or permanent base where the equipment is stored when not in use. The camera traps will not be redeployed in the field until the next dry season. Follow the guidelines in this section to ensure equipment receives proper care when not in use.

4.11.1 Preparations for the last field trip of the season

Take no fresh batteries or memory cards on the last field trip. Follow steps 3, 4, 6, 7 and 9 in Section 4.5.1, "Preparations for the data retrieval and redeployment trip" . Follow Step 7, but do not bring blank *Camera Trap Forms* or *Camera Trap Point Forms;* you will not need them.

4.11.2 Picking up the camera traps and memory cards for the last time in the season

Follow the guidelines in Section 4.5.2 ("Picking up the camera traps and memory cards"). When all camera traps have been collected, bring them back to the laboratory or permanent base where equipment is stored. See the section that follows for checkup and final storage of the equipment.

4.11.3 Equipment check-in

When camera traps have been returned to the laboratory or permanent base, they need to be checked and cleaned before storage. Follow the steps in Section 4.6 ("Equipment examination") to separate working cameras from nonworking camera traps. Fill in the *Damaged Camera Trap Form* and give it to the site manager so that these cameras can be repaired or replaced before the next sampling season.

4.11.4 Camera storage

All camera traps that are in proper working condition must be cleaned and stored in a dry place until they are needed again. Follow the steps below:

1. Remove batteries. Check again and remove any remaining type "C" batteries in the camera.

2. Discharge the rechargeable batteries. Discharge all rechargeable type "C" batteries using the discharge mode in the battery charger. This is essential to prolong battery life while the batteries are stored.

3. Store the batteries. If the batteries did not come with their own plastic case, store them in a zipper-like, re-sealable plastic bag. Write the beginning storage date on the bag. Store the rechargeable "C" batteries in a cold and dry place (an air conditioned room or a 4°C refrigerator are preferable).

4. Clean the cameras traps. Open the front over and clean the interior of the camera trap with a dry rag (do not use a wet or damp cloth) making sure to remove all debris (dry leaves, dust, etc.). Clean the outside lens cover of the case, the cover of the sensor, and the flash cover. If any of these covers is too dirty to clean with a dry rag, use a barely damp cloth to remove the dirt. Make sure to thoroughly dry these parts afterward.

5. Check the seals. Replace the front cover of the camera trap making sure it gives some resistance. If it closes easily, inspect the seals to make sure they are not wasted or run down. If they are, apply a thin layer of silicone rubber around the edge of the camera trap case to improve sealing. Do not close the case until the silicone rubber is dry (~12 hours).

6. Store the camera traps. Place a moisture control packet inside each camera trap and replace the front cover. Store the camera traps in an air conditioned room, a dry closet, or an airtight container. The moisture control packets do not need to be oven-dried or put in the microwave.

5. POWER ANALYSIS TO DEFINE SAMPLE SIZE

After all data from the first field season have been collected and uploaded to the TEAM data repository, the TEAM Terrestrial Vertebrate Protocol manager will determine whether the initial number of camera trap points (60) is enough to detect the minimum level of biodiversity change required by the TEAM program (Figure 1). The TEAM Terrestrial Vertebrate Protocol manager will produce a report showing the results from this analysis 15 days after receiving the data.

If the report determines that the initial number of camera trap points is enough, then deployment of the protocol in subsequent years will continue using 60 camera trap points. If the report determines the number of camera traps is insufficient, then additional camera traps points will need to be established at the site at the beginning of the next sampling period. In this case, with data from the power analysis report, the site manager will need to prepare a deployment plan for these new points using the same guidelines from the first-year deployment plan and submit it to TEAM Terrestrial Vertebrate Protocol manager at least 3 months before deployment to the field. Follow all the steps in Section 3.

6. PROTOCOL IMPLEMENTATION FOR SUBSEQUENT YEARS

The process of field deployment, data processing, and data upload for subsequent years of the TEAM Terrestrial Vertebrate Protocol is similar to the first-year implementation except for the following:

- No deployment plan needs to be submitted **UNLESS** additional points need to be deployed as detailed in the power analysis report submitted by TEAM Terrestrial Vertebrate Protocol manager.

- Because the camera trap points have already been located in the field, the process of establishing new camera trap points will be needed only if a point needs to be moved from its location from the previous season or if new camera trap points need to be established (see Section 5).

- Uploading spatial data from camera trap points is necessary only if a camera trap point is moved from its previous season location or if new camera trap points need to be established (see Section 5).

A detailed workflow for deployment of the TEAM Terrestrial Vertebrate Protocol in subsequent years appears in Figure 7. The main steps are described below with emphasis on the differences between deployments in the first year and subsequent years. The steps below assume that no new camera trap points are to be installed. If this is true, follow all the steps in Section 4.3 after a new deployment plan has been approved (Section 3).

6.1 Determine Whether Camera Trap Points Need to be Moved

The site manager should examine the camera trap forms from last season and determine whether any Point needs to be moved? columns have been checked. The site manager should do this at least 3 months before the field crew expects to travel to the field to make proper arrangements to take the approved differential correction GPS unit to the field (units are shared between sites) (see below).

6.2 Equipment Preparation and Calibration

Follow Section 4.2 with the following modification:

If camera trap points need to be moved, the following extra items need to be taken to the field:

- A blank *Camera Trap Point Form* to record information for the new points for the camera traps that need to be relocated, and

- A TEAM-approved differential correction GPS unit.

6.3 General Field-planning Meeting

The crew leader should meet with the other technicians to plan the deployment of camera traps in the field. Because camera traps are being taken to points that have already been established, much less time and effort should be needed to establish camera traps. Nevertheless, follow the general guidelines in Section 4.2.6, recognizing differences in the effort and number of temporary camps needed to successfully

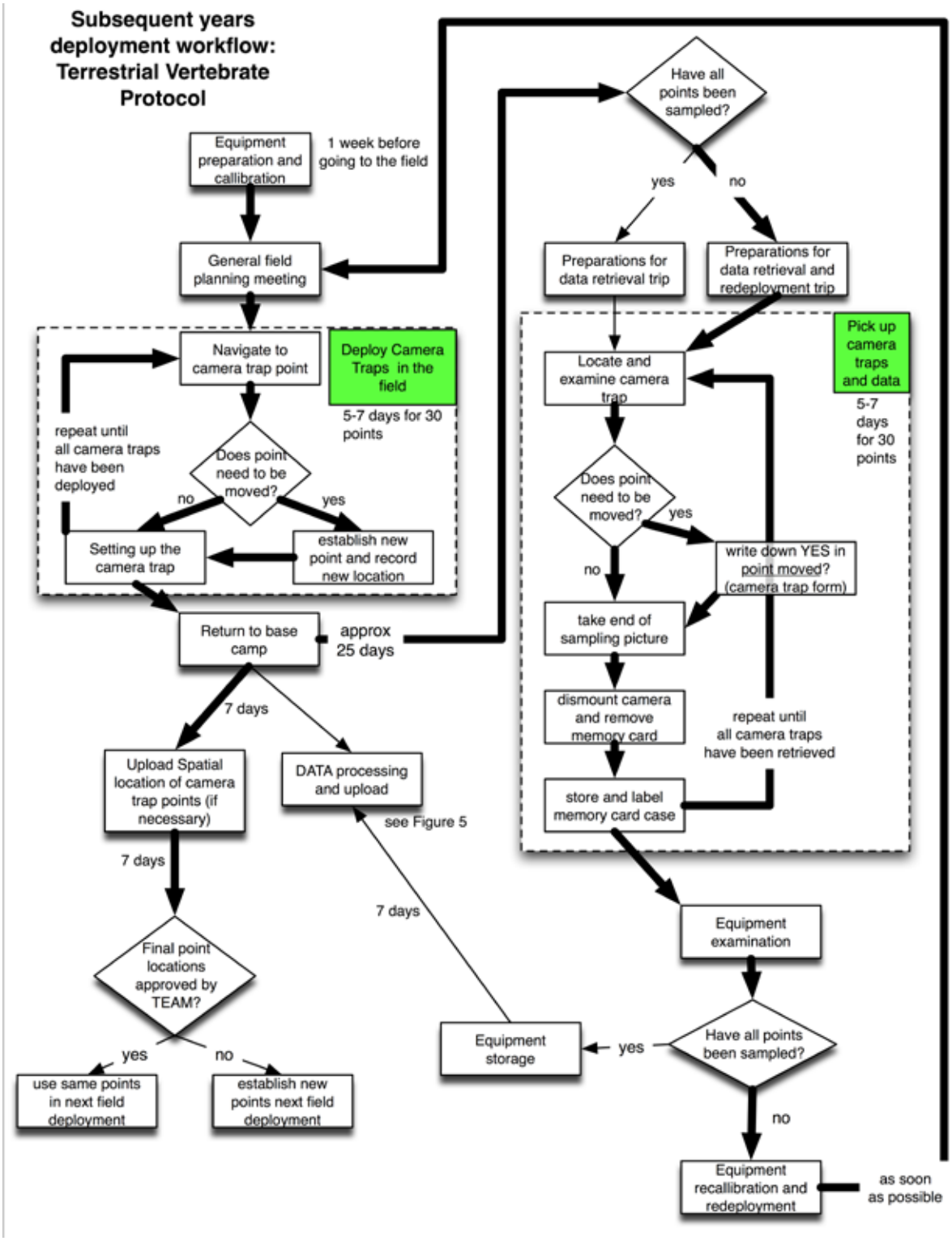


Figure 7. Workflow illustrating the main steps during subsequent years of deployment of the Terrestrial Vertebrate protocol. The workflow moves from deployment of camera traps to pick-up and redeployment if necessary .The thick arrows show the main steps in the workflow during the first cycle of deployment and pickup of camera traps.

deploy the camera traps. In general, the crew should aim to finish this process in 5–7 days of intensive field work.

6.4 Deployment of Camera Traps in the Field

The crew should follow the guidelines outlined in Section 4.3.3, assuming the points do not need to be relocated. If the points need to be moved from their original established location follow these steps:

1. Establish and geo-reference the new point. Find a new location as close as possible to the original location and geo-reference it. Follow all the steps in Sections 4.3.1 and 4.3.2.

2. Mark this point with a new camera trap point ID. Use the old camera trap point ID, followed by a dot (".") and a sequential numeral. For example, if the camera trap point ID that needs to be relocated is CT-CX-3-23, then the new camera trap point ID will be CT-CX-3-23.1. If this camera trap point ID needs to be moved again in a future season, then keep increasing the number after the "." (e.g., CT-CX-3-23.2). Write this ID on a blank aluminum tag and affix or nail it to the tree where the camera trap will be mounted.

3. Fill in all the relevant information. Fill in all the information in the *Camera Trap Point Field Form*. When returning from the field this information will need to be transcribed and uploaded to the TEAM data repository (even if it is only for one point).

6.5 Return to the Base Camp

When returning to the base camp, follow all the steps in Section 4.4. If new camera trap points were established, immediately transcribe the information from the *Camera Trap Point Field Form* to the *Camera Trap Point Excel Worksheet* and upload this information to the TEAM data repository (follow all steps in Section 4.4).

6.6 Pick Up the Cameras and Redeploy to New Locations

After camera traps have completed their sampling time (30 days) in the first set of points deployed, they need to be picked up, memory cards collected, and camera traps redeployed to the remaining set of points (if any). Follow all the steps in Sections 4.5, 4.6, 4.7, and 4.8.

6.7 Data Processing and Upload

Follow all steps in Section 4.10 to appropriately process the data from the first deployment cycle and upload all data to the TEAM data repository. Do this as soon as memory cards return from the field to the laboratory. **Do not wait until all camera trap points have been sampled to process and upload the data**.

6.8 Last Field Trip of the Season

After the sampling time of the second set of points has been completed, plan a last field trip to pick up the camera traps and collect all memory cards. Follow Sections 4.11.1 and 4.11.2.

6.9 Equipment Check-in and Storage

Follow all steps in Sections 4.11.3 and 4.11.4 to check in and properly store all the equipment.

7. ROLES AND RESPONSIBILITIES IN THE TERRESTRIAL VERTEBRATE PROTOCOL

Role	Responsibility
Site Manager	• Prepare and submit deployment plan and sampling design • Assemble deployment crew • Approve equipment for field deployment • Upload spatial location of camera trap points • Maintain and oversee equipment • Upload data and photographs • Maintain backups for field forms and digital data • Prepare camera trap points that need to be moved • Supervise proper equipment check-in and storage
Field Crew Leader	• Supervise equipment preparation and calibration • Convey planning meetings before field deployment • Establish camera trap points • Record spatial location of camera trap points • Supervise setting up of camera traps in the field • Supervise and train technicians to transcribe data from field forms • Supervise and train technicians to examine and recalibrate equipment
Technicians	• Prepare and calibrate equipment • Complete camera trap checklist • Implement field work to establish, deploy, and collect camera traps • Transcribe information from field forms to Excel templates • Process photographs and transfer memory card data to computer • Create backups of all data (digital and paper) • Examine and recalibrate equipment • Adequately process damaged camera traps • Prepare camera traps for storage
TEAM Regional Manager	• Evaluate protocol implementation through periodic site visits • Ensure original field forms and backups are properly stored • Ensure all digital data are properly backed up • Answer questions about protocol implementation • Ensure data comply with TEAM minimum data standards • Ensure all TEAM personnel read and sign the TEAM Data Use Policy
TEAM Remote Sensing Specialist	• Evaluate deployment plan and sampling design • Evaluate all new camera trap points
TEAM Information Systems Manager	• Ensure data comply with TEAM minimum data standards
TEAM Technical Director	• Evaluate deployment plan and sampling design • Ensure consistent protocol implementation at the site • Revise protocol documents and communicate changes • Evaluate site changes in initial planned sampling schedules

8. EQUIPMENT LIST

Role	Quantity	Manufacturer	Model Supplier	Contact Info	Responsibility
Camera Trap	32	Reconyx	RM45	Reconyx	http://www.reconyx.com
Cable locks	30	Master Lock	Phyton	Reconyx	http://www.reconyx.com
Memory cards	60	SanDisk	1GB Compact Flash	Flash Memory Store	http://www.flash-memory-store.com/
C NiMH batteries - 20 pack	18	Total Energy	C NiMH 5000 mAH	Battery.com	http://www.all-battery.com
Battery charger	10	Vanson	BCIHU	Battery.com	http://www.all-battery.com
Card reader	2	SanDisk	Imagemate 12-in-1 USB reader	Flash Memory Store	http://www.flash-memory-store.com/
Aluminum tags (box)	2	Forestry Suppliers	79260	Forestry Suppliers	http://www.forestry-suppliers.com
Moisture control packets	60	Zorb-it	2-inch x 2-inch packets	Zorb-it	http://www.zorb-it.com

9. GLOSSARY OF TERMS

• **Camera trap.** A piece of equipment that is installed in the field to take photographs of animals passing by. The camera trap consists of a camera, a control unit, a sensor, a memory card, and the batteries that power both the camera and the control unit.

• **Camera trap array.** The camera trap array consists of a set of camera trap points (usually 20–30) distributed locally in space in some particular way (e.g., regularly, following a trail, etc.). A camera trap array is, in a statistical sense, a random spatial unit.

• **Camera trap checklist.** A paper form to check the status and maintenance records of camera traps before they are deployed in the field. A blank camera trap checklist appears in Appendix 2.

• **Camera trap Excel file.** A file in Microsoft Excel containing camera trap data that can include camera trap point data, camera trap metadata, photo data, and damaged camera trap data.

• **Camera trap Excel template.** A blank Excel file with predetermined worksheets and columns used to create camera trap Excel files.

• **Camera trap form.** A form used in the field to record camera trap data such as date and time the camera is set, camera trap number and serial number, name of person setting up the camera trap, etc. A blank camera trap form appears in Appendix 3.

• **Camera trap point.** A particular point in space (latitude and longitude) where the camera trap will be located during sampling.

• **Camera trap point form.** A form used in the field to record **camera trap point** information such as latitude and longitude of camera trap point, date and time the camera trap point was geo-referenced, who collected this information, with which equipment, etc. A blank camera trap point form appears in Appendix 1.

• **Camera trap point ID.** A code assigned to a particular camera trap point (not a camera trap), that uniquely identifies it and distinguishes from other similar camera trap points. See the Data Management Protocol for the TEAM convention for labeling camera trap point IDs.

• **Control unit.** An electronic board with a small central processor unit that turns the camera on and off in response to a signal provided by the sensor. The control unit can be programmed by the user to allow different sensitivities of movement, how many photographs the camera should take when it wakes up, etc.

• **Damaged camera trap form.** A form used in the field to record information about damaged camera traps such as nature of the damage, camera trap serial number, etc. A blank damaged camera trap form appears in Appendix 4.

• **Field forms.** Paper forms used to collect information about camera traps and camera trap points. The Terrestrial Vertebrate Protocol uses four field forms: camera trap form, camera trap point form, damaged camera trap form, and camera trap checklist.

• **Memory card.** A small electronic card that stores the photographs taken by the camera trap. It resides in the front of the camera trap and can be taken out to retrieve the photographs.

• **Sampling cycle.** A period of 30 days during which a set of camera traps is active (sampling) in a given area.

• **Sampling period.** A sampling event is defined as a data collection effort within a specified period of time (week, month, climatic season). The TEAM Terrestrial Vertebrate Monitoring Protocol has only one sampling event per year (during the dry season, see below).

• **Sensor.** A small piece of equipment mounted in the external front of the camera trap that detects movement and heat within a specific area in front of it. Signals from the sensor travel to the control unit, which then controls the camera.

10. USEFUL BIBLIOGRAPHY

Henschel, P., and J. Ray. 2003. Leopards in African Rainforests: Survey and Monitoring Techniques. WCS Science and Exploration, http://www.savingwildplaces.com/swp-home/swp-researchmethods.

Karanth, K.U., and J.D. Nichols. 1998. Estimation of tiger densities in India using photographic captures and recaptures. Ecology 79 (8): 2852–2862.

Karanth, K.U., and J.D. Nichols. 2000. Ecological status and conservation of tigers in India. Final Technical Report to the Division of International Conservation, U.S. Fish and Wildlife Service, Washington D.C. and Wildlife Conservation Society, New York. Centre for Wildlife Studies, Bangalore, India.

Karanth, K.U., and J.D. Nichols. 2002. Monitoring tigers and their prey: A manual for researchers, managers and conservationists in Tropical Asia. Centre for Wildlife Studies, Bangalore, India.

Karanth, K.U. 1995. Estimating tiger (Panthera tigris) populations from camera-trap data using capture–recapture models. Biological Conservation 71: 333–338.

Maffei, L., E. Cuéllar, and A. Noss. 2004. One thousand jaguars (Panthera onca) in Bolivia's Chaco? Camera trapping in the Kaa-Iya National Park. Journal of Zoology 262 (3): 295–304.

Otis, D.L., K.P. Burnham, G.C. White, and D.R. Anderson. 1978. Statistical inference from capture data on closed populations. Wildlife Monographs 62: 1–135.

Rexstad, E., and K.P. Burnham. 1991. User's guide for interactive program CAPTURE. Abundance estimation of closed populations. Colorado State University, Fort Collins, Colorado.

Silver, S.C., L.E. Ostro, L.K. Marsh, L. Maffei, A.J. Noss, M.J. Kelly, R.B. Wallace, H. Gomez, and G. Ayala. 2004. The use of camera traps for estimating wildlife (Panthera onca) abundance and density using capture/recapture analysis. Oryx 38 (2): 148–154.

Wallace, R.B., H. Gomez, G. Ayala, and F. Espinoza. 2003. Camera trapping capture frequencies for wildlife (Panthera onca) in the Tuichi Valley, Bolivia. Mastozoologia Neotropical 10 (1): 133–139.

White, G.C., D.R. Anderson, K.P. Burnham, and D.L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory, Los Alamos, New Mexico.

Tropical Ecology Assessment and Monitoring Network
Camera Trap Point FIELD FORM

Site ID: _____

			Date of reading	Person Taking the reading				
Point ID	Latitude	Longitude	yyyy/mm/dd	First Name	Last Name	GPS Make and Model	Number of Points	Notes

Tropical Ecology Assessment and Monitoring Network
Camera Trap CHECKLIST

Site: _____
Date (yyyy/mm.dd):_____
Name of Person checking: _____

Signature: _____

Camera Number	Camera Serial Number	Memory Card Serial Number	Is memory card empty?	Camera batteries FULLY charged?	Correct DATE and TIME?	Correct Camera Settings?	Case, Seals and Locking Bracket in good condition?	Zorb-it packet included?	Locks and keys marked and checked?	Notes

13. APPENDIX 3. CAMERA TRAP FORM

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Tropical Ecology Assessment and Monitoring Network
Camera Trap FIELD FORM

Site ID: ________

Sampling Event: ________

Point ID	Camera Trap Number	Camera Trap Serial Number	Memory Card Serial Number	START DATE	Name of Person Setting the Camera	END DATE	Name of Person Picking-up the Camera
				yyyy/mm/dd	First & Last Name	yyyy/mm/dd	First & Last Name

Site ID: _____

Sampling Event: _____

Tropical Ecology Assessment and Monitoring Network
Camera Trap FIELD FORM

	Fill these columns when picking up camera trap from the field					
Point ID	Camera working?	Camera missing?	Case damage?	Camera damage?	Card damage?	Notes

14. APPENDIX 4. DAMAGED CAMERA TRAP FROM

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Tropical Ecology Assessment and Monitoring Network
Damaged Camera Trap FIELD FORM

Site ID: ________

Camera Trap Number	Camera Trap Serial Number	Date damage was noticed yyyy/mm/dd	Date of first deployment yyyy/mm/dd	Person reporting damage First & Last Name	Case damage?	Notes	Is Camera Firing?	Notes

Site ID: _____

Tropical Ecology Assessment and Monitoring Network
Damaged Camera Trap FIELD FORM

Camera Trap Number	Camera Trap Serial Number	humidity inside camera?	Notes	Follow-up step	Additional Notes

15. APPENDIX 5. INSTRUCTION MANUAL FOR RECONYX RM45