TROPICAL ECOLOGY, ASSESSMENT, AND MONITORING (TEAM) INITIATIVE

CAMERA TRAPPING PROTOCOL

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Introduction

Habitat destruction and illegal hunting have led to increased concerns regarding the status of wildlife. Concern is not limited to unprotected areas. However, the lack of baseline data and absence of accurate estimates of population trends has prevented biologists and wildlife managers from identifying, quantifying, and addressing suspected negative impacts. To assess wildlife population trends, scientifically based monitoring programs must be implemented.

A common method to monitor birds is to walk through a forest, stop at each station in sequence, and record every bird species observed or heard. This is the direct method of monitoring: the observer records detailed observations of what is observed or heard. Direct methods work for such species as birds and primates because they are typically more easily observed. Direct methods have also been employed to monitor prey populations.

Most often, however, direct observations of animals cannot be made. Moreover, monitoring cryptic wildlife species such as top carnivores is often difficult or impossible. Small carnivores and herbivores suffering hunting pressure typically elude direct methods of observation. In many forests within the tropics we still do not know what animals are present.

Major challenges must be overcome to monitor carnivores and other shy species. Carnivores, particularly those in tropical forests, are usually elusive and are not easily observed by humans. Some are nocturnal or move about the landscape using dense cover. Typically, carnivores range widely and occur infrequently over large parts of their home range. Their population densities are usually low making direct observation methodologies unreliable. The basic ecology of carnivores makes their populations inherently difficult to monitor. Moreover, the population trends of some small carnivores are even more difficult to monitor effectively.

Scientific monitoring of carnivores and their prey populations are essential requirements to objectively evaluate the effectiveness of management decisions. Most often baseline data on population numbers must first be established. Continuous population monitoring can then be used to assess outcomes of management strategies. As knowledge of various management strategies and their effect on populations increases, managers can develop a predictive capacity that allows them to deal with new and unexpected situations.

A new generation of camera phototraps and the use of well-developed capture-recapture models have led to an increase in the use of remote surveying and monitoring methodologies for terrestrial species. Population estimates can now be made for individually identifiable species and relative abundance indices can be calculated for other species. For instance, Karanth (2000) estimated tiger densities in four national parks in India and Trolle and Kéry (2002) estimated ocelot densities in an area of the Pantanal. Carbone et al. (2001) suggested camera traps be used to estimate densities of animals that cannot be individually identified. To monitor shy or secretive species indirect methods such as camera phototraps have been used. Camera phototraps and powerful statistical methods have been employed to quantitatively monitor populations of cryptic, wide-ranging carnivores when individuals of the species can be identified (Karanth and Nichols 2002). Concurrently, prey populations can also be monitored using camera phototraps.

Camera phototraps have also enabled more accurate estimates of species richness, species diversity, total mammalian biomass, and the spatial variation and population size of some mammals. With long-term use camera phototraps enable monitoring of changes in populations over time. Activity patterns can be determined, even for mammals that cannot be individually identified. To aid law enforcement activities, camera phototraps have been used to identify individual humans committing illegal acts in protected areas. For instance, fully one quarter of all photographs taken by camera traps in a Malaysian national park were of humans. Humans undertaking illegal activities in the forests of Cambodia have also been documented.

Both closed (no immigration or emigration) and open statistical models can be used to estimate survival and recruitment in mammals that can be individually identified with camera phototraps (Pollock et al.

1990). With sustained use camera phototraps can be used as an early warning system to detect changes in number, composition, and relative abundance beyond what is background noise.

CamTrak Phototraps

There are currently 22 manufacturers of camera phototraps. We have selected CamTrak because of their ease of use, power requirements, robustness, simple programmability, and because the units can be locked in place.

A CamTrak phototrap is a single camouflaged unit that is attached to a tree, rock or post. An infrared-motion sensor is used to detect body heat-in-motion. There are 8 toggle switches inside the unit of which 3 must be in the “on” position. The first 3 are used to set continuous (toggle 1), day (toggle 2), or night (toggle 3) use. The last two toggles (numbers 7 and 8) are used to set the minimum time between exposures: fast (8) or slow (7). If fast is used there are 3 options: 5 minutes, (toggle 4), 3 minutes (5), or 20 seconds (6), If slow (7) is enabled longer times can be set as the minimum time between exposures: 45 minutes (4), 20 minutes (5), or 10 minutes (6). For instance, a setting of 1-6-8 means that the phototrap will work day and night and wait a minimum 20 seconds after taking a picture. Time and date stamps are imprinted onto the film automatically by the camera.

An exterior on/off switch enables/disables the unit. Since the camera is in a waterproof housing all parts remain dry. Interior lens moisture is a problem that desiccants can slow but not eliminate. CamTrakker phototraps can detect heat-in-motion within 10m of the unit. Each CamTrakker uses 4 C-cell batteries. The camera operates from the C-cells and does not require its own battery. When installed in the field a unit can function for a maximum of 4 weeks. With an optional battery pack a unit can function for 8 weeks.

A time lapse occurs between the moment the sensor detects heat-in-motion and the camera records a photograph. For the 35-mm camera that is always on the time lapse is 0.6 seconds. For the digital unit the time lapse is 3 seconds rendering the digital unit less useful.

Site selection

Time in place and complete area coverage are the two most important factors in camera trap data collection. As photographs accumulate comparisons can be made between sites. Site selection is important in targeting specific species. Since some animals follow seasonal patterns leaving cameras in place for a year or more might be required. Because human presence disturbs wildlife leaving the phototraps unattended for as long as possible enables better opportunities to photograph wildlife.

As with humans, many animals use forest trails to move about the landscape. Other places where animals visit such as water holes, salt licks, food sources such as fruiting trees or patches of preferred vegetation attract certain species. Visual aids and chemical attractants are often used to bring in wildlife to phototraps. For instance, a popular men's cologne appeals to ocelots. Small species such as the smaller carnivores often do not use trails. Camera phototraps restricted to trails are thus less likely to record these illusive predators. One phototrapping campaign in Sumatra captured more tigers on film than Leopard cats that probably more commonly occur in the forest. This is because most of the camera phototrapping occurred on trails and tigers are known to use such trails. Leopard cats are thus more likely to avoid these trails for that very same reason.

An important consideration is to ensure coverage of the entire sample area without leaving holes or gaps that are sufficiently large to contain a target species' movements during a sampling period and within which one of the target individuals has *zero chance* of being photographed. That is, the sample area must have *no holes* where the target species can hide during a trapping occasion. An *occasion* is the number of contiguous trap-days a set of camera phototraps operates in a sample area. One occasion will be 10 days. A minimum of 18 occasions will be used to sample an area.

Camera phototraps must cover an area approximately uniformly. A hexagonal grid minimizes the size of the uncovered area. Camera phototraps will be placed in a hexagonal pattern so that each site is approximately 3-4 km distant from all other sites. An idealized coverage pattern of 12 sites with 2 cameras per site located at a distance of 3-4 km from the nearest adjacent site might look like:

1 2 3 4

5 6 7 8

9 10 11 12

This is an idealized illustration of a covered area. In actuality, each location will differ and offer unique challenges. Each site (a pair of cameras) will be assumed to cover a circular area whose radius is 2 km. Thus, the area covered by a single site is 13.6 km^2. Placing the cameras 3-4 km apart permits adequate area coverage and minimizes the area of interior holes. The total area covered by 12 sites would ideally be approximately 163.2km^2 or 16,320ha.

After 360 days each pair of cameras at each site will be shifted in its position so as to cover an adjacent area. For instance, if the second hexagonal grid is positioned to the right, then the new site number 1 position would be placed 2-4 km to the right of the previous number 4 site.

Target species

Though many species will be monitored, we will focus on monitoring *target* species that can be individually identified. We will assume the population is *closed* during the sampling period of 180 days. That is, we assume there will be no immigration or recruitment of adults into the population being sampled. A *sample area* is an area that is being sampled with camera phototraps. In each sample area, forest trails or traplines will be selected that cover the study area and are suspected to be used by target species. A *trap-day* is defined as a pair of camera phototraps deployed at a single trap site for 24 hours. Since mark-recapture methods require that individuals be identified, typically two cameras mounted facing each other will be used to record both sides of each animal enabling individual identification.

Protocols

1. Areas will be selected for camera phototrap deployment. Pairs of camera phototraps will be placed to enable the identification of individuals of certain species where individuals are uniquely marked in some way. Generally sites will be 3-4 km distant and every attempt will be made to adequately cover areas.

2. Each area will have at least 12 pairs of camera phototraps.

3. Camera phototraps toggle switches 1 (continuous)-6 (20 second wait)-8 (fast) will initially be on. If excessive photographs of the same animals or birds (as happens with peccaries) are taken then the settings can be changed to 1-7 (3 minutes)-8 on.

4. Cameras will be set to record the day and time on the photograph.

5. Print film, typically ASA 200 with 36 exposures will be used.

6. An elastic cord is required to hold the unit to a tree. A chain and lock act as deterrent to theft.

7. Camera phototraps will be placed approximately 30 cm above the ground on trees or boulders except in special cases when large herbivores are present and photographs of entire animals are required. The units will be placed opposite each other at a site so that both sides of the subject can be photographed nearly simultaneously.

8. Each specific location will have a GPS location and a description that will include some information about the local vegetation, trail condition, or other useful information such as if a fruiting tree is present. An attempt should be made to answer the question: why is this phototrap being placed here?

9. All camera traps at each site will be baited with scent or other lures to attract carnivores that occur in lower densities than most herbivores. Baits can be tested for their effectiveness.

10. Each phototrap site will be visited every 45 days to change the film and batteries.

11. Each camera phototrap site will be relocated to an adjacent area every 360 days.

12. Print film will be developed within 15 days of being collected.

13. Photographs will be analyzed within 30 days of developing the film. No photograph will be rejected even if nothing appears to be present.

14. Excel data sheets will be completed within 40 days of film collection.

15. Quick reference information such as camera number, GPS location, and date and time will be recorded on the back of each print.

16. One set of prints and the original negatives will be filed at the local research station. Photographs and negatives will be kept in plastic photograph notebooks. A database consisting of the Excel data sheets will permanently record all information locally and at CABS.

Data Analysis

Statistical method

Capture histories will be developed for each individual adult that has been photographed. The capture history of individual i will consist of a row vector of J entries, where J denotes the number of occasions for the particular sample area. Each entry, denoted as X_{ij} for individual i on occasion j, assumes a value either "0" if it has not been photographed or "1" if it has been photographed on the particular occasion. The matrix of such t-dimensional row vectors for all M individuals caught during the sampling is often referred to as the X matrix and these matrices will be the data from which target species abundances are estimated. We will analyze the X matrix using a computer program called MARK.

For example, if 5 individuals were photographed multiple times during $J = 6$ occasions then X might look like:

individual 1: 100101
individual 2: 001110
individual 3: 110010
individual 4: 000100
individual 5: 101010

Program MARK will then be executed to compute a population estimate, the number of individuals populating the area.

Relative abundance of non-target species

Estimating populations of species that cannot be identified as individuals is difficult. Karanth and Nichols (1998) and many others use line-transect methods. For surveying large-bodied herbivores in fairly open country line-transect methods work well. Line-transects did not work well in Cambodia or Guatemala (this author), Taman Negara (Kawanishi personal communication), or Venezuela (Sunquist and Sunquist personal communication) where dense undergrowth occurred and where species were hunted. Camera phototraps can be used to estimate a relative abundance index (RAI). The number of photos cannot be used to determine population or compare abundance among sites over time. Sunquist and Sunquist (personal communication) have defined a detection unit of observation, or simply *detection*, as one photograph of a species per camera phototrap per day (24 hours). If a male and female were detected this would count as two detections. If, as rarely happens, all 36 photographs are taken of a single species in the course of a day, then this is counted as a single detection.

To compute the RAI for each species, all detections for each species are summed for all camera phototraps over all days, multiplied by 100, and divided by the total number of camera phototrap days. For example, if 12 pairs of cameras are run for 180 days, then 12 * 180 = 2160 phototrap days. Suppose 3 male and 4 female peccaries were photographed together each day for 90 days at a site. The peccary RAI would be computed as 7*90*100/(180*12) = 29.17. If a bear was photographed 8 times during a single day and twice on separate days, the bear's RAI = (1+2)*100/2160 = 0.139. Apparently peccaries are more abundant than bears. Note that if different habitats were sampled then RAI could be computed separately for each habitat type.

Global Network

CABS envisions a global camera phototrapping network of technicians and researchers that will share experiences every three years at a central location. Presentations will highlight progress in methodology and deployment techniques, improvements in camera trap units, data analysis, and results. Meetings will include non-CABS efforts from around the world in an effort to encourage openness and partnerships between camera phototrapping efforts globally.

Literature Cited

Carbone, C. and many others. 2001. The use of photographic rates to estimate densities of tigers and other cryptic mammals. Animal Conservation **4**:75-79.

Karanth, K.U. and J.D. Nichols. 2002. Monitoring tigers and their prey. Centre for Wildlife Studies, India.

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

Pollock, K.H. 1982. A capture-recapture design robust to unequal probability of capture. Journal of Wildlife Management **46**:757-760.

Pollock, K.H., J.D. Nichols, C. Brownie, and J.E. Hines. 2000. Statistical inference for capture-recapture experiments. Wildlife Monographs 107.

Trolle, M. and M. Kéry. 2002. Ocelot density estimation in the Pantanal using capture-recapture analysis of camera trapping data. To appear in the Journal of Mammalogy.

Appendix I

Materials Required

1. We have chosen CamTrakker camera phototrap units. The most up-to-date model uses a fully automatic Yashica T4 Zoom 35mm camera with Carl Zeiss lens combined with a passive infrared motion detector that senses heat-in-motion within a conical area. The units are available directly from:

CamTrak South
1050 Industrial Drive
Watkinsville, Georgia 30677
USA 800-654-8498 – toll free in the USA
USA 706-769-4025 - phone
USA 706-769-4026 - fax
info@CamTrakker.com

2. Four (4) C-cells are required to operate each unit for 45 days.

3. One roll of ASA 200 36 exposure film. Any brand is sufficient.

4. One elastic cord that is used to secure the unit to a tree.

5. If necessary, one metal chain and lock to prevent theft of the unit.