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A Calibration Method for Optimizing Detection of Species Using Camera Traps

Paul D Meek[1,2]*, Lucy Collingridge[3], Deane Smith[2,3] and Guy Ballard[2,3]

[1]*Department of Primary Industries, Vertebrate Pest Research Unit, Australia*

[2]*School of Environmental and Rural Science (PEST), University of New England, Australia*

[3]*Department of Primary Industries, Vertebrate Pest Research Unit, University of New England, Australia*

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***Corresponding author:** Meek PD, Vertebrate Pest Research Unit, Department of Primary Industries, Coffs Harbour, New South Wales 2450, Australia

Abstract

Camera traps have become a common tool in research, monitoring, and conservation practice. Placing camera traps to detect wildlife accurately requires an understanding of how they detect animals. Importantly, how passive infrared sensors (PIR) detect radiant heat, the subsequent detection zone, heat signatures of target species, background temperature effects and appropriate height and orientation of the animal's trajectory in relation to the camera trap are critical. We describe a calibration approach we developed to optimise detection of wildlife using a watermark overlay that delineates the detection zone of the camera trap in relation to the passage of travel of the target species.

Keywords: Passive infrared sensor; Freznel lens; Placement; Detection zone

Short Summary for Table of Contents

Camera traps are rarely considered to be precision instruments and are often placed in the field without an understanding of the relationship between the passive infrared sensor (PIR) and radiant heat. We present a calibration approach that simplifies placement of camera traps to optimize detection of wildlife in research and monitoring.

Introduction

Camera trapping is commonly used throughout the world in conservation projects and pest management and in recent years has become a center piece of research and monitoring projects [1-3]. Camera traps are, more often than not, deployed into the field without the practitioner recognizing that these devices are a precision instrument requiring accurate placement to be an effective survey tool. Camera traps are more complex than they appear because the technology used for detecting and initiating a trigger of an animal relies on radiant heat differentials [4-6]. As a result, a poorly placed camera trap may have a low detection capability because the passive infra-red sensor (PIR) behind the Fresnel lens is not optimized to ensure there is a temperature differential between the background temperature and the heat signature of the animal [4,6]. Placement methods for camera traps often refer to the height and orientation necessary to detect a suite of size class animals [7-9]. These recommendations were developed by trial and error and predictions of the main sources of radiant heat transmitted from target species body. Therefore, ensuring that the Fresnel lens is placed at a height and orientation that maximizes the potential for detection by the PIR [4,10-12].

Passive infrared sensors in Reconyx camera traps require the accurate placement of the camera to ensure that the heat signature of the animal enters the detection zone (shown in pink on Figure 1). The camera will only trigger when the heat signature of the animal crosses between at least two sectors within the detection zone. As such, an animal could conceivably walk right past the camera if it does not cross into the pink zone shown in Figure 1.

Camera trap placement can often be constrained by the method of attachment, i.e., to a tree or post, and in some cases prevents an accurate alignment of the PIR with the expected movement of the animal. Critical to placement is the understanding that the PIR detects heat-in-motion of the animal, and this movement needs to be precisely detected to ensure the camera trap triggers before the animal walks past the camera trap. There are a plethora of brackets and fittings that can be used for attaching camera traps to posts and trees [4]. However, in our surveys of predators on roads and service tracks [10] they are exposed to theft and vandalism [13] resulting in our researchers developing security posts [14,15]. These security posts are permanent and therefore are set deep into the ground with cement to prevent theft. As such, camera trap placement must be exact, because once the concrete hardens the camera traps cannot be easily repositioned. This factor, plus our aspiration to optimise our probability of detecting our target species, led to the refinement of this camera trap placement method over several years. The purpose of this paper is to share the method we have developed to help practitioners understand the relationship between camera trap placement, how the PIR/detection zone in camera traps and the animals passage of travel affect detection.

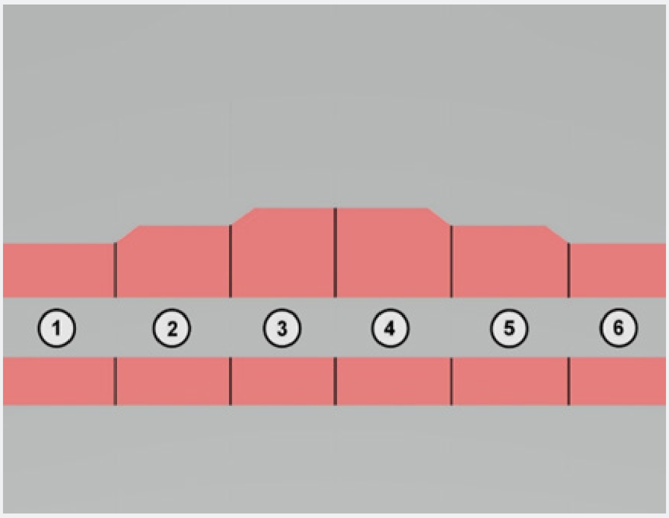

Figure 1: An example of how the camera trap detection zone can be visually depicted.

Methods

Camera traps use PIR sensors to assess the radiant heat transmitted from an animal compared to the heat of the background environment [6]. The detection area and the way camera models detect heat varies with the type and model of PIR. The camera brand our research team has used since 2012 is Reconyx and as such the method described is based on PIR information and watermark images provided by the Reconyx company. We have been unable to obtain technical information on the PIR's used by other camera trap companies.

Two Reconyx camera trap models have been used to develop this method; HC600 and HP2X. The HC600 model and HC500 use the same PIR sensor and this PIR setting is the default detection zone. The HP2X has three detection zone modalities: long range (default), legacy (similar to HC600) and high frequency (Figure 2). The type of watermark used is also affected by the image resolution (4.3 Standard or 16.9 Wide) in the HP2X and 1080p (wide) or 3.1mp (standard) in HC600 (Figure 2).

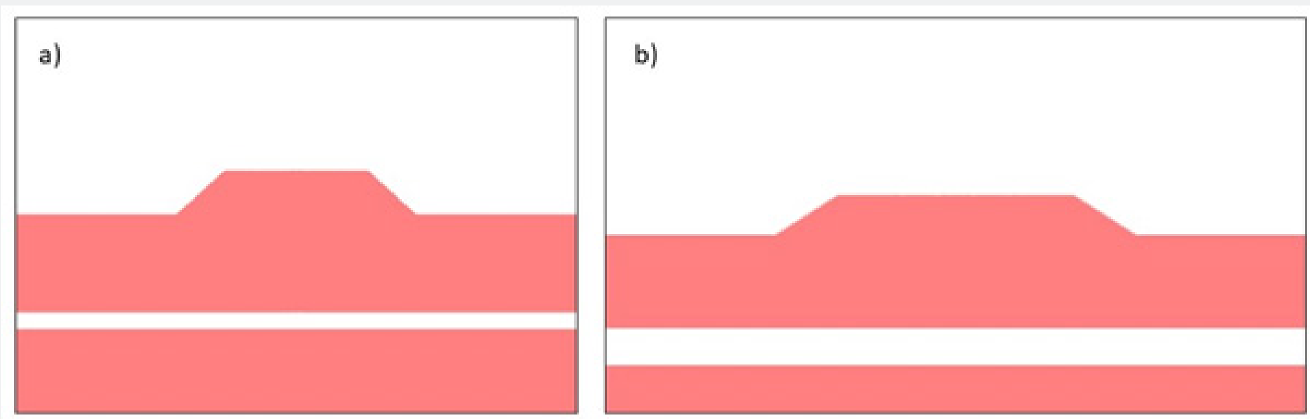

Figure 2: Example of watermarks for Reconyx modality. a) is the standard 4:3 setting and b) is 16:9 wide setting found under "resolution" in the programming menu.

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The calibration approach hereafter will describe a method for detecting Australian pest predators that frequent service tracks and trails such as free-ranging dogs (*Canis familiaris*), foxes (*Vulpes vulpes*) and feral cats (*Felis catus*), although this method can and has been adapted for many native species e.g., Spotted-tailed quoll (*Dasyurus maculatus*).

The camera trap should be set in or on a post, or on a bracket in the chosen location to detect the target species, preferably where the camera cannot be moved thereafter. However, the principles of the method do apply to setting cameras on trees etc. To help provide a focal point for the camera trap, use a measuring tape or rope place a peg in the middle of the road, 5-6 m from the camera roughly at 22.5 degrees to the road edge (Meek, P. unpub data) . Position the rope at 50cm above ground on the camera post (where the Fresnel lens is located) and same height on the peg. If using a bait station or lure, choose the placement of the attractant and align the camera. Visually position the camera trap to the preferred height (Fresnel lens 50cm above the ground for small-medium sized mammals) and alignment, focusing on the centroid point measured and marked by the peg. The "walk-test" function can be used to select the general alignment. Trigger the camera trap by crawling at dog height down the track towards the peg so you can scale the watermark against a known height. This will ensure that you can evaluate whether the potential heat signature of the animal overlaps with the detection zone watermark.

Remove the SD card and open an image using IrfanView software© or alike that permits image overlays. Select the image that represents the first detection of the human so you can understand how the passage of the human intersects with the PIR (Figure 3). Overlay the watermark on the camera trap image. The earlier the human is detected the more images in a sequence you can obtain. If the first detection is at or after the peg, use the watermark to realign the camera trap such that the detection zone and sectors respond to the human earlier. This can be done by moving the camera trap slightly while keeping in mind the detection zone bands and where the human was detected in the images. Continue to check the detection until the camera trap is triggered as early as possible, preferably as the human crosses the PIR in the first sector. This process will ensure that the target animal will be detected as early as possible and that a series of images are taken as the animal walks through the detection zone. (Figure 4).

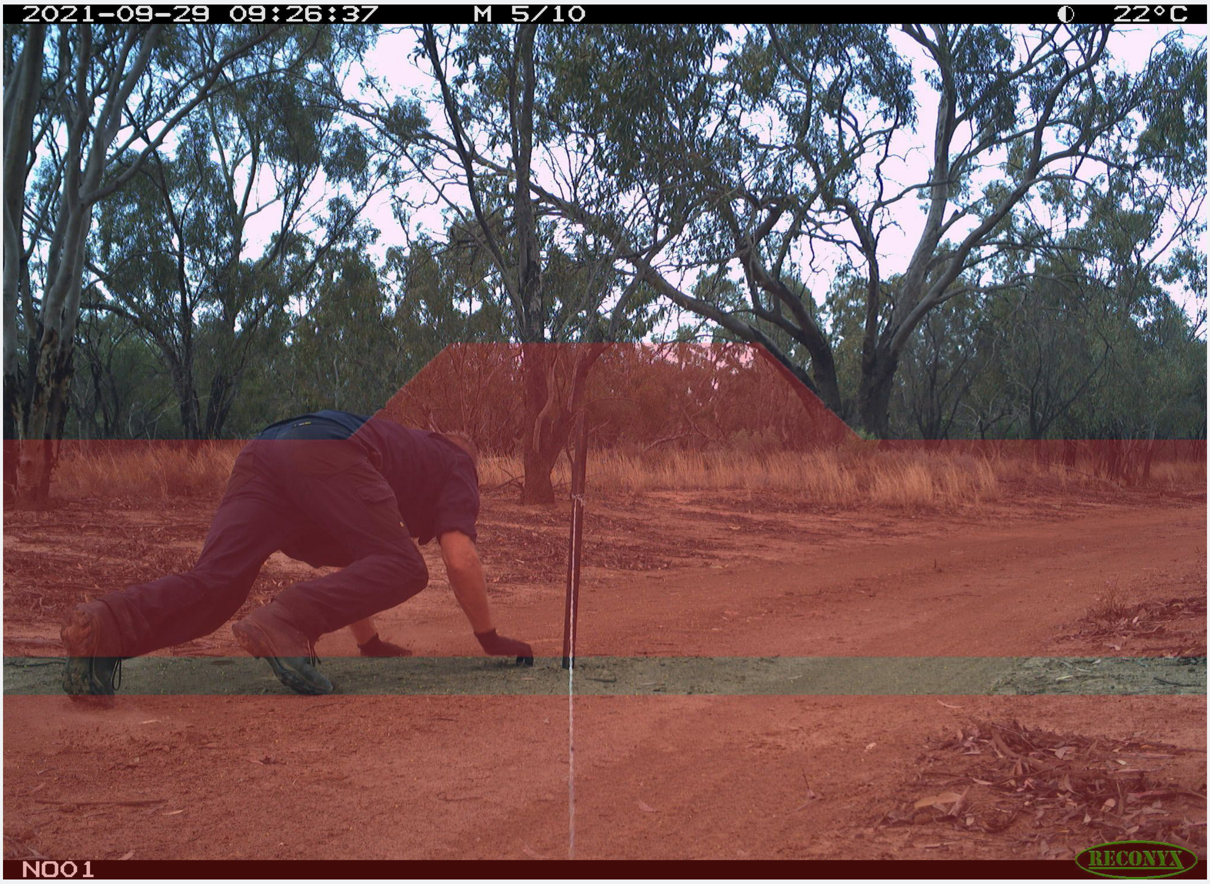

Figure 3: Crawling low to the ground allows the operator to overlay the detection zone watermark and assess how soon an animal is likely to be detected.

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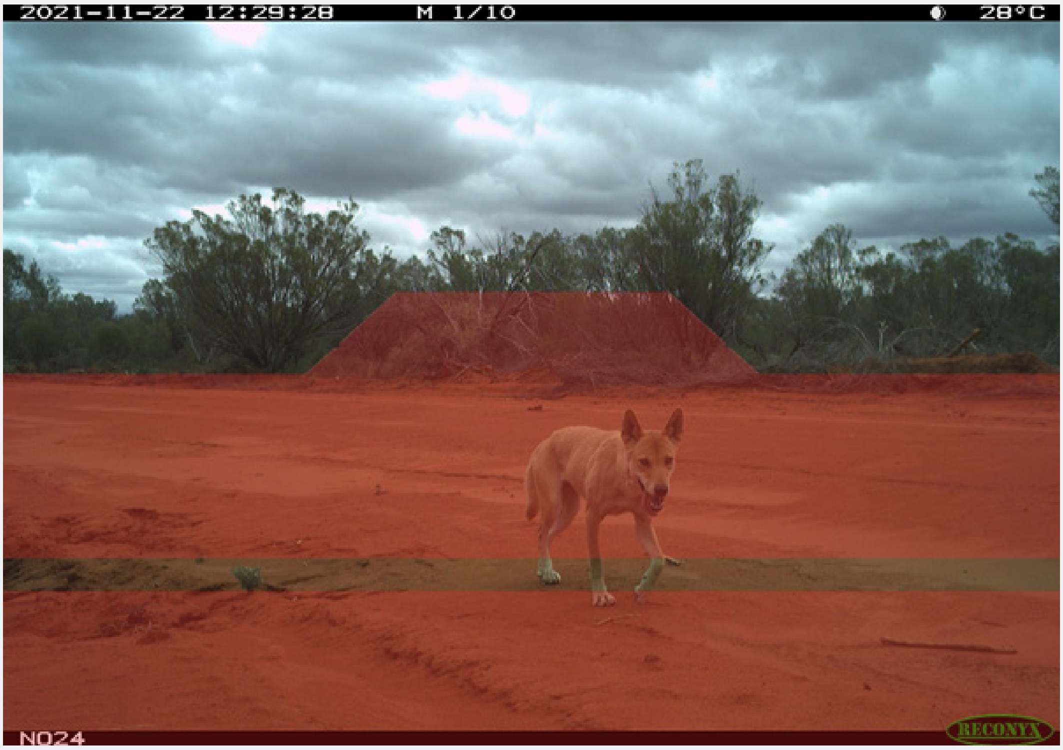

Figure 4: The detection zone watermark shows when the free-ranging dog was detected, under cooler conditions the dingo would probably be detected earlier.

Discussion

This camera trap placement method has not been experimentally tested against random camera trap placement because it has been developed in an adaptive framework for practical application. It is a means of calibrating scientific equipment. We recognised the limitations and problems with poor camera trap placement and developed a procedure based on the information provided in the camera trap manual. It was not our intention to test how PIR sensors work, but to develop a methodology to standardise camera trap placement. This method has been used in the installation of hundreds of permanently installed security posts in NSW (NSW DPI unpub data) based on the manufacturers guidelines and has proven to be effective. We have also used this method post hoc to assess accuracy of placement and poor wildlife detections where this method wasn't used. While the lowest differential between background and animal body temperature for a PIR to detect heat-in-motion is supposed to be 5 degrees Fahrenheit [4], we have found in the arid zone that detection becomes unreliable after ambient temperature reaches approximately 30 degrees Celsius. In these conditions we use a cold bottle of water and hold it at dog height while walking past the camera trap to create an inverse temperature differential because the bottle is much colder than the background temperature (Figure 5).

The camera trap placement method described can also be used for all species surveys. If camera traps are being set at bait stations or lures, the alignment system is similar. To account for the small heat signature of Australian small and medium sized mammals at bait stations or lures, the heat differential can be optimized by setting the bait station beside a log which retains a cooler background heat signature (Figure 6). In this case the detection zone watermark can be aligned so that animals walking on top of the log are triggered by the top of the detection zones, while animals on the ground approaching the bait station are detected by the bottom of the zones.

This placement method provides a systematic approach to reducing the likelihood of failed animal detections using camera traps that can lead to less-than-ideal data analysis and subsequent conservation outcomes. The authors have attempted to obtain detection zone watermark images for other camera trap models and brands with no success, and often no response from the manufacturers. The types of PIR used, and their installation will affect the detection zone for different cameras, although using the Reconyx watermark on other models can still provide some guidance on alignment. Using this method does require additional operator time and computer access in the field. However, we have found that using this approach is more target specific, effective and a more reliable placement method than aligning camera traps by eye and/or using the walk test function.

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Figure 5: During hot conditions when the background-human temperature differential is not significant to trigger the PIR, a cooler temperature item like a cold-water bottle from the car fridge will also trigger the PIR.

Figure 6: Alignment of the watermark over a small-medium size mammal bait station. Note the detection zone is placed to ensure visitation to the bait station from the top of the log and the ground.

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Conflict of Interest

The authors and associated agencies have no commercial or financial relationship with any camera trap manufacturer or distributor.

Declaration of Funding

Funding has not been provided in developing this method, although funding from DAWR, CISS, NSW DPI and the Environmental Trust have provided salaries and equipment used in our research.

Data Availability Statement

NSW DPI does not have the approval to provide watermark images from Reconyx and they cannot be supplied for commercial reasons However, practitioners can request files direct from the manufacturer.

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