Camera Traps in Conservation

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A part of the WildCRU Tiger Ecology Project,
Bandhavgarh National Park, India

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Introduction

In 1996, the Wildlife Conservation Research Unit at Oxford initiated a project titled "Conservation and management of *Panthera tigris tigris* in Bandhavgarh National Park, (BNP) India". The project was selected in response to the growing awareness that there was an immediate pressing need for scientific research and data to be made available to managers in the field to optimise management techniques for the conservation of tigers. Highly endangered species, tigers in India are being threatened by not only poaching but also due to the burgeoning human population and its consequent pressures on the few remaining pockets of tiger habitat. Habitat destruction, prey depletion, human animal conflict over the sharing of meagre resources all threaten the very existence of these majestic cats.

The WildCRU, in keeping with its mission of undertaking original research on aspects of fundamental biology relevant to solving problems of wildlife conservation and environmental management, undertook a project wherein it would study a representative area of tiger habitat in central India with the following objectives:

1. To study the population characteristics of the major ungulate prey species of the tiger in BNP and to study the effects of seasonality and disturbance on the density and abundance of these species.
2. To study the diet and feeding behaviour of tigers in BNP
3. To estimate the population size of tigers in BNP. Validation of the pugmark and mark recapture techniques.
4. To study tiger population dynamics
5. To study tiger human interaction in and around BNP and to create a disturbance index for the Park and its buffer zone.
6. To create a GIS on tigers for BNP and also identify important sink areas around the Park and any existing forest corridors connecting tiger populations in Eastern Madhya Pradesh.

One of the most controversial aspects of tiger management has always been the problem of numbers. Several decades of debate by more than one generation of conservationists have been spent on debating about the best methods of identifying and reliably estimating the numbers of tigers in an area. Over the years two schools have emerged – one that supports the use of the traditional pugmark technique and the other that promotes the use of automated camera systems –‘ the camera trap’ for individual tiger identification. The WildCRU project used a combination of these techniques to identify and monitor the tigers in the study site over a period of three years.

Camera traps have been used for several decades in the Indian Sub Continent for photographing tigers but till date there was no manufacturing unit that produced these units using indigenous parts and technology at prices suited to the Indian market.

This project attempted to design a camera trap made for Indian field conditions, and then transfer the technology to a local firm to enable them to commercially manufacture the units. The units were also designed to minimise the training required in their use and enable rapid assembling and moving in the field. Twenty sets of camera traps, each with two cameras, were made to our specifications and tested in the field. Several forest department staff were given basic training in their use. Problems encountered whilst in the field were ironed out at each stage and three prototypes were developed with modifications and improvements added to each one. Despite the severe paucity of time (only six months versus the 18 initially planned for) the units were completed and tested in the field. An Indian firm now has the capability to manufacture these units commercially at about half the rates of similar units available from overseas.

Project Objectives

A) To transfer the technology and know how for manufacturing camera traps to an Indian concern.

B) To set up a network of camera traps in a National Park to demonstrate their utility as an instrument for census, Park management and wildlife biology.

C) To develop a manual for Park managers to enable them to set up a network of camera traps within their areas of concern.

The Study Site

Bandhavgarh National Park lies in the north eastern section of the tiger state of India, Madhya Pradesh. The Park is located in the Vindhyan Ranges of Central India and is part of the Umaria and Jabalpur districts. The Park lies between Latitudes 23° 30'12"N and 23° 45'45"N and Longitudes 80° 47'15"E and 81° 11'45"E.

Bandhavgarh Tiger Reserve – genesis and history

Bandhavgarh National Park is named after the famous natural fort located in the centre of the core area of the present day Park. Legend has it that the Hindu god King Ram gave the fort to his brother Lakshman and hence, it acquired the name Bandhavgarh (Bandhav = brother, garh=fort). References to this fort are found in ancient hindu scriptures like the Narad Panch and Shiv Samhita Puranas (Sonakia 1993). The fort was given to the kings of the Baghela Dynasty as part of the dowry they received in a marriage and was a part of the princely state of Rewa till independence.

Rewa was one of the oldest and largest states in the Central Provinces of India. Its rulers were avid hunters and each had to shoot 108 male tigers to ensure good fortune for his family and kingdom. Rulers protected their forests and animals and there were rigid laws and controlled and banned the illegal felling of trees and poaching of animals. Hunting reserves were maintained for the use of the kings and these areas till today hold some of the best examples of the forests and wildlife of India today. In 1927, the area around Bandhavgarh fort was given the status of 'reserve forest' and managed along the lines as instituted in British India. After independence in 1947, each king was allowed to keep and maintain one hunting reserve for himself. However, with the loss of the resources of the kingdom it became increasingly difficult to provide the means and manpower for the management of this forest block. The late Maharaja of Rewa, HH Martand Singh, handed over his hunting reserve to the government of India with the proviso that it be declared a National Park. In 1968, the government established Bandhavgarh National Park, comprising a 105 km^2 under the M.P. National Park Act vide No. 2977-10/68 dated 23.03.1968.

In 1993, recognising the importance of the biodiversity of Bandhavgarh and its large tiger population along with its potential for creating corridors connecting it to several other protected areas, the Park was included as a Project Tiger Reserve by the Government of India. The New Project Tiger Reserve covered an area of 1161.471 km^2 · The 448.84 km^2 National Park and Panpathha Sanctuary comprised a core area of 624.752 km^2 and a buffer zone was proposed of 536.719 km^2 .

The tiger has always been a significant presence in the area. Legend has is that the local protector god of Bandhavgarh, Sidh Baba (a form of the Hindu god shiva), had a pet tiger that he kept tied to an iron stake in a cave. The tiger was on a short chain and thus could only pace up and down. In frustration the animal used to walk on the roof and walls of the cave. The cave can be seen till date and there are rough Pugmarks still visible on the roof and walls. The local people call the spot Baghdalaka. Bagh, in the regional language, means tiger. Till today, brightly coloured roughly made deities of the tiger can be seen in the villages around Bandhavgarh. These images are worshipped to propitiate the tiger gods "Ghanshyam" or "Khera" to ask for their protection from the beasts and demons in the forests. Today, the caves are used by the wildlife of Bandhavgarh as shelter and for breeding.

The three live temples in the Park are important pilgrimage sites for the surrounding populace. In the Tala Range between 4000 to 10000 people (Forest Department, GOI, 1998) visit the Ram temple and Kabir cave atop the fort twice a year on the hindu festivals of Ramnaumi and Janamashtami. These people enter the Park on foot. The Dhaurkhoh Temple in Khituali Rain is also visited by over 10,000 people during the monsoon period.

The area in and around the Bandhavgarh Tiger Reserve falls within one of the tribal belts of India. The area is populated by a number of tribes including the Baigas and the Gonds. The local populace has historically used the forests to meet the requirements of their daily lives. Traditionally these areas have been used to graze and water cattle, as a source of fuel wood, medicinal plants, and the fruit, flower and leaves of plants like Mahua (*Madhuca indica*), harra , (*Terminalia chebula*), amla (*Phyllanthus embilica*), chiraunji (*Buchanania latifolia*) and tendu (*Diospyros melanoxylon)*.

There are 101 villages immediately adjoining the Tiger Reserve. All these villages share a boundary with the Tiger Reserve. There are three forest and eleven revenue villages within the Tiger Reserve.

Flora

The vegetation of the Park falls under the following forest types according to the classification by Champion and Seth 1968.

I Moist tropical Forest

Group 3 – Tropical moist deciduous forests

Sub Group 3C – North India moist deciduous forests

i) 3c/C2a – moist peninsular low level sal

ii) 3c/C3a – west gangetic moist mixed deciduous forest

The forests on the shallow soils of the hill slopes and eroded areas are edaphically conditioned and have the characteristic composition of northern dry deciduous forests. The forest is dominated by Sal (*Shorea robusta*) and bamboo (*Dendrocalamus strictus*). Bamboo is the most abundant species and virtually ubiquitous. Sal forms the climax vegetation comprising more than 20% of the canopy cover. These forests are dotted by deciduous forests mainly due to edaphic factors.

Fauna

Mammals: Over 35 species of mammals have been listed for Bandhavgarh (Tyabji, 1994). The major mammalian species include the following:

Felids : Tiger (Pa*nthera tigris tigris*), Leopard (*Panthera pardus*) and Jungle Cat (*Felis chaus*). An annual census suggests that between 45 to 50 tigers exist in Bandhavgarh and Panpatha Sanctury. The population size of leopard is not known. Tigers and leopards have an aggressive and competitive relationship and tigers will almost always kill a leopard if they can catch them. Leopards tend to avoid paths and trails used by tigers and it is almost impossible to find pugmarks for a census. Jungle cats too are solitary but during the winters these cats are often seen sunning themselves on roads and trails.

Canids: Bandhavgarh has four members of the canid family. The largest are the Indian Wolf (Canis lupus). Wolves are not permanent residents of the Park and tend to use the marginal lands adjoining the Park more intensively than the thickly afforested areas in the core zone. Another visitor to the Park are the Dholes or Indian Wild Dogs (*Cuon alpinus*). Packs of these with as many as 16 or more members are seen regularly in the Park though the packs tend to move from one range to the other. These dogs will often vanish for months and then suddenly be seen again. Jackals (*Canis aureus*) and the Bengal Fox (*Vulpes bengalensis*) are common within the Park though the fox tends to be seen more on the Park peripheries adjoining villages.

Other prominent carnivores in the Park include the Sloth Bear and Hyaena. The Park is also home to several deer, antelopes, the Indian Gazelle (*Gazella gazella*) and the largest bovid – the gaur (*Bos gaur*). Also found in the Park are wild boar, civets, mongoose, pangolins, several poisonous and non poisonous species of snakes, insects and amphibians

Avifauna – 246 different bird species have been identified in Bandhavgarh National Park. With its varied landscape and vegetation it provides habitat ideal for a wide spectrum of bird species. The stark rock cliffs of Bandhavgarh, Bandhaini and other mountains are ideal nesting sites for 4 species of vultures and the shaheen falcon. Other spectacular birds include the Osprey, the lesser adjutant stork, sarus cranes, Mottled wood owl, malabar pied hornbill, paradise flycatchers and the Indian pitta to name but a few. In the thick jungle undergrowth the flight and calling of the jungle crows, tree pies and vultures are often the only signs that lead to the spot where a tiger has a kill. Bandhavgarh cannot boast of being a great bird park like those in the terai belt of India but with its varied resident and migrant bird populations is an interesting site for most ornithologists.

Reasons for selection of Study Site

The project was conducted entirely within one of the five ranges of the tiger Reserve – Tala range. Tala range, the original hunting reserve of the maharaja of Rewa, now the only portion of the Tiger Reserve officially a National Park, with an area of 105 km^2 is famous for its high density of tigers. The area has had no scientific studies conducted in it and other than the management plan of the Park authorities no information is available on the flora and fauna of the Park. The area has a very good road network allowing access to large areas of the Park and the terrain and vegetation permit walking off roads.

Tala is the site of the Government Ranger Training School and is the headquarters of the Assistant Conservator of Forests and Deputy Director of the National Park. In Tala there are also several wildlife resorts which draw a large clientele of wildlife tourists. Because it is relatively away from the usual tourist sites, the tourists that visit Tala tend to be dedicated and knowledgeable conservationists. This in turn ensures that the tourist lodges have a degree of competence in conservation and wildlife issues. This is a resource that was shall drawn upon.

The Bandhavgarh National Park is also fortunate in having enlightened and competent forest officers. The Director, Deputy Director and Assistant Director are all experienced wildlife specialist forest officers, open to modern methodology and scientific management. They have been trained in wildlife management by the Wildlife Institute of India and have between them several decades of experience managing National Parks in Madhya Pradesh. They have started a programme of helping the villagers living around the boundary of the park. This project counted heavily on their help and has been planned in conjunction with them.

Another factor is that this park was formed at the suggestion of the Late Maharaja of Rewa. The family continues to take an active interest in the Park. The current Maharaja is an ardent conservationist and represented INTACH in Madhya Pradesh. He was the former Minister for Education for the state of Madhya Pradesh and a member of the state legislative assembly.

The rail head is at Umaria, 35 km away from Tala. Besides Umaria, nearby railway stations include Satna (112 Km) and Katni which is a little closer. It can also be approached by air to Khajhuraho and then by road (212 Km) to Tala.

Tiger identification and camera traps

Tigers, charismatic elusive 'mega cats', have long been used as the flagship species in the efforts to conserve the rapidly diminishing wildlife resources of many countries. Project tiger, initiated by the Government of India and the WWF has successfully drawn the plight of the tiger to the attention of the world. Despite the acknowledged urgency of the situation, the tiger population continues to dwindle in numbers and is listed as a highly endangered species. Today habitat destruction and consequent prey depletion as well as organised poaching for body parts are the main threats facing these cats (Karanth 1987, Jackson , Sedensticker 1986, Seidensticker et al. 1999).

In order to effectively manage tiger populations it has become increasingly important that not only the actual population numbers be known, but that scientific and tested methodologies be used for the identification and long term monitoring of individual tigers, both within and outside of the protected area networks.

In India, traditionally tigers have been counted using the pugmark technique (Panwar, 1979). This technique can be effective when used by trained personnel for identifying pugmarks created on only certain types of soil. The pugmark of a tiger is as distinctive as a persons fingerprint and properly applied the method gives a good estimate of the tiger population in any particular range. If a pugmark census is done by expert and well trained groups of workers, an acceptably reliable population estimate can be obtained. On the other hand, there is a lot of scope for error, and the improper selection of index pugmarks can lead to a wildly incorrect estimate. Factors like the substratum, the slope of the area, the gait of the animal and even the moisture content of the stratum can lead to great differences in the pugmarks of the same tiger at different places and at different times. In many cases, inexpert workers identify these pugmarks as belonging to different animals. This results in population figures that are mere 'guesstimates' and cannot be confirmed.


Male tiger: left hind Pugmark

Schaller, in his study in 1967, noted that tigers can be identified individually using the stripe patterns on their bodies. McDougal 1977, in his book 'The Face of the Tiger' described in detail how he used the facial stripe patterns of tigers to identify them. He further pointed out that stripe patterns differ on not only between individuals but also on the left and right sides of each tiger's body. These distinctive markings can be used for identifying tigers in the wild and also from photographs.



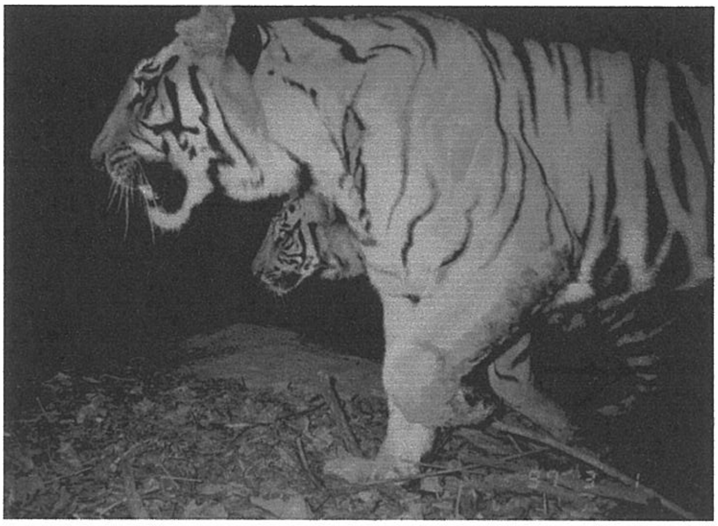
The Left, Front and Right Profiles of a Tigress in Bandhavgarh National Park. Note the difference in cheek stripe patterns between the two sides. Photo credit: Nanda S.J.B. Rana

Under ideal conditions a database is built for an area consisting of a record of pugmarks and photographs of individual tigers. These data can be used for an accurate estimation of the number of tigers in an area and can also be used to identify individuals if skins are caught from poaching networks.

Photographing these elusive cats has also been a problem. Automated camera systems -camera traps -, which can be set up and left unmanned for long periods of time in the jungle, offer a solution to this problem. The camera trap is essentially a device that is triggered by an animal itself. Cameras are set up along trails and any animal passing in front of or over the trigger sets of the camera. This technique also has the advantage of being non-interfering and minimises the hours of direct human observation, contact or disturbance. The system potentially provides information on the presence of species, their home range sizes, individual recognition and density estimates, activity cycles, behaviour, seasonal variation in movement and abundance and also allows for comparisons to be made between areas (Griffiths, 1993)

Some of the finest tiger photographs were taken by FW Champion in the early years of this century. His book, published in 1927 when photographic equipment was bulky and basic, films were slow and cumbersome to load and flash was provided by igniting flash powder still gives us fascinating access to excellent photographs taken under unbelievable conditions. Champion used camera traps but his cameras were triggered by trip wires. Trip wires and pressure pads continue to be used to trigger cameras and many modern scientists such as those at the Wildlife Institute of India have experience of such work. McDougal, 1977, too used camera traps activated by pressure pads to create some memorable photographs of tigers.

Modern camera traps have evolved considerably since the days of trip wires and pressure pads. Today devices are available that electronically trigger cameras and recording devices. They are activated either by the



Camera trap photograph of a tigress with her young cub in Bandhavgarh National Park, India.

infra-red radiation of passing animals, or by the interrupting of a beam of visible light or infrared radiation. There are also devices that can be set of by detecting movement. Unfortunately these devices are difficult to get in India and have to be imported from abroad. Cameras too have become much less expensive. Very sophisticated cameras are available as 'point and shoot' devices that have auto-wind, auto exposure and automatic flash and data backs when needed.

Besides the use for conducting a census, camera traps can be very useful for many management tasks. The utility is exemplified by the recent photograph taken by a camera trap of a poaching party in the Bandhavgarh National Park. The photographs led to the arrest and conviction of known offenders.

Types of camera traps commonly used for photographing wildlife

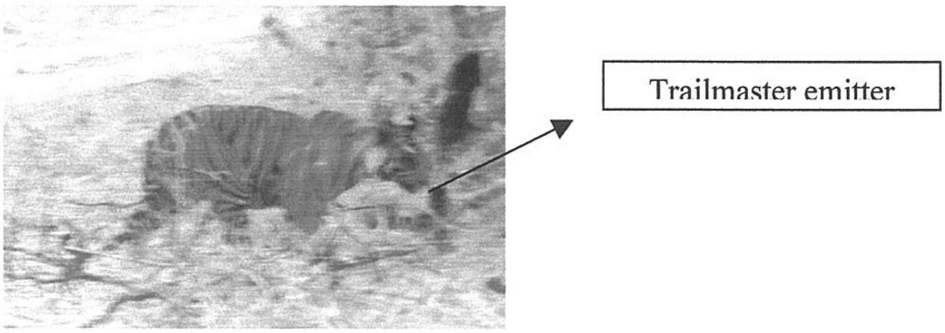
There are various types of camera traps used today for photographing wildlife. These can be divided into two types – those that use a manual 110 size camera and those that use automatic 35 mm cameras (Kucera et al. 1995). Here I shall describe only the different types belonging to the latter category.

There are various means employed by designers to trigger the cameras. The two major categories are sensors and pressure pads. I shall describe only the single sensor types and the dual sensor types.

In the single censor variety an infrared beam is broken when the animal passes through it and this triggers an electronic impulse that wither directly triggers the camera or causes a series of reactions that result in the activation of a mechanical finger that depresses the camera button. In the dual censor variety, there is a microwave sensor that detects motion and a passive sensor that detects change in ambient temperatures. Under normal operations both these are triggered simultaneously and operate the camera. These systems allow the animal to repeatedly trigger the mechanism which can be set to take photographs with a predetermined minimum time interval. With modern cameras with data backs these systems allow you to record the time or date of the photograph.

The most common type of camera trap used for most studies on the tiger are those manufactured by the TrailMaster company in the USA. These systems can cost upwards of $600.

Remote camera systems are currently available from several manufacturers in the USA. Brands include the Trailmasters, Cam Trakkers, Trail Timers, Compu-Tech Systems, Deerfinder, Manley etc. (Kucera et al, 1995).



A tiger cub investigating a trailmaster emitter box – (which it subsequently chewed!) – camera trap photograph – Bandhavgarh National Park. Photo credit: Latika Nath, WildCRU

Field Problems of using camera traps in India

1. Most camera trap units supplied by manufacturers are contained in plastic units or are kept on stands in the open. These units attract attention and cameras and camera trap boxes are often stolen especially in remote tribal areas where plastic boxes are a rarity.
2. Monkeys are attracted by these units and spend hours jumping on them and through the beams to see the flashes work resulting in large numbers of rolls of wasted film.
3. Elephants destroy units if they find them.
4. It is not possible to spend large amounts of time training field staff and often specially trained volunteers and researchers are the only people using these traps.
5. Camera traps are expensive. Importing units from the USA creates several problems as special permissions have to be obtained from the government to convert rupees into US $ or to receive funds in foreign currency. Further clearances have to be obtained from the customs or large import duties are levied on all items.
6. For any repair, maintenance or technical assistance the manufactures had to be contacted in America.

All these factors mean that it was not ordinarily possible to use camera traps on as large a scale as would be useful. Thus, we decided that it would be very useful to wildlife biologists in India and also the tiger conservation programme if cheap, easy to use units could be manufactured in India, that could be used on a large scale for tiger monitoring.

Features that had to be integrated into systems designed for use in India

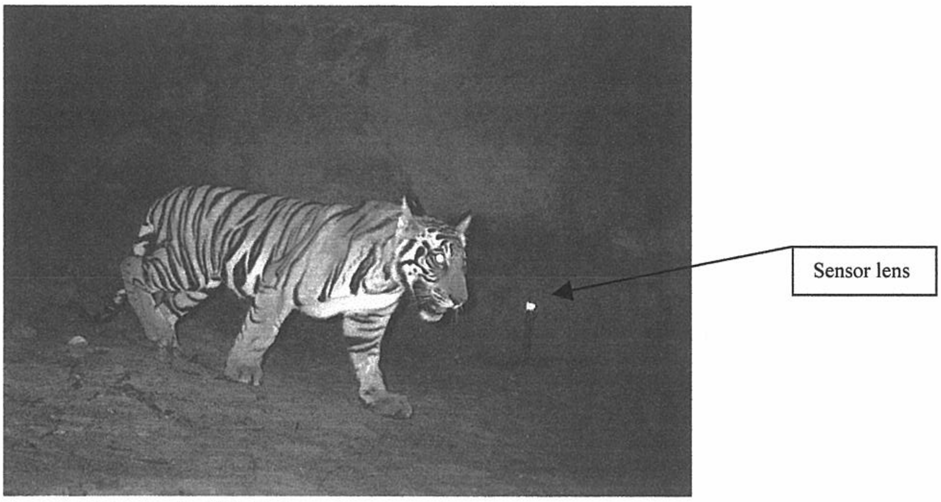
1. The units had to be made of locally available materials.
2. The units had to be sturdy
3. The design of the units had to be such that they could be assembled with the minimum effort so that large numbers of units could be set up quickly.
4. Limited training should be required to use the units
5. The units had to designed so that they were secured to the ground and could only be removed from the site with great difficulty by thieves and passers by.
6. The camera units had to be weather proof and monkey proof
7. The costs of the units had to cut to less that half the imported unit price and the technological know-how for the manufacture of these units had to be transferred to an Indian firm.

The "LMN-WildCRU Sentinel" – a Camera Trap

Early during the development of the project various options regarding the type of camera trap were debated and considered. The first issue considered was whether the trap would be triggered by a pressure pad or by some form of infrared or other beam or a movement sensor. Pressure pads were the simplest alternative. It was also relatively easy to fabricate a pressure pad. Experiments to fabricate a pressure pad made by modifying an air pillow proved that the usual rubber and fabric air pillow, modified by being opened and thick foil cemented to either side would function effectively as a pressure actuated switch if it was minimally inflated so as to prevent contact between the two pieces of foil. However it was decided that the pressure pad had many problems in field situations. We feared that placement and camouflage of pressure pads would be tedious and limited to soft dusty tracks. The size would also necessitate precise placement as pressure pads could not be very big and thus could only cover part of a road for example. They could not be used over rocky ground, and certainly could not be used at waterholes and similar situations.

The next decision was to decide upon the type of mechanism to be used for actually activating the camera shutter. Looking at available commercial models two types of mechanisms were found. The simplest was where a mechanically activated 'finger' was made to press down on the shutter release of a camera held rigidly in place so that the shutter release and the 'finger' were appropriately matched. A camera trap using a solenoid-operated device to physically push down upon the shutter release was fabricated. This device was field tested in the National Park. It worked well and the only problem encountered was that the solenoid required a relatively large current and that meant that we had to use a fairly robust battery and that the battery needed frequent charging. This had the natural disadvantage that the camera trap could not be left untended at a suitable spot for more than about 48 hours at the longest.

Another problem encountered with the early prototype was that the beam of the infrared transmitter was very focused. In effect the beam was about the thickness of a pencil and though this allowed a fair range between the transmitter and the receiver, it made aligning of the equipment a major and difficult task. The slightest movement, by a breeze for example, caused the beam to become misaligned and the shutter to be released. Defocusing the beam made alignment much easier but drastically reduced the acceptable distance between the transmitter and receiver.



Photograph of a young tiger cub approaching a water hole taken with the early camera trap prototype. Note sensor lens shining behind cub. Camera trap photograph. WildCRU Tiger Ecology Project. PhotoCredit: Latika Nath

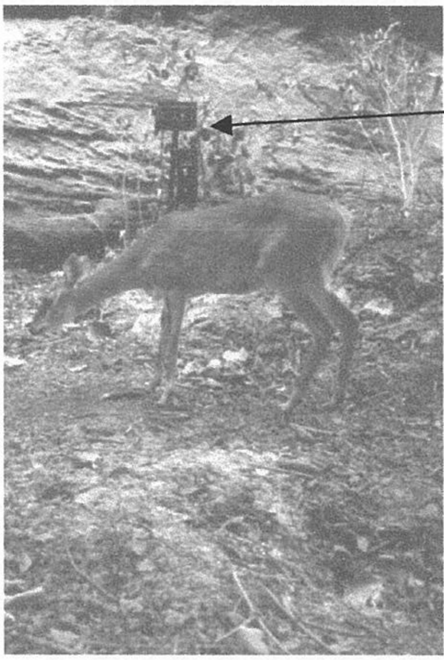
We also found that it was necessary to build in a delay so that small interruptions of the beam did not trigger the device. In spring when many trees shed their leaves in preparation for new foliage, we got 36 very good pictures of leaves dancing in the air! Each momentary break in the beam caused by a leaf floating across the path resulted in a picture being taken.

The early prototype of the camera trap brought several problems to our attention. The first one was about the difficulty in aligning the camera trap. This was important as it was felt that the more time that had to be spent setting up the trap, the greater the chances of disturbance in the area and the ability to set up multiple traps was also reduced because of the time needed at each location.

Another problem was that the device needed to draw a relatively large current to actuate the solenoid for the shutter release. This limited the duration that the equipment could function without attention. These problems were addressed in the next model of the camera trap.

The next option was to consider the electrical triggering of the shutter device. This was easy as several modern cameras are designed for being triggered via a remote release that was essentially a switch that closed a circuit to fire the camera. This brought us face to face with the choice of camera. The easiest option was to use a single lens reflex with an electric remote release. Some of the Nikon models were found eminently suitable. However camera traps are always liable to be stolen, and the SLR option was an expensive one. For this reason it was decided to explore the possibility of using simple point and shoot cameras with built in flash.

Point and shoot cameras had several advantages. Firstly they were relatively inexpensive and robust. In addition almost all of them had automatic film advance and a built in flash. Many used easy to get AA cells as a power source. In addition several models were available with auto focus. The type of flash used was critical. It was found that some models had the electronics built in to switch of the camera or the flash if the camera was left on for a long period of inaction. If left on for a long period, these required a double activation of the shutter release so that the camera and flash got into the ready mode with the first activation and only released the shutter on the second attempt. Other cameras did not have this feature and could be left on for many hours and both the shutter release and the flash would fire at the first attempt. While it was possible to design the electronics to cope with the former type of camera, it was decided to select the latter variety and thus obviate the need for one additional electronic circuit.



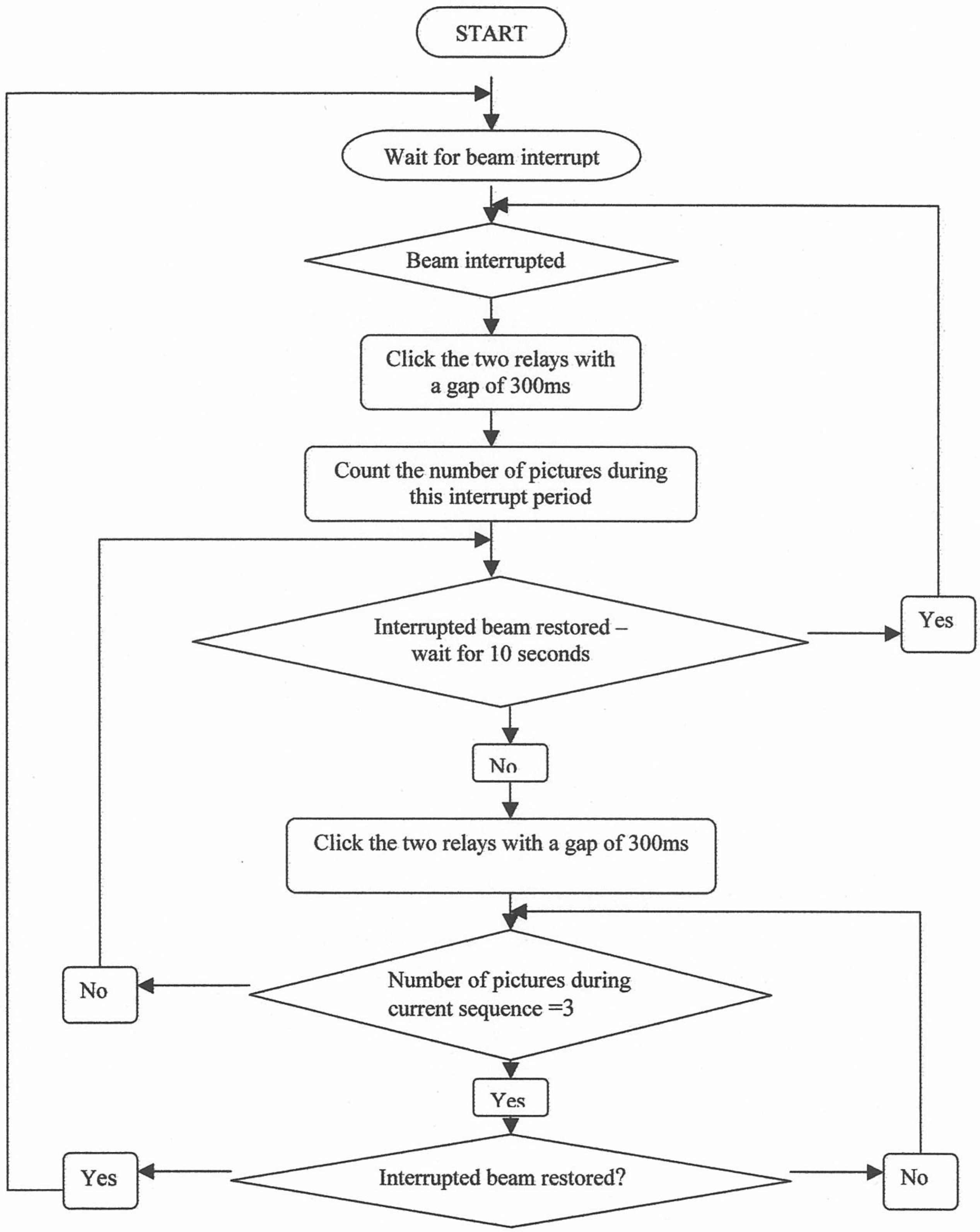
The final model of the WildCRU LMN Sentinel camera trap at work photographing a rare four horned antelope female.

Adapting the cameras for remote release produced a camera trap that worked reliably in the daytime but which mysteriously did not take pictures at night even though the flash worked and the camera shutter was released and film wound. This was discovered after the camera traps were placed in the field and seemed to work but did not produce any pictures. After some investigation and experimentation it was found that the flash was not synchronised with the shutter. Opening the camera to check this out did not suggest any solutions until we found that it was necessary to introduce a small delay of a few microseconds between closing the circuit for the flash and that for the shutter release. In the camera this delay is provided by the fact that depressing the release had a linear movement sufficient to first close one circuit and only then the next. Once this problem was solved through an electronic delay mechanism, the camera trap worked well.

It was decided that it would be desirable to trigger two cameras, one placed on either side, by the same trap, so as to photograph both sides of the animal at the same time. When two units were placed virtually facing each the flash from the other camera would tend to register on the facing camera as a very bright light. The camera adjusted itself accordingly and reduced the exposure on the facing camera. This was obviated by putting in a small delay between the firing of the two camera units triggered from the same trap. This worked well.

The problem of the thin infrared beam remained until it was possible to locate a infra red transmitter and receiver used in burglar alarms. This set had double sending and sensing units that worked alternately by pulsing. This unit tested in the field proved excellent. It was easy to align and actually had a small prismatic arrangement for sighting that made it easy to position the two units appropriately.

Logical Sequence for the LMN WildCRU Sentinel Camera Trap



Field methodology

The entire area of the range was divided into five equal units using roads or compartment boundaries as the demarcating factors. Each area was thus about 20 km^2 – roughly the size of the home range of a female tigress in Bandhavgarh (pers. Obs.).

Four sets of camera traps were placed in each of these units for a week at a stretch. The units were placed only at those points where fresh tiger footprints had been found on at least two occasions in the past week. Likely sites were normally along roads, on jungle trails especially those leading to water holes or off kills, water holes and dry river beds.

A pair of cameras, attached to a common camera trap detector, was placed on both sides of the trail or water hole. Distances between cameras varied between 5 feet to as much as 25 feet. Cameras were placed at a height of about 2.5 feet while the sensors were placed about half a foot lower.

The entire apparatus was camouflaged using leafy vegetation and branches cut from surrounding trees. The wires crossing the road were buried in the soil and then impression pads were created at the site.

Camouflaging the camera trap using leafy vegetation available at the site

To create impression pads an area of about four feet was cleared across the width of the road. All large protruding pebbles were removed and the area was swept using a broom. Then fine sandy soil was dusted over the cleared patch to create a patch about 2 mm thick. These layers enable the creation of clear and sharp pugmarks of all animals that crossed through the camera traps.

Sites located at water holes were checked on the 4^{th} and 7^{th} days whereas camera traps placed on roads and trails were checked only on the 7^{th} day. This was done to minimise interference due to human presence and to avoid any behavioural changes in the animals.

Traps located at waterholes were made inoperative in daylight hours to avoid monkey pictures. Monkeys once cut the beam 1800 times in three hours at a waterhole sight during the mid day hours.

Training of field staff in camera trap use

While the final design of the camera trap had been perfected and tested in the field, several beat guards (official rangers of junior most rank responsible for between 10 to 15 km^2 of the National Park called a 'beat') expressed their interest in trying out the traps in their beats. Three different beats were selected and camera traps were handed over.

There was a single demonstration of how to select the site for installing the trap, changing film, aligning and testing the beam, camouflage techniques etc. After this we left the traps with the guards and returned to the site three days later. In all cases the guards not only had been using the beat but were also full of enthusiasm about the animal behaviour and movement patterns they were discovering. As the camera traps were only used most efficiently if they were installed in areas animals used regularly, the guards had to patrol their territories regularly, pinpoint the most frequented jungle trails and water holes and discover the times of day when animal movement was maximum.

Left and right sides of a sloth bear taken by Beat Guard Chandra Bhan Singh, Damna Beat, Bandhavgarh National Park India, using the LMN WildCRU Sentinel Camera Trap. Both sides of the animal are photographed simultaneously to enable complete identification of the animals. Photo credit: Latika Nath/ WildCRU Tiger Ecology

Most guards began to try and differentiate between different tiger and leopard individuals based on their pugmarks. They also began to keep notes of when and where different pugmarks crossed infront of the traps. Being able to finally see the photographs of the animals they spent their days protecting was a huge reward for them.

A side benefit of the increased patrolling was that a lot of the illegal felling, fuel wood gathering and cattle grazing was detected and stopped in time. Another important benefit was that attention was taken off tigers and was given equally to the shier, nocturnal, rarely seen species like the four horned antelopes, sloth bear and porcupines.

Camera trap photograph showing villagers walking through the national park.
Photo credit : Latika Nath, WildCRU Tiger Ecology Project

Technology transfer for commercial production of Camera Traps in India

The initial design work for the camera trap was undertaken in New Delhi, India in collaboration with Prof. L.M. Nath (Association for Health, Environment and Development (AHEAD), India) and Dr. Sneh Anand (Indian Institute of Technology, Delhi, India). The early prototype was developed and tested in the field with the help of Dr. Anand and her team of technicians .

Subsequently, Mr. P. Viswanath (Sentinel Safety Systems private Ltd.) worked with Prof. Nath to develop and test the final model. Sentinel Systems has produced 20 pairs of camera traps and now has the capability to produce these systems on a commercial basis. The final price of each unit is approximately half that of the Trail Master and has been made entirely from locally available materials. The electronic circuit boards were designed by Dr. Nath and Mr. Viswanath. These were produced by Mssrs. Sentinel Safety Systems Private Ltd. The photoelectric twin beam sensors type PB-60Tk and 12 volt, 7 Ah SMF rechargeable Back up batteries were also supplied by Sentinel Systems. The cameras used were Minolta cameras model C10, supplied and modified by Mr. Inderjit Singh (Pritam Cameras Ltd.).

Conclusion

One hundred and six photographs of tigers were obtained in 368 trapping days, using a pair of cameras at each site, in an area of 105 km^2. In addition many more photographs of other animals, occasional birds and human intruders in the park were obtained. The project would have yielded a far larger number of photographs if the time period in the field had been longer as originally planned. Due to the delay of almost 18 months in funding, the project had to be completed in the short span between November 1998 and May 1999.

The camera trap project meets its objectives as a camera trap as been designed using indigenously produced material, at a cheaper price. These traps have been tested in the field and have found to be easy to use and maintain. An Indian firm now has the capability to produce these units commercially. Forest department staff were trained to use these traps and successfully did so.

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Mr. Inderjit Singh supplied me with 40 cameras and modified them for remote release to our specifications almost overnight.

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