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Abstract: For the most part, it is impossible to conduct direct counts of large cats like lions, leopards and cheetahs. For counting them scientists apply a variety of indirect methods which combine ancient skills like tracking or the reconstruction of activity from the spoor of animals with the most current technology and scientific theory. The use of tracks has been refined in a method known as the scent-station survey which eliminates some of the variation in track counts by attracting cats to a series of counting stations. Further methods are faecal analysis and telemetry, but the most accurate estimations of numbers are obtained by camera-trapping. With the relentless pressure of habitat destruction and persecutions, it is critical that researchers have at their disposal reliable, repeatable and cost-efficient methods for estimating felid abundance.


LUKE HUNTER

The Will-o'-the-Wisp is out on the marsh,
And all alone he goes;
There's not a sight of his glimmering light
From break of day to close;
But all night long, from dusk till dawn,
He drifts where the night wind blows.

THE WILL-O'-THE-WISP, 1900

COUNTING cats

TEXT BY GUY BALME

Annie Campbell Huestis could have been describing almost any wild cat when she wrote this poem. Apart from the gregarious lion and the diurnal cheetah, cats epitomise the solitary, the nocturnal and the secretive in the animal kingdom. But large cats are also apex predators, and biologists and wildlife managers must be able to gauge how their numbers fare in relation to those of their prey, as well as monitor any dramatic changes in their status. How do you count what cannot been seen? How do you monitor what cannot be found? Guy Balme lets us in on a few tricks of the trade.

GUY BALME (2)

Tracks, such as those of a male leopard (page 36) or a lion (above), provide one method of monitoring big cat populations. They confirm the presence of species in an area, and when rigorously counted by experts they can also generate estimates of numbers.

OPPOSITE Radio-collaring cats, like this female leopard at Phinda in KwaZulu-Natal, South Africa, furnishes the most detailed data of any method when it comes to understanding populations. However, telemetry is expensive, requires years of effort, and is enormously challenging to deploy – cats are very difficult to catch.

TELLTALE TRACKS

For the most part, it is impossible to conduct direct counts of such cryptic animals as the large cats. Instead, when scientists try to count them, they resort to a variety of indirect methods which combine ancient skills with the most current technology and scientific theory. Among the ancient skills is tracking, or the reconstruction of activity from the spoor of animals. This age-old practice is still employed by modern-day hunter-gatherer communities throughout the world, but it is also a skill that has been harnessed by the scientific community.

Tracks allow researchers to confirm a species' presence in an area and, more valuably, they can be used to decipher its ecology – how far it moved in a night, how many times it hunted, whether it met other members of its species or was accompanied by cubs, and so on. But can they also provide an accurate estimate of population density?

The scientific community is divided. The method relies on assuming that a population at high density leaves more detectable signs than one at low density. In its simplest form, tracks are counted along transect lines and the resulting tally is used to derive an estimate of abundance: more tracks equals more cats. However, a host of variables influences how often tracks are deposited along a trail, to say nothing of the ease with which they can be detected. Certain paths – those along a watercourse or in areas of high prey density – are more heavily used than others. Substrate plays a key role: track-friendly environments like sand and dusty trails yield far more distinguishable tracks than rocky or well-vegetated habitats. Finally, individual cats can influence the results. Certain individuals may be more likely to use paths than others and a single animal may cross a transect line repeatedly, exaggerating the number of individuals assumed present.

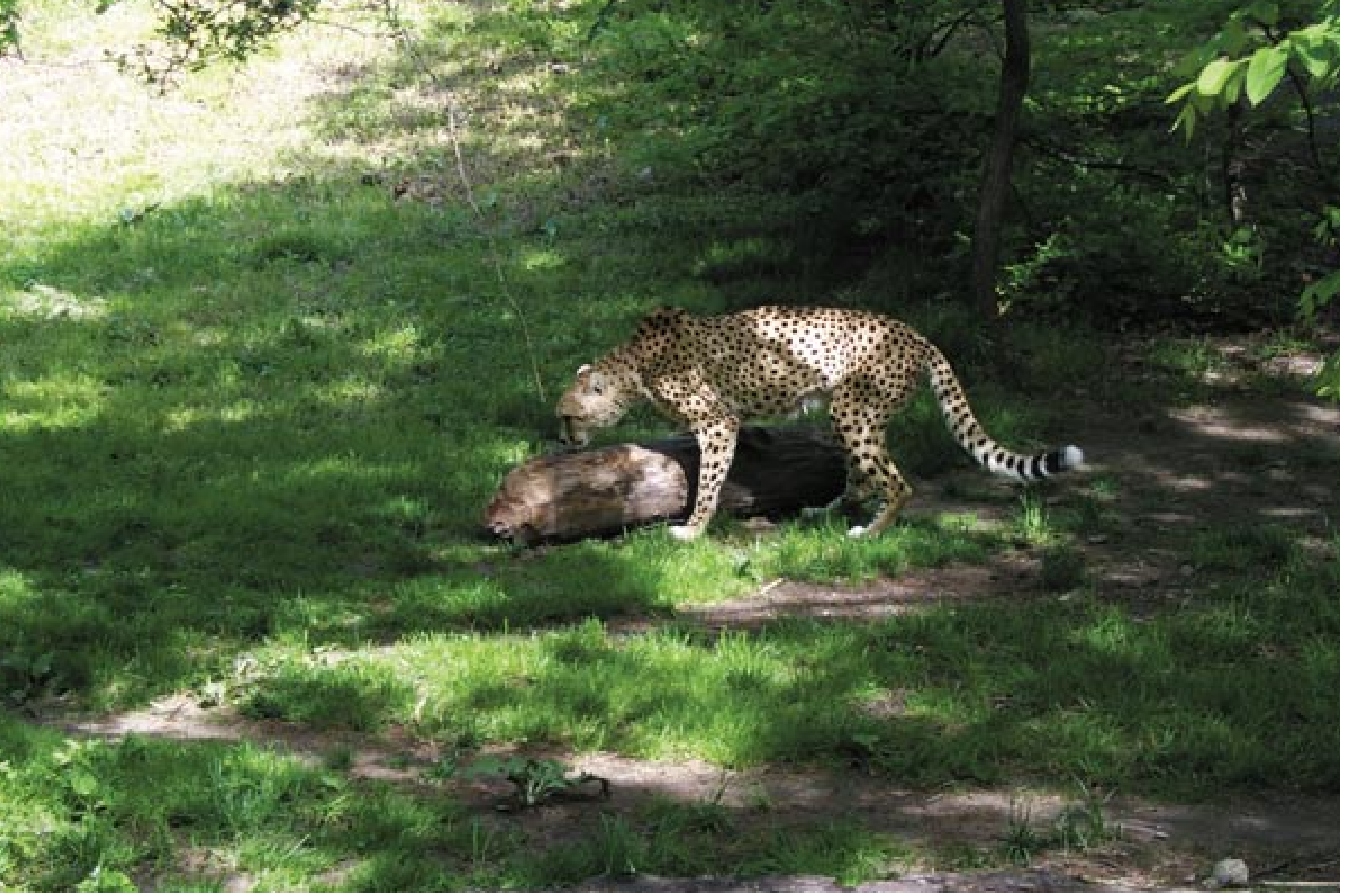
Biologists have refined the use of tracks in a method known as the scent-station survey. Pioneered in the United States, the method eliminates some of the variation in track counts by attracting cats to a series of counting stations. The stations comprise a lure (usually a plaster disc filled with synthetic fatty acids) surrounded by a uniform tracking substrate such as a layer of fine powder or even metal plates covered in soot. The density of tracks yielded at the stations can be related to population numbers and, because the artificial tracking conditions are so favourable, researchers are often able to distinguish between individual cats.

The ability to recognise individual animals is the Holy Grail of surveys. It allows biologists to estimate the total number of animals present instead of merely obtaining an impression of how a population is faring. For many years, the Indian government has used track uniqueness to quantify tiger numbers in its periodic censuses of the country's reserves. Researchers trace outlines of pugmarks onto glass plates or they make plaster-of-Paris casts of tracks. The technique assumes that differences between individual tiger tracks will be consistently detectable.

However, Ullas Karanth, who is the head of the Wildlife Conservation Society's (WCS) India programme and has studied wild tigers for over 20 years, thinks the technique is virtually worthless. He tested six experienced Indian wildlife managers by making 33 tracings of pugmarks of four captive tigers on two different soil substrates. While 75 per cent of the respondents were able to identify the sex of the tiger correctly, performance was much poorer on establishing whether the tracks were made by fore, hind, left or right paws. Worse still, the total number of tigers estimated by the managers varied wildly, from six to 24 individuals. All were overestimates, the highest by 600 per cent!

The ability to recognise individual animals is the Holy Grail of surveys

In an attempt to address this, biologists have occasionally employed some questionable techniques. Scientists in Utah surgically removed a rear toe from all resident adult pumas in their study area so that any new cat immigrating into the region could be recognised immediately. No puma showed adverse effects from the surgery, but it would be difficult to justify such extreme measures today. Less severe experiments have attempted to quantify the natural ▶



JULIE MAHER (2)

A female cheetah in New York's Bronx Zoo rubs against an experimental scent station, leaving a swatch of her DNA-rich fur. Captive cats appear to show more interest in novel perfumes, perhaps because their environment has few stimuli compared to that of their wild counterparts.

variation in tracks using statistics. Researchers on snow leopards, jaguars and pumas have used powerful statistical models to attempt to unlock the key to 'uniqueness' in tracks. The idea is that while an individual cat's tracks vary depending on substrate, gait and even whether or not it has a full stomach, there is a relationship between the pads of the feet (the toes and the main plantar pad) that never changes. Accordingly, a series of intricate pugmark measurements should be able to distinguish between individuals. In trials with zoo animals, the technique bore fruit with a small number of individuals, but it broke down as additional animals were included. For the most part, statistical models are not yet capable of discriminating between individuals in a large, wild population.

Notwithstanding these limitations, highly skilled trackers are capable of astonishing accuracy. Philip Stander, a biologist specialising in carnivores in arid north-eastern Namibia, tested the ability of Ju/ Hoan' Bushmen to distinguish the spoor of individual leopards, lions and wild dogs. The team of Bushmen easily identified slight variations in individual pugmarks, but also used very fine differences in spacing distances between strides and the specific placement of feet to recognise gaits particular to individuals. In the final appraisal, the Ju/ Hoan' were correct in 98 per cent of the spoor reconstructions.

On balance, tracking is a useful and cost-effective means for gauging trends in felid populations. But unless conditions are optimal (that is, in arid and track-friendly environments with expert trackers), it is unlikely to be useful for accurately quantifying population size. For that, scientists are now turning to census methods that are more technologically advanced.

FACTS FROM FAECES

Scatology. The word says it all. A khaki-clad researcher, magnifying glass in hand, is studiously peering at a foul-smelling amorphous mass, possibly prodding it with a stick or, worse still, an uncovered finger. This may be the least glamorous side of feline research, but the information gained from faeces far outweighs any unpleasantness in collecting them. With modern molecular techniques, it is now possible to obtain accurate density estimates from faeces, along with a wealth of information on a species' demographics, genetics and life history.

But how can an animal's dung tell us anything about population size or, for that matter, anything other than what it ate the day before? The answer lies in genetic sequencing or 'genotyping'. An animal's faeces contain cells shed from its intestinal lining, providing DNA that can be isolated and analysed. By amplifying short pieces of DNA, a number of genetic markers can be identified, and by analysing several of these markers or microsatellites, a 'genetic fingerprint' which is unique to each individual animal can be obtained.

To census a population using this technology, it is necessary to collect as many scats as possible – and this is the major challenge. Carnivore scats are generally hard to find, especially in tropical environments where faeces tend to decay extremely rapidly. A study investigating leopard dynamics in the forests of Gabon overcame the problem by paying local people for leopard scats! Once enough scats are in hand, their unique microsatellite markers can be isolated. Over time, the relationship between known genotypes and new genotypes is used to define a curve which levels off when the estimated population size is reached. In other words, at the stage that no new genotypes are added to the collection, all the individuals within the population have been sampled; the population size is effectively the number of unique microsatellite genotypes discovered. To date, molecular scatology has been applied to only a handful of felid populations, but it holds great promise as a method for assessing the abundance of cats in the future.

CALVIN KLEIN FOR LIONS?

WCS scientists George Schaller, Peter Zahler and Luke Hunter were looking for ways to count the last of the Asiatic cheetahs. Some 400 years ago, this elusive subspecies was found from the verdant floodplains of the Ganges to the barren mountainous regions of the Middle East. Today, there are thought to be fewer than 100 left, all dispersed over the vast and desolate Dasht-e-Kavir Desert of central Iran. Their low numbers would not allow the use of established techniques such as camera-trapping (see next page), so the WCS team would have to come up with another, more ingenious approach for counting this critically endangered felid.

Testing a variety of perfumes and colognes on his captive cats, Thomas found that they had expensive tastes

Loading up a hair snare with perfume. One of the ongoing problems in using hair traps is that target animals become conditioned to them and stop responding. Biologists experiment endlessly with scents and techniques to keep hair traps attractive.

They enlisted the help of the Bronx Zoo in New York. Using the zoo's wild cats, mammal curator Patrick Thomas experimented with ways to attract and count cheetahs. If they could induce a cat to rub against a hair-trap – essentially a dog brush nailed to a tree – they could use the resulting hair sample to genotype individuals in much the same way as scats are used. Thomas turned to scent. Testing a variety of perfumes and colognes on his captive cats, he found that they had expensive tastes. The zoo's cheetahs, lions, tigers and leopards were most fond of Calvin Klein's Obsession for Men. Other firm favourites were Samsara, L'Air du Temps, Paco Rabonne and Drakkar Noir. One particularly engrossed female cheetah refused to leave the aromatic scent-trap, rubbing vigorously on it for a full 15 minutes. Within no time, the zookeepers had more hair than they would ever need.

In 2003, we tested this technique at Phinda Private Game Reserve in northern KwaZulu-Natal, South Africa. With easily observed lions, leopards and cheetahs, the reserve was ideal for checking whether wild cats responded with the same delight displayed by the Bronx Zoo's animals. The results ▸

LUKE HUNTER

Camera-trapping delivered results that would not have been possible using more conventional census methods

ABOVE The author sets a camera-trap in KwaZulu-Natal. Camera-trapping has long been used in Asia and Latin America to survey cats, but is relatively new in Africa.

OPPOSITE To count cats (or any species) reliably, biologists must be able to identify individuals, typically by unique markings such as spots and stripes. With high-resolution digital camera-traps now hitting the market, it becomes increasingly possible to use far less obvious marks, such as the whisker spots of this lioness.

were mixed. Leopards and lions showed interest in the scents and were occasionally induced to rub up against the brushes, but the cheetahs did not respond. Sometimes, the reaction from interested animals was less than desirable – one inquisitive female leopard burst into an uncontrollable sneezing fit after smelling a dose of L'Air du Temps and avoided the perfume stations thereafter. For the most part, however, Phinda's wild cats were indifferent to the scents. Perhaps the natural environment provides so much stimulation that perfumes are not especially interesting. Or perhaps the South African cats just have different tastes to their Bronx relatives. Testing other lures such as catnip, glandular extracts, urine from exotic species (such as the zoo's Siberian tigers) and blood might hold more promise.

SAY CHEESE!

It is easy to recognise individuals in certain cat species from their coat patterns. The markings of all spotted cats, as well as tigers, are unique to the individual and, if distinct enough to observers, can be used to assign identity correctly. This is the basis for one of the most exciting, accurate and non-invasive methods of counting cats – remote photography surveying or, as it is usually called, camera-trapping.

Ullas Karanth and James Nichols pioneered the technique when they were attempting to census the tiger population of the Nagarahole National Park in Bangalore, India. By placing cameras triggered by infra-red units in promising tiger habitat, they were soon able to recognise a number of different individuals based on their unique stripe patterns. They quickly realised, though, that there was a key difference between the number of cats they were photographing and the true population size – some cats were never photographed even though they were known to be around. Simply counting the number of individuals from the photos was a promising start, but it was not the full picture. Karanth and Nichols realised that they could generate very accurate estimates of density by modifying existing formulae, such as the 'capture-recapture' model (an animal survey method that investigates the relationship between the total number of animals 'caught' and the probability of a 'capture').

Camera-trapping sounds simple, but it entails a great deal more than just placing cameras out in the bush. To employ the powerful statistics of the capture-recapture model, a number of fundamental criteria have to be met. The first is that the population must be 'geographically and demographically closed', meaning that no animals leave or enter it during the survey period. Of course, in reality this is impossible – cats die, disperse and immigrate – so researchers limit the effect of these changes on the count by running the surveys for a limited period, usually no longer than 90 days. Secondly, there can be no gaps in the survey design. Every cat must have at least some chance of being 'trapped', and in order to achieve this, the distance between stations must be smaller than the minimum home range size of the target species. In the case of most cats, adult resident females have the smallest territories. In Karanth's study site, Nagarahole, this can be as small as 10 square kilometres, so the cameras are spaced no further than two or three kilometres apart. Finally, positioning cameras on well-used game trails and other areas likely to be frequented by cats is critical. There is no point in putting a camera in a dense thicket or on a rocky cliff if a cat is never going to go there.

Karanth and Nichols demonstrated that the result of camera-trapping furnished very accurate estimations of numbers. Karanth had studied the Nagarahole tiger population for many years, so virtually all individuals were known to him before he started camera-trapping. By putting their photo data into the capture-recapture model and comparing what emerged, they found that camera-trapping delivered results that would not have been possible using more conventional census methods.

As this has proved to be one of the most reliable methods for counting cats, a great deal of similar work has been done since Karanth and Nichols' groundbreaking attempts. In my work on leopards in KwaZulu-Natal, I used camera-trapping to generate the first reliable population estimates of the species anywhere in southern Africa. Leopards are also being camera-trapped in Gabon, Tanzania, Uganda and South Africa's Cedarberg Mountains (see page 25 for an update from the Cape Leopard Trust), as well as in various parts of their Asian range. Cheetahs, ocelots, jaguars and snow leopards have also been counted using camera-trap surveys. Researchers are even experimenting with its application to uniformly coloured cats such as lions and pumas using high-resolution pictures to distinguish between individuals by scars, mane colour and even whisker spots.

This is just a small sample of the many techniques employed by wildlife biologists to count wild felid populations across the globe. One scientist has suggested cynically that there are more methods for counting cats than there are people out in the field attempting to do so! With the relentless pressure of habitat destruction and persecution driving decreases in cat populations, it is critical that researchers have at their disposal reliable, repeatable and cost-efficient methods for estimating felid abundance. Without crucial baseline data on carnivore population numbers, it is impossible to identify areas of high conservation concern and evaluate the effectiveness of management decisions – and soon there may be no wild cats left to count. ■

MUNYAWANA LEOPARD PROJECT

THE NITTY GRITTY

Text by Dr Jim Sanderson of the Tropical Ecology, Assessment and Monitoring programme, Conservation International

My work as a 'camera-trapper' takes me to tropical forests located in biodiversity hotspots (see *Africa Geographic* Vol.10 No.2). Ideally, the camera-traps I place will operate for a year or more, with film and batteries being replaced every two months, so durability is a major consideration in my choice of product.

Basically each battery-powered unit comprises a camera that is triggered by a sensor. Mostly the cameras are simple 35mm ones containing a standard roll of film. Digital versions are also available but are generally more expensive, and video camera-traps have recently come onto the market. Some units are triggered by an animal passing through and breaking an invisible infra-red beam; in others, a heat-in-motion detector activates the shutter. Units vary from being completely programmable to being controlled by a set of toggle switches. They can be set to operate during the day, exclusively at night or continuously, and the time interval between triggers can be regulated from 20 seconds to 45 minutes to avoid multiple photographs of the same animal.

Positioning the camera-trap is always a challenge, especially in a dense tropical forest where there is little light and the field of view is severely limited by the thick vegetation. The type of sensor used by the camera-trap defines the space in which a photograph may be taken, and the size of the subject determines the ideal distance it should be from the camera in order to obtain a useful picture. Taking these difficulties into account, I also have to decide on a location that will produce a good result: on a trail used frequently by animals (and possibly humans) or deep in the forest where big cats such as jaguars often lurk?

One major drawback of camera-trapping is having to wait two or more months before visiting the cameras to see what we've photographed. Sometimes the results are very exciting, more than making up for the agonising wait. Recently we documented the existence of pampas cats in Emas National Park, Brazil. This small cat has never been studied before, but now we are planning a radio-telemetry project based solely on information collected from cameras. Another happy surprise was the discovery that the Siamese crocodile, recently thought to be extinct, still exists in the Areng Valley, Cambodia, where it was captured on film by my colleagues.

AFRICA Geographic online

Guy Balme and Luke Hunter's research on leopards at Phinda, South Africa, featured in the February 2004 issue.

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