TECHNIQUES USED IN THE STUDY OF AFRICAN WILDCAT, *FELIS SILVESTRIS CAFRA*, IN THE KGALAGADI TRANSFRONTIER PARK (SOUTH AFRICA/BOTSWANA)

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Keywords:
African wildcat; capture techniques; chemical immobilisation; habituation; Kalahari

Dates:
Received: 04 Aug. 2009
Accepted: 11 Dec. 2009
Published: 24 May 2010

How to cite this article:
Herbst, M. & Mills, M.G.L., 2010, 'Techniques used in the study of African wildcat, *Felis silvestris cafra*, in the Kgalagadi Transfrontier Park (South Africa/Botswana)', *Koedoe* 52(1), Art. #939, 6 pages. DOI: 10.4102/koedoe.v52i1.939

This article is available at:
http://www.koedoe.co.za

ABSTRACT

The techniques used for the capture, marking and habituation of African wildcats (*Felis silvestris cafra*) in the Kalahari are described and evaluated in this paper. African wildcats were captured, with either baited cage traps or chemical immobilisation through darting. Darting proved to be a more efficient and less stressful way of capturing cats. Very high frequency (VHF) radio collars fitted with activity monitors were especially effective in the open habitat of the Kalahari for locating and maintaining contact with cats; they also aided in determining if the cats were active or resting in dense vegetation. The habituation of individual cats to a 4×4 vehicle proved to be time consuming, but it provided a unique opportunity to investigate the feeding ecology and spatial organisation of cats through direct visual observations.

Conservation implications: In describing and comparing the various methods of capture, handling and release of the African wildcats that we followed during our study in the southern Kalahari, we recommend the most efficient, least stressful method for researchers to follow – both in relation to time and energy, as well as in terms of the impact on the animals being studied.

African Protected Area Conservation and Science
Article #939

INTRODUCTION

The African wildcat (*Felis silvestris cafra*), is widely distributed throughout the African continent and listed by the International Union for Conservation of Nature (IUCN) as least concern (Nowell 2008). However, status and density estimates of African wildcats are poorly known throughout most of its range. Therefore, the ecological status of wildcat populations is frequently determined from incomplete or unverified data (Nowell & Jackson 1996). Previous research efforts on African wildcats have focused on scat analyses and opportunistic sightings of cats in their natural environment (Palmer & Fairall 1988; Smithers 1971; Smithers & Wilson 1979; Stuart 1977; Stuart 1982). The aim of this study was to gain insight into the population genetics and behavioural ecology of African wildcats in the southern Kalahari. This required the capture of cats for the fitting of radio collars, taking morphometric measurements and obtaining DNA samples. Radio telemetry was crucial for locating individual cats for the collection of data on feeding behaviour, home range and movement patterns. Investigating the foraging and social behaviour relied on the habituation of certain individuals for direct observations.

Steel, wire, mesh and Tomahawk cage traps are widely used in the live trapping of small mammals, for example in the European wildcat and domestic cats (Biró, Szemethy & Heitai 2005), lynx (Breitnemoser & Haller 1993), kodkod (Dunstone *et al*. 2002), Blanford's foxes (Geffen *et al*. 1992; Geffen & MacDonald 1993), leopard cat (Grassman & Tewes 2005), caracal (Marker & Dickman 2005; Melville 2004), black-footed cats (Sliwa 2004, 2006), dhole (Grassman *et al*. 2005), ferrets (Norbury, Norbury & Heyward 1998) and civits (Jennings, Seymour & Dunston 2006).

The successful capture and release of an animal is not only determined by the capture of the animal, but also by how the animals are handled, transported and kept after capture (Ebedes, Du Toit & Van Rooyen 1996). This paper provides detailed information on the methodology involved in capturing, immobilising and habituating of African wildcats in the southern Kalahari.

STUDY AREA

Kgalagadi Transfrontier Park

This study was initiated in March 2003 and continued until December 2006 (46 consecutive months) in the Kgalagadi Transfrontier Park (KTP), which comprises the Kalahari Gemsbok National Park (South Africa) and the adjacent Gemsbok National Park in Botswana. The KTP is a 37 000 km^2 semi-arid wilderness area in the southern Kalahari, described as the western form of the Kalahari Duneveld (Mucina & Rutherford 2006), consisting of extreme open savannah of *Acacia erioloba*, *Acacia haemotoxylon* and desert grasses. The study was primarily conducted in a 53 km^2 area surrounding the Leeudril waterhole (26º28'17.7" S, 20º36'45.2" E), in the south of the park, and included the Nossob riverbed together with adjacent calcrete ridges, *Rhigozum* veld and dune areas (Figure 1).

METHOD

All capture, darting and handling of African wildcats were approved by the ethics committee, University of Pretoria, (EC 030305-007) and South African National Parks Animal Use and Care Committee (SANParks AUCC). Approval to conduct research in the Botswanan side of the KTP was obtained from the Office of the President: OP 46/1 CVII (48), with a supplementary permit from the Department Wildlife and National Parks (9 July 2006).

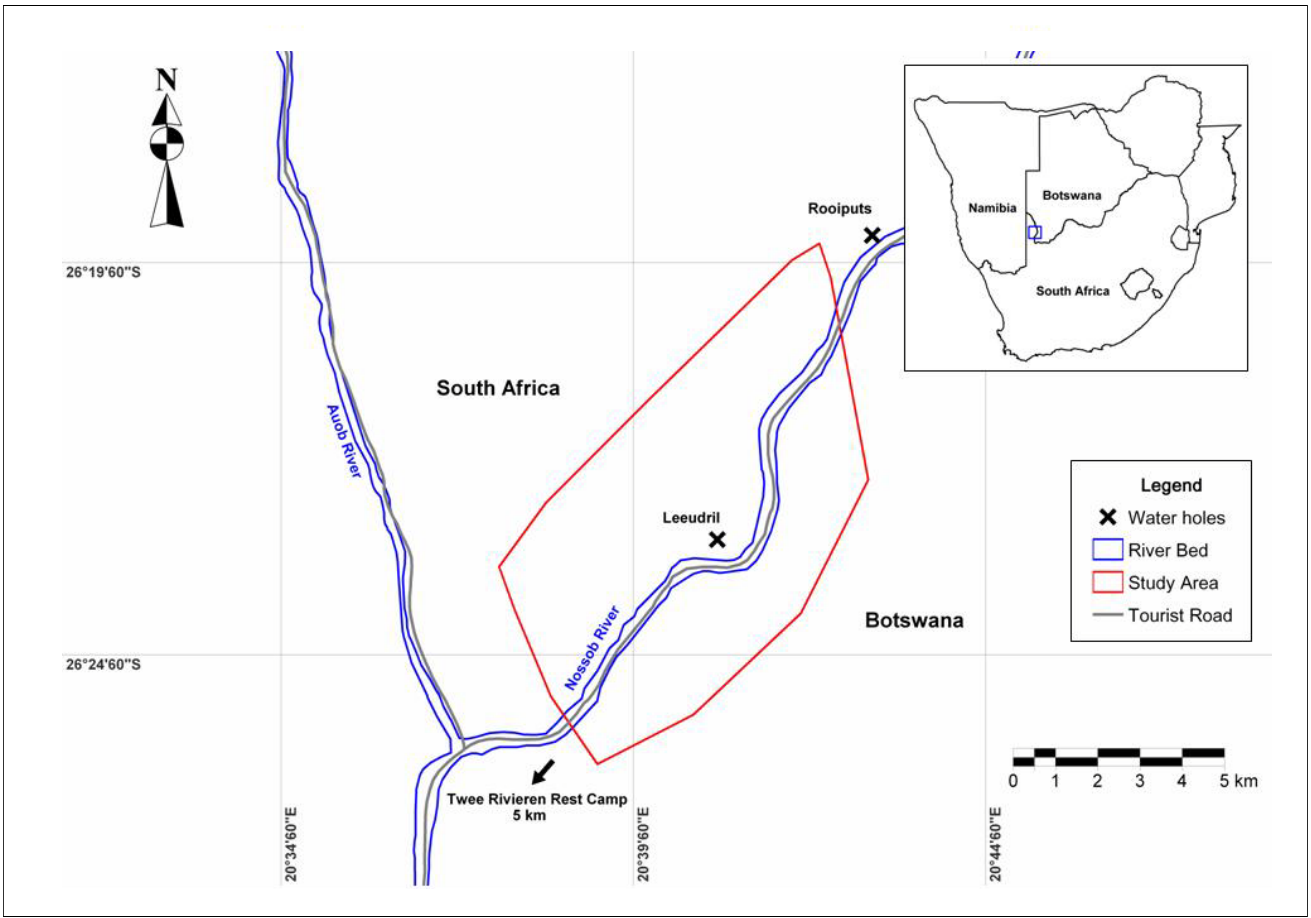

FIGURE 1
Study site in the Kgalagadi Transfrontier Park, indicating the area around the Nossob riverbed and Leeudril waterhole, where African wildcats, *Felis silvestris cafra*, were radio collared and monitored

Capture techniques

Cage traps / Drop door traps

Cage traps (50 cm × 50 cm × 150 cm) were constructed from welded mesh, with a single sliding door. A stepping plate mechanism towards the rear end of the cage activated the trap door. The size of the cages permitted cats to enter fully before depressing the plate, causing the door to drop. Bait, either locally bought chicken pieces or fresh road kills, suspended from a wire over the plate, was used as lure. Additionally, cat urine was collected opportunistically whenever following a focal cat, stored in plastic bags and added to baited traps as a supplementary attractant for other cats (6 out of 12 cats were caught with the use of urine as attractant). Cages were sometimes camouflaged by hiding them in vegetation, or covering the sides (only two of the 12 cats were caught when the cages were camouflaged). The stepping plate was covered with soil to give it a more natural feel.

The traps were set late in the afternoons and checked daily, early in the mornings. When a cat was found inside the trap, the far end was covered with a blanket in an attempt to provide a measure of security for the cat. A 40 cm × 40 cm crush plate, attached to a steel rod, was inserted at the front of the trap and, slowly and gently, the cat was pushed towards the back of the cage. In this way, the cat could be trapped at the far end of the cage, from where it was possible to hand inject it through the wire mesh. Zoletil[R] (Tiletamine hydrochloride with Benzodiazephine derivative Zolazepam in 1:1 combination). A dosage of approximately 2.5 mg/kg was used for all cats caught by this method.

Once anaesthetised, cats could be removed from the cages without difficulty, whereupon standard body measurements were taken (Table 1). A small skin sample was collected for molecular analysis and, if relevant, a radio collar was fitted. All procedures were conducted as quickly as possible and in the immediate vicinity of the trap. On completion of the necessary procedures, the cat was returned to the shaded cage and left to recover from the anaesthesia. It was released when it had fully recovered.

Darting

A CO_2 rifle (Dan-inject JM Standard model) was used to propel a standard dart syringe (10.5 mm, 1.5 mL capacity) and fitted with a small rubber stopper to reduce penetration. Owing to the small size of the cats, it was necessary to lower the CO_2 pressure in the rifle as much as possible to reduce the projectile velocity and, in so doing, lessen the impact and therefore the chances of injury to an animal. As a trade-off, the range over which the dart could be propelled had to be reduced. Cats were thus always stalked to within 10 m.

Cats caught by darting were immobilised with a combination of drugs and an appropriate antidote as follows (P. Buss & D. Govender, pers. comm.): either Butorphanol (1.38 mg/kg) and Medetomidine (0.4 mg/kg), with the antidote of Antipamezole administered at five times the Medetomidine dose (mg) intramuscularly and Naltrexone administered at 10 times the Butorphanol dose (mg) intramuscularly, or Zoletil (1.58 mg/kg) and Medetomidine (0.07 mg/kg), with the antidote of Antipamezole administered at 6.25–12.5 times the Medetomidine dose (mg) intramuscularly. Zoletil does not have an antidote.

Radio collars

African wildcats were fitted with radio collars from Africa Wildlife Tracking CC, weighing 80 g – 85 g, with external

TABLE 1
Standard body measurements collected from all African wild cats trapped and darted during 2003–2006 in the Kgalagadi Transfrontier Park

ID	Sex	Status	TL	HB	T	Hf s/u (cm)	E	Mass (kg)	Capture method
2	♂	Adult	93.5	62.5	31	15.5	7	5	Cage trap
9	♂	Adult	93.4	63	30.4	15.4	7.4	4.9	Cage trap
10	♂	Adult	104	69	35	15.3	7.3	5.9	Road kill
12	♂	Adult	106.6	68	38.6	15.7	6.5	6	Cage trap
14	♂	Adult	97.5	63	34.5	15.2	6.8	5.7	Cage trap
15	♂	Adult	96.3	60.6	35.7	15.5	6.8	4.2	Cage trap
17	♂	Adult	104.8	67	37.8	15.2	6.2	5.7	Cage trap
22	♂	Adult	100.6	63.8	36.8	16	7.5	6	Dart
23	♂	Adult	98.3	63.7	34.6	15.6	7.1	4.1	Dart
24	♂	Adult	98.8	62.8	35.7	16.2	7	6.1	Dart
26	♂	Adult	100.4	66.6	33.8	15.5	8	5.2	Dart
27	♂	Adult	96.8	60.8	36	15.8	7.9	4.4	Dart
31	♂	Adult	102.1	67.6	34.5	16.1	7.1	5	Cage trap
4	♀	Adult	90	59	31	14.5	6.2	4.5	Cage trap
5	♀	Adult	108	67	41	15	7.4	4	Cage trap
6	♀	Adult	98	64	34	14	7.5	4	Cage trap
7	♀	Adult	92.3	60.3	32	14.5	6.6	3.4	Cage trap
8	♀	Adult	96	62	34	15.7	7.7	4.6	Cage trap
028*	♀	Adult	-	-	-	-	-	4.3	Dart
029*	♀	Adult	90.3	58.7	31.6	-	6.8	4.1	Dart
30	♀	Adult	89.6	58.7	30.9	15.7	7.5	3.6	Dart
32	♀	Adult	88.6	57.4	31.2	13.3	6.4	3.7	Dart
34	♀	Adult	89	54	35	15	7.2	3.7	Dart
40	♀	Adult	98.9	61.8	37.1	15.5	7.1	4.4	Dart
001*	♂	Sub adult	78	46	32	15.5	6.8	3.3	Road kill
016*	♂	Sub adult	89	56.5	32.5	14.8	5.6	3.3	Dart
025*	♂	Kitten	84.4	52.9	31.5	14.7	6.5	3.1	Dart
033*	♂	Kitten	82.4	51.4	31	14.2	7.3	2.2	Dart
036*	♂	Kitten	79.6	51.3	28.3	12.8	7.2	2.3	Dart
037*	♂	Kitten	79.6	52.1	27.5	13.5	7	2.6	Dart
039*	♂	Kitten	77.7	48.5	29.2	13.8	6	1.9	Dart
Average	♂	(*n* = 14)	99.2 ± 4.07	64.4 ± 2.73	34.8 ± 2.29	15.7 ± 0.45	7.2 ± 0.51	5.2 ± 0.68	
Average	♀	(*n* = 9)	94.3 ± 6.10	60.2 ± 3.67	34.0 ± 3.16	14.8 ± 0.77	7.1 ± 0.53	4.0 ± 0.42	

Sub-adult cats, kittens and cats with insufficient data (*) were not included in the calculation of averages and standard deviation (SD); TL, total length; HB, head body length; T, tail length; E, ear length; hf s/u, hind foot.

antennae of 20 cm and a battery life of up to 18 months. Radio collars were each fitted with an activity monitor to assist in the remote detection of cat activity. Cats were detected with a two or three element handheld Yagi antenna by traversing the home range of the individual study animal and using the dune crests as high vantage points, using a Telonics handheld receiver.

Habituation

The open, clear spaces of the Kalahari provide ideal conditions for visual observation of animals (Begg 2001; Mills 2003), although the stealthy nature of cats, especially at night, required close proximity to the focal animal at all times. All radio collared cats were habituated to the presence of the research vehicle, allowing the researchers to closely follow individual cats without any obvious influence on their behaviour. This was achieved by patiently following cats daily for the first week after initial capture and collaring, at a distance of 50 m – 100 m, while keeping the engine running. Habituation appeared to be facilitated by keeping the engine running in the beginning and slowly moving closer to the cats. After 1 week, the following distance was gradually decreased, until the cats could be followed from a distance of 10 m – 30 m without them looking back at the vehicle. Wildcats were followed on a rotational system, allowing continuous monitoring of a focal animal every night. Cats were located at night by radio tracking, with the initial visual contact being made with a 1 000 000-candle spotlight. Once a cat was located, the headlights of the research vehicle were usually sufficient to follow cats, with the spotlight used only periodically to re-establish contact when lost in patches of denser vegetation, or when cresting sand dunes. Care was taken to keep the spotlight trained behind the cat – to neither influence their hunting success negatively by blinding them, nor positively, by dazzling prey animals.

RESULTS

Capture success

Cage traps

African wildcats were frequently spotted during opportunistic searches and cage traps were placed in close vicinity to these spots. Seven of the ten cats caught in the study site were trapped after being spotted in a specific area. Only three cats were caught by randomly placing the traps in the study site. Trapping success for African wildcats in the Kalahari was 1.4 cats per 100 trap nights. The trapping frequency between wildcats is highly variable and for African wildcats it was estimated at 73 trap nights per new cat, compared to the results of the European wildcat (*Felis s. silvestris*) (Biró *et al*. 2004; Corbett 1979), at 860 and 299 trap nights per new cat, respectively. Trapping of feral domestic cats (*Felis s. catus*) ranged between 75 and 823 trap nights per new cat (Barratt 1997; Biró *et al*. 2004; Bromley 1986; Corbett 1979; Daniels *et al*. 2001; Molsher 2001, 2006), for lynx (*Lynx canadensis*) it was 67 trap nights per new cat (Mech 1980), ocelot (*Leopardus pardalis*) was 116 trap nights per new cat (Dillon

TABLE 2
The percentage capture success expressed as the total of traps (n = 1244) used during all the trapping days (n = 301) in the Kgalagadi Transfrontier Park

ID	Scientific name	Total	%
Cape fox	*Vulpes chama*	113	9.1
Jackal	*Canis mesomelas*	38	3.1
African wildcat	*Felis silvestris cafra*	17	1.4
Genet	*Genetta genetta*	2	0.2
Porcupine	*Hystrix africaeaustralis*	1	0.1
Spotted hyena	*Crocuta crocuta*	1	0.1
Springhare	*Pedetes capensis*	1	0.1
Empty cages		870	69.9
Bait stolen from cage		120	9.6

& Kelly 2008) and leopard cat (*Prionailurus bengalensis*) 405 trap nights per new cat (Grassman *et al*. 2005). The main drawback of cage traps appeared to be the reluctance of wildcats to enter, as well as their non-selective nature (Table 2). Loss of bait could possibly have been attributed to the ineffective setting of cages. Bait was stolen on numerous occasions, by smaller mammals such as the yellow mongoose (*Cynictis penicillata*) and rodents; in some instances it was consumed by ants.

Darting

During two darting expeditions, consisting of four nights each (10 h – 14 h per night), in August 2005 and January 2006, a total of 18 African wildcats were successfully darted, with only one injury reported. Cats were spotted by driving up and down the riverbed, constantly scanning with spotlights in two vehicles and looking for retinal reflections. When cats were spotted, the research vehicle slowly moved in the direction of the cat, maintaining visual contact with the vehicle headlights and a spotlight. Assistants with spotlights in the second vehicle acted as spotters, and when necessary, pedestrian herders directed the cat towards the darting vehicle. The cat was slowly approached until it stopped and a clear shot was possible. Cats were darted from a distance of no more than 10 m. Once successfully darted, a cat was followed at a distance of 30 m – 40 m, with spotlights, until it became fully immobilised. This was important, as a premature approach could have caused the cat to flee, leading to a temporary loss of contact with a highly vulnerable animal. Within 10 min – 15 min after the drugs were administered, it was possible to walk up to the cat and carefully cover the head and eyes with a blanket. Standard body measurements and genetic samples were taken, and in two cases the cats were fitted with radio collars. Antidotes were very effective and cats regained full motor control within minutes after administering.

African wildcats did not appear to associate the vehicle with the darting procedures, as two cats that were fitted with radio collars were easily habituated to the vehicle afterwards. The majority of cats were darted primarily to collect genetic material for molecular analysis and were not approached again afterwards. Owing to the risk of missing the small target area on the thigh of a cat and potentially injuring it, only qualified, experienced wildlife veterinarians were employed in darting.

African wildcats were immobilised on 31 occasions (13 cats were hand injected and 18 cats were darted). No fatalities were recorded, although the fate of the injured one is not known.

Radio collaring

Radio collaring proved to be invaluable for finding and following cats, as they do not return to a fixed den site and are difficult to find at night. The estimated total home range sizes (100% Minimum Convex Polygon) were: adult male = 13.17 km² ± 7.32 km² (n = 5) and adult female = 11.75 km² ± 2.01 km² (n = 3) (Herbst, unpublished). In total, 12 African wildcats were radio collared. Only one female cat showed a slight irritation to the radio collar, symptomised by localised hair loss ten days after been collared. Symptoms lasted for 4 weeks, with hair growing back gradually. The cat was monitored daily until all symptoms had disappeared. On two occasions, damaged radio collars were retrieved, (3 weeks and 2 months after being fitted) suggesting that the cats had fallen prey to a larger predator (one unknown and one confirmed from tracks as a caracal, *Caracal caracal*). Two radio-collared cats disappeared (a young female, two months after being fitted and a young male, two days after), either as a result of malfunctioning radio collars or emigration to an area outside the range searched. External antenna of radio collars broke off within 2–6 months, however, this did not seem to make a difference in the detection of cats, because the cats had known home ranges (Herbst, unpublished) and searching for a signal from high dunes was almost always successful.

Habituation

On average, the habituation period took 73.8 h ± 63.9 h (n = 8), although large individual differences occurred (Table 3). In general, females were easier to habituate (average 36.7 h ± 5.8 h; n = 3). Three radio-collared and habituated females had litters during the study period and dens and kittens could be approached without difficulty. Kittens were extremely curious and would investigate the research vehicle of their own accord. Male cats were more difficult to habituate (96 h ± 74 h; n = 5), as they move faster and over a much larger area than females, making observations of males more difficult. Habituation was lost quickly and maintaining the maximum degree of habituation required that weekly contact with each cat was maintained.

Habituated African wildcats were visually observed for 1538 h (males for 657 h, females for 881 h) on a rotational basis. Continued observations of selected individuals provided detailed information on sexual and seasonal differences in diet, foraging behaviour, movement patterns, reproduction and inter-specific interactions.

DISCUSSION

Long-term and intensive field studies on smaller cats are still uncommon and even the common species have not been well studied (Macdonald & Loveridge, in press; Nowell & Jackson 1996). The reason for this is the relative difficulty associated with studying small felids. Previous research on African wildcats was based on opportunistic sightings, scat and stomach analysis (Palmer & Fairall 1988; Smithers 1971; Smithers & Wilson 1979; Stuart 1977). Their nocturnal behaviour and general shy and elusive nature, make it practically impossible to study cats in their natural environment without the aid of radio telemetry. Radio telemetry has become more reliable and efficient since the 1980s (Nowell & Jackson 1996); recently, radio collars have been designed smaller, lighter and reliable enough for the use on smaller cats. However, in spite of the advances in technology, the time required to catch smaller cats for radio collaring purposes poses a challenge. The trapping frequency of African wildcats is comparable with frequencies of the trapping of feral domestic cats (*F. s. catus*) (Barratt 1997; Molsher 1999,

TABLE 3
The time (days and hours) invested to habituate three female and five male African wildcats in the Kgalagadi Transfrontier Park

ID	Sex	Days	Hours
VL01654	♀	7	30
VL01656	♀	10	40
VL01658	♀	8	40
VL01662	♂	62	210
VL01665	♂	21	50
VL01667	♂	30	130
VL01672	♂	14	60
VL01673	♂	7	30
Average		19.9 ± 18.8	73.8 ± 63.9

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2001). This is much lower than the results on European wildcats (*F.s. silvestris*) (Biró *et al*. 2004; Corbett 1979), which are difficult to catch, the reason possibly being that these populations in Europe have declined, are fragmented and, in many places, are already extinct (Nowell 2008). For black-footed cats (*Felis nigripes*), the trapping frequency was one cat for 100–200 trap nights (including recaptures) (A. Sliwa, pers. comm.). African wildcats in the Kalahari were regularly spotted during our study period, therefore it is believed that densities are much higher in the Kalahari than in Europe.

The results in this study not only confirm the difficulty of catching African wildcats, but also emphasise the general low success rate of trapping small carnivores in the southern Kalahari. Mainly trap door cages, with various combinations of bait and urine to attract cats were used. Positioning cages in areas of high animal activity should increase the selectivity of the trapping efforts (Boddicker 1999). Our results suggest that, after an extensive search in the riverbed with a spotlight and placing of traps close to sightings of cats, the success of trapping increased in comparison with randomly placed traps.

The use of a CO_2 Dan inject dart gun proved to be the best method in the capture of free range African wildcats. The time and cost effectiveness of this capture method was enhanced with the use of drugs combined with antidotes. Once all the data and measurements were collected from the cats, they could be revived with the antidote and the darting operation could continue. Special care and qualified personnel (two wildlife veterinarians and four assistants in two vehicles) were needed to assist with darting operations, because the target animal was so small. The cost of qualified veterinarians and personnel needed in a darting operation is high; however, to obtain a representative sample size using only conventional trapping methods might have taken the researcher another few years of intensive fieldwork.

It was relatively easy to habituate African wildcats to a research vehicle (590 h were needed to habituate eight cats). The Kalahari is the ideal location to study small carnivores, such as African wildcats, because the openness of the environment makes it possible to follow them, even at night (Begg 2001; Mills 2003). Although there were large individual differences between the times needed to habituate individuals (Table 3), it was possible to collect data on feeding, hunting, reproduction and mating behaviour of African wildcats (Herbst & Mills 2010; Herbst, unpublished). To achieve this, radio telemetry was essential and because African wildcats do not travel to the same extent than larger felids, it was feasible to traverse the whole study area in a few hours in search of a signal. This was enhanced by using high dunes as a vantage point.

CONCLUSION

For dispersed and elusive animals, radio collaring might be the key to obtaining appropriate data (Kenward 2001). Despite the advances in the use of satellites for radio tracking – platform transmitter terminals and global positioning system collars – they remain relatively expensive in comparison with the VHF transmitters (Kenward 2001). In this study visual observations of habituated cats fitted with VHF transmitters enabled us to record valuable behavioural information on a nocturnal and secretive animal that more sophisticated and expensive tracking devices could not. This is the first report on the methodology of darting of wildcats (*F. silvestris*), and it proved to be a more efficient and less stressful method than cage trapping of African wildcats in the KTP.

ACKNOWLEDGEMENTS

This research was supported by the Endangered Wildlife Trust's Carnivore Conservation Group (South Africa), the Elizabeth Wakemen Henderson Charitable Foundation, the Mammal Research Institute and the Molecular Ecology and Evolution Programme (Department of Genetics) at the University of Pretoria, the National Research Foundation (South Africa), the Kaplan Awards Program from Wildlife Conservation Society and the Skukuza Marathon Club. We thank SANParks and the Department of Wildlife and National Parks, Botswana for permission to conduct the study in the Kgalagadi Transfrontier Park. N. du Plessis (SANParks Section Ranger) is thanked for assistance in the chemical immobilisation of cats and Dr P. Buss and Dr D. Govender (SANParks wildlife veterinarians) for darting the cats. M. Haupt, Dr L. Jansen van Rensburg, P. Odendaal and N. Read are also thanked for their support in the darting operations.

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