The Rufford Small Grants Foundation

Final Report

Congratulations on the completion of your project that was supported by The Rufford Small Grants Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Alexander Loiruk Lobora
Project title	An assessment of the status of small to medium mammals in Mkomazi National Park in northern Tanzania
RSG reference	03.11.09
Reporting period	April 2011
Amount of grant	£5978
Your email address	carnivores@habari.co.tz
Date of this report	September 2011

1. **Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.**

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Determining the species found in the area and their distribution			√	Species distribution maps for all species trapped have been developed for all 45 species trapped.
Establishing a mammal geo-database			√	A mammal geo-database has been established at TAWIRI and used to produce distribution maps.
Raise conservation awareness to communities surrounding the park			√	Both posters and brochures where printed and distributed to the park and the surrounding communities described in this report.
Establish a comprehensive species list of the area			√	A comprehensive species list has been developed
Provide data to the national database to increase the robustness of future mammal conservation plans			√	Data emanating from this survey have been submitted to the National Mammal database based at TAWIRI for further action.

2. **Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).**

Camera malfunction

Eleven out of sixty cameras set in various locations worked intermittently and a few others took blank photos leading to reduced trapping success. The survey employed a total of 60 fixed cameras triggered by infrared sensors that trap images of passing animals. They are auto-triggered placed a few meters above the ground usually 0.25 to 0.5 meters depending on the terrain level and the size of the target species. Regular checking of all stations was conducted every two weeks to replace films and batteries which helped to reduce loss of trapping success and information to a large extent.

3. **Briefly describe the three most important outcomes of your project.**

i) **First ever camera trapping survey in Mkomazi national park and Capacity building to the park wildlife officials**

Camera trapping is a relatively new technique in Tanzania and the African continet at large and therefore very few wildlife managers employ this technique. One of the objectives of this study was to introduce this new technique to the park personnel by providing training on how to implement camera trap surveys in the field using standardized protocols developed from our previous surveys (appendix 4). Prior to setting cameras in the field, the team presented trapping protocols to the park personel including the park ecologist Mr. Emanuel Stephen Sisya who was the main target person. Having gone through and understood protocols, field training started which included setting the cameras in the field, changing batteries and films whilst recording all the associated information as indicated in the protocol sheet (appendix 4-the last two pages). When camera setting was finished, the team and the park personel conducted a joint session at the park headqarters and the latter taught how the photos from previous surveys are transformed into meaningful information for decision making. Photos from previous surveys were used because film development takes place after the survey is completed and this is usually done in big towns like Arusha where the field team is based. This session impressed park officials and requested the PI to do all in his capacity to raise money for a few traps for the park to enable park officials continue collecting information particularly on small mammals within the park from time to time. They particularly liked the fact that the method has user defined protocols which are relatively easy to follow. In addition to the aforementioned beauties of the method, they also liked the fact that cameras can also be used to deter poachers away as they tend to think as being the target. Most areas that we have surveyed across the country showed a significant decline in poaching as compared to the ones that have not been surveyed by camera traps. The PI agreed to raise money for a few camera traps for the park and in the meantime, TAWIRI will consider lending a few cameras until when the park get theirs.

Further to training of wildlife officials, this survey captured a total of 45 different mammal species ranging from small to large (Table 1) with the overall trap rate of 0.54 photographs/trap nights which is generally higher compared to many others surveys conducted elsewhere in the country. The observed leading species were Dik dik, Grey duiker, Lesser Kudu, Impala and Bushbuck (Table 1). The lowest captured rates were recorded for Common waterbuck, African hedgehog, Small eared galago, Grant gazelle, and Striped hyena. Overall, the probability for recording carnivores was relatively low as opposed to other species and this represent pretty much what we expected as revealed from most of our surveys especially because carnivores are principally nocturnal and secretive (Maffei *et al*,2002). However, camera trapping method remain the most appropriate of all in carnivore surveys as it has relatively low labour costs; is non- intrusive; incurs minimal environmental disturbance (Henschel & Ray 2003, Silveira, Jacomo & Diniz-Filho 2003) and is robust to variation in ground conditions or climate (Cutler & Swan 1999, Silveira *et al*. 2003, Pettorelli *et al*. 2010, Carter and Slater,1991, Kucera and Berrette,1993, Pei,1998). In addition, cameras can as well be used to gain information on all ground dwelling medium to large mammals, including highly cryptic species, in difficult terrain and across a range of habitats where other field methods are likely to fail (Cutler & Swan 1999, Silveira *et al*. 2003, Griffths and van Schaik 1993, Karath, 1995, Karath, 1998 and Tobler *et al*, 2008).

Table 1: Mammal species photo trapped at Mkomazi National Park

	Species	No. trapped	No. trapped /night	Probability of detection	Relative abundance index
1	Aardwolf	23	0.0144	1.4375	1.4375
2	Aardvark	7	0.0044	0.4375	0.4375
3	African Buffalo	4	0.0025	0.2500	0.2500
4	African hedgehogs	1	0.0006	0.0625	0.0625
5	African civet	9	0.0056	0.5625	0.5625
6	Bat eared fox	3	0.0019	0.1875	0.1875
7	Beisa oryx	2	0.0013	0.1250	0.1250
8	Black backed jackal	26	0.0163	1.6250	1.6250
9	Bush pig	3	0.0019	0.1875	0.1875
10	Bushbuck	33	0.0206	2.0625	2.0625

11	Cape hare	3	0.0019	0.1875	0.1875
12	Caracal	18	0.0113	1.1250	1.1250
13	Common genet	19	0.0119	1.1875	1.1875
14	Common waterbuck	1	0.0006	0.0625	0.0625
15	Crested porcupine	22	0.0138	1.3750	1.3750
16	Dik-dik	178	0.1113	11.1250	11.125
17	Eland	31	0.0194	1.9375	1.9375
18	Elephant	5	0.0031	0.3125	0.3125
19	Gerenuck	13	0.0081	0.8125	0.8125
20	Giraffe	14	0.0088	0.8750	0.8750
21	Grant's gazelle	1	0.0006	0.0625	0.0625
22	Grey duiker	66	0.0413	4.1250	4.1250
23	Honey badger	15	0.0094	0.9375	0.9375
24	Impala	58	0.0363	3.6250	3.6250
25	Kongoni	23	0.0144	1.4375	1.4375
26	Leopard	18	0.0113	1.1250	1.1250
27	Lesser galago	1	0.0006	0.0625	0.0625
28	Lesser kudu	65	0.0406	4.0625	4.0625
29	Lion	4	0.0025	0.2500	0.2500
30	Tatera rat	14	0.0088	0.8750	0.8750
31	Red duiker	23	0.0144	1.4375	1.4375
32	Serval cat	11	0.0069	0.6875	0.6875
33	Egyptian mongoose	2	0.0013	0.1250	0.1250
34	Southern reedbuk	9	0.0056	0.5625	0.5625
35	Spotted hyaena	7	0.0044	0.4375	0.4375
36	Steinbuck	11	0.0069	0.6875	0.6875
37	Striped Hyaena	1	0.0006	0.0625	0.0625
38	Unstripped ground squirrel	10	0.0063	0.6250	0.6250
39	Vervet monkey	4	0.0025	0.2500	0.2500
40	Warthog	21	0.0131	1.3125	1.3125
41	White tailed mongoose	21	0.0131	1.3125	1.3125
42	Wild cat	19	0.0119	1.1875	1.1875
43	Wild dog	3	0.0019	0.1875	0.1875
44	Yellow baboon	17	0.0106	1.0625	1.0625
45	Zebra	23	0.0144	1.4375	1.4375

(ii) Trapping of wild dog

More interesting from this survey is the trapping of African Wild dog (*Lycaon pictus)* (Figure 1) which was last photographed in the area in 1997 and recently thought to being locally extinct in the park (Coe *et al*,1999). The dog is one of Africa's most endangered carnivores and listed on the Red List by the International Union for the Conservation of Nature (IUCN) as an Endangered Species. The reasons given by IUCN for their decline are human induced loss of habitat and persecution by humans. According to the IUCN report on wild dogs, there are between 3,000 and 5,500 free ranging wild dogs left in Africa today.

In 1992, the then Mkomazi Game Reserve (now Mkomazi national park) introduced a captive population (Coe *et al*, 1999) and five years later, i.e. 1997 a free ranging pack was observed in the then game reserve but disappeared since then and not actually known when the current population reappeared as the park log book that is updated daily by park rangers whilst doing daily patrols have no wild dog records to the end of this survey. The work ahead of the park management and the rest of us is to carry out a more systematic survey to identify their numbers and whereabouts of the individuals/packs in the area and carry out regular monitoring of the species.

Figure 1: Wild dog trapped during the survey

Apart from the trapped wild dog, the team sighted Black and White Colobus (*colobus angolensis)* near the Umba River located $4^{0}30'$ and $4^{0}45'$ South and $38^{0}30'$ and $38^{0}45'$ East. According to Coe *et al*, 1999 on page 508, species was recorded by various game department personnel as late as 1957 and that the species has not been recorded since then and one possible reported sighting was on 1995 near Umba River gate in the river bank tree. Our team which was accompanied by the park ecologist reported seeing the species in large numbers during the survey suggesting a quick recovery of the population along the Umba River south of the park. We strongly recommend a census for the species in the near future to establish their population status and the factors that lead to their disappearance in late 1950s. Mammal species that are though to be extinct in the park today include Greater kudu, wildebeest and sable antelope.

(iii) Development of the park species list

A number of studies regarding biodiversity of Mkomazi in terms of both higher plants and wildlife have been conducted and published. However, none have put together a comprehensive species list for the area that is acceptable to the park officials. This survey filled in this gap by putting together the first comprehensive species list of the park and submitted to the park officials for endorsement. The list was developed using a combination of methods including our remote cameras, direct mammal sightings by the team, park patrols logbook, literatures as well as from the questionnaire survey also conducted by our team alongside camera trapping to supplement the data. This list is attached to this report (Appendix 3) and once approved by the park officials, it will be made available online at the Tanzania Mammal Atlas Project website at www.tanzaniamammals.org, Tanzania Mammals website at www.tanzaniamammals.org and the TAWIRI website at www.tawiri.or.tz. Furthermore, an article detailing the survey outcome will be drafted and submitted to our widely read newsletter namely the carnivores newsbytes, which will be freely distributed to our network of conservation stakeholders in the country including conservation NGO's.

4. **Briefly describe the involvement of local communities and how they have benefited from the project (if relevant).**

Local communities surrounding Mkomazi National Park were randomly selected with the assistance of the District Natural Resources Officers of Same and Lushoto districts, where the survey area is located. About 14 villages living adjacent to the park were identified and sensitized in groups. Villages include Kwakoa,Toloha, Kigonigoni, Ruvu, Vumari, Kisiwani, Maore, Ndungu, Bendera, Mngaro, Mbaramo, Lunguza, Mnazi and Muheza. The team visited each of the villages and met with the village governments for a briefing and ultimately requested them to identified individuals known to have strong influence over other members to participate in the sensitization workshop. The content of these sensitization workshops included presentation packages on (1) how should communities participate in wildlife conservation (2) who owns wildlife and benefits attached to wildlife conservation and (3) wildlife identification just to mentioned but a few. A number of posters and brochures were distributed as promotional materials which contain contact information in case they get something to share with us in future (Appendices 1 and 2). A network of twenty eight individuals (two from each village) have been created and will be used by the PI to connect with the individuals from time to time in an effort to persuade them to continue sensitising others in future. We envisage that these sensitized groups will be the project legacy as they will continue to sensitize others on how best to ensure the survival of mammals and their habitat in their areas for the benefit of the present and future generations. In addition, the survey established a network with key people in the fourteen villages and it is our hope that they will be key reporters in matter relating to wildlife including sending in sightings to the established database.

5. **Are there any plans to continue this work?**

Yes. As mentioned above, this is the first camera trapping survey conducted in Mkomazi National Park and moreover, it largely aimed at determining presence and absence only. It would therefore be important to revisit the area and conduct a more systematic survey aiming at determining densities of some key species such as Serval cats, leopards and Wild dogs. As aforementioned, a census on Black and white colobus to establish their current numbers is also of paramount importance and may need to be conducted as a matter of priority in the near future. Such studies will build on the data already developed from this and other surveys, to establish the status and trends of various wildlife species over a longer period. Furthermore, education being the key to everything still needs to be disseminated to many more people in these areas using a combination of campaigns such as leaflets, posters, public meeting, etc. I'm considering putting a project proposals targeting more holistic approach targeting science, conservation and capacity building at a much broader level in the future.

6. **How do you plan to share the results of your work with others?**

First and foremost, the data gathered from this survey have been submitted to the national mammal database based at the carnivore centre at TAWIRI and will be used to updating both Carnivore and Mammal conservation action plans in Tanzania (www.tanzaniamammals.org and www.tanzaniacarnivores.org) when time is due. National species action plans provide a framework of priorities for conservation that will be used by all stakeholders countrywide. I also intend to submit an article to the carnivore newsletter to share our findings with the wider community. Additionally, I also intend to present results of the survey to the TAWIRI Scientific Conference in December 2011 which is usually attended by at least 1000 scientists from within and outside the country. This is a key national conference which brings together both local and foreign research scientists working in Tanzania as well as wildlife managers in the country including Tanzania National Parks (TANAPA), Forestry and Beekeeping Division (FBD), Ngorongoro Conservation Area Authority (NCAA) and the Wildlife Division (WD). The full report of our findings will be sent to the Tanzania National Parks who is the custodian of all parks in Tanzania for further actions.

7. Timescale: Over what period was the RSG used? How does this compare to the anticipated or actual length of the project?

The assessment of the status of small to medium mammals in Mkomazi national park was conducted as envisaged. The anticipated project length mimicked very well with actual length of the project.

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	Budgeted Amount	Actual Amount	Difference	Comment
Vehicle cost **a) Fuel** Travelling from Arusha-Mkomazi National Park-Arusha	80.00	85.00	-5.00	
b) Car maintenance Normal car service over the survey period	260.00	240.00	20.00	
Purchase 6 new tyres	780.00	780.00	0.00	
c) Survey Fuel cost for the survey in Mkomazi	384.00	380.00	0.00	
Purchase topographic maps of the area	60.00	60.00	0.00	
Purchase films	540.00	550.00	-10.00	
Batteries both 9V and AA	1,065.00	1080.00	-15.00	
Film processing	150.00	150.00	0.00	
Meals and accommodation throughout the survey period	1154.00	1150.00	4.00	
Publicity Leaflets-1000 copies	250.00	250.00	0.00	
Posters-1000 copies	500.00	500.00	0.00	
Stationery Printing papers	9.00	9.00	0.00	
Toner	65.00	65.00	0.00	
Note books	5.00	5.00	0.00	
Pens and pencils	2.00	4.00	-2.00	
Publications Production and Binding cost	120.00	120.00	0.00	

Disseminating project results to stakeholders using leaflets in Kiswahili language	500.00	500.00	0.00	
Bank and Auditing Charges	50.00	45.00	5.00	
TOTAL	**5974.00**	**5973.00**	**-3.00**	

9. Looking ahead, what do you feel are the important next steps?

→ Submission of this report for implementation to Mkomazi National Park
→ Disseminate survey results using leaflets in Swahili which is the national language to the identified villages
→ Put together the manuscript to be submitted to the TAWIRI Scientific Conference in Dec' 2011
→ Put together the manuscript to be submitted to the Carnivore Newsletter
→ Submit the proposed species list of the park for approval/endorsement
→ Continue updating the database from time to time

10. Did you use the RSGF logo in any materials produced in relation to this project? Did the RSGF receive any publicity during the course of your work?

Rufford logo was used in all posters and leaflets placed in a prominent positions.

11. Any other comments?

The grant has been very useful and demonstrated that a lot can be achieved with a relatively small budget

References:

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4. Griffiths, M. G. and C. P. van Schaik. 1993. Camera-trapping: a new tool for the study of elusive rainforest mammals. Tropical Biodiversity 1:131 - 135.
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14. Silveira, L., A.T.A. Jacomo, and J.A.F. Diniz-Filho 2003. Camera trap, line transect census and track surveys: a comparative evaluation. Biological Conservation 114: 351-355.
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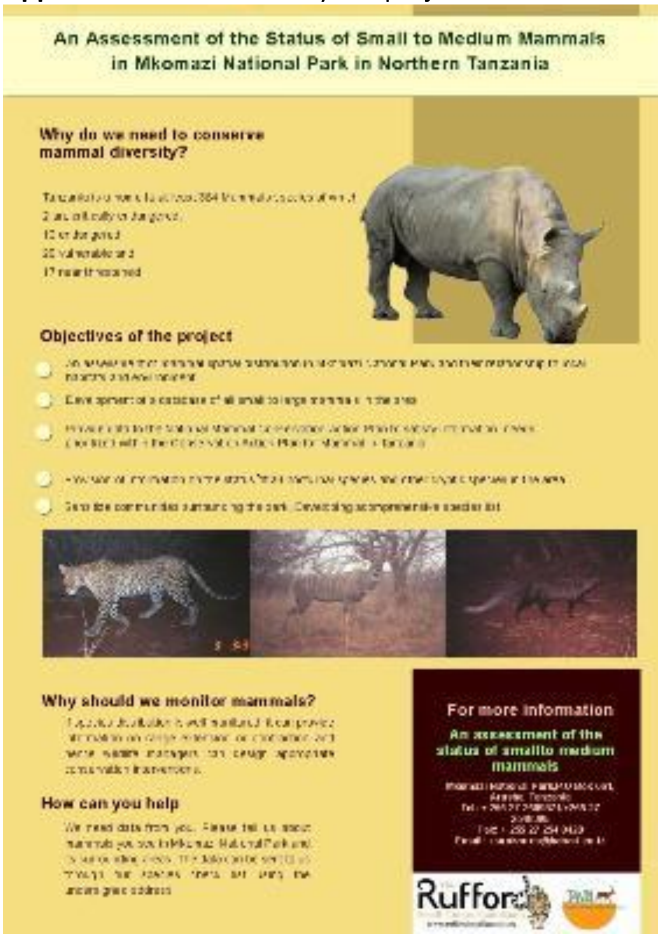
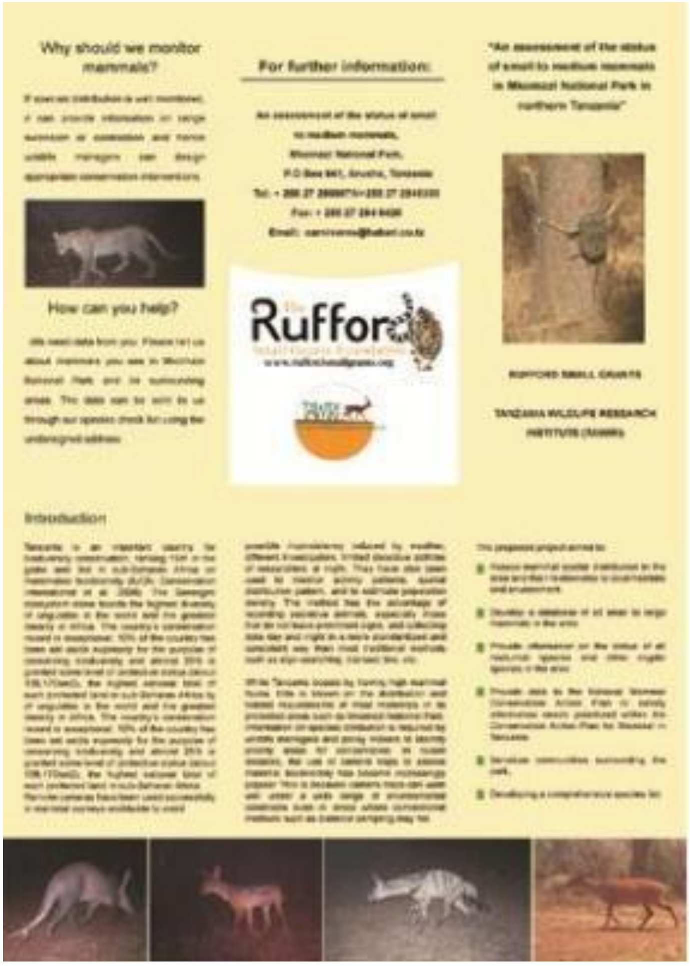
Appendix 1: Poster used by the project



Appendix 2: Brochure used by the project



Why should we monitor mammals?

For further information:

How can you help?

Introduction

Appendix 3: Species list

S/N	Common name	Swahili name	*Scientific name*	Source				
				Camera trapping	Questionnaire survey	Park ranger log book	Literature	Sighting by our team
1	Aardvark	Muhanga	*Orycteropus afer*	Trapped	Recorded		Cited	
2	Aardwolf	Fisi ya nkole	*Proteles cristata*	Trapped			Cited	
3	African Buffalo	Mbogo/Nyati	*Syncerus caffer*	Trapped	Recorded		Cited	sighted
4	African civet	Fungo	*Civettictis civetta*	Trapped			Cited	sighted
5	African hedgehogs	Karunguyeye	*Atelerix albiventris*	Trapped	Recorded		Cited	
6	Banded mongoose	Nkuchiro	*Mungos mungo*		Recorded		Cited	sighted
7	Bat eared fox	Mbweha masikio	*Otocyon megalotis*	Trapped			Cited	
8	Beisa oryx	Choroa	*Oryx beisa*	Trapped	Recorded		Cited	sighted
9	Black backed jackal	Mbweha Nyekundu	*Canis mesomelas*	Trapped	Recorded		Cited	sighted
10	Blue monkey	Kima			Recorded		Cited	
11	Bohor reedbuck	Tohe	*Redunca redunca*				Cited	
12	Bush hyraxes	Perere mawe	*Heterohyrax brucei*		Recorded		Cited	
13	Bush pig	Nguruwe mwitu	*Potamochoerus larvatus*	Trapped	Recorded	Recorded	Cited	
14	Bushbuck	Pongo	*Tragelaphus scriptus*	Trapped	Recorded	Recorded	Cited	
15	Black and White or Pied Colobus	Mbega mweupe	*Colobus angolensis*			Recorded		sighted

16	Cape hare	Sungura	*Lepus capensis*	Trapped	Recorded		Cited	sighted
17	Caracal	Simbamangu	*Felis caracal*	Trapped			Cited	
18	Cheetah	Duma	Acinonyx jubatus		Recorded	Recorded	Cited	
19	Chequered elephant shrew	Njule madoa	*Rhynchocyon cirnei*				Cited	
20	Coloubus monkey	Mbega	Colobus agolensis		Recorded			
21	Common genet	Kanu	Genetta genetta	Trapped			Cited	
22	Common waterbuck	Kuro	*Kobus ellipsiprymnus*	Trapped	Recorded	Recorded	Cited	
23	Crested porcupine	Nnungu	*Hystrix cristata*	Trapped	Recorded		Cited	
24	Dik-dik	Digidigi	*Madoqua kirkii*	Trapped	Recorded		Cited	sighted
25	Dwarf mongoose	Kitafe	*Helogale parvula*				Cited	
26	Egyptian mongoose	Nguchiro	*Herpestes ichneumon*				Cited	
27	Eland	Pofu	*Taurotragus oryx*	Trapped	Recorded		Cited	sighted
28	Elephant	Tembo	*Loxodonta africana*	Trapped	Recorded		Cited	sighted
29	Four toed elephant Shrew	Isanje	*Petrodromus tetradactylus*				Cited	
30	Gerenuk	Swala twiga	*Litocranius walleri*	Trapped	Recorded		Cited	sighted
31	Giraffe	Twiga	*Giraffa camelopardalis*	Trapped	Recorded		Cited	
32	Grant's gazelle	Swala Granti	*Gazella granti*	Trapped	Recorded		Cited	sighted
33	Grey duiker	Nsya	*Sylvicapra grimmia*	Trapped			Cited	sighted
34	Ground Pangolin	Kakakuona	Phataginus temminckii		Recorded		Cited	

35	Honey badger	Nyegere	*Mellivora capensis*	Trapped			Cited	sighted
36	Impala	Swala Pala	*Aepyceros melampus*	Trapped	Recorded		Cited	sighted
37	Klipspringer	Mbuzi mawe	*Oreotragus oreotragus*		Recorded	Recorded	Cited	
38	Leopard	Chui	*Panthera pardus*	Trapped	Recorded	Recorded	Cited	
39	Lesser elephant shrew	Sengi	*Elephantulus rufescens*				Cited	
48	Lesser galago	Komba	*Otelemur garbetti*	Trapped			Cited	
41	Lesser kudu	Tandala Ndogo	*Tragelaphus imberbis*	Trapped	Recorded		Cited	sighted
42	Lichtenstein hartebeest	Kongoni	*Alcelaphus buselaphus*	Trapped	Recorded		Cited	sighted
43	Lion	Simba	*Panthera leo*	Trapped	Recorded	Recorded	Cited	
44	Marsh Mongoose	Nguchiro wa maji	*Atilax paludinosus*				Cited	
45	Ochre bush Squirrel	Kuchakuro	*paraxerus ochraceus*				Cited	
46	Olive baboon	Nyani	*Papio anubis*				Cited	
47	Red duiker	Funo	*Cephalophus natalensis*	Trapped	Recorded		Cited	sighted
48	Rhinoceros	Faru	*Diceros bicornis*		Recorded		Cited	
49	Rock Hyrax	Pimbi	*Procavia sp.*				Cited	
50	Scrub hare	Sungura	*Lepus saxatilis*				Cited	
51	Serval cat	Mondo	*Felis serval*	Trapped			Cited	
52	Side striped jackal	Bweha	*Canis adustus*				Cited	
53	Egyptian mongoose	Nguchiro	*Herpestes ichneumon*	Trapped			Cited	sighted
54	Dwarf mongoose	Kitafe	*Helogale parvula*				Cited	

55	Southern reedbuk	Tohe ya kusini	*Redunca arundinum*	Trapped	Recorded	Recorded	Cited	
56	Spotted hyaena	Nyangao	*Crocuta crocuta*	Trapped	Recorded	Recorded	Cited	
57	Steinbuck	Insha	*Raphicerus campestris*	Trapped	Recorded		Cited	sighted
58	Striped Hyaena	Fisi	*Hyaena hyaena*	Trapped	Recorded		Cited	
59	Suni	Paa mwekundu	Neotragus moschatus		Recorded		Cited	
60	Syke's Monkey	Nyani samango	*Cfercopithecus mitis*				Cited	
61	Tatera rat	Panya		Trapped			Cited	sighted
62	Tree hyrax	Perere	*Dendrohyrax validus*				Cited	
63	Unstripped ground squirrel	Nguchiro asiye miraba	*Xerus rutilus*	Trapped			Cited	
64	Vervet monkey	Tumbili	*Cercopithecus pygerthrus*	Trapped	Recorded	Recorded	Cited	
65	Warthog	Ngiri	*Phacochoerus africanus*	Trapped	Recorded		Cited	sighted
66	White tailed mongoose	Karambago	*Ichneumia albicauda*	Trapped			Cited	
67	Wild cat	Paka mwitu	*Felis sylvestris*	Trapped			Cited	
68	Wild dog	Mbwa mwitu	*Lycaon pictus*	Trapped	Recorded		Cited	
69	Yellow baboon	Nyani	*Papio cynocephalus*	Trapped	Recorded	Recorded	Cited	
70	Zebra	Pundamlia	*Equus burchellii*	Trapped	Recorded		Cited	sighted
71	Zorilla	Kicheche	*Ictonyx striatus*				Cited	

Appendix 4: Camera trapping protocols developed from our previous surveys and being employed in all surveys

TANZANIA MAMMAL ATLAS PROJECT

Camera Trapping: Survey Design and Method Implementation Manual

Grid system

The grid system is used to determine density of species with individually recognisable coat patterns. Cameras are set up in a minimum of 20 stations, each with a pair of cameras (to photograph both sides of the animal) spaced at regular intervals for a minimum of a two month period. Grids should preferably be square or circular, though there is some flexibility in grid shape (L shaped grids can been used for instance). Short, narrow grid sections should be avoided, and grids should be a minimum of 3 stations wide. Grid shape is dictated by previous camera placements, so if some stations are placed slightly differently than planned for instance due to inaccessibility or unsuitable habitat, placement of subsequent stations need to be adjusted accordingly. Grid placement therefore needs to be adaptively modified during the survey.

Intervals between stations are dictated by the home range size of the target animal. A 2-km interval is appropriate for leopards and possibly other species such as servals and pangolins. Grids smaller than 20 stations are possible, though not recommended; the absolute minimum is 15 stations, but in this situation the survey period should be increased to ensure that a minimum of 1000 trap nights is obtained. The team should keep track of malfunction rates and adjust the survey period accordingly (to meet rule of 1000 trap nights). When operating in remote areas, include extra camera traps to ensure the 1000 trap nights rule is nights is met; ideally there should be a minimum of 22 stations in a grid system.

This design should be chosen with the following considerations:

a) The team wants population density estimates of leopard, possibly servals and genets and other species with natural markings.
b) You would like a more defendable estimate of presence, absence and abundance.
c) The habitat and access are relatively easy, and there is sufficient area to fit a grid of 20 camera stations.
d) The area is of sufficient importance to warrant a more time intensive grid approach

Random sampling

In random sampling cameras can be placed anywhere within the target area, in any sequence or formation.

This method should be used under the following conditions:

a) Basic biodiversity information is needed across a large area with different habitat types
b) The team want to target specific areas likely to have high biodiversity such as waterholes, mineral licks, trails down to rivers.
c) Logistics and access for setting up a grid are difficult, if not impossible.
d) The aim is to cover all habitat types in an area

e) When working in small patches of habitat where it is not possible to fit a grid of 20 camera stations

A ballpark figure is that 1000 trap nights provides a good estimate of absence in a survey area, however cameras can be moved to coincide with team movements, and be left up for short or long periods of time.

Given optimum conditions it is best to use a combination of both systems – a grid of 20 stations and a further 20 camera traps randomly placed to ensure good coverage of habitat types and landmarks such as waterholes.

Survey protocol
Prior to initiating a survey topographic maps should be acquired and the grid plan designed in advance. The survey should make use of existing road systems where possible to ensure ease of access for camera maintenance and checking.

Camera set-up

a) Each camera should have a unique identifying number and each station during each survey should have a unique number.
b) Cameras should ideally be 2m from trail, but certainly within 1.5 and 4 meters.
c) Optimally animal trails should be narrow and well used showing signs of recent spoor, and preferably not part of a larger parallel trail system. Ideally the vegetation should funnel the animals in front of the cameras. Trails used by people should be avoided because of potential camera loss.
d) Cameras should be set at a height of 30-40cm and secured in place with bungy cords. The cameras should be tested for small animals by having a person crawl on their belly on ground in front of the camera, and for larger animals by a person crawling on their knees.
e) Suitable attachment points for cameras can be difficult to find (particularly when using a grid system), so cut poles should be carried with the team.
f) Locks and chains should be used on every camera, and particular attention should be paid to high human usage areas.
g) Adequate numbers of locks and bungy cords of different lengths should be carried by team during set up. Provision should be made for at least 2 bungy cords per camera of different lengths and one lock and chain per camera.
h) The ground in front of cameras should be cleared when the trap is set up, and should be re-cleared each time cameras are visited for maintenance.
i) When cameras are set up then a photo should be taken of a clearly marked sheet with the camera no. station no. and date (dd/mm/yy) to ensure that this photo is at the start of each film. A board with an erasable marker pen should be used for this process.
j) When cameras are being set up, data sheets should be completed – this includes noting the perpendicular distance of the camera from the trail measured with a tape measure.
k) The GPS waypoint of each camera trap should be marked, and care should be taken to ensure adequate satellite coverage. If coverage cannot be obtained at the exact site of the camera trap, find the nearest site with open canopy and record that. After satellite coverage has been obtained, wait for 30 seconds before recording the GPS point, as initial readings can be inaccurate.*

l) Data sheets of camera locations should be copied into waterproof notebooks during each camera set up and copied onto separate sheets in the evening.
m) Cameras should be checked every 7 days in savannah, every 10 days in forest according to camera checking protocol as attached.
n) Cameras should not be removed until the team is certain that the target total of camera trap nights has been achieved – this can be done by roughly totting up the total days cameras or stations have been operational, taking account of estimates of days lost due to theft, camera destruction, malfunction and/or running out of film or battery failure (in a grid design two cameras at one station count as one).
o) Outside protected areas a protocol to minimise camera theft should be agreed on prior to initiating survey – such a protocol might involve local communities to safeguard cameras and/or consultation with village heads.
p) Baits should not be used unless in specific circumstances and not under any circumstances within a grid system

*A GPS is not always reliable under heavy canopy cover; this can make it difficult to find exact points in a forest – and easy to get lost! Satellite coverage therefore needs to be checked regularly, and the team should carry a compass and map at all times and be familiar with navigating in this fashion. When leaving the vehicle the GPS of the vehicle should always be waymarked and noted in notebook. Spare batteries for the GPS should always be carried.

Picture 1: Camera trap attached to a wooden stake.(Figure deleted due to size)
Picture 2: Testing sensor angle on camera trap.(deleted due to size)

Grid sampling protocol
a) It is always better to have a better trail or site than to reach the exact point – where possible cameras need to be placed within 100m of prior selected location by the best trail indicating highest usage. Cameras should be placed always on animal trails.
b) The team should carry extra cameras to take advantage of particularly promising sites that are not at the grid points.
c) Poles must be used to ensure cameras are suitable distance apart – ideally more or less opposite, offset from the trail by no more than 2m.
d) Cameras should be angled so that flash does not shine in the opposite camera

Data entry
Two weeks should be budgeted for data entry at the end of each survey.

Film
When films are printed the roll should be checked to ensure that all photos are printed.

Photo interpretation
The start and end date is noted from the first day of film and the time on the very last photo taken, not the last animal photographed.

Each photo captures a trap event. An event is classified as follows:

- A recapture after a 30 minute period

- A different individual within a 30 minute period

If the same animal is photographed within 30 minutes this counts as the same event. If it is difficult to tell whether individual animals are the same within 30 minutes they should be counted as one event.

If two or more animals are captured in one or more photographs within the same group within the same 30 minute period it counts as one event with a group size of two or more.

When a camera runs out of film it creates bias towards increasing trap success. This is probably not a problem in savannah where events are frequent – at least one a day, usually much more - so here take the final date as the date of last photo in film. In forests where events are less common, calculate half the interval between the last event and the camera collection date to estimate the end date of the camera operation. A similar method should be used (for both forest and savannah habitats) when the batteries die during the field period.

Photo interpretation issues with Grid sampling
When one camera stops working at a station, the station is still considered operational. However the station is no longer considered operational when the second camera stops working. Missing days are calculated from when the second camera stops working.

Using Digital Cameras
The Reconyx Digital cameras takes many more photographs than film cameras and should not be used within a grid system. Photographs of little birds (smaller than spur fowl size) should not be entered into database.

Safety issues
a) In buffalo and elephant areas always make sure accompanied by ranger.
b) Never venture out into bush when visibility poor – e.g. when dark, heavy rain or fog.
c) Let others know which area you will be operating in each day
d) Carry basic first aid kit and hypothermia bag.

Data Sheets for Camera Set up and Camera Checking
There are 2 data sheets for Camera Trapping.
1 Data sheet for initial station set up – see appendix 1
2 Data sheet for checking the camera in the field – see appendix 2

Data Sheet 1) Initial Camera Set up
Station: This data sheet consists of a Station Number. This is usually an alpha-numeric code that has some meaning and is easy to remember. For example – AP1 could stand for Arusha Park camera station 1. Or TG5 could be Tarangire station 5. Two or three letter codes are usually sufficient. If you are doing repeat surveys in the same area you may want to say 2TG5 which would stand for 2nd Tarangire survey station 5.

Camera # : This corresponds to the number written on the DeerCam (or which ever camera you are using). So DC14 stands for DeerCam Number 14. There are 2 spaces here (one on top of the other) to accommodate 2 cameras per station, if doing a density survey.

Physical Location: This is some description of the trapping location that will jog your memory as to where the camera is located. This can help immensely in the field when trying to remember exactly where you put the camera station.

GPS location: There are 2 columns here for UTM coordinates. If you would like to use latitude and longitude that is fine. But it is easier to judge distance when walking to stations in the field when you have UTM coordinates.

Date begin: This corresponds to the first date that you set the camera up in the field.

Road, Trail, New Trail, Game Trail, etc: This column simply lets you know what type of trail you camera is set up on and it is useful for data analysis later in the study to determine which trail type is most effective. New trail refers to one that you cut yourself specifically for camera trapping.

Width of road/trail in meters: This helps keep track of the effectiveness of camera at different distances and also is interesting in later data analysis to determine what animal use which size trails.

Distance from the camera to the middle of the trail: Here we are interested in the “shooting distance” of a camera and the effectiveness of the sensor at different distances. If the camera is angled at something other than 90 degrees from the trail, remember to measure the distance from the sensor or the camera lens to what would be the middle of the trail at that angle. In other words: do not just measure perpendicular distance to the trail from the camera if the camera is angled.

Human Use Pattern: Some trails have human use in the form of either people driving or walking. Human use categories are noted at the bottom of the data sheet and go from very high use (> 1 per day) to very low (< 1 per week) or 0 (only camera work). This can be noted C(VH) which would be Car, very high human use or W(L) for walking, very low human use.

Canopy cover: this can just be eyeballed. You can see the categories at the bottom of the data sheet which goes from 0-100 in 10% increments.

Land Use: These categories are also listed at the bottom of the data sheet and goes from P for Pastoral to PA for protected area.

Habitat Type: This is also listed at the bottom of the data sheet and goes from F for Forest to SS for Saline swamp etc. See notes at the bottom of the data sheet.

Notes: This section is for anything unusual or noteworthy about the camera site or cameras themselves.

Data Sheet 2) Camera Checking
Station Code: this is the same as Station on the above data sheet. This is usually an alpha-numeric code that has some meaning and is easy to remember. For example – AP1 could stand for Arusha Park camera station 1. Or TG5 could be Tarangire station 5.

Camera Type and Number: This is the same as camera number on the above data sheet and corresponds to the number written on the DeerCam (or which ever camera you are using). So DC14 stands for DeerCam Number 14.

Location- Physical Description: This is the same as physical location above. It is some description of the trapping location that will jog your memory as to where the camera is located.

GPS: Same as above. There are 2 columns here for UTM coordinates. If you would like to use latitude and longitude that is fine. But it is easier to judge distance when walking to stations in the field when you have UTM coordinates.
Date: This time date refers to the day that you checked the camera for proper functioning.

Pics to date: This refers to the number of photographs taken by the camera at the time of checking. This helps you determine if you need to change film immediately or if you can wait until the next camera checking. This is a judgment call that depends on how many pictures the camera has over how many days it has been out. If you think it will run out of film before the next checking, then change the film.

After this is a whole series of check boxes designed to jog your memory about what to check on the camera to ensure proper functioning. Its best that each box be checked with a check mark (✓) once that complete and that dash (-) be used if the box did not need to be checked.

Check Boxes:
Trigger camera with date/station/ Camera # card. This refers to whether you approached the camera to determine if it was functioning by holding up the ID card as you approached camera. This does 2 things. One it determines if the camera is working. Second, if it is working, then there is a photographic record that you checked the camera on that particular data. This is very important – especially when a camera's data/time malfunctions.

Check film: press the button on the bottom of the DC200s to and count the number of red blinks. See below.

Check 9-volt battery level: press the button on the bottom of the DC200s to and count the number of green blinks. See below.

Check double AA battery level: This must be read off of the top of the camera itself. Change double AAs if anything other than completely full reads on the top of the camera. See below.

Change film: Change film in the camera if you deem it necessary. Once in the high 20s (out of a roll of 36) change film no matter what.

Camera number on film canister: Write the number of the camera on the film canister (e.g. DC14). Occasionally you can not read the date/time/cam # card that you used to take a photograph when you approached the camera for checking. If this happens it is important to know which film came from what camera. However, this also means that when you get the film developed, you must tell the developer to write down the number on the film canister and note that on the film that are developed.

Check the date/time stamp on the camera. When changing batteries, the data/time can get off on the camera and you will lose the information about what animals were photographed when. Double check that the camera is set to the correct day and time so that you a record of correct animal captures. Please also note that the black bar over this date/time stamp must be present and not blinking. If it is not present, or it is blinking, the date/time will not be displayed on the photographs.

Flash always on (optional setting). You may not need these. Some people are worried about backlit photographs and not being able to identify animals. You can set the cameras to flash all the time if you think this may be a problem.

Lock and reposition: Anytime you change film or adjust the camera, you must check that the alignment is still Ok. This requires crawling around on the ground again to determine if the camera is still aligned.

Trigger camera with Date/station/cam # card: As with checking cameras, after changing film trigger the camera with the card that has the date, station number and camera number on it. This provides a photographic record of the date the film was changed as well as determines if the camera is functioning properly.

NOTES: Here one records what needs to be done to which camera (film changed, batteries changed or camera replaced due to malfunction, etc.).

EQUIPMENT AND PROTOCOL FOR CAMERA SETTING AND CHECKING USING DEERCAM

Equipment to Bring for All Camera Types

- Map
- GPS unit
- Compass
- GPS coordinates of cameras
- Laminated sheet (or dry erase board) for writing date and station number
- Dry erase pen
- Rag to wipe off dry erase pen
- Machete/Panga
- Film
- Sharpie
- Extra ziplock baggie to put film in from cameras
- Data sheet (note: there are 2 data sheets: 1 for initial set up and one for camera checking. Make sure you have the right one).
- Extra sign, optional (camera trapping project sign – e.g. VT camera trapping project or TAWIRI camera trapping project – do not disturb)
- Tape Measure (will need if taking trail measurements for set up or you are moving camera to new location)
- Ball Point Pen
- Swiss army knife or leatherman or some kind of multi-tool with phillips head screwdriver for TrailMasters. But knife good for all camera types.
- WD-40 or some type of oil for padlocks.

Note:

If it is raining - **do not** open cameras in the field to change film if at all possible. Cameras are very susceptible to moisture which causes

- **Equipment for DEERCAM units**
- Two 9-volt batteries per unit
- 2 AA batteries per unit
- Extra DEERCAM UNIT in case of malfunction
- Keys for locks on DEERCAM
- DEERCAM manual
- Camera manual for camera inside DeerCam (optional)
- Extra Bungee Cord or two

DEERCAM CAMERA SETTING AND CHECKING PROTOCOL

1) Checking Cameras

a. If it is raining – do not open cameras in the field. Cameras are very susceptible to moisture which causes malfunctions. If you are close to a vehicle you can replace film while in the vehicle. Wait until rain stops or construct some type of makeshift shelter. NOTE: if cameras do get wet inside, they can be dried off in a dry location (back at the lab) and will function again once dry.

b. Approach camera and determine if camera is still functioning by writing **station number, camera number, and date** on the laminated blank sheet or on dry erase board and display that in front of the cameras. It is important to document the date and station in case the camera's date/time display malfunctions (unfortunately this is somewhat common).

c. If camera takes a picture – go on to check the number of pictures taken and the battery levels.

   i. Number of pictures can be checked by pressing the button on the bottom of the deercam once and counting the number of **red blinks** – see data sheet for number of blinks: But in the meantime, 1 long blink = 10 photos and short blinks = 1 photo. So if you see one long blink followed by 6 short blinks that equals 16 photos. If you think you will not return by the time a camera has run out of film, replace film. You do not want to let the camera run out of film because you may miss data. You want to replace film before it runs out.

   ii. The battery level of the 9-volts can be checked by pressing the button on the bottom of the deercam a second time and counting the number of **green blinks**. See data sheet for number of pulses. But in the meantime 4 blinks = Full battery power, 3 blinks = ¾ full; 2 blinks = ½ Full; 1 blink = ¼ full. Change batteries at 2 blinks or less.

   iii. Battery level of the Double AAs can only be checked by opening up the deercam and checking the top of the camera. But, if the camera is not taking a picture of you, but the sensor seems to be working, then the AAs probably need to be changed. Replace batteries when anything other than completely full AA is displayed by camera.

2) Changing film in the DEERCAM

a. If the camera appears to have taken all the pictures, hit the rewind button again, just in case film has not completely rewound, and then open camera to replace film.

b. If you think you will not return by the time a camera has run out of film, replace film. You do not want to simply let the camera run out of film. You want to replace film before it runs out. If you are unsure – replace the film.

c. Make sure that the film that you take out of the camera has the camera number written on it. If not, write it on the canister as described below in 2d.

d. Write camera number on film canister itself before you load the film into the camera. It should say something like, "DC12".
e. Make sure the film was loaded correctly and winds in properly. This is a common problem with DEERCAM. If the camera reads nothing or is flashing 3, this is actually and E for Error, this means the film is not loaded properly. Open up the camera and push the film in a little further to help it wind in. Close the camera back and try again. It should read "1" for first picture when it is properly loaded.
f. Make sure the **day and time** setting mode is on the camera. This is extremely important. Make sure it is stated in **24 hr clock** and that it is set correctly. The **black bar must be present** above the time display for date and time to display on each picture. If the black bar is not present, no date or time will be displayed on the photograph. This is important information so please make sure the mode is correct after you replace the film. Again, the mode should be day and time like this **4 14:25**. This means the 4^{th} of the month at 2:25 pm. This is the correct mode.
g. Set the camera to flash all the time (lightning bolt setting on). Optional.
h. Make sure the plastic in front of the camera lens if clean and that the plastic lens over the sensor is clear of debris.
i. Reposition camera and clear the area of grass debris or other things that may block or trigger the sensor. Cut the grass with the machete/panga so it does not grow up in front of the sensor. Crawl around on the ground to make sure the camera will photograph something as small as an ocelot/civet/genet while also capturing a jaguar/leopard/tiger. Take your time testing the alignment. You can get all cameras to sense large and small animals but it may take some crawling around on the ground. In other words belly crawls are necessary.
j. Make sure laminated informational sign is present attached to a nearby tree or stuck in the bungee cord (e.g. VT camera trapping project, please do not disturb).
k. Lastly – push the button on the bottom of the camera to arm it and take the first picture with your laminated sheet or dry erase board displaying the **station number, camera number, and date (including year)**. If you are not sure you got the picture – take another photo. Make sure that photograph of the information board is clear.
l. Write all information on the data sheet – including, film changed, batteries changed, or anything that was wrong with the camera. If nothing was wrong and everything was good, write that too.
m. Note: the more level you can put the camera the better. Positioning camera at downward angles often leads to missed photos, especially if the trail is wide.

3) Settings for DEERCAM

Double check settings: for this project (Tanzania mammal surveys) we want the delay to be 1 minute between pictures (setting 2 on the dial) and we want the sensitivity jumper to be on high sensitivity unless we determine that a particular camera should be set to lower sensitivity (which should be noted on the data sheet). We could also leave the camera flash set to on all the time (rather than automatic) in order to prevent back-lit photographs especially in sunny locations. You can decide if this is important. In addition, this allows you to check that the flash on the camera is still working. Sometimes these cameras malfunction and the flash breaks. Cameras need to be sent in for repair at this point.

4) Trouble-shooting. If the DEERCAM camera is not working when you come back to check it...

a. Check to see if the film has finished and rewound.

b. Check that the film was loaded correctly – see 2d above.
c. Make sure the DEERCAM is properly aligned. Sometimes the heat sensor does not point directly level out of the plastic lens, but rather is angled up or down slightly. Correct camera alignment.
d. Check the batteries (9 volts and double AAs). This can be done by determining how many times the green light blinks for 9-volts and by examining the top of camera for the double AAs. See data sheet or manual for number of blinks corresponding to battery level for 9-volts.
e. Make sure the shutter is open on the camera.
f. Check the wires going to the 9-volts. Sometimes the black wire comes un-soldered. It can be pushed back in stuck into the middle of the connection point for a temporary fix.
g. Take out the manual and go through it to check for anything you may have missed.
h. Replace camera if you can not figure out what is wrong. Back in the lab, clean the camera itself (clean O-rings with alcohol) and clean the sensor lens and retest. Sometimes allowing the camera to thoroughly dry in the lab for a few days helps. Send back to DEERCAM if you can not trouble shoot problems.

5) Wrapping up a survey and camera maintenance upon completion of a survey

a. Use dry erase board displaying date, camera number, and station number as in a normal camera check. Take last photo with dry erase board.
b. Rewind film, remove from camera, and make sure film canister has camera number written on it (e.g. DC46).
c. Put film in ziplock bag or other water proof bag.
d. Remove cameras from trees etc.
e. Upon return to the lab, remove all batteries from camera – both 9-volts and double AAs. This is to prevent corrosion while storing cameras.
f. Test all DeerCams for proper functioning. Use new double AA and 9-volt batteries to test the cameras. If the DeerCam is not functioning properly, determine if it is the sensor or the camera (or something else) that is malfunctioning. If the sensor is not working, you can remove the camera from the DeerCam unit (to be used as a back up for other DC units) and simply return the unit without its camera for repair of the sensor. Leave a note in the DC unit indicating that the sensor is malfunctioning and needs repair. If the sensor appears to be functioning, but the unit will not take a photograph, return the entire DC unit, including its camera, for repair. DCs need to be returned to Non-typical (see address below) for repair.
g. All DeerCam units need to be thoroughly cleaned before storing and before being deployed on another survey. In particular, the O-rings surrounding the unit should be cleaned of debris using alcohol swabs (alcohol prep pads work well for this). Cleaning the O-rings helps ensure a proper seal on the DC unit which will prevent water from entering the case. This will help prevent malfunction and increase longevity. In addition to O-rings, clean sensor lens of debris, but be careful not to push on sensor lens too hard and damage it. Also clean plastic covering camera lens and flash and light meter.
h. Clean all animals (e.g. spiders, ants, other bugs) out of DeerCams. Scrape them out and use alcohol prep pads to clean residual animal debris out of the inside of DCs including the area where locks are positioned. This also increases longevity.
i. Make sure DC numbers (e.g. DC12) are still legible on the DC units. If not, re-write them with sharpie.

j. Store units in such a way that the lens over the sensor, flash, camera lens, and light meter are not being squished, punctured, or otherwise damaged. The sensor lens is particularly susceptible to puncture. Take care in storage and in moving cameras not to damage the sensor lens.
k. Use WD-40 (or some type of oil) on padlocks to ensure they continue to function.

Data sheet for initial station set up

Data sheet for checking the camera in the field

SITE: ________________________________

Station	Camera #	Physical location	GPS location Easting (UTM X) or decimal degrees	GPS location Northing (UTM Y) or decimal degrees	Date begin (D/M/Y)	Road (R), Trail (T), New Trail (NT)	Width of road or trail in meters	Distance from camera to middle of road or trail (m)	Human use pattern* Car, Walk (C or W) - high, med, low, zero)	Canopy cover (%) at station **	Land use ***	Habitat type ****	Notes

* Human use: very high = > 1 per day, high = 4-7x/week, med = 1-3 per week, low = < 1x per week, zero = only camera work.

** Canopy cover: 0 = 0-10%, 10 = 10 - 20%, 20 = 20 -30%, 30 = 30 -40%, 40 = 40-50%, 50 = 50-60%, 60 = 60 - 70%, 70 = 70 - 80%, 80 = 80 - 90%, 90 = 90 - 100%.

*** Land use: P pastoral, C crops, PL plantation, PA protected area, R roads, BA built up area.

**** Habitat: F forest, W woodland, G grassland, B bushland, T thicket, WG wooded grassland, AA Afro-Alpine, M mangrove, FS fresh water swamp, SS saline swamp (/ = transition between two types), R riverine

Station Code	**Camera type & number** DC = DeerCam RE = Reconyx	**Location** physical description	**GPS (UTM X)**	**GPS (UTM Y)**	**Date (d/m/y)**	Pics to date	Trigger camera with date/station placard	check film (press button once count film number in red blinks)*	9-volt batteries level (count green blinks)**	double AA batteries (read top of camera)	change film	camera # on film canister	Check date/time stamp on cam	set to day/time- black bar solid (not blinking)	flash always on (optional)	lock and reposition	Trigger camera with Date/station plastic card	Notes