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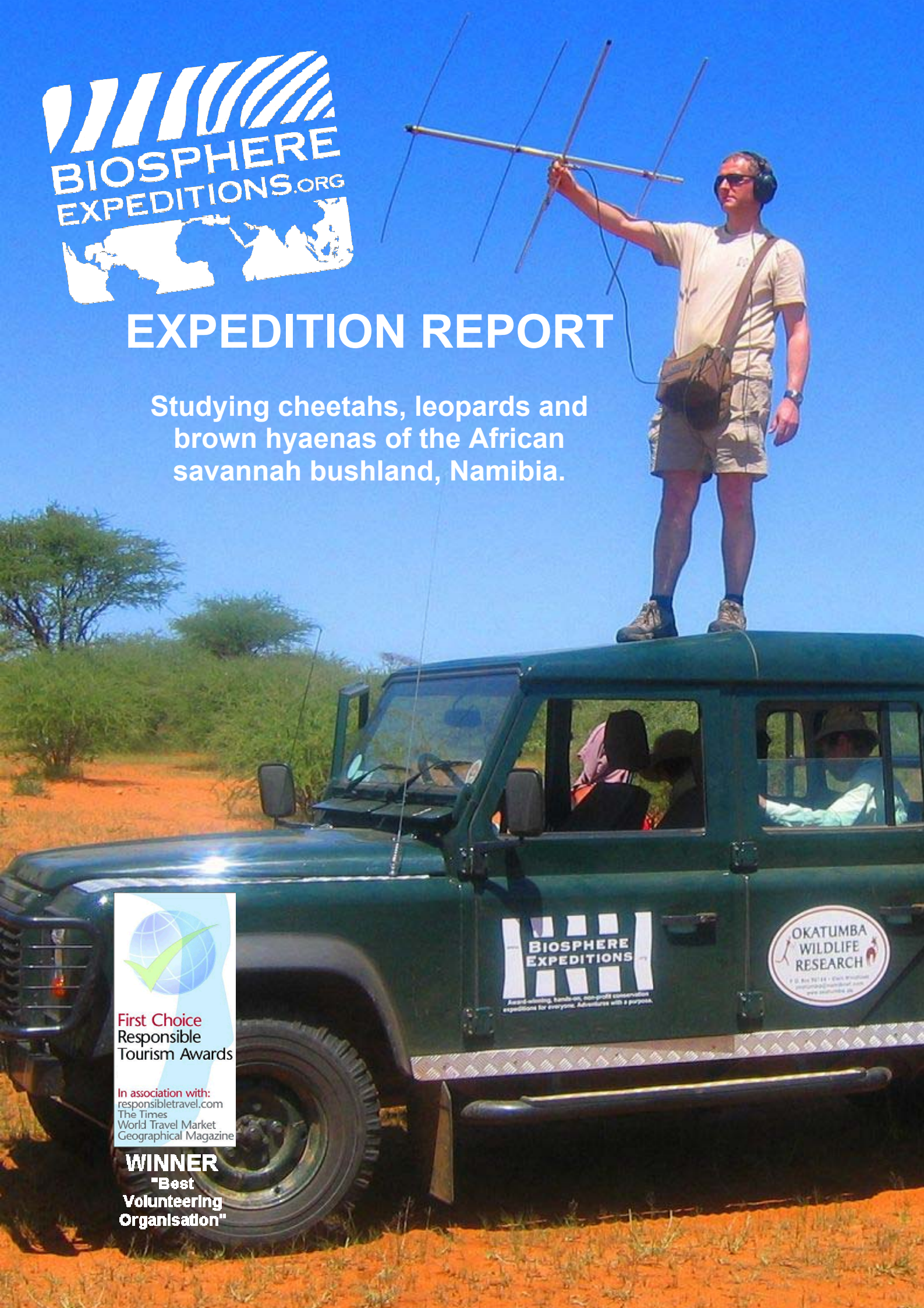
EXPEDITION REPORT

Studying cheetahs, leopards and brown hyaenas of the African savannah bushland, Namibia.



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Studying cheetahs, leopards and brown hyaenas of the African savannah bushland, Namibia.

Expedition dates:
3 October - 3 December 2005
4 September - 18 November 2006

Report published:
April 2007

Authors:
Birgit & Harald Förster
Okatumba Wildlife Research

Matthias Hammer (editor)
Biosphere Expeditions

Abstract

Namibia is thought to hold one third of the global cheetah population and it is one of the few African countries where six species of large carnivores occur. About 40% of the total area in Namibia is used for commercial livestock farming, 40% are communal areas and 20% are national parks and restricted areas. Much of the wildlife lives outside protected areas on private farmland. Namibian farmland, therefore, has a crucial role to play in the sustainable management and conservation of the country's wildlife in general and cheetahs in particular.

This study argues that although the cheetah's relative genetic monomorphism is potentially important to its conservation, to date there is no convincing evidence that the health and reproduction of wild populations is compromised. On the contrary, it appears that free-ranging cheetahs on Namibian farmland are healthy, reproducing well and sustain more youngsters through to adulthood than in East African national parks, where lions and spotted hyaenas frequently kill cheetah offspring. Furthermore persecution by humans appears to be the only but not a serious threat to the largest cheetah population in the world and in this context continued education of local farmers to reduce human-wildlife conflict is an important component of large carnivore conservation. For example, it is known that cheetahs and leopards rarely prey on livestock and it is important to communicate such findings to farmers.

Despite this positive news, so far no reliable population estimates for large carnivores on Namibian farmland exist. This study aims to compute indices that reflect true population density, but found that cheetah ecology on Namibian farmland generally makes it difficult to use spoor counts as an indirect sampling method to determine this. Whilst it is relatively easy to determine how many different individuals range over a specific area, it is difficult to estimate true population density.

Results also show that single male cheetahs range over very large areas up to more than 2000 km² (average 837 km²), whilst male coalitions use small home ranges of 60-170 km² and appear to hold territories. Space use patterns of female cheetahs depend on and vary with their reproductive status and it appears that they visit marking trees in each reproductive status. When the females are in oestrus, they use larger home ranges, but when they have cubs, they range in small areas. The bigger the cubs grow, the larger the home range becomes. Males visit marking trees more frequently than females

This report summarises the work of two expeditions in 2005 and 2006 at a new study site (Okomitundu) and found that due to the arid climate at Okomitundu, its carrying capacity is lower than it was in the previous study site (Seeis). Furthermore, poaching activities are a serious threat at the new study site. These two factors together result in lower densities of potential prey animals at Okomitundu and therefore to lower densities of large carnivores, cheetahs in particular. Okomitundu protects large carnivores, but is surrounded by several farmers that conduct trophy hunting of cheetahs and leopards. Male leopard removal, in particular, makes it difficult to assess leopard density within the study site.

Zusammenfassung

Es wird angenommen, dass ein Drittel der weltweiten Gepardenpopulation in Namibia lebt. Außerdem gehört Namibia zu den wenigen afrikanischen Ländern, in denen sechs Arten von Großraubtieren vorkommen. Etwa 40% der Landesfläche werden für Nutztierwirtschaft genutzt, 40% sind kommunale Stammesgebiete und 20% sind Schutz- bzw. Sperrgebiete. Viele Wildtiere leben außerhalb von Schutzgebieten auf privatem Farmland. Folglich spielt das Farmland eine grosse Rolle, wenn es um eine nachhaltige Nutzung und den Erhalt der Wildtiere in Namibia geht. Dies gilt besonders für den Geparden.

Diese Studie erläutert, dass die genetische Gleichartigkeit der Geparden zwar potenziell wichtig ist für deren Erhaltung, dass es bis heute aber keine überzeugenden Beweise dafür gibt, dass die Gesundheit oder die Fortpflanzung wild lebender Populationen beeinträchtigt ist. Im Gegenteil sieht es so aus, als seien frei lebende Geparden auf Farmland in Namibia sehr gesund. Außerdem pflanzen sie sich sehr gut fort und die Überlebensrate der Jungtiere ist weit höher als in Ostafrika, wo viele Gepardenjunge von Löwen und Gefleckten Hyänen getötet werden. Es scheint, dass die Verfolgung durch den Menschen die einzige, aber keine ernsthafte Bedrohung für die weltweit grösste Gepardenpopulation darstellt. Dennoch ist die Reduzierung des Mensch-Tier-Konflikts durch Umweltbildung eine wichtige Komponente für den Schutz großer Raubtiere. Zum Beispiel wurde ermittelt, dass Geparden und Leoparden nur selten Nutztiere reißen und es ist wichtig, derartige Ergebnisse an die Farmer weiter zu geben.

Trotz dieser positiven Neuigkeiten existieren bis heute keine zuverlässigen Bestandesschätzungen für Großraubtiere auf Farmland in Namibia. Diese Studie zielt darauf, Indikatoren für die tatsächliche Populationsdichte zu ermitteln und hat herausgefunden, dass die Ökologie der Geparden es schwierig macht, das Zählen von Spurenhäufigkeiten als indirekte Methode zu benutzen. Es ist zwar relativ leicht, zu ermitteln, wieviele verschiedene Geparden in einem bestimmten Gebiet umherziehen, aber es ist sehr schwierig festzulegen, wieviele Individuen sich gleichzeitig dort aufhalten.

Weitere Ergebnisse zeigen, dass männliche Geparden, die einzeln umherstreifen, sehr große Streifgebiete von bis zu mehr als 2000km² (Durchschnitt 837km²) haben. Katergruppen benutzen sehr viel kleinere Gebiete von 60-170km² und scheinen ihr Territorium zu verteidigen. Das Raumnutzungsverhalten weiblicher Geparden wird durch ihren Reproduktionsstatus bestimmt. Wenn die Katzen sich im Östrus befinden, gebrauchen sie grössere Streifgebiete, aber wenn sie Junge haben, bewegen sie sich in kleinen Arealen. Je älter die Jungtiere werden, umso grösser wird das Streifgebiet. Besuche der Weibchen an den Markierungsbäumen scheinen in jedem Reproduktionsstatus zu erfolgen. Männliche Tiere besuchen diese Bäume häufiger als die Katzen.

Dieser Bericht fasst die Arbeit zweier Expeditionen in 2005 und 2006 in einem neuen Studiengebiet (Okomitundu) zusammen. Bedingt durch das trockene Klima ist die Tragfähigkeit der Weide geringer als im vorigen Studiengebiet (Seeis). Außerdem spielt die Wilderei auf Okomitundu eine grosse Rolle. Insgesamt führt dies zu einer deutlich geringeren Dichte potentieller Beutetiere und folglich auch zu einer geringeren Dichte von Großraubtieren. Dies gilt vor allem für Geparden. Okomitundu schützt Großraubtiere, ist aber von einigen Nachbarn umgeben, die Trophäenjagd auf Gepard und Leopard betreiben. Besonders das Entfernen männlicher Leoparden macht es schwierig, die Populationsdichte von Leoparden zu ermitteln.

Contents

1. Expedition Review

1.1. Background

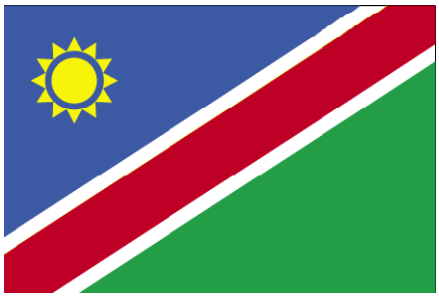
Biosphere Expeditions runs wildlife conservation research expeditions to all corners of the Earth. Our projects are not tours, photographic safaris or excursions, but genuine research expeditions placing ordinary people with no research experience alongside scientists who are at the forefront of conservation work. Our expeditions are open to all and there are no special skills (scientific or otherwise) required to join. Our expedition team members are people from all walks of life, of all ages, looking for an adventure with a conscience and a sense of purpose. More information about Biosphere Expeditions and its research expeditions can be found at www.biosphere-expeditions.org.

This expedition report deals with two expeditions to Namibia that ran from 3 October - 3 December 2005 and 4 September - 18 November 2006. The expeditions were part of a long-term research project on large carnivores living on farmland in Namibia. The expedition's emphases were on capture activities, radio-tracking, counting spoor (also known as tracks) frequencies and on recording prey animals by hide-based observations at water points and on game study drives.

Namibia harbours the world's highest population of cheetahs and is one of a few African countries that support six species of large carnivores. Lions, spotted hyaenas and wild dogs are mainly restricted to protected areas, but cheetahs, leopards and brown hyaenas still occur on areas with intensive livestock and/or game farming. Today about 40% of the total area in Namibia is used for commercial livestock breeding and it is estimated that this land provides the habitat for 90% of the current Namibian cheetah population. Ensuing conflict with humans has resulted in large numbers of predators being captured and/or shot. Large carnivores do kill livestock, but the extent of losses and financial damage to the farmers has to date not been properly quantified.

Although the Namibian cheetah is a fascinating flagship species, its ecology is poorly understood and this makes conservation of the species difficult. Hunting quotas are set without scientific basis, removal through human conflict is poorly monitored and no reliable population density estimates exist (the frequently used and well-published figure of 2,500-3,000 individuals has been quoted for the past 20 years, but is very likely inaccurate as it is based on unscientific guesswork). Due to this lack of scientific data, the effectiveness of present conservation efforts are in doubt. New baseline data on population density, demography and ecology are thus urgently required. Data gathered during this expedition will be an essential ingredient to a new and effective conservation strategy for the Namibian cheetah, leopard and brown hyaena.

1.2. Research Area



Flag and location of Namibia and study site.

An overview of Biosphere Expeditions' research sites, assembly points, base camp and office locations is at Google Maps.

The research site lies in the central Namibian savannah and the terrain is level at around 1200 metres altitude with rocky outcrops up to 1800 metres. The dominating vegetation type is tree and shrub savannah. The characteristic plant species are various types of commiphora, as well as the false umbrella thorn (*Acacia reficiens*), Western woody euphorbia (*Euphorbia guerichiana*), mopane (*Colophospermum mopane*) and quarda (*Maerua schinzii*).

The core zone of the research area covers approximately 18,000 hectares (180 km^2) on conservancy farmland, as it is this farmland, not the national parks, which harbour 90% of the Namibian cheetah population. Conservancies are created by neighbouring farmers who agree to manage their land and livestock sustainably and in return are granted ownership of the game on their land by the state. In addition to the core zone, where most of the research activities take place, the research area has a perimeter zone of more than 50,000 hectares (500 km^2), which is used as necessary, for example for radio-tracking.

1.3. Dates

The expeditions ran over a period of 18 weeks, divided into nine two-week slots, each composed of a team of international research assistants, guides, support personnel, local scientists and an expedition leader. Slot dates in 2005 were 3 - 15 October | 17 - 29 October | 7 - 19 November | 21 November - 3 December. Slot dates in 2006 were 4 - 16 September | 18 - 30 September | 9 - 21 October | 23 October - 4 November | 6 - 18 November.

Team members could join for multiple slots (within the periods specified). Dates were chosen at beginning of the rainy season when vegetation is still sparse (and animal visibility therefore high) and cheetahs tend to congregate into groups, increasing the chances of capture and study opportunities.

1.4. Local Conditions & Support

Biosphere Expeditions is collaborating with Okatumba Wildlife Research, a non-profit organisation that conducts research projects and is involved in wildlife management for conservancies.

Expedition base

The expedition team was based at Okomitundu Guest Farm, about 160 km northwest of Windhoek in a remote region of savannah farmland. The expedition base consisted of a central farm house and several guest houses for the expedition team. Team members shared twin or double rooms with a toilet, shower and all mod cons. Lunch and dinner was prepared for the team at Okomitundu Guest Farm. Breakfast packs were taken into the field. Vegetarians and special diets could be catered for. Okomitundu Guest Farm had 220V mains electricity from European style sockets.

Weather

The habitat is semi-arid savannah climate with distinct wet and dry seasons. The summer rainfalls peak from February to April. The expeditions were in Namibia when it is hot and dry with the occasional downpour or thunderstorm. Day time temperatures reached 42°C, and night time temperatures 20°C.

Field communications

There was a telephone and fax at Okomitundu Guest Farm for emergency communication. Two-way radios were used for communication between teams around the study site. There was also mobile phone coverage at some sites around base.

Transport & vehicles

Team members made their own way to the Windhoek assembly point. For the expedition, the team had the use of two Land Rover Defender 110 Station Wagons, two Land Rover Defender 130 Double Cabs, and various other vehicles. The vehicles were provided by Land Rover as part of its Fragile Earth policy, which is the company's commitment to the environment through the sponsorship of leading environmental organisations such Biosphere Expeditions, the development of sustainable practices and technologies and the company's 'Off-Road Code'.

Medical support & insurance

The expedition leaders were trained first aiders, and the expedition carried a comprehensive medical kit. Namibia’s healthcare system is of an excellent standard and the nearest doctor and hospital were in Windhoek. Emergency medical support was provided by SOS International. All team members were required to carry adequate travel insurance covering emergency medical evacuation and repatriation. The only medical incidents were one moderately severe case of stomach upset and vomiting, minor cuts from thorn bushes and a severely bruised finger.

1.5. Local Scientists

Birgit & Harald Förster, originally from Germany, have lived and worked in Namibia since 1997. Birgit Förster trained as a veterinary assistant and studied Biology. Harald Förster is a trained horticulturist and after his apprenticeship studied forestry, specialising in tropical forestry and wildlife biology. The Försters founded Okatumba Wildlife Research together with local farmers and a veterinarian in an effort, amongst other aims, to conduct research on the farmland habitat, especially regarding complex ecological patterns and human influence on wildlife populations. Their main research interest is in developing strategies for the sustainable use of natural resources and all their projects are conducted in close co-operation with the Namibian Ministry of Environment and Tourism (MET). Various MET scientists provide the Försters with logistical support as well as scientific advice. Okatumba Wildlife Research is also working with various universities and research institutes in Europe.

1.6. Expedition Leaders

The 2005 expedition was led by David Moore. David Moore was born and educated in England and now lives in the UK and France. He graduated in French and German and studied Japanese while working for two years in Tokyo. His expedition/group leading experience began with Japanese educational trips in Australia and he has since worked in the Caribbean and throughout Europe for companies such as P&O, Explorica and Alyson Adventures. David joined Biosphere Expeditions in 2003 and has led expeditions to the Azores, Namibia, Peru and Brazil. He is also active in running the Biosphere Expeditions operations in France.

The 2006 expedition was led by Clare Fothergill. Clare Fothergill graduated from the University of Wales, Aberystwyth, with an MSc in Environmental Impact Assessment. She has led groups into the field to places such as Lesotho, South Africa and Zimbabwe, working for organisations such as Outward Bound. Clare's experience in co-ordinating logistics in remote locations is drawn from her involvement in organising a major international adventure challenge in the South Pacific. Her interest in the natural environment means she is happiest when being active in the outdoors, be it mountaineering, mountain biking or climbing. She has travelled extensively in Europe, Africa, India and the South Pacific.

1.7. Expedition Teams

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of all ages, nationalities and backgrounds. They were:

3 - 15 October 2005: Ginette & Jean-Luc Favier (France), Robert Foster (USA), Elizabeth & David Hodgson (UK), Alan Lesko (USA), George Malloch (UK), Dagmar Roesch (Germany), Sonja Schlaepfer (Switzerland), Susanne Steinberger (Germany), James Vause (UK), Klaus Walter (Germany).

17 - 29 October 2005: Elke Besendorfer (Germany), Lisa Compton (UK), Helga-Ingeborg Fleischmann (Germany), Alison & Brian French (UK), Tina Fuchs (Germany), John Martin (UK), Lorna Moffat (UK), Horst Paehlke (Germany), Gwen Paterson (UK), Diane Rollin (UK), Sonja Schlaepfer (Switzerland).

7 - 19 November 2005: Marjorie Beebee (UK), Axel Biermann (Germany), Louise Conway (UK), Janet & Alan Hoffberg (USA), Laurence Massiera (France), Peter Maszlen (Germany), Iris Nowak (Germany), Lynn Prosser (UK), Nina Rieger (Germany), Hervé Sempels (France), Gillian Sinclair (UK).

Also MTV film crew (all UK): Olayemi Bamiro, Dillon Khan, Trevor Nelson, Pippa Rodger, Jon Williams.

21 November - 3 December 2005: Steven Bertram (UK), Martin Cooper (Israel), Clare Davies (UK), Karen & Dita Hoekstra (The Netherlands), Simone Krueger (Germany), Linda Pollard (UK), Pascal & Peggy Tchengang (France), Tim Woods (UK).

Also in 2005: Annegret & Horst Fechter (farm manager), Stefan, Hendrik, Daniela, Meike & Peter (interns), Silke (Au Pair), Katharina & Silvana (trainees of Okomitundu), Adam & Alfred (trackers), Melschia, Wilika, Fine, Annatjie & Emelie (cooking, cleaning, dishes, laundry, etc.), Lazarus, Sprinkhaan, Niko, Anton, Pinias (farm workers).

4 - 16 September 2006: Amanda Bibbey (UK), Dominique Faye (France), Jethro Frankenberger (Germany), Matthias Gutendorf (Germany), Ulrike & Manuela Kälberer (Germany), Stefan Kiessling (Germany), Kathleen & Malcom Miller (UK), Karolin Renkel (Germany), Manuela Schaefer de Monteiro (Germany), Christa Theunissen (Germany).

18 - 30 September 2006: Mark & Stepheney Burleigh-Thurston (UK), Jim Butcher (UK), Hilary Cox (UK), Helga Dobbs (UK), Daniela Gunz (Switzerland), Peggy Hansen (USA), Gillian Holmes (UK), Denis Koller (Switzerland), Jo Long (UK), Steffan Stringer (UK), Kerry Utton (UK).

9 - 21 October 2006: Margot Coulter (Canada), Federica Dall'Aglio (Italy), Jenny Dieck (Germany), Gillian Holmes (UK), Steven Knox (Australia), Renate Kurt-Petersen (Germany), Karin Locht (Germany), Jane Murphy (Australia), Nora Nagel (Switzerland), Sally Reid (Australia), Lutz-Willem Voß (Germany).

Also journalist from Universum magazine (Austria): Oliver Lehmann and film team from ZDF (Germany).

23 October - 4 November 2006: Jocelyn Fiske (UK), Solene Guede (France), Tanja Hofmann (Switzerland), Dagmar Hofmeister (Germany), Lindsay Hughes (UK), Albert Landert (Switzerland), Pilvi Lassila (Finland), Eva Nou-Janele (Germany), Nathalie Civrais Velarde (France), Céleste & Valentin & Lucca Velarde (France).

6 - 18 November 2006: Michele Acton (UK), Shelley Bray (UK), Jane Eades (UK), Angela Holz (Germany), Veronique Loutelier (France), Birgit Mandl (Germany), Erin McCloskey (Canada), Michael Sweeney (Ireland).

Also from BBC Radio 4 (UK): Mike Hally & Cathy Howieson.

Also in 2006: Annegret & Horst Fechter (farm manager), Steffi, Jürgen & Robin (interns), Dorothe (Au Pair), Piet & Josef (trackers), Bellinda, Melschia, Wilika, Fine, Annatjie & Emelie (cooking, cleaning, dishes, laundry, etc.), Paul, Adam, Sprinkhaan, Niko, Anton, Pinias (farm workers).

1.8. Expedition Budget

Each team member paid towards expedition costs a contribution of £1200 (in 2005) or £1250 (in 2006) per person per two week slot. The contribution covered accommodation and meals, supervision and induction, a permit to access and work in the area, all maps and special non-personal equipment, all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses like telephone bills, souvenirs etc., as well as visa and other travel expenses to and from the assembly point (e.g. international flights). Details on how this contribution was spent are given below.

Income	£
Expedition contributions	118,435
Expenditure	
Base camp and food includes all meals, base camp equipment, gas, wood	33,675
Transport includes fuel, car maintenance	6,270
Equipment and hardware includes research materials & gear etc purchased in UK & Namibia	1,644
Biosphere Expeditions staff includes salaries, travel and expenses to Namibia	12,453
Local staff includes salaries, travel and expenses, gifts	16,564
Administration includes permits, registration fees, sundries, etc.	1,345
Scientific services & logistics organisation Payment to Okatumba Wildlife	4,000
Team recruitment Namibia as estimated % of PR costs for Biosphere Expeditions	4,376
Income – Expenditure	38,108
Total percentage spent directly on project	67%

1.9. Acknowledgements

This study was conducted by Biosphere Expeditions which runs wildlife conservation expeditions all over the globe. Without our expedition team members (listed above) who provided an expedition contribution and gave up their spare time to work as research assistants, none of this research would have been possible. The support team and staff (also mentioned above) were central to making it all work on the ground. Thank you to all of you, and the ones we have not managed to mention by name (you know who you are) for making it all come true. Biosphere Expeditions would also like to thank Land Rover, Cotswold Outdoor, Globetrotter Ausrüstung, Buff and the Friends of Biosphere Expeditions for their sponsorship and/or in-kind support.

1.10. Further Information & Enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expeditions website www.biosphere-expeditions.org.

Copies of this and other expedition reports can be accessed via at www.biosphere-expeditions.org/reports.

Enquires should be addressed to Biosphere Expeditions at the address given below.

Please note: Each expedition report is written as a stand-alone document that can be read without having to refer back to previous reports. As such, much of this section, which remains valid and relevant, is a repetition from previous reports, copied here to provide the reader with an uninterrupted flow of argument and rationale.

2. Large Carnivores of the Namibian Farmland

Birgit & Harald Förster
Okatumba Wildlife Research, Namibia

2.1. Introduction

Namibia is one of the few African countries, where six species of large carnivores occur: cheetah (*Acinonyx jubatus*), leopard (*Panthera pardus*), lion (*Panthera leo*), brown hyaena (*Hyaena brunnea*), spotted hyaena (*Crocuta crocuta*) and wild dog (*Lycaon pictus*). Namibia is thought to host one third of the cheetah's world population.

About 40% of the total area in Namibia is used for commercial livestock farming, 40% are communal areas and 20% are national parks and restricted areas (Berry 1990). It is estimated that commercial farmland provides the habitat for 95% of Namibia's cheetah population (Marker 1998, Morsbach 1987) and about 80% of the commercially useable larger game species (Brown 1992). Therefore Namibian farmland has a crucial role to play in the sustainable management and conservation of the country's wildlife.

Most scientific knowledge on large carnivores is based on studies that were conducted in conservation areas like the Serengeti (Caro 1994, Durant 1998), the Kalahari (Funston et al. 2001, Mills 1984) or the Kruger National Park (Broomhall et al. 2003, Bowland 1995, Mills et al. 2004). In contrast very little is known about large carnivores living outside protected areas on private farmland in Namibia, a habitat in which they are much more difficult to monitor due to their timidity as well as logistical problems. Precisely because of this lack of information, this study will provide sound scientific data on cheetahs, leopards and brown hyaenas living in co-existence with Namibian farmers.

Living conditions for carnivores vary substantially between protected areas and freehold farmland (Fig. 2.1a). Therefore Namibian carnivore ecology in freehold farmland differs from carnivore ecology in national parks. Cheetahs, for example, show unusually large group sizes on Namibian farmland (Gaerdes 1974, Joubert 1984, McVittie 1979), prey size expands and litter sizes increase compared to East African cheetahs (McVittie 1979, Morsbach 1987, personal observation). Durant (1998), Joubert and Mostert (1975) and McVittie (1979) have argued that lack of inter-specific competition with lion and spotted hyaena in particular might be one of the main reasons for the success of the cheetah on farmland.

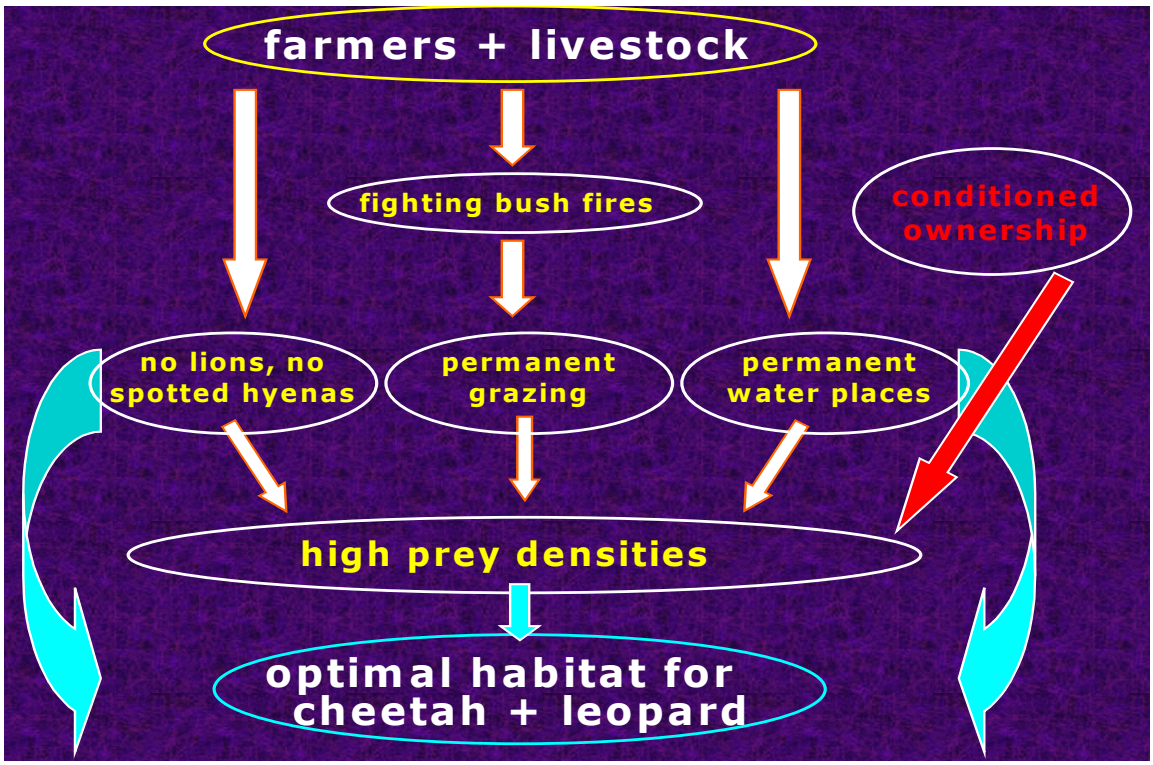


Figure 2.1a. Important factors and environmental conditions of the farmland habitat.

Most of our research questions require data collection within different study sites to depart from the regional level and to get reliable information on a more national scale. Due to logistical reasons and financial constraints, we are not able to run several study sites simultaneously, but instead run them in succession. As a result this study needs to be carried out over a long time to gain a full understanding of large carnivore ecology on Namibian farmlands. Collaboration with Biosphere Expeditions is a great opportunity to receive research assistance for a certain time of the year, as well as additional funding on a long-term basis.

The two expeditions in 2005 and 2006 were the first ones in a new study site (Figs. 2.2a & b). The 2005 expedition took place from 3 October to 3 December, in 2006 the expedition ran from 4 September to 18 Novvember. The expedition teams consisted of four (2005) and five groups (2006) of 8-12 team members plus staff (see above). Each group worked for two weeks, and was divided daily into four research activity teams. Each team of 2-3 team members, which was guided by one local scientist or student, had the use of a Land Rover Defender 110 Station Wagon, or a Land Rover Defender 130 Double Cab. Team members rotated through the various activities daily. This expedition design led to a large amount of data being collected.

2.2. Study area and timing of research

The average farm size (commercial unit) in Namibia depends on the average annual rainfall and ranges from 5,000 ha in the North to 30,000 ha in the South (Brown 1992). For reasons of efficient livestock management, farm areas are divided into smaller units, called “camps”. In central parts of Namibia one camp is about 200 to 400 ha (personal observation). Watering places are supplied with ground water pumped through wind power, each providing water for four camps. Livestock herds are rotated from camp to camp, depending on the season and quality of grass.

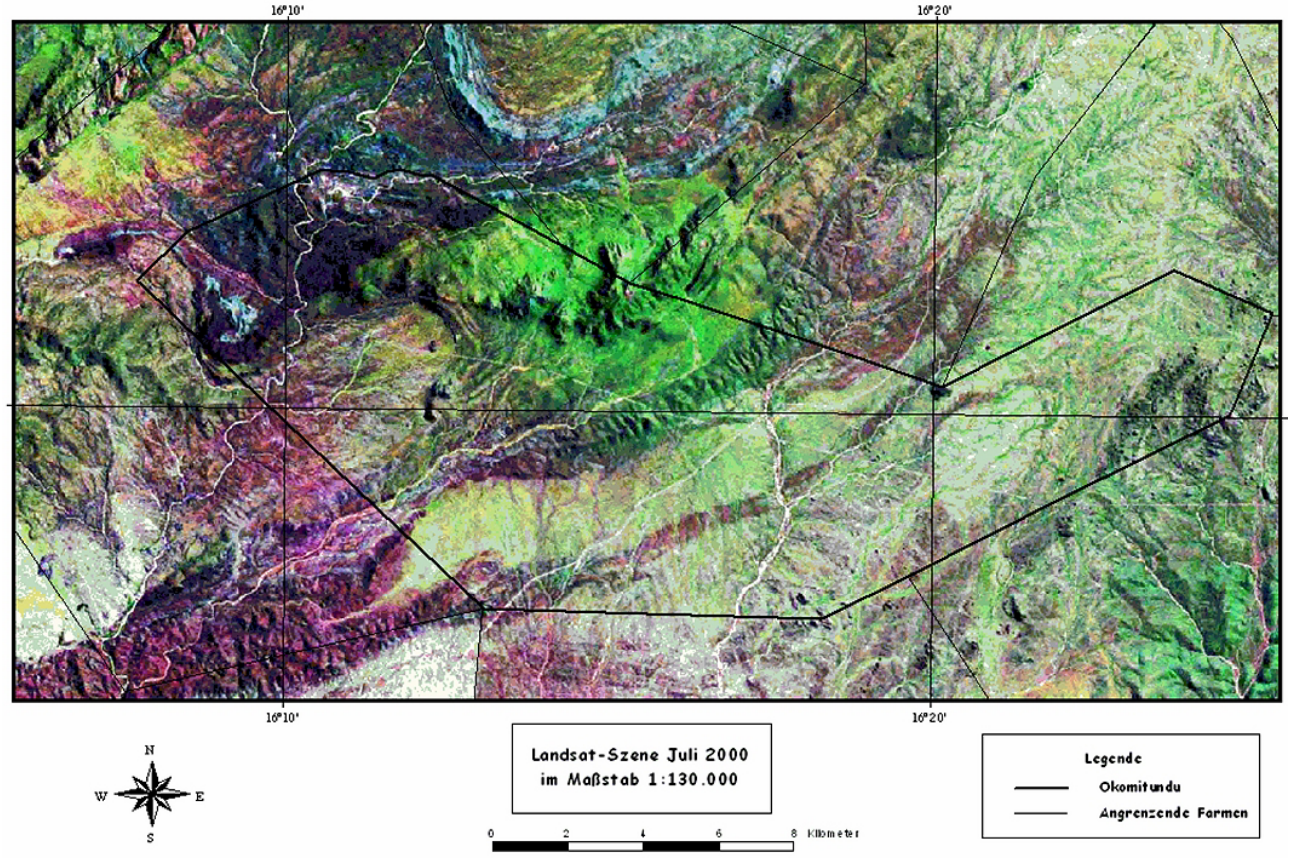


Figure 2.2a. Satellite image of Okomitundu study site. Bold black line = farm boundaries. See also Google Maps.

Private farmland in Namibia is fenced in, either with stock-proof fences on cattle farms, or with game-proof fences on game farms. Many farmers substitute their decreasing revenues from livestock breeding by consumptive and non-consumptive use of wildlife (Barnes & de Jager 1996). This leads to both types of fences on one property. Stock-proof fences are 1.40 m in height and consist of five wires running between wooden poles. These fences keep cattle within restricted grazing areas (camps), but are no barrier for the local wildlife. Game-proof fences are either 1.40 m in height and consist of eight to eleven wires, or 2.20 m in height and consist of 18 to more than 20 wires. The first type restricts “crawling” game like gemsbok (*Oryx gazella*) or hartebeest (*Alcelaphus buselaphus*), which can crawl under fences, but it can be crossed by “jumping” game like kudu (*Tragelaphus strepsiceros*) or eland (*Taurotragus oryx*), which jump over the fence.

The second fence type prevents movement of jumping species too. However, holes dug by warthogs (*Phacocoerus africanus*) are also used by other species such as small antelopes such as steenbok (*Raphicerus campestris*) or duiker (*Sylvicapra grimmia*) and all carnivores (personal observation).

The study site has a core area of about 180 km² where most research activities such as capture, mark and release, sample collection, telemetry, spoor tracking, counting prey animals and investigation of marking trees take place. One part of the core area (about 95 km²) is game-proof fenced, while the remaining part (about 85 km²) is stock-proof fenced (Fig 2.2b). Okomitundu hosts a few goats and some cattle, but the predominant enterprise is a guest farm.

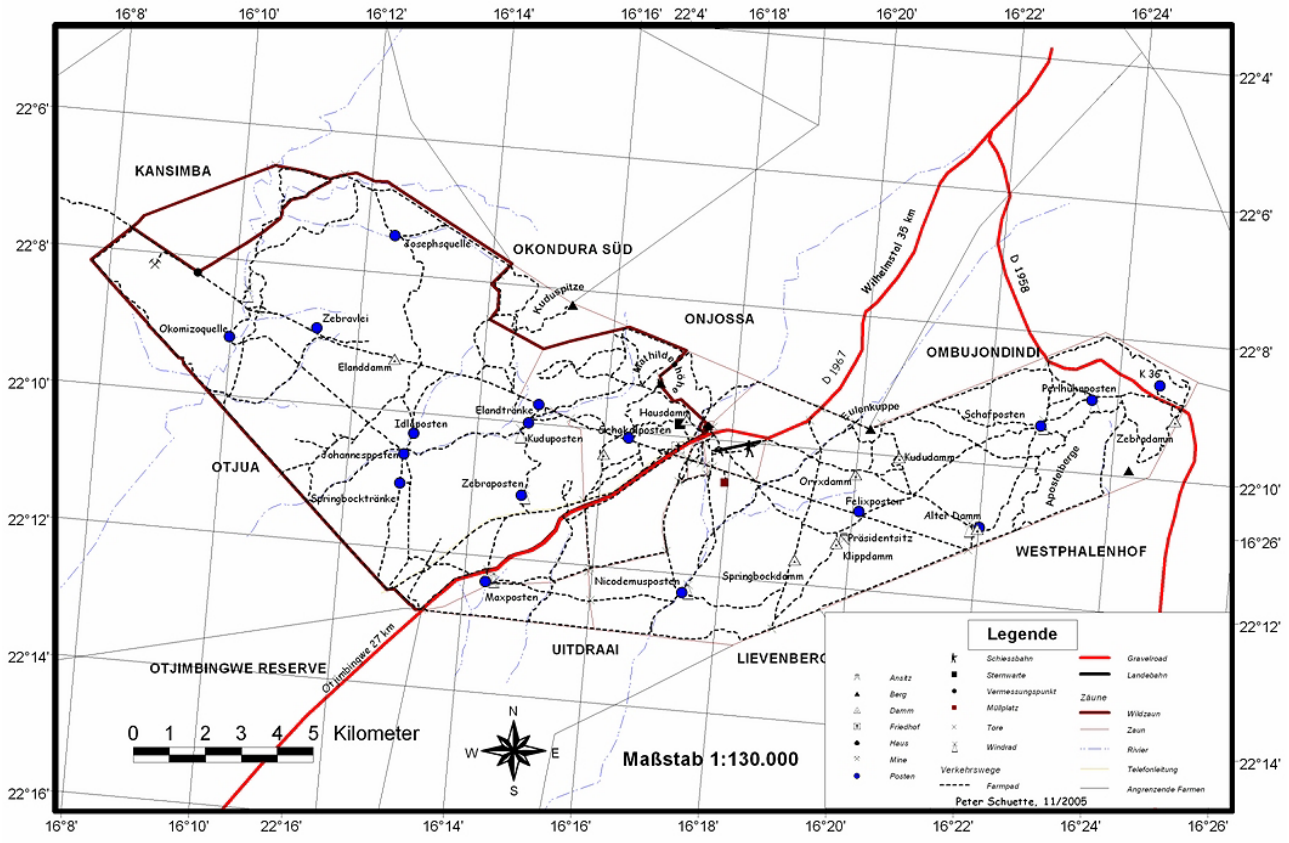


Figure 2.2b. The study site showing roads (red), tracks (dotted black), fences (brown), watering places (blue).

The dominant game species are kudu, gemsbok, mountain zebra, steenbok, warthog, hartebeest, eland and springbok. Densities of potential prey species are considered to be medium, and persecution of large carnivores by humans is assumed to be low to medium (personal observation and personal communication).

African spring time (Sep - Nov) offers ideal conditions to conduct a variety of research activities, so expeditions take place during this season. It is the only time of the year when all expedition activities can be carried out simultaneously (Fig. 2.2c).

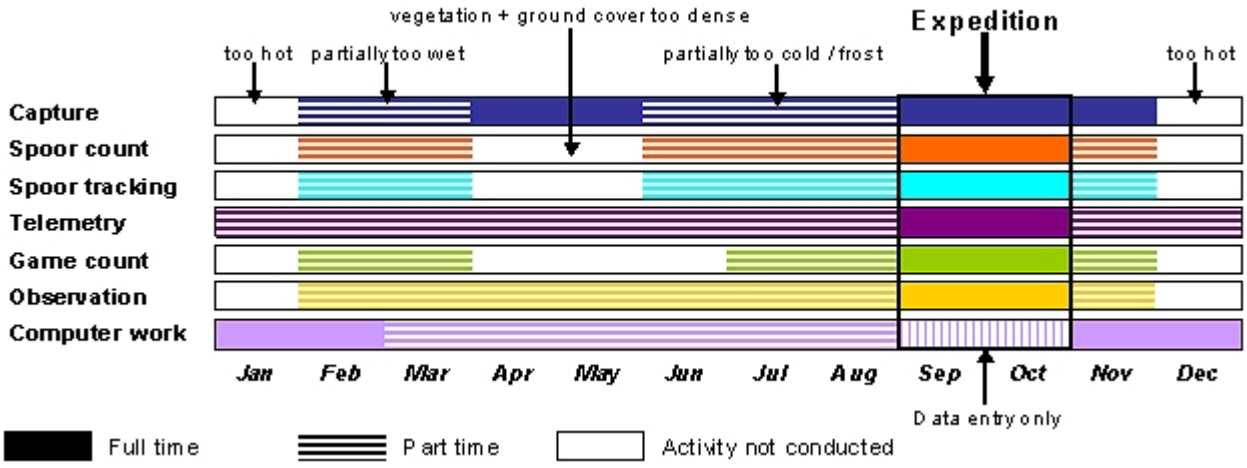


Figure 2.2c. Time schedule of research activities conducted throughout the year.

In September and October most trees and shrubs are still leafless and detection rate for wildlife is high. This allows more accurate game counts than during vegetation periods. Besides, ground cover (grass) is sparse, so that carnivore tracks can be easily detected and followed. Due to the lack of rain during this season permanent access to all parts of the research area is also possible. Traps are not washed away by flash floods and captured animals do not get hypothermic from being drenched. Furthermore temperatures are moderate so that trapped animals are neither harmed by frost during the night, nor by extreme heat during the day.

2.3. Study animals

The project previously concentrated on the Namibian cheetah population. In the new site the study expanded to the behavioural ecology of three large carnivore species: the cheetah, the leopard and the brown hyaena, all of them present outside protected areas on private farmland in Namibia.

The cheetah is listed in Appendix I in CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) and protection of this highly endangered species is of outstanding importance (Nowell & Jackson 1996). Since the 70s the cheetah's distribution has been drastically reduced and fragmented. According to Marker (1998), Myers (1975) and Nowell & Jackson (1996), the global population fell from about 30,000 animals in 1975 to fewer than 15,000 in the 90s. It is assumed that the vast majority of cheetah populations are concentrated in sub-Saharan Africa (Estes 1997) with Namibia having about one third of the world's population. Significant populations are also present in Botswana, South Africa, Tanzania, Kenya and Zimbabwe (Bashir et al. 2005).

The cheetah is the most specialized of all cats. It is lightly built with long, thin legs, small feet and a small, rounded head with foreshortened face. The ears are broad but low, and the teeth, especially the canines, are relatively small. Cheetahs have a tawny colouration with white underparts and fluffy hair on their abdomen and chest. The black, rounded spots are small and solid, and the outer part of the long, white-tipped tail is black and white

ringed. Characteristic of this species are black “tear lines” running from the eyes to the mouth (Estes 1997). Cheetahs are diurnal and most active around sunrise and sunset. Females live either solitary or they are accompanied by their offspring. Male cheetahs may range alone or in coalitions of up to five animals. These cheetah groups are considered to be brothers of the same litter. The cheetah is built for speed and specialised to prey on the fastest antelopes, especially gazelles. Cheetahs chase their intended prey over short distances (not more than 300 m) and kill them through strangulation. They lack the strength and weapons to defend their kill or their youngsters against aggressive competitors such as lions or spotted hyaenas. Thus Namibian farmland with permanent water supply, plenty of small to medium-sized prey mammals and no lions or spotted hyaenas provides an optimal habitat for the cheetah.

The leopard is the most ubiquitous wild cat - it occurs throughout Africa and from the Arabian Peninsula through Asia to Manchuria and Korea. Nevertheless it is listed in Appendix II in CITES (Nowell & Jackson 1996).

In contrast to cheetahs, the leopard is the least specialized of the big cats (Estes 1997). It is strong and compact built with short and massive limbs, a wide head with short, powerful jaws and long canines. The base colour is tan, but highly variable depending on the habitat. The black spots are grouped in rosettes on the torso and upper limbs. The long tail is spotted or rosetted. Males are significantly bigger and heavier than females. Leopards are nocturnal and solitary. Mother and offspring stay together for about 20 months, but adults associate for mating purposes only. Both sexes are territorial and defensive against conspecifics of the same sex. Leopards are stalkers and pouncers; they do not chase their prey over long distances. Leopards kill their prey by biting through the throat and nape of the neck. They tend to prey on animals below 70 kg, which are predominantly medium-sized antelopes, as well as the young of larger species, but also hares, dassies, birds and even insects. We hypothesise that the common practise of hiding and eating kills in trees is not observed where lions and hyaenas are not present, e.g. Namibian farmland.

Like the leopard, the brown hyaena is listed in Appendix II in CITES. Its occurrence is limited to the South West Arid Zone, mainly Namibia and Botswana, but also South Africa (Estes 1997). The brown hyaena is of typical hyaena build, being higher at the shoulder than at the rump. Head, neck and shoulders are large. The brown hyaena has long, pointed ears, and the muzzle is broad with robust teeth for cracking bones. The shaggy coat is dark brown with partly straw-coloured hair; the legs are dark yellow-brown with black stripes. As in the cheetah, there is no significant difference between the sexes.

Brown hyaenas are nocturnal and live in groups of up to 15 animals. These clans occupy fixed territories and their social structure is highly developed. The cubs are reared communally in a centrally located den. Brown hyaenas are opportunistic foragers that predominantly scavenge. They eat almost everything even insects, as well as various fruit and vegetables. Brown hyaenas show no more respect for leopards than for cheetahs. They are large and aggressive enough to chase a male leopard from its kill. It often happens that brown hyaenas cache some parts of a kill in a thicket or take scavenged items back to the den.

2.4. Demography of large carnivores

2.4.1. Introduction

To understand the ecological factors that determine demographic trends in carnivores, it is important to study free-ranging populations under natural selection pressure. Vital rates of large carnivores have been reported in East Africa (Caro 1994, Laurenson 1995), but cheetahs, leopards and brown hyaenas in Namibia are subject to different conditions. Due to constant conflict with farmers, large carnivores in Namibia suffer high levels of removal (Marker et al. 2003a). Determination of vital rates and demographic parameters such as sex ratios, age and social structure, litter sizes and survivorship is needed to establish whether the level of removal threatens the long-term viability of the populations.

Due to persecution by humans, predators on Namibian farmland live very secretive lives (Gaerdes 1974, McVittie 1979, personal observation). The difficulty of observation in the wild, especially bushy areas, and the wariness of Namibian large carnivores require the use of indirect sampling methods, rather than depending on direct observations. This is why capture, mark and release, counting spoor frequencies and radio telemetry are combined in this study.

2.4.2. Methodology

Box traps are either located at cheetah marking trees (Fig. 2.4.2a), in riverbeds, which are frequently used as travel routes by large carnivores, or near to fresh carcasses. While it is impossible to bait a cheetah (as cheetahs will only consume their own fresh kills), leopards and brown hyaenas can be baited by pieces of meat fixed in a box trap (personal observation). In order to capture cheetahs, marking trees, which function as an important place of communication for cheetahs, are enclosed in a thorny hedge, and the box trap is the only access route to the tree.

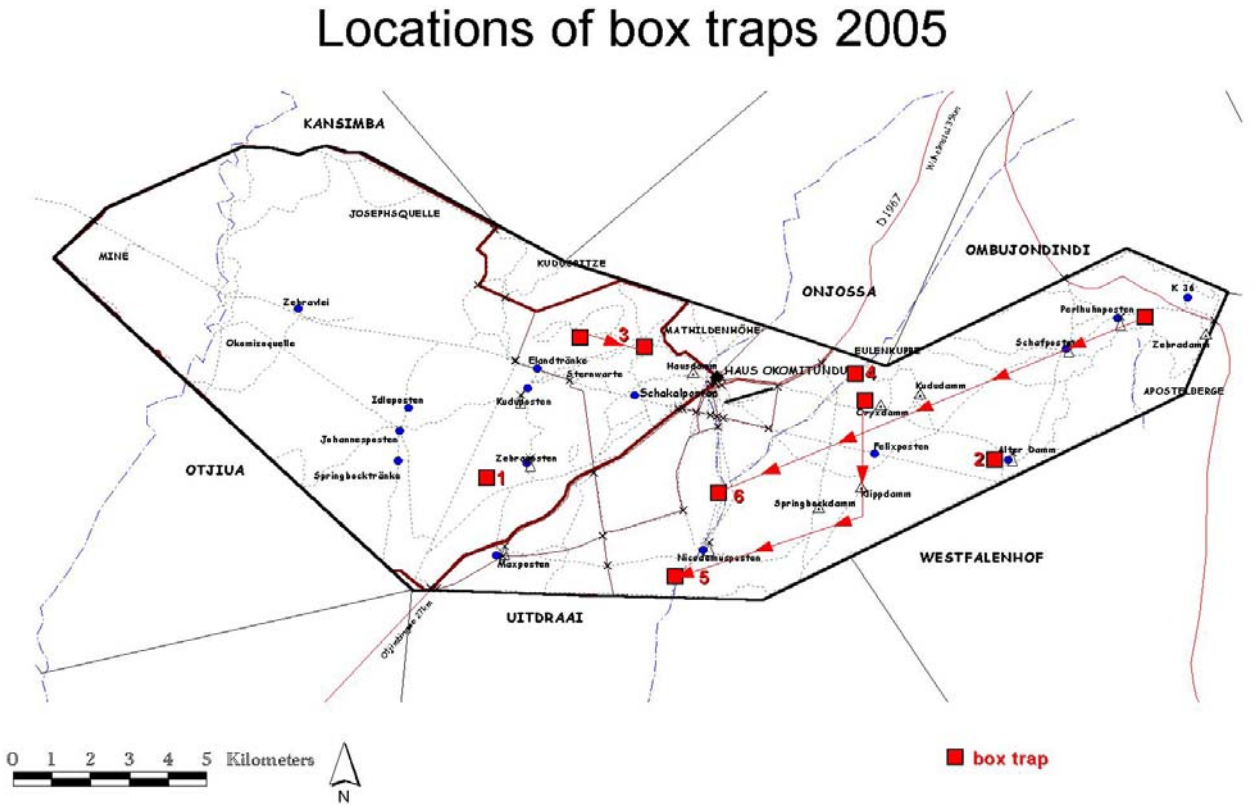
Figure 2.4.2a. Box trap located at a cheetah marking tree.

Study animals are live-trapped using capture cages with trap release doors at each end and a trigger plate in the middle (Fig. 2.4.2a). Box traps are checked every morning. The members of the box trap team also search for carnivore tracks around the traps.

Box traps were either found open, or closed without an animal inside or closed with an animal inside. Captured animals, others than cheetahs, leopards or hyaenas were released by the box trap team immediately. Large carnivores were immobilised, radio-collared (adults only), marked with ear tags and transponders (all animals), thoroughly investigated, sampled and released in the early morning of the following day with all expedition team members present (Fig. 2.4.2b)

Immobilisation of the study animals is achieved by using a blow pipe (cheetahs, hyaenas) or a dart gun (leopards), while the reversal agent is injected with a hand syringe.

Figure 2.4.2b. Investigating, sampling and radio-collaring a male and a female leopard during expedition in 2006.



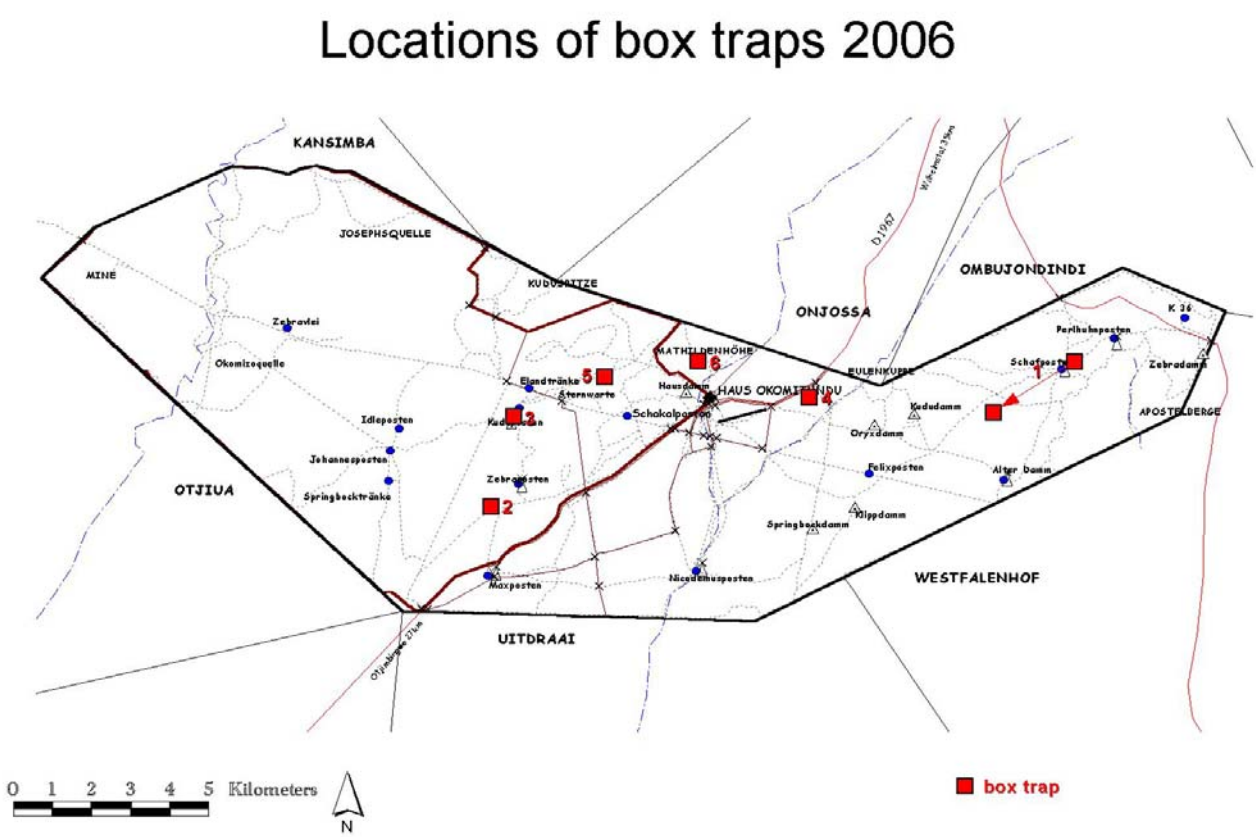


Figure 2.4.2c. Box traps locations in 2005 & 2006. Due to detection of new marking trees or fresh carnivore spoors, three capture cages (no. 3, 5 and 6) were relocated (see arrows) in 2005. In 2006 only box trap no. 1 was relocated when a fresh zebra carcass was discovered.

Cheetahs and leopards are immobilised with 0,4 ml HBM (Hellabrunner mixture: 100mg Ketamine + 125mg Xylazine/ml) per 10 kg body mass, and reversed with 1mg Yohimbine per 10 kg body mass. 15 to 20 minutes after administration of the antidote, the animal recovers from immobilisation. Darting is performed by a trained and authorised person, ideally a vet.

Because of their different metabolism, brown hyaenas are immobilised with Zoletil (50 mg/ml Tileatmine and 50 mg/ml Zolazepam). This drug is not reversible, so some of the team members must wait at the capture site until the animal wakes up on its own.

From each immobilised animal, a set of samples are taken. These samples are stored either in ethanol (e.g. hairs for DNA analysis), in a deep freezer (e.g. faeces for prey identification) or in liquid nitrogen (e.g. saliva, blood for parasitology, virology). Blood samples are collected in three different tube types: red ones without any detergent, green ones with heparin and purple ones with EDTA.

While working in the field blood samples are put into a cool box. Shortly after arrival at base they are processed into serum, plasma, buffy coat and blood clots using a centrifuge. These component parts are then pipetted in plastic vials and stored in a liquid nitrogen container. Saliva, conjunctival fluid and nasal smear are put into liquid nitrogen immediately after taking the samples at the capture site.

Figure 2.4.2d. Darting exercises during the expedition.

Samples from our previous study site were sent to the Institute for Zoo and Wildlife Research (IZW) in Berlin, Germany for analysis. Results gleaned from the analyses will be published as soon as the doctoral theses of the two students from the IZW are completed, which should be some time in 2007. One paper on determination of prey hair in faeces has already published by Wachter et al. (2006). Samples of the current study site will be given to another laboratory.

Figure 2.4.2e. Taking samples from a brown hyaena.

Figure 2.4.2f. Processing blood samples for storage in a liquid nitrogen container.

2.4.3. Results

Capture activities in the new study site at Okomitundu started in July 2005. Since then, seven cheetahs, six leopards and two brown hyaenas were captured (Table 2.4.3a).

Table 2.4.3a. Large carnivores captured at Okomitundu study site from July 2005 to November 2006.

Study animals	N_M	N_F	N_{JM}	N_{JF}	N_{Tot}	*N* collared animals
Free-ranging cheetahs	7	-	-	-	7	3
Free-ranging leopards	4	2	-	-	6	5
Free-ranging brown hyaenas	-	-	2	-	2	-

N_M: number of adult males; N_F: number of adult females; N_{JM}: number of juvenile males; N_{JF}: number of juvenile females; N_{Tot}: number of total animals.

All captured animals were immobilised, except one male leopard, which was very old and in a bad state of health, and one brown hyaena, which was very young. One group of four sub-adult male cheetahs, as well as one other brown hyaena were immobilised but too young to be fitted with a collar. Three cheetahs and five leopards (three males, two females) were radio-collared (Table 2.4.3b).

Table 2.4.3b. Capture data.

Date of capture	ID	Species	Sex	Age	Mass	Condition	Collar	Comments
2005-08-08	F001	Cheetah	male	< 2 years	41 kg	good	no	full stomach
2005-08-07	F002	Cheetah	male	< 2 years	32 kg	good	no	
2005-08-08	F003	Cheetah	male	< 2 years	38 kg	good	no	full stomach
2005-08-08	F004	Cheetah	male	< 2 years	34 kg	good	no	bleeding gums
2005-08-10	F005	Cheetah	male	~ 4 years	60 kg	excellent	yes	
2005-08-11	F006	Cheetah	male	~ 4 years	57 kg	excellent	yes	
2005-08-11	F007	Cheetah	male	~ 4 years	56 kg	excellent	yes	
2005-10-30	F008	Leopard	male	3-4 years	61 kg	excellent	yes	dead in June 2006
2005-11-15	-	Leopard	male	very old	N/A	very bad	no	not immobilised
2006-05-15	F009	Leopard	female	2,5 years	29 kg	excellent	yes	part of tail missing
2006-06-04	F010	Leopard	male	> 8 years	52 kg	good	yes	dead in July 2006
2006-09-20	F011	Leopard	male	~ 4 years	63 kg	excellent	yes	dead in Nov 2006
2006-09-21	F012	Leopard	female	~ 3 years	32 kg	excellent	yes	mating with F011 (?)
2006-10-17	F013	Brown Hyaena	male	< 1 year	25 kg	good	no	changing teeth
2006-10-25	-	Brown Hyaena	male	< 1 year	N/A	good	no	not immobilised

During the expeditions six box traps were set throughout the study site (Fig. 2.4.2c). Each trap, which is set active, counts as one trap night. One night with six armed box traps is therefore counted as six trap nights. During the expedition in 2005, box traps were active on 44 days with a total of 260 trap nights (Table 2.4.3c). In 2006, box traps were armed on 54 days with a total of 309 trap nights

Table 2.4.3c. Trapping effort and success during the expedition in 2005 / 2006.

	2005				Total
	Group 1	Group 2	Group 3	Group 4	
Number of trap nights	64	66	64	66	**260**
- open traps	56	52	51	61	**220**
- closed but empty traps	3	4	4	2	**13**
- captures	5	10	9	3	**27**

	2006					
	Group 1	Group 2	Group 3	Group 4	Group 5	
Number of trap nights	59	57	61	66	66	**309**
- open traps	39	42	48	56	59	**244**
- closed but empty traps	12	6	10	6	5	**39**
- captures	8	9	3	4	2	**26**

In 2005 the box trap group found 84.6% of the traps open. 5.0% per cent of the traps were closed but empty and 10.4% captured an animal (Fig. 2.4.3a). Two male leopards, two aardvarks, 13 baboons, one caracal, one honey badger, seven porcupines and one warthog were caught.

In 2006 the box trap group found 79.0% traps open. 12.6% of the box traps were closed but empty and 8.4% captured an animal (Fig. 2.4.3a). One baboon, one bird (guinea fowl), two hyaenas, two caracals, three cheetahs, two honey badgers, two leopards, twelve porcupines and one warthog were captured.

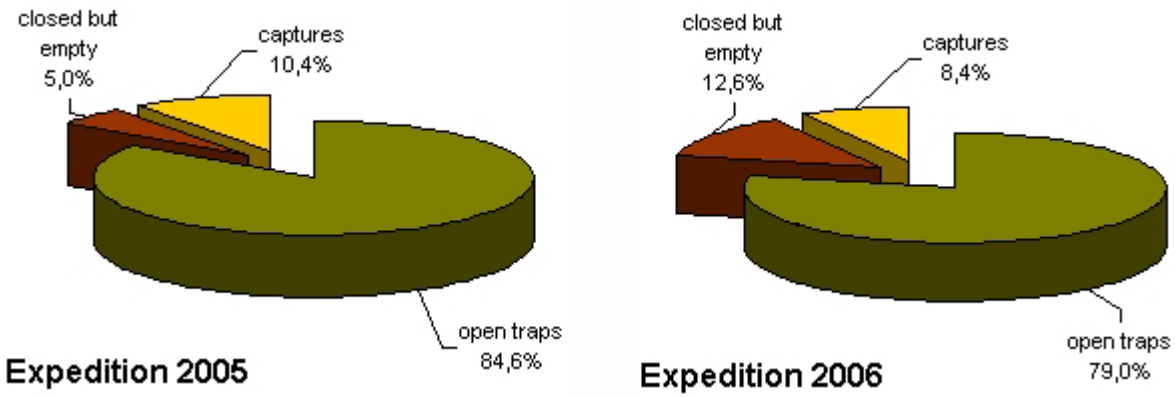


Figure 2.4.3a. Open traps, closed but empty traps and captures during expedition 2005 / 2006.

In our previous study area 70 cheetahs and four leopards were caught between July 2002 and April 2005. We caught 19 male cheetahs that were roaming alone, 20 male cheetahs in coalitions of 2-3 animals, 10 adult females, 9 male sub-adults, 7 female sub-adults, 2 male cubs and 3 female cubs. Some of these study animals were caught twice or even three times. In addition 10 cubs (sex unknown) were detected during aerial radio tracking.

With a total of about 8620 trap nights an average of 120 trap nights per captured cheetah can be calculated. The majority of these cheetahs were in a good to excellent condition and were considered to be healthy (Schulze & Lonzer 2006 and personal observation).

Preliminary results from the IZW have revealed that free-ranging female cheetahs on Namibian farmland are reproductively healthy (Schulze & Lonzer 2006). All adult females caught in our previous study area (n=10) were either in oestrus, pregnant or raising cubs, whereas out of nine females in captivity, six were reproductively inactive (personal communication). Free-ranging male cheetahs in Namibia produce 50-60% morphologically abnormal sperm (personal communication), which is less than it was found in zoos (71-76%). (O'Brien et al. 1983, Wildt et al. 1993) More detailed results will be published by the IZW.

2.4.4. Discussion

The number of captures at Okomitundu to date is too low to draw any conclusion about the demography of cheetahs and brown hyaenas in this area. We were however, able to gather information on leopard demography, identifying that the sex ratio between adults was two males to one female (n=6). Additional data on cheetah, leopard and brown hyaena demography were gathered through spoor counting and spoor tracking activities.

The ratio between open traps, closed but empty traps and captures was almost equally distributed between the two expeditions, but in 2006 the proportion of trapped large carnivores to total captures was higher. This is probably because some of the box traps were set on more suitable locations than in 2005 due to a better knowledge of the study site in 2006.

In 2006 the number of captures decreased from the first to the last expedition group. Assuming this to be due to an intrinsic factor such as disturbance through running the expedition, the same phenomenon should have occurred in 2005. Since that was not the case, we must look for extrinsic factors. We believe that the lack of early rain and several bush fires in 2006 could have caused the migration of potential prey animals, which results in movement of the carnivores too. This notion is supported by the results of the game counts (see 2.6.3.).

Looking at cheetah captures in a previous study area (Seeis), sex ratio between juveniles (11 males and 10 females) was nearly 1:1, whilst sex ratio between adults (n=49) was strongly biased towards males with 3.9 males to 1 female. We believe this bias to be a product of our trapping methodolgy. Since marking trees are more frequently used by male cheetahs than by females (see 2.8.4.), males are more likely to be captured. The sex ratio of 230 adult cheetahs examined by the Cheetah Conservation Fund (CCF) over a time period of twelve years was at 2.9 males to 1 female (Marker et al. 2003a) while AfriCat reports a sex ratio of 1.75 males to 1 female (Conradie 2006).

Our findings that almost half of the males (n=19) roam alone, whilst the other half (n=20) live in coalitions matches with results from CCF and AfriCat. CCF examined 73 single males and 97 coalition males (Marker et al. 2003), and AfriCat found 16% of all captured cheetahs to be adult single males, while 20% were adult males in coalitions (Conradie 2006).

The CCF found the proportion of young animals increasing during their study (Marker et al. 2003a). Assuming that captures reflect actual trends in wild populations this result supports the theory that farmers mainly have an impact on the adult cheetah population. This is in contrast to cheetah demography in the Serengeti where cub mortality is high due to interspecific competition with lion and spotted hyaenas (Laurenson 1995).

2.5. Population density of large carnivores

2.5.1. Introduction

Monitoring the abundance and distribution of animals is fundamental to the research, management and conservation of wildlife populations. Estimates of abundance are particularly important where the principal objectives are to assess, maintain and enhance the size of endangered target populations. That is why this project aims to establish spoor density as an index for true cheetah, leopard and brown hyaena density, similar to the methodology developed by Stander (1998) for lion, leopard and wild dog. In order to do this the true population density has to be ascertained by confirming the presence of each individual carnivore that uses the study area. Once this is done spoor counts can be made to asses the relationship between true population density and spoor density. The expectation is of course that there is a predictable relationship between the two and that higher population densities of large carnivores result in higher spoor densities, while lower spoor densities indicate lower population densities.

In Namibia lions, spotted hyaenas and wild dogs are mainly restricted to protected areas, whereas cheetahs, leopards and brown hyaenas still occur on areas with intensive livestock and/or game farming (Berry et al. 1997). Bashir et al. (2005) and Kraus & Marker-Kraus (1991) think that Namibia hosts the largest population of cheetahs in the world, but to date no reliable population density estimates exist and Namibian cheetah ecology is poorly understood. This lack of scientific data makes management and conservation of the species difficult. We believe that the frequently used and well published figure of 2,000 to 3,000 cheetahs for Namibia (Marker et al. 2003b, Morsbach 1987) underestimates the true population density considerably. More recent data from the Large Carnivore Atlas (Stander & Hanssen 2003) programme indicate that cheetah numbers might be double or even more than this.

Direct assessments of population density depend on recognition of individuals and groups, and as such they are very expensive and time-consuming (Stander 1998). Indirect sampling methods (Becker et al. 1998, Martin & de Meulenaer 1988, Mills et al. 2001, Panwar 1979, Smallwood & Fitzhugh 1995) are cost-effective, objective and repeatable, but are questioned by some (Norton 1990). Stander (1998) criticises a general lack of understanding the results of indirect sampling because only a few studies have combined both direct and indirect measurements. In his study on lions, leopards and wild dogs he found a strong linear correlation between spoor density and true population density.

2.5.2. Methodology

The current project aims to provide reliable data on cheetah, leopard and brown hyaena density through a combination of mark-recapture (Caughley 1977, Cormack 1968, Otis 1978), telemetry (MacDonald & Amlaner 1980, Sargeant 1980) and counting spoor frequencies (Stander 1998, Stander et al. 1997). All these techniques were employed by the expeditions at Okomitundu in 2005 and 2006.

Counting spoor frequencies

Every morning the spoor counting team covered one of four different transects in search for large carnivore tracks that either run along the path or cross the path. This team was joined by a local tracker (bushman). One expedition team member and the tracker place themselves on the mudguard of the Land Rover (Fig. 2.5.2a) to detect spoors while the Land Rover was driven at walking pace.

Figure 2.5.2a. Counting spoor frequencies along transects.

The four transects were sampled alternately at equal frequency. When a cheetah, leopard or hyaena track was found, its GPS position was recorded using a Silva Multi-Navigator. All relevant information such as date, time, start and end position, as well as the total length of the transect, species, number of animals, sex and age class, freshness and direction of the track, further comments were collected in pre-printed data sheets. Negative results (no tracks found along transect x on day y) were included into data analyses.

These data were entered into an Excel database to assess spoor density (number of individual carnivores' spoor per area unit), as well as spoor frequency (number of kilometres per individual carnivore spoor) and to calculate correlation coefficients. Only fresh tracks ($\leq$ 24 hours) were used for analyses. Observations of tracks were weighted by group size. Therefore, spoor refers not to a group of animals, but to an individual carnivore. An individual animal's spoor was only counted once per day.

Radio telemetry

The VHF radio collars, receiver, headphones and antenna used in this study are from ATS (Advanced Telemetry Systems) in Minnesota, USA. The collars weigh 240 g, which is less than 1% of the study animal's body mass. They are fitted with activity and mortality sensors and emit three types of signals: resting signal - regular single signals when the animal is resting; activity signal - irregular signals of different rhythm when the animal is walking or running; mortality signal - regular single signals, but twice as frequent as the resting signal when either the collar was lost or the animal was dead

The collars are equipped with a VHF antenna, 30 cm in length, extending 17cm from the collar. The other half of the antenna is embedded in the collar band. The batteries of the collars last for approximately three years.

Every day the telemetry team covered central parts of the study area. To locate collared animals, the team stopped at vantage points (Figure 2.5.2b) and tried to receive signals emanating from the surrounding area with the radio telemetry equipment (see cover page). At every stop the date, the time and the GPS position were recorded using a Silva Multi-Navigator. If a signal was detected, the signal bearing was measured with a Silva compass. The strength of the signal and the activity status of the study animal were recorded, too.

These data had to be collected at three different locations (triangulation) to get reliable information on cheetah and leopard positions and movements. Telemetry data were entered into an Excel database for further processing with different extensions to ArcView such as Home Range Extension, Animal Movement (Hooge & Eichenlaub 1997) or Spatial Analyst (Hooge et al. 2001). Various methods may be used to analyse telemetry data. In this report we look at two of them: the Minimum-Convex-Polygon (MCP) method and the Kernel method.

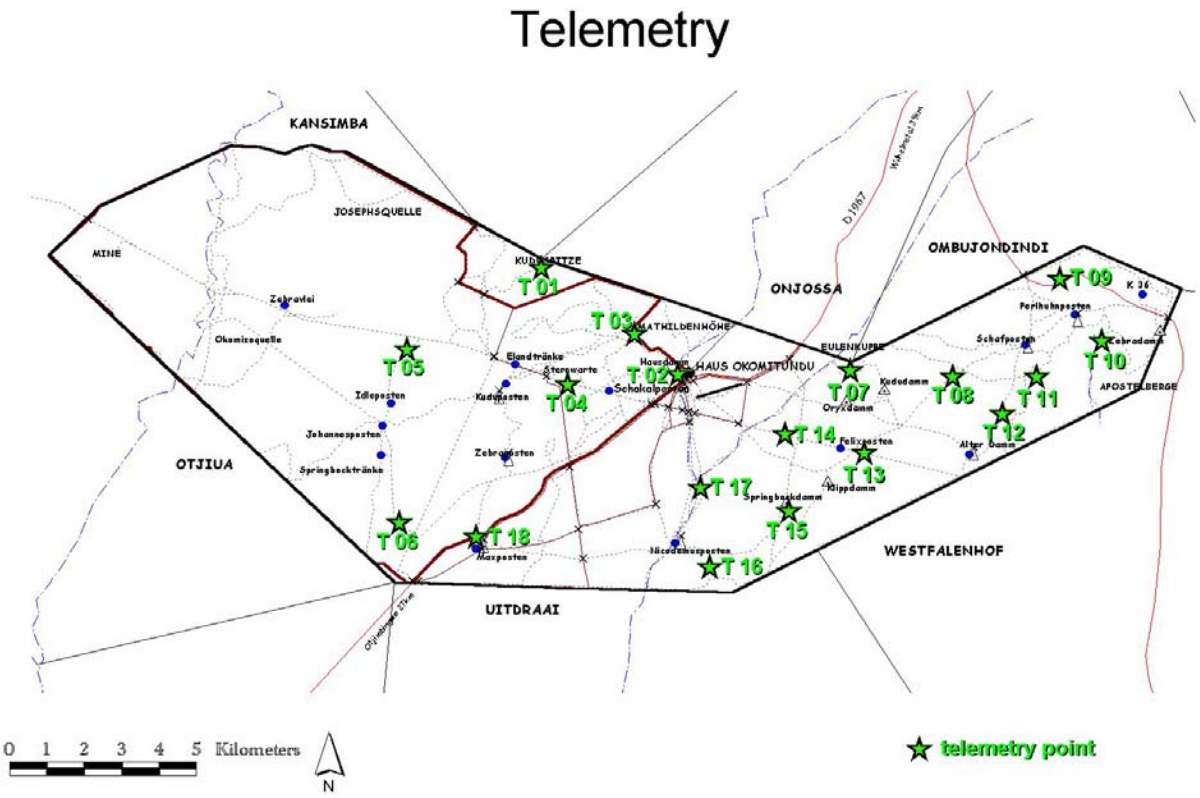


Figure 2.5.2b. Map of the study area with fixed spots (vantage points) to perform ground telemetry.

The MCP method is one of the earliest (Hayne 1949) and still a widely used method for calculating home ranges (Harris et al. 1990). In this method the peripheral locations of a given data set are connected so that they form a polygon. The MCP method is very simple and the resulting home ranges are strictly comparable between studies, but it has several disadvantages. For example, the home range is highly correlated to the number of locations, and it does not give any information on how the area is used. Evaluation of areas that are more important to the animal than others is not possible with the MCP method. Besides, occasional exploration trips of an animal may lead to home range sizes that are (much) too large. This is why researchers often take a certain part of the locations (e.g. 95%) for data analysis only (see Fig 2.5.2c).

Currently, the Kernel method is considered to be the most suitable one for home range estimation (Powell 2000, Worton 1995). With this method a probability density function from the locations is calculated in order to determine a utility distribution. Home ranges are then defined by drawing contours around areas with equal intensity of use. From a biological point of view the Kernel method is much more reasonable than the MCP method (Fig. 2.5.2d).

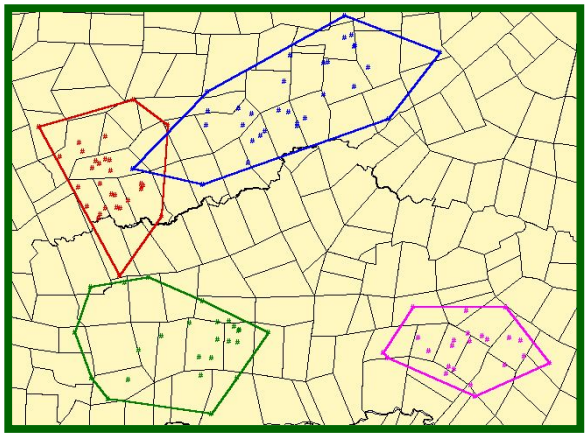


Figure 2.5.2c. Home ranges of four female cheetahs using the MCP method (95%)
Background: Farm boundaries

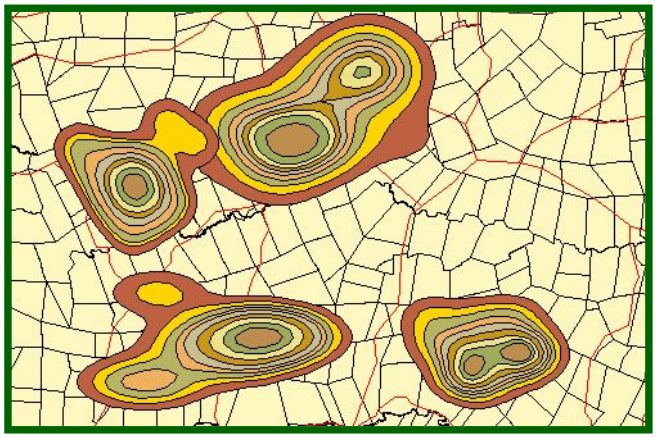


Fig. 2.5.2d. The same home ranges estimated with the Kernel method.
Background: farm boundaries

To visualize this method each location is covered by a three-dimensional bell-curve, the kernel. Directly at the data point the intensity of use is high. The further away from the location, the flatter the kernel becomes, and the smaller the intensity of use by the animal is. The resulting home range looks like a hilly surface. Hills resemble areas that are intensely used by the animal, valleys show areas that are less frequently used. The method itself selects occasional explorations of the animal, which are not part of the estimated home range.

2.5.3. Results

In 2005 expedition team members performed spoor counts along the four different transects 52 times (range 9-18 times each). They drove a total of 411 km. During the expedition in 2006 the same transects were sampled 38 times (range 8-11 times each) and 343 km were driven in total.

During the expedition in 2005 we detected 36 cheetah tracks, 31 leopard tracks and 21 hyaena tracks (Table 2.5.3a). 20 cheetah tracks, 9 leopard tracks and 9 hyaena tracks were found during spoor count activities only, all other spoors (16 cheetah, 22 leopard and 12 hyaena) were detected by chance (Fig. 2.5.3b, Fig. 2.5.3d, Fig. 2.5.3f).

Table 2.5.3a. Total numbers of large carnivore spoors detected during the expeditions in 2005 and 2006.

	2005			2006		
	spoor count	by chance	**Total**	spoor count	by chance	**Total**
Cheetah	20	16	**36**	7	19	**26**
Leopard	9	22	**31**	12	30	**42**
Hyaena	9	12	**21**	11	13	**24**
Total	38	50	**88**	30	62	**92**

In 2006 we found 7 cheetah tracks, 12 leopard tracks and 11 hyaena tracks during spoor count activities. An additional 19 cheetah tracks, 30 leopard tracks and 13 hyaena tracks were detected by chance (Table 2.5.3a). This gives us a total amount of 26 cheetah tracks, 42 leopard tracks and 24 hyaena tracks.

With 88 large carnivore spoors in 2005 and 92 large carnivore spoors in 2006 the total amount of spoors detected during expeditions was similar in both years (Table 2.5.3a), but the composition of species differed from 2005 to 2006 (Fig. 2.5.3.a).

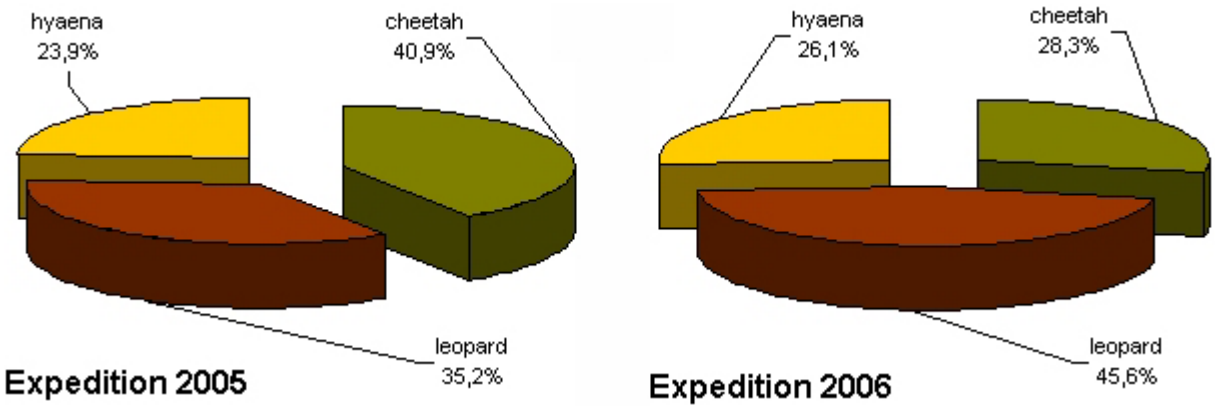


Figure 2.5.3a. Ratio between large carnivore spoors detected during the expeditions in 2005 and 2006.

With 23.9% in 2005 and 26.1% in 2006 the proportion of hyaena tracks to the total amount of large carnivore tracks was similar in both years. The proportion of cheetah tracks decreased from 40.9% in 2005 to 28.3% in 2006, whereas the proportion of leopard tracks increased from 35.2% in 2005 to 45.6% in 2006.

The maps below showing the distribution of large carnivore spoors indicate that cheetahs and brown hyaenas mainly range in the eastern parts of the study site, while the leopards predominantly occur in the western parts and this pattern is not surprising. First of all leopards prefer mountainous habitat, which is present in the western area. Secondly, a brown hyaena den is situated at the Apostle hills in the south east of the study site. Thirdly, on Namibian farmland the leopard is the only competitor to the cheetah, and the latter is therefore likely to avoid areas where many leopards occur.

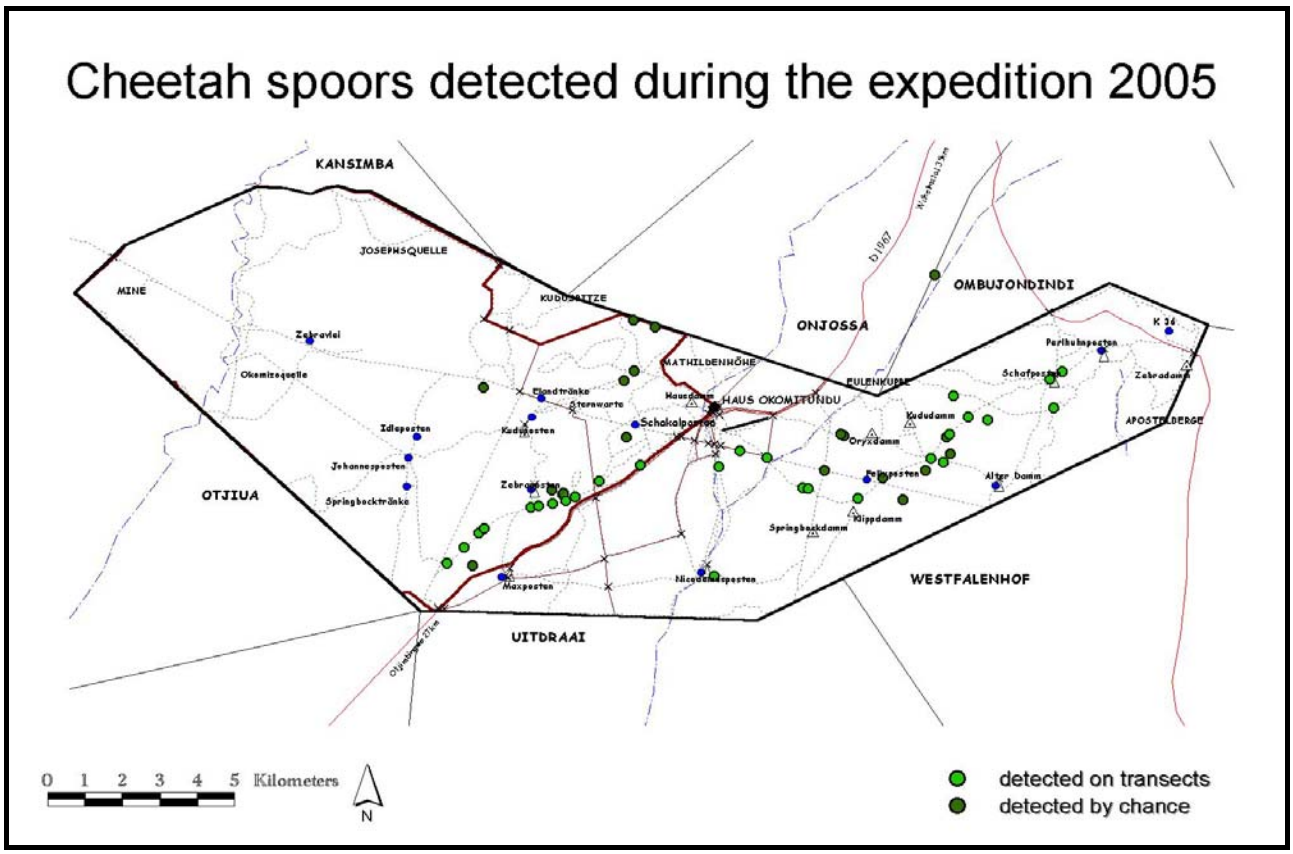


Figure 2.5.3b. Locations of cheetah spoors that were detected during spoor counts (on transects, light green dots) or other research activities (by chance, dark green dots) in October/November 2005.

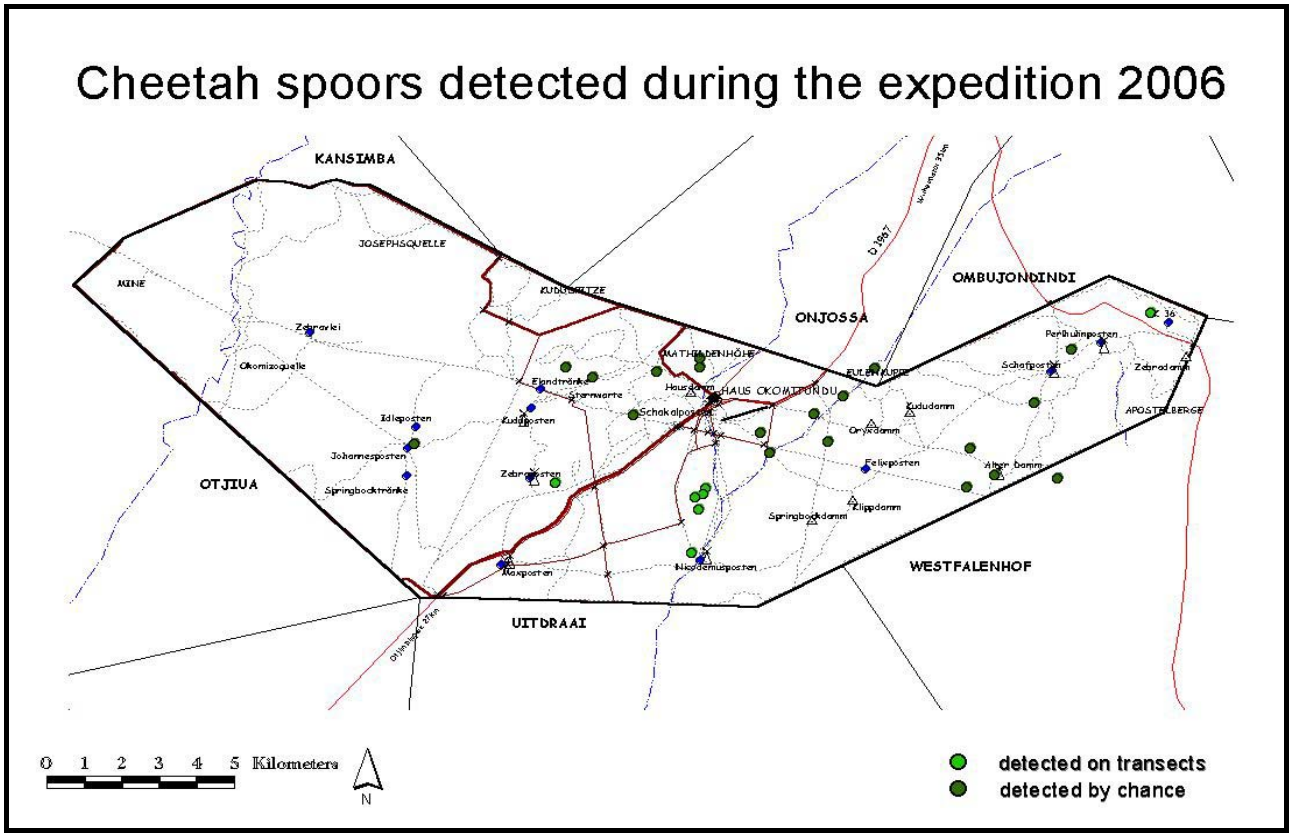


Figure 2.5.3c. Locations of cheetah spoors that were detected during spoor counts (on transects, light green dots) or other research activities (by chance, dark green dots) in September/October 2006.

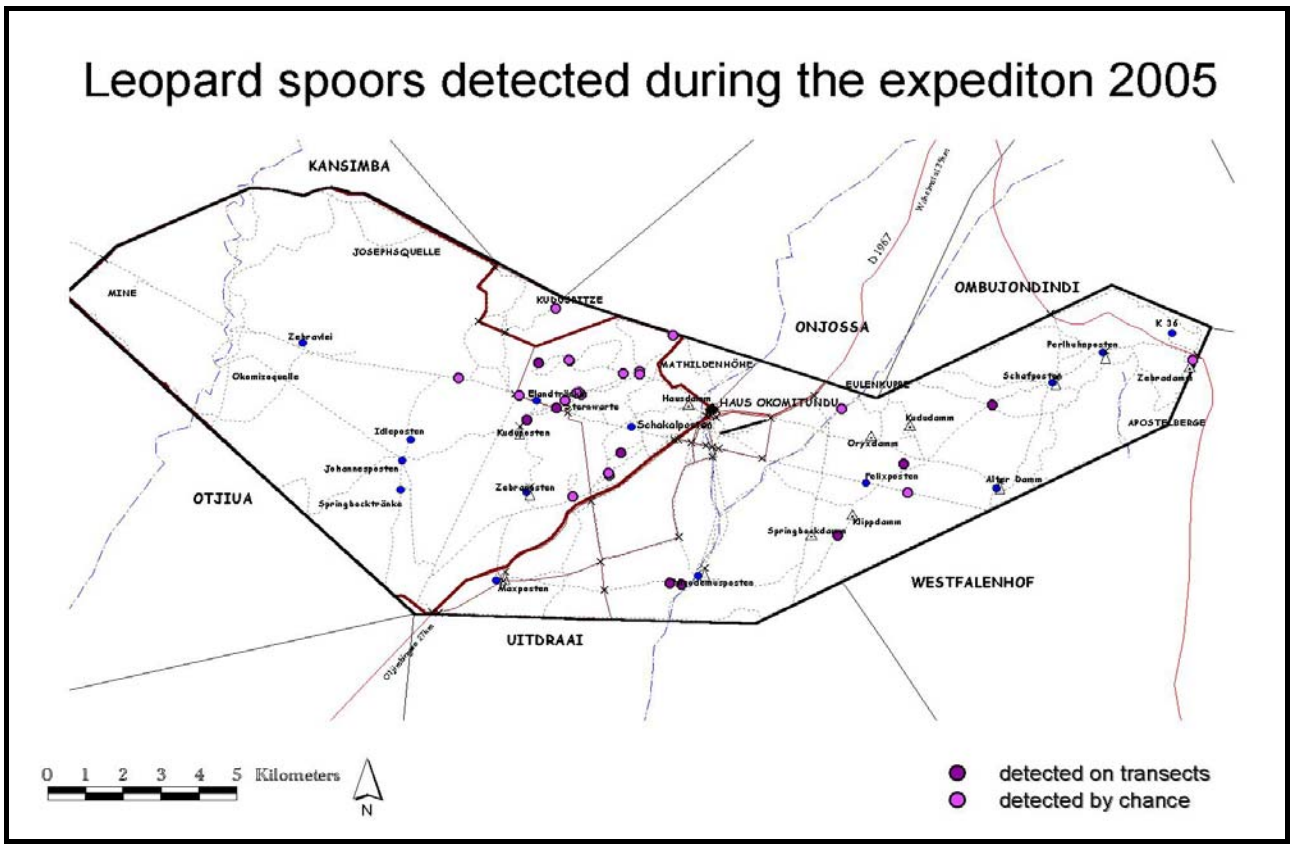


Figure 2.5.3d. Locations of leopard spoors that were detected during spoor counts (on transects, dark violet dots) or other research activities (by chance, light violet dots) in October/November 2005.

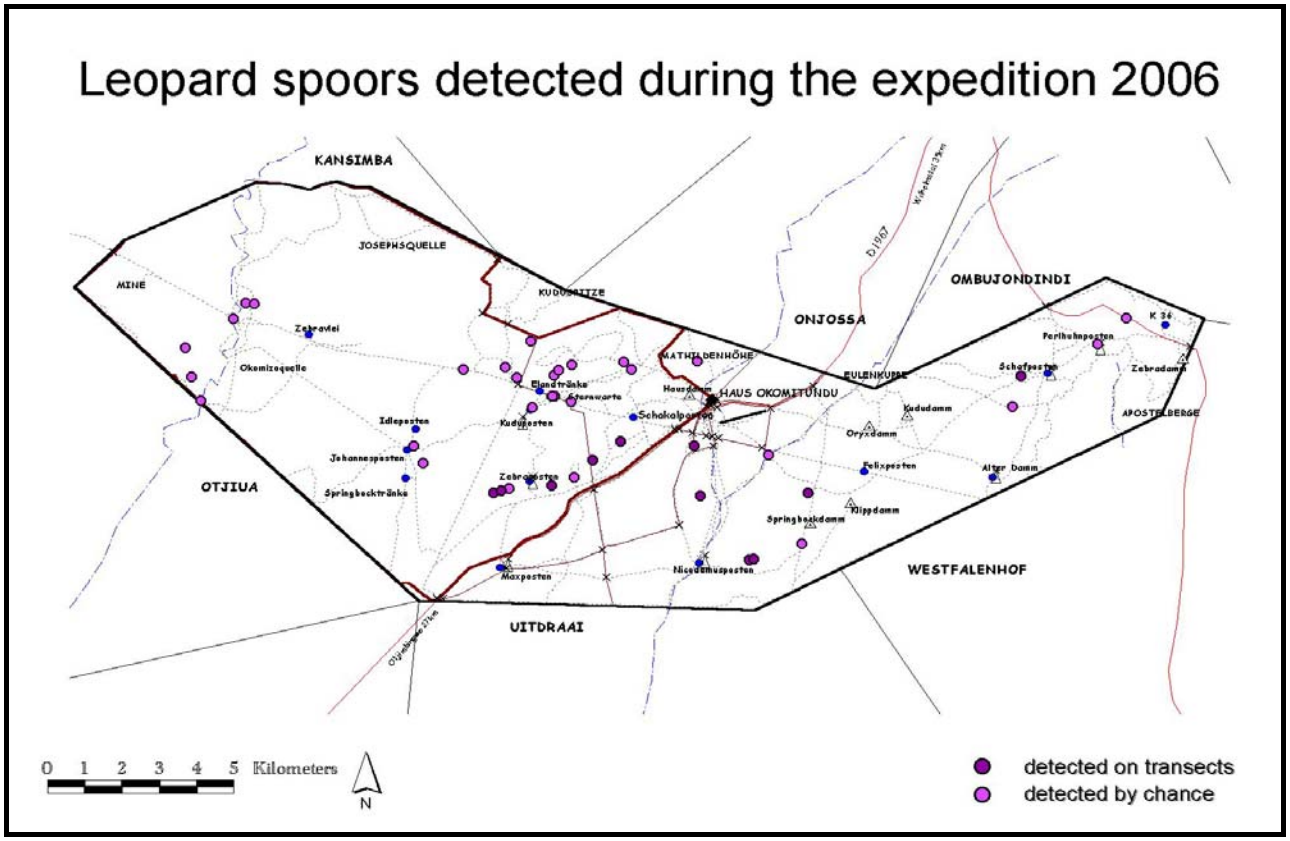


Figure 2.5.3e. Locations of leopard spoors that were detected during spoor counts (on transects, dark violet dots) or other research activities (by chance, light violet dots) in September/October 2006.

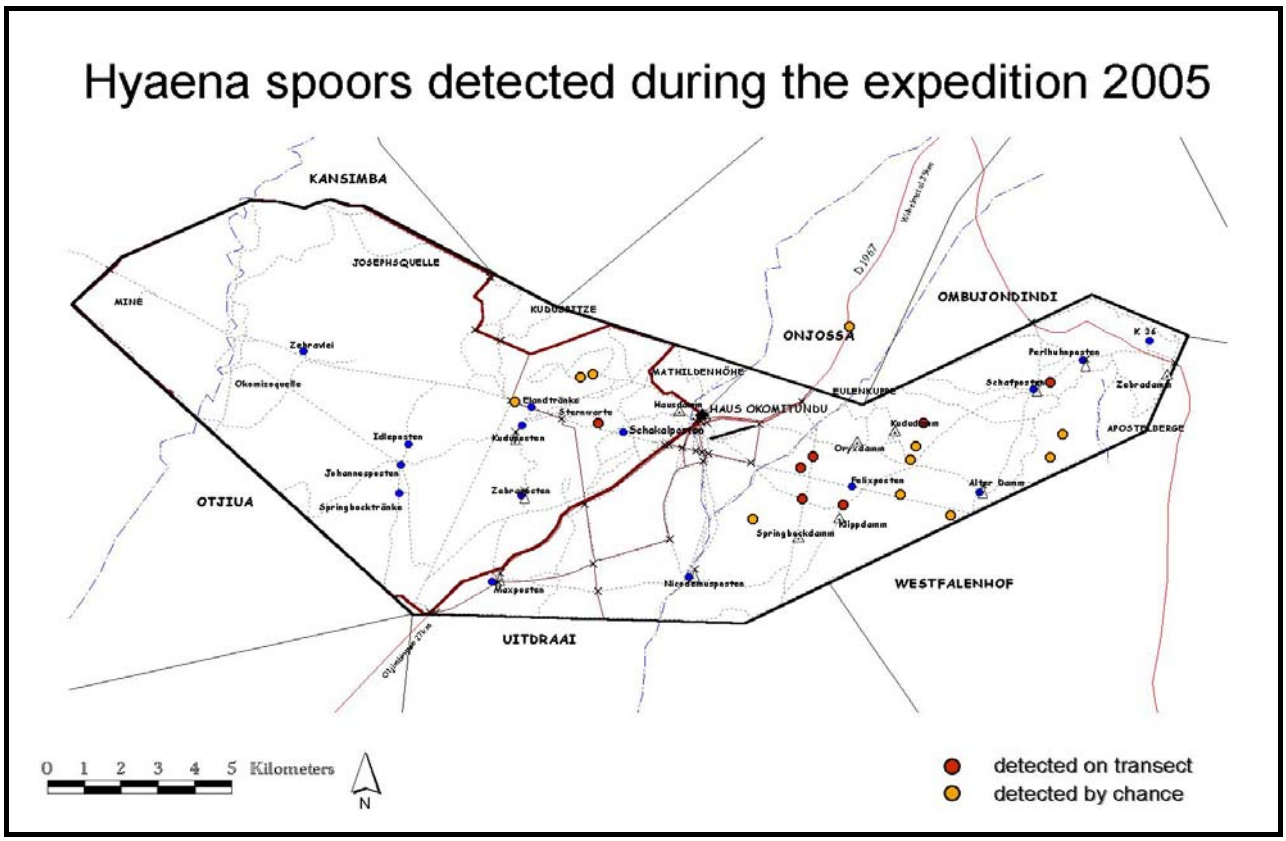


Figure 2.5.3f. Locations of brown hyaena spoors that were detected during spoor counts (on transects, red dots) or other research activities (by chance, orange dots) in October/November 2005.

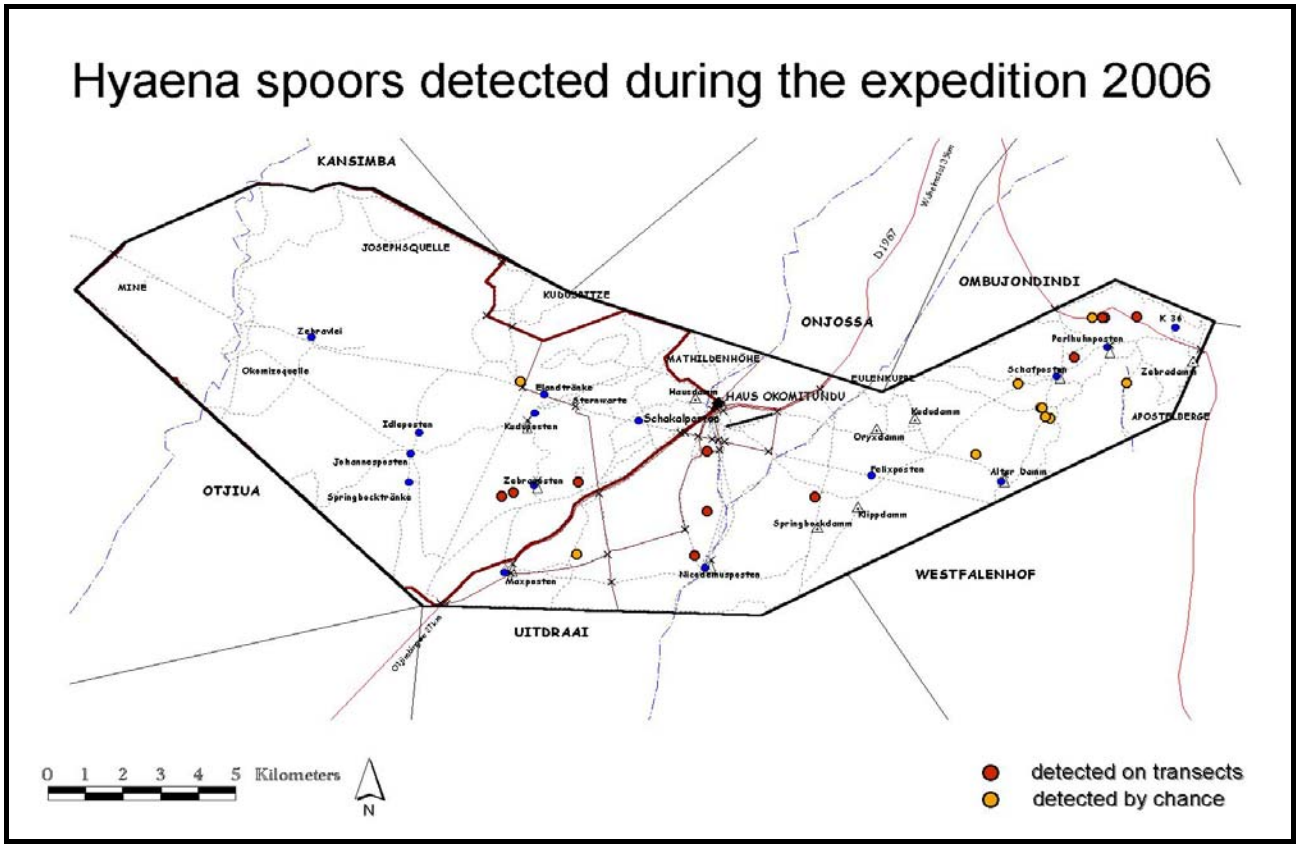


Figure 2.5.3g. Locations of brown hyaena spoors that were detected during spoor counts (on transects, red dots) or other research activities (by chance, orange dots) in September/October 2006.

On the basis of these tracks 9 individual cheetahs, 5 individual leopards and 4 individual brown hyaenas were identified during the expedition in 2005 (Table 2.5.3b). In 2006 these numbers changed to 5 cheetahs, 8 leopards and 5 hyaenas.

Table 2.5.3b. Numbers of individual carnivores identified on the basis of tracks during the expeditions in 2005 and 2006.

	2005				2006			
	males	females	juveniles	**Total**	males	females	juveniles	**Total**
Cheetah	4	2	3	**9**	4	1	-	**5**
Leopard	2	2	1	**5**	3	3	2	**8**
Hyaena	2	2	-	**4**	1	2	2	**5**

During the expedition in March 2005, which was conducted shortly before leaving our previous study site, 16 individual cheetahs were ranging within a core area of about 100 km². At the same time 8.5 cheetah tracks per 100 km² were found and spoor frequency was 11.8 km per cheetah track (table 2.5.3c).

Table 2.5.3c. Comparison of cheetah spoor density and cheetah spoor frequency during expeditions in 2005 and 2006 - previous study site versus current study site.

	March 2005 Seeis	Oct/Nov 2005 Okomitundu	Sep/Oct 2006 Okomitundu
Total number of transects	15	52	38
Total number of kilometres driven	201	411	343
Total number of cheetah tracks	17	20	7
Spoor density (tracks per 100km²)	8,5	4,9	2,0
Spoor frequency (km per track)	11,8	20,6	49,0

The table above shows that spoor density and therefore cheetah density, is much lower at Okomitundu than it was in the previous study site. At Okomitundu 4.9 cheetah tracks per 100 km² were counted in 2005 and 2.0 cheetah tracks per 100 km² were counted in 2006,. Accordingly spoor frequency decreased from 20.6 km (range 0.2 to 57.9 km) per cheetah track in 2005 to 49 km (range 0.2 to 98.6 km) per cheetah track in 2006.

In 2005 the expedition team performed five triangulations on a coalition of three male cheetahs, which were trapped and radio-collared in August 2005. During the expedition in 2006 these study animals (F005, F006, F007) were successfully located four times. An additional 39 data points were gathered by the local scientists and interns of Okatumba Wildlife Research throughout the year (Fig. 2.5.3h).

This male coalition appears to be fairly successful in holding its territory (Fig. 2.5.3i). The three cheetahs traverse a comparatively small area (142 km²) and they even stay there when conditions become unfavourable as was the case after a very bad rainy season in 2006/2007. During the first weeks after radio-collaring the coalition mainly ranged north of the Eulenkuppe hill (Fig. 2.5.3i), but later on the core area (36 km²) of the cheetahs' home range shifted to between Felixposten and Eulenkuppe hill (Fig. 2.5.3i).

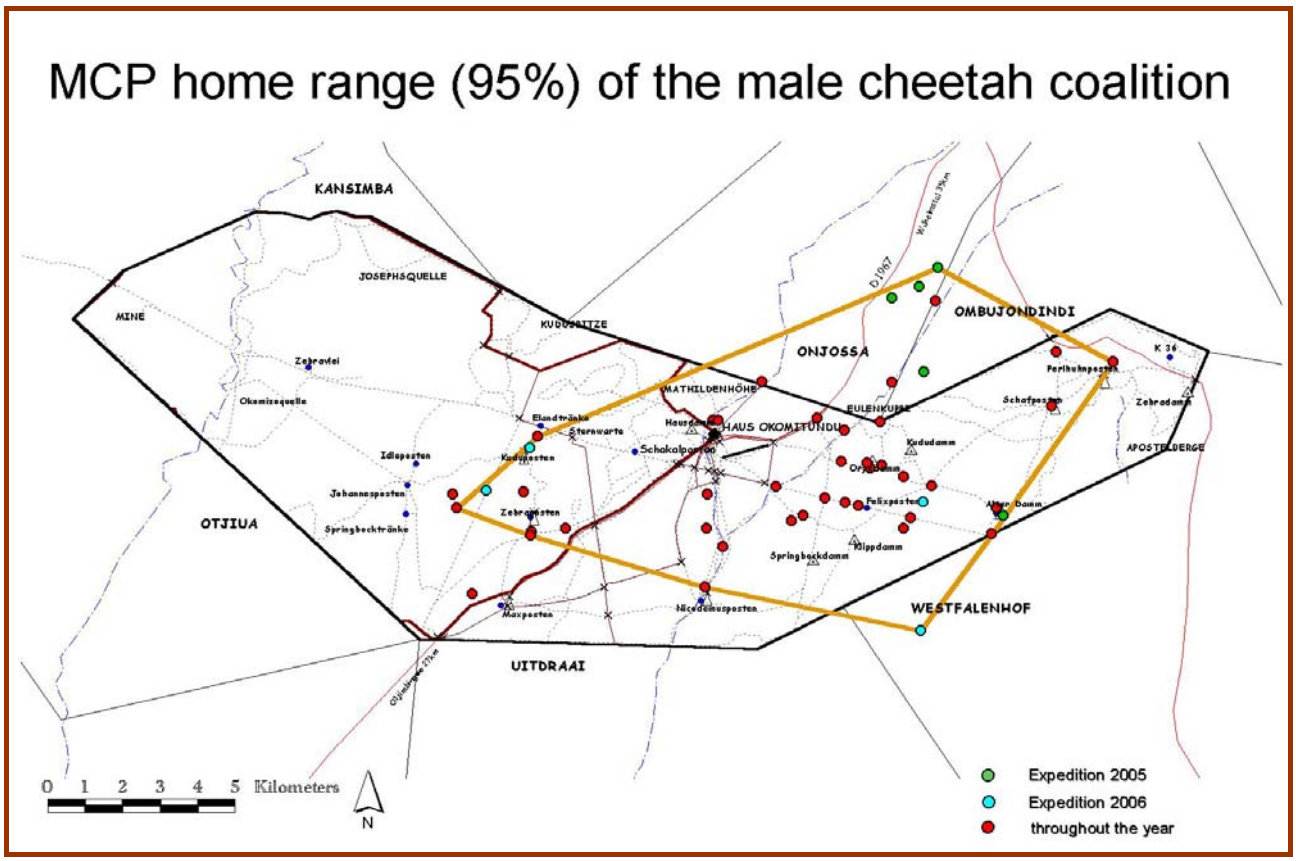


Figure 2.5.3h. 95% MCP home range of the male cheetah coalition (F005, F006, F007) showing their locations during the expedition in 2005 (green dots), during the expedition in 2006 (blue dots) and throughout the year (red dots).

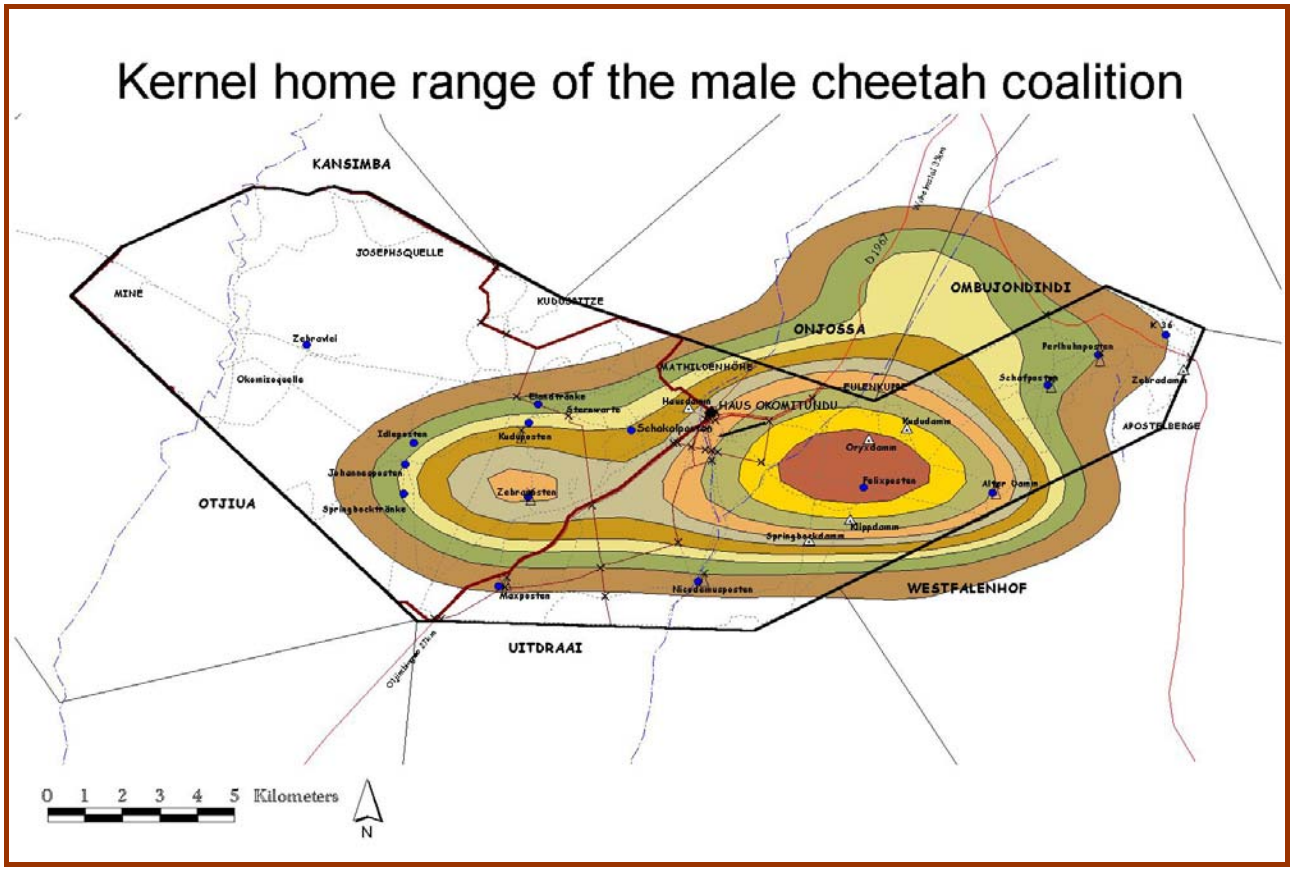


Figure 2.5.3i. Kernel home range (95%) of the male cheetah coalition (F005, F006, F007).

The two female leopards (F009 and F012) were radio-collared in May 2006 and in September 2006 respectively. During the expedition in 2006 nine triangulations on F009 were performed and F012 was successfully located 13 times. An additional 19 data points for F009 and 12 data points for F012 were gathered afterwards. Figures 2.5.3j & k show the resulting home ranges (95% Kernel) of these study animals.

These two home ranges may still change with an increasing number of locations, but we are already certain of the core areas. F009 has a small core area; she mainly ranges around the Mathildenhöhe. Several times she was found on the neighbouring farm (Onjossa) or between the Eulenkuppe and Felixposten. Sometimes she also travels west up to Johannesposten. The core area of F012 is much larger. This animal predominantly ranges between the Kuduberg and the Kuduposten, but it also travels east up to the Eulenkuppe. Although the two home ranges overlap we never located F009 and F012 at the same time at the same place. The two females appear to avoid each other, and our guess is that F012 is dominant.

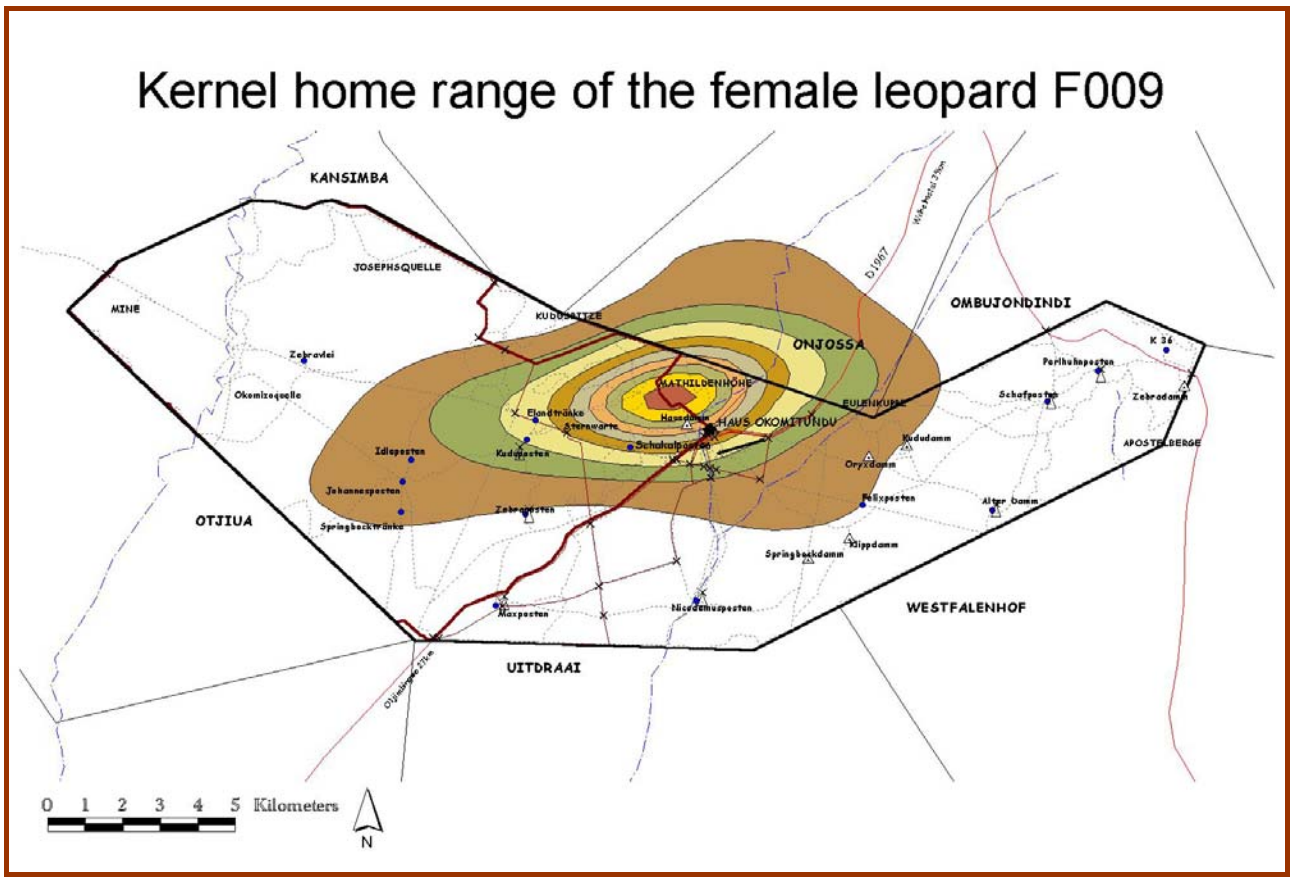


Figure 2.5.3j. Kernel home range (95%) of the female leopard F009.

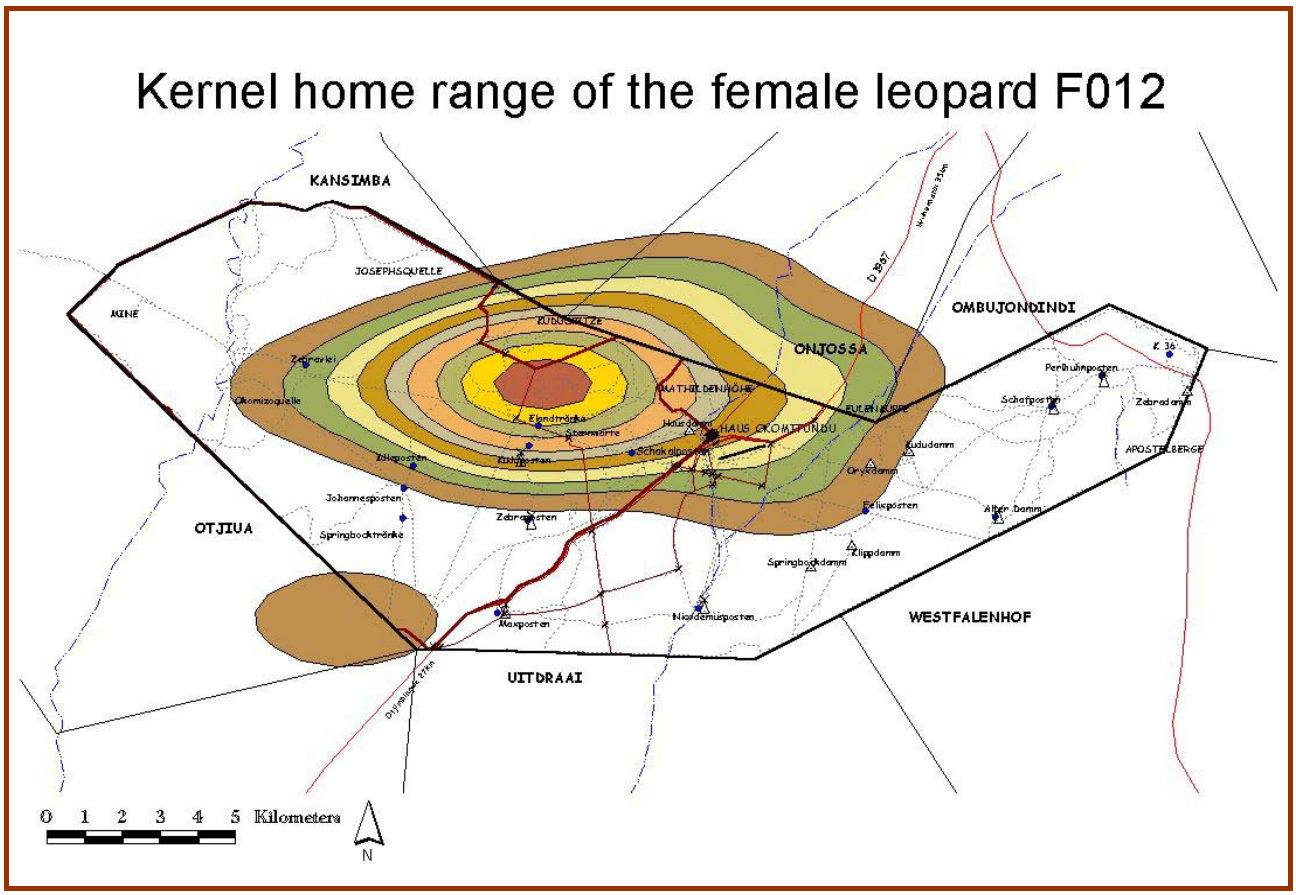


Figure 2.5.3k. Kernel home range (95%) of the female leopard F012.

2.5.4. Discussion

Ecological field studies rely on the ability to make reliable estimates of animal abundance, but any estimate of abundance is influenced by sources of error associated with extrinsic (environmental) or intrinsic (methodological) factors. Consideration of these potential influences is very important for both study design and data analyses. The development of effective methods to monitor abundance of large carnivores presents particular challenges, as they are often secretive and widely dispersed. It is also acknowledged that the sample sizes in this study are statistically small, but nevertheless the data and analyses are of ecological and economic importance.

The data gathered thus far does not allow for an accurate estimate of true population densities for any of the three large carnivore species at the Okomitundu study site. On the one hand capture success, for cheetahs and brown hyaenas in particular, was low. On the other hand, radio-collared animals, male leopards in particular, did not provide sufficient data due to being shot shortly after they were collared. Assuming that the spoor density of large carnivores shows a strong linear correlation with true density (Stander 1998), the above results at least reveal that cheetah density within the Okomitundu study site is much lower than it was in the Seeis study site. True population density still needs to be assessed.

It must also be noted that the four transects used for counting spoor frequencies were not truly random. Due to the heterogeneous habitat they were selected to cover different vegetation and geological types and to avoid very stony roads due to a low detectability of carnivore tracks on rocky soils. An increase in the number of roads and/or in the total length of roads sampled would increase data precision.

Looking at the total numbers of spoors detected during the expeditions, it is immediately obvious that the ratio between cheetah spoors and leopard spoors changed markedly from 2005 to 2006. The proportion of cheetah spoors to the total numbers of large carnivore spoors decreased from 40.9% in 2005 to 28.3% in 2006, whilst the proportion of leopard spoors increased from 35.2% in 2005 to 45.6% in 2006. One reason may be that the cheetah tries to avoid interspecific competition with the leopard and therefore switches to areas with lower leopard density. Secondly, cheetahs may be more vulnerable to changing habitat conditions such as drought, which result in limited (food) resources. Generally, the leopard and the brown hyaena are better adapted to poor habitat conditions than the cheetah.

So far data from the Okomitundu study site are insufficient to estimate cheetah home ranges sizes. In our previous study site home range sizes of cheetahs varied from 60 km² to 1580 km² (MCP method). Male coalitions of two or three cheetahs, which are considered to be brothers, use small home ranges of 60-170 km² and appear to hold territories, while single males roam over very large areas up to more than 2000 km² with an average of 837 km². Home range sizes of females are 230 to 480 km². We are of the opinion that space use patterns of female cheetahs depend on and vary with their reproductive status. When they are in oestrus they use larger areas, but when they have cubs they range in small areas. The bigger the cubs grow, the larger the home range becomes.

Regarding leopards, we determined the home ranges of two females (F009, F012) and one male (F008). The two other male leopards (F010, F011) were shot some weeks after they were radio-collared. Thus we gathered nine locations of F010 and four locations of F011 only. These data are not sufficient to estimate their home ranges.

Male leopard removal through trophy hunting around Okomitundu makes it very difficult to assess the leopard density within the study site. Each time one leopard is killed or dies of natural causes, its territory becomes available to other males. Usually more than one male leopard would migrate to the area and try to take over this territory. This may lead to a higher leopard density in the short term and possibly an overestimation in the long term.

2.6. Prey availability

2.6.1. Introduction

The large carnivore habitat, like any habitat, is the home of specific types of animals and must satisfy the requirements of all the animals in it for survival and successful existence. Fluctuations are an essential part of any ecosystem to keep the system viable. Thus the ecological limits set by the environment need to be monitored long term. In this context counting prey animals is therefore a crucial contributor to the successful management and to conservation of predator populations. An obvious assumption is that high densities of potential prey animals support high carnivore densities, while low game densities lead to low carnivore densities. Since game counts are conducted in two different parts of the study site, the data may also be used to glean information about migration patterns of free-ranging prey species on open farmland (which includes the cattle-proof fenced area) in comparison to prey species within the game-proof fenced area. While animals living on the open farmland can react to external influences such as rain or drought, animals within the game-proof fenced area cannot disperse.

2.6.2. Methodology

Every afternoon the expedition team conducted a road strip count by driving along a predetermined counting route, covering all types of habitat of the study site without going along farm boundaries. This route was chosen as randomly as possible. The Land Rover was manned by one driver in the cab, and three observers and a tracker on the pick-up platform (Fig. 2.6.2a).

Figure 2.6.2a. A game count team.

The driver operated the Land Rover at very low speed (about 15-20 km/h) and observers on the back counted all animals they detected on both sides of the road, no matter how far away they were detected. Team members also had to ensure that every single animal occurring on the transect line (angle = 0) was seen. When animals were detected, the observers signalled the driver to stop the vehicle.

Observers then identified and counted all animals detected and recorded the distance to the Land Rover, the angle from the transect (midline of the Land Rover), the number of individuals and, if possible, the sex and age composition (Fig. 2.6.2b).

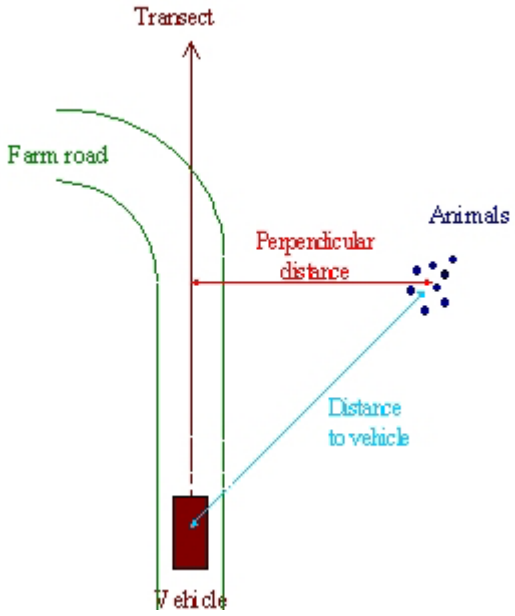


Figure 2.6.2a. Game count methodology.

A protractor sheet on top of the Land Rover helped to assess angle, and a range finder was used to measure distance. The km reading was recorded at each sighting and at the end of the count the total km driven was also recorded.

One route (A) within the game-proof fenced area and another route (B) outside this area were covered alternately. Data were entered into an Excel database for statistical analyses with the Distance Sampling software (Buckland et al. 1993, Burnham et al. 1980 - available for download at www.ruwpa.st-and.ac.uk/distance/).

2.6.3. Results

During the expedition road strip counts were conducted on 31 days in 2005 and on 36 days in 2006 (Tables 2.6.3a & b). In 2005 a total of 649 km were driven (339 km on route A and 310 km on route B), which results in an average of 21 km per counting day. In total 1891 animals were detected. The number of sighted animals per day ranged from 42 to 144 with an average of 71.6 on route A (n=16), and from 16 to 96 with an average of 49.1 on route B (n=13).

Table 2.6.3a. Game count effort 2005.

	Group 1	Group 2	Group 3	Group 4	**TOTAL**
Number of transects	8	7	7	9	**31**
Total km driven	157	150	163	179	**649**
Total number of animals sighted	521	342	477	504	**1891**
Average number of animals per day	65	49	68	56	**61**

In 2006 a total of 647 km were driven (377 km on route A and 270 km on route B), leading to an average of 18 km per counting day, which is equivalent to 86% of the average length of the counting route in 2005. In total 1338 animals were sighted. The number of sighted animals per day ranged from 13 to 107 with an average of 52.2 on route A (n=18), and from 9 to 44 with an average of 26.2 on route B (n=13).

Table 2.6.3b. Game count effort 2006.

	Group 1	Group 2	Group 3	Group 4	Group 5	**TOTAL**
Number of transects	7	6	7	8	8	**36**
Total km driven	121	108	124	150	144	**647**
Total number of animals sighted	293	162	269	260	354	**1338**
Average number of animals per day	42	27	38	33	44	**37**

While the expedition in 2005 consisted of four groups (eight weeks), the expedition in 2006 comprised five groups (ten weeks). This led to five more counting days in 2006 than in 2005, but afternoon activities had to be terminated several times because of bush fires, thunderstorms and rain, and relocations of box traps at short notice. Therefore the average counting route per day was 3 km less than in 2005, which resulted in almost the same total km driven.

Within the same total distance we detected about 30% fewer animals in 2006 than in 2005. The average number of sighted animals per 10 km was 29 in 2005 and 21 in 2006. On the open farmland (route B) 60.3% of the total number of animals counted in 2005 were detected, whilst within the game-proof fenced area (route A) 78.4% of the total number of animals counted in 2005 were sighted.

In 2005 the most numerous species were kudu (651), zebra (244) and oryx (201), followed by steenbok (180), springbok (142) and hartebeest (140). In addition to this 75 blesbok, 63 warthog, 59 baboon, 50 wildebeest, 33 impala, 23 waterbuck, 17 eland, 9 jackal and 4 cheetahs were counted. Potential prey animals are listed in table 2.6.3c.

Table 2.6.3c. Potential prey animals sighted on two different transects during the expedition in 2005.

	Kudu	Zebra	Oryx	Steenb	Spring	Harteb	Blesb	Wartho	Wildeb	Impala	Waterb	Eland	**TOTAL**
Route A	369	143	111	122	123	140	75	30	50	33	23	17	**1236**
Route B	282	101	90	58	19	-	-	33	-	-	-	-	**583**
TOTAL	**651**	**244**	**201**	**180**	**142**	**140**	**75**	**63**	**50**	**33**	**23**	**17**	**1819**

In 2006 the most numerous species were kudu (485) and oryx (300), followed by steenbok (162) and hartebeest (125). In addition to this 76 warthog, 60 zebra, 59 springbok, 34 eland, 14 black wildebeest and 3 cheetahs were counted. Potential prey animals are listed in table11.

Table 2.6.3d. Potential prey animals sighted on two different transects during the expedition in 2006.

	Kudu	Zebra	Oryx	Steenb	Spring	Harteb	Blesb	Wartho	Wildeb	Impala	Waterb	Eland	**TOTAL**
Route A	376	47	167	106	57	125	0	43	14	0	0	34	**969**
Route B	109	13	133	56	2	-	-	33	-	-	-	-	**346**
TOTAL	**485**	**60**	**300**	**162**	**59**	**125**	**0**	**76**	**14**	**0**	**0**	**34**	**1315**

Lower game numbers within the game-proof fenced area were mainly due to a decline of zebra and springbok populations. In 2005 the expedition team counted 143 zebra and 123 springbok, whereas only 47 zebra and 57 springbok were detected in 2006. Numbers of introduced species such as blesbok, wildebeest, impala and waterbuck were also lower in 2005.

Accordingly, on Route A the proportion of zebra and springbok to the total amount of sighted animals declined from 13% to 5% and from 23% to 11% respectively. The proportion of kudu, hartebeest and steenbok to the total number of sighted animals was similar in both years, whilst the proportion of oryx, warthog and eland increased from 2005 to 2006 (Fig. 2.6.3a).

On open farmland kudu and zebra populations declined drastically from 2005 to 2006. In 2005 the expedition team counted 282 kudu and 101 zebra, whereas only 109 kudu and 13 zebra were detected in 2006. On Route B the steenbok and the warthog numbers were almost the same in both years, and the number of sighted oryx increased from 90 to 133 animals.

On open farmland the proportion of kudus to the total amount of animals sighted was 49% in 2005 and 32% in 2006. The proportion of zebra also declined from 17% in 2005 to 4% in 2006 (Fig. 2.6.3b), whereas the proportion of oryx was more than double in 2006 (37%) compared to 2005 (15%). The proportion of small to medium-sized prey animals increased from 19% in 2005 (10% steenbok, 6% warthog and 3% springbok) to 27% in 2006 (16% steenbok, 10% warthog and 1% springbok).

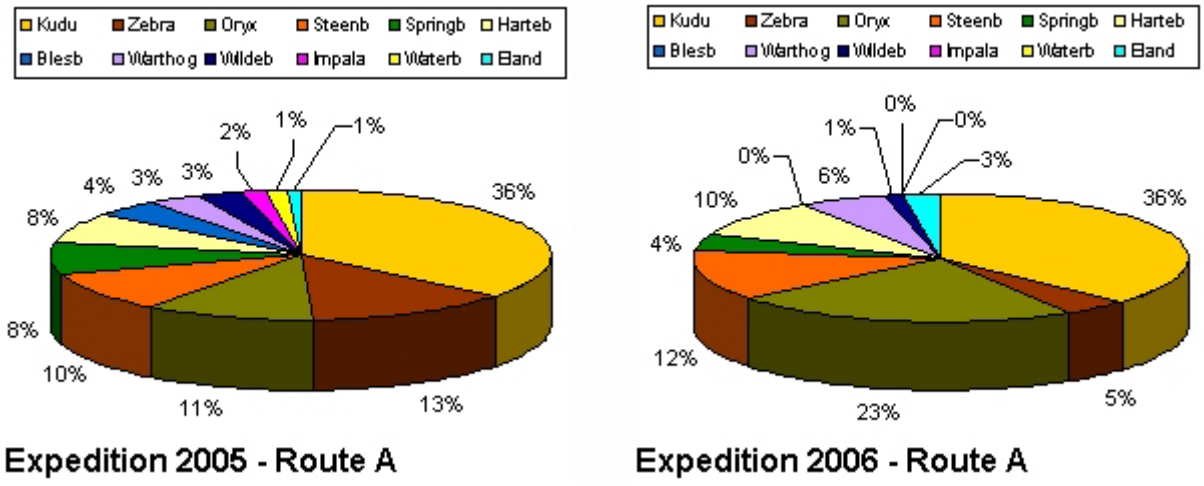


Figure 2.6.3a. Ratio between the various game species sighted on Route A in 2005 and 2006.

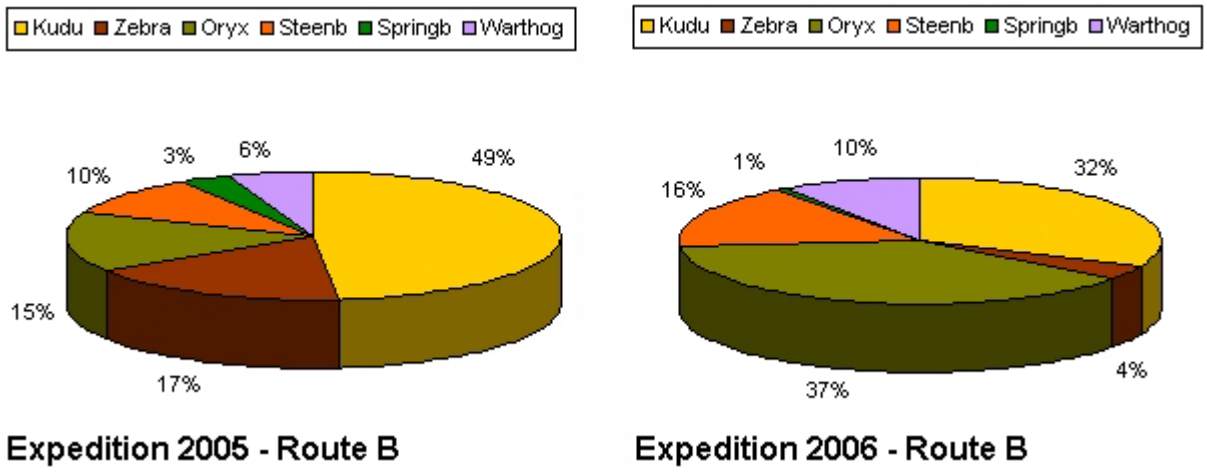


Figure 2.6.3b. Ratio between the various game species sighted on Route B in 2005 and 2006

Game densities in both parts of the farm were estimated for each expedition group as well as for all the expeditions (see tables and figures below). Fluctuations from one group to the other in all species are mainly due to rainfalls (in 2005) or rather their absence (in 2006) and usual travel patterns of the animals within the study site. Since the transect covers a certain part of the study area only, one expedition group may pass many kudu and few steenbok, whereas the next group may record fewer kudu, but many steenbok. Statistically this is a normal variation.

Rainfalls in Namibia are the most crucial factor for any kind of land use and they can vary significantly from year to year. Usually the rainy season starts in October and lasts to April with the main rainfalls from February to April. The rainy season in 2005/2006 started with some early rains at the end of September 2005 and as a whole was far above average. In contrast to this the rainy season in 2006/2007 was one of very little rain. As a result the grazing and browsing capacity of the study site decreases and potential prey animals will migrate to other regions.

Table 2.6.3e. Estimated game densities (No. of animals per 10 km²) of the dominant game species within the game-proof fenced area (Route A) during the expedition in 2005.

ROUTE A	Group 1	Group 2	Group 3	Group 4	**Entire expedition**
Kudu	10.43	52.83	38.51	29.86	**32.91**
Mountain zebra	21.50	7.54	12.76	0.00	**10.45**
Oryx	1.99	30.26	1.83	1.51	**8.89**
Steenbok	14.34	30.06	28.08	22.81	**23.82**
Springbok	8.31	1.54	13.18	3.70	**6.68**
Warthog	4.13	3.36	2.69	0.78	**2.74**

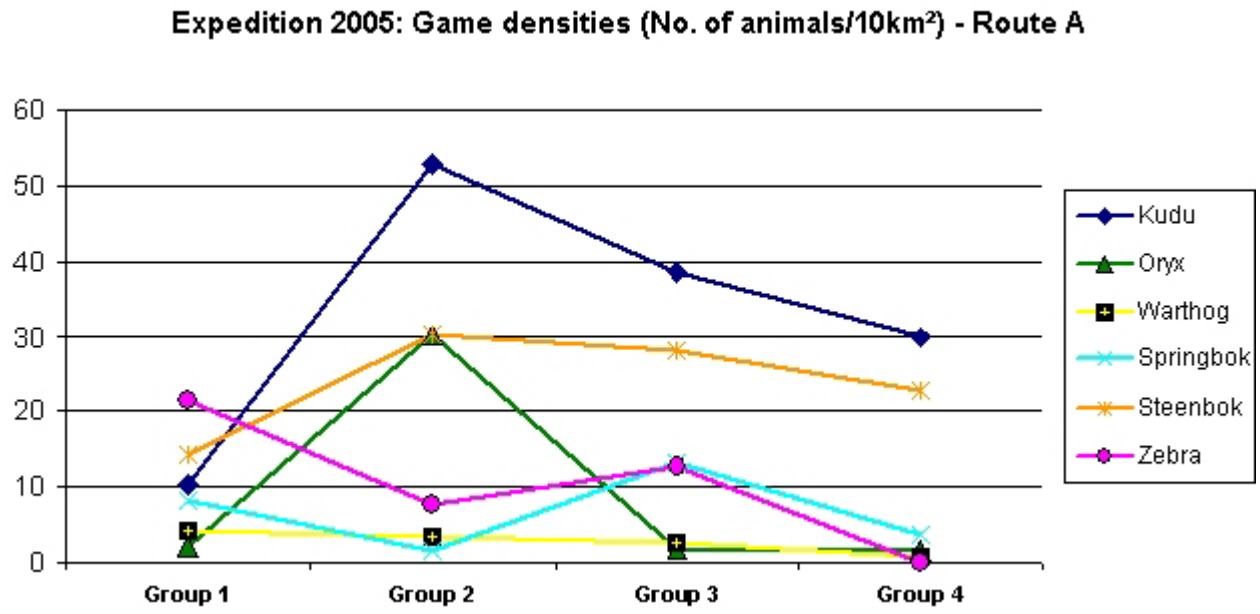


Figure 2.6.3c. Estimated dominant game species densities within game-proof fenced area in 2005.

A comparison between both parts of the farm shows that in 2005 population densities of kudu, zebra, oryx and warthog were higher on the open farmland (Route B), whilst population densities of steenbok and springbok were higher within the game-proof fenced area (Route A). Since springbok were introduced to the game camp and steenbok can crawl easily under fences through holes dug by warthogs, these findings do not surprise.

Table 2.6.3f. Estimated game densities (No. of animals per 10 km²) of the dominant game species within open farmland (Route B) during the expedition in 2005.

ROUTE B	Group 1	Group 2	Group 3	Group 4	**Entire expedition**
Kudu	67.44	27.00	56.83	57.32	**52.15**
Mountain zebra	33.77	0.53	27.93	0.73	**15.74**
Oryx	44.57	6.60	20.42	3.92	**18.88**
Steenbok	13.12	12.81	21.76	16.02	**15.93**
Springbok	15.36	0.00	0.00	2.26	**4.41**
Warthog	18.77	1.86	4.77	9.11	**8.63**

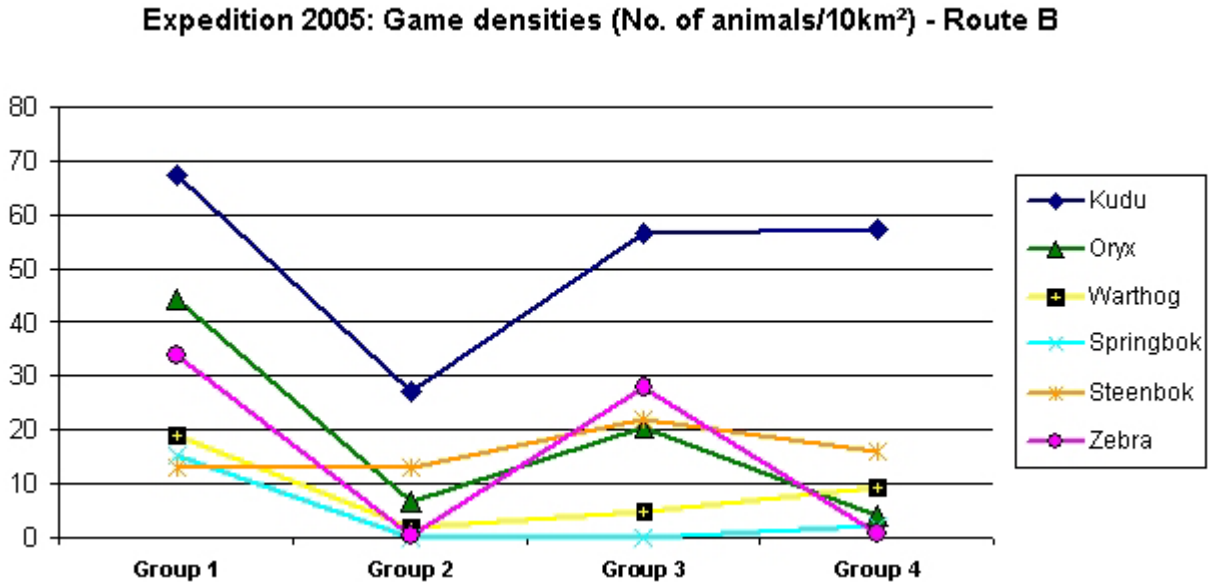


Figure 2.6.3d. Estimated dominant game species densities on open farmland in 2005.

Table 2.6.3g. Estimated game densities (No. of animals per 10 km²) of the dominant game species within the game-proof fenced area (Route A) during the expedition in 2006.

ROUTE A	Group 1	Group 2	Group 3	Group 4	Group 5	**Entire expedition**
Kudu	48.27	16.43	11.94	36.29	60.68	**34.76**
Mountain zebra	0.54	0.00	1.43	0.00	0.00	**0.39**
Oryx	4.81	9.72	24.52	15.23	23.32	**15.52**
Steenbok	18.05	38.04	21.39	12.76	28.13	**23.67**
Springbok	4.58	0.55	1.76	2.79	5.46	**3.03**
Warthog	4.61	15.82	7.30	13.27	0.00	**8.20**

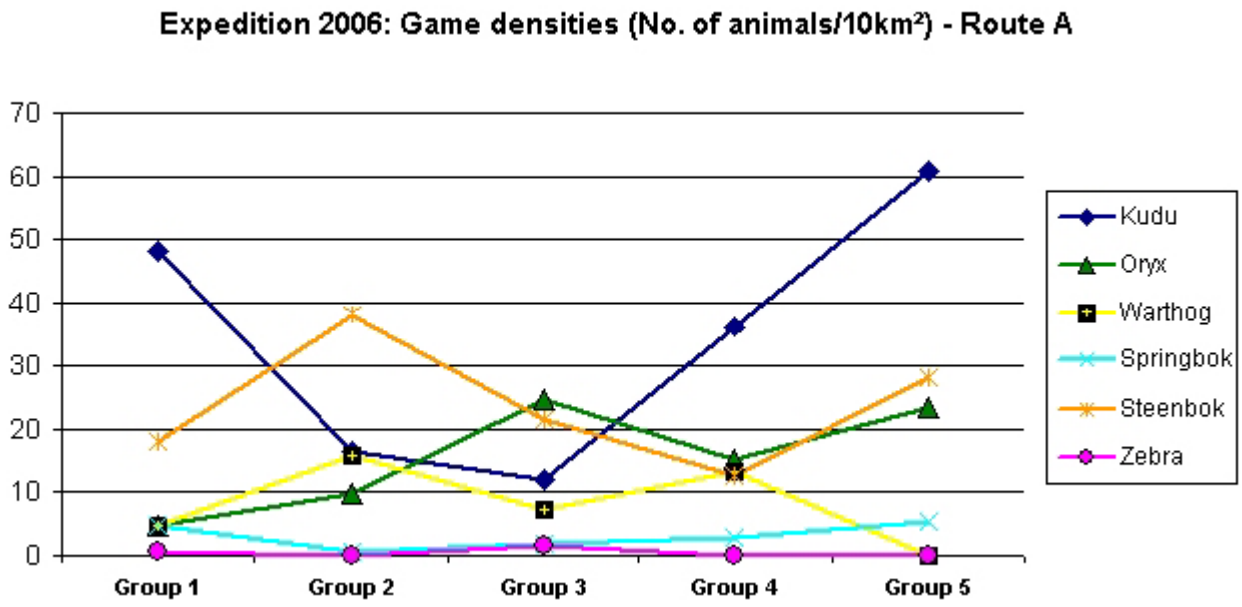


Figure 2.6.3e. Estimated dominant game species densities within the game-proof fenced area in 2006.

Table 2.6.3h. Estimated game densities (No. of animals per 10 km²) of the dominant game species within the game-proof fenced area (Route B) during the expedition in 2006.

ROUTE B	Group 1	Group 2	Group 3	Group 4	Group 5	**Entire expedition**
Kudu	25.77	7.97	13.06	15.83	17.42	**16.01**
Mountain zebra	0.00	0.00	0.00	0.00	0.00	**0.00**
Oryx	2.27	6.04	7.40	4.61	25.66	**9.20**
Steenbok	14.46	22.30	16.55	11.15	19.64	**16.82**
Springbok	0.00	0.00	0.00	0.00	0.52	**0.10**
Warthog	3.09	13.45	0.00	5.13	12.95	**6.92**

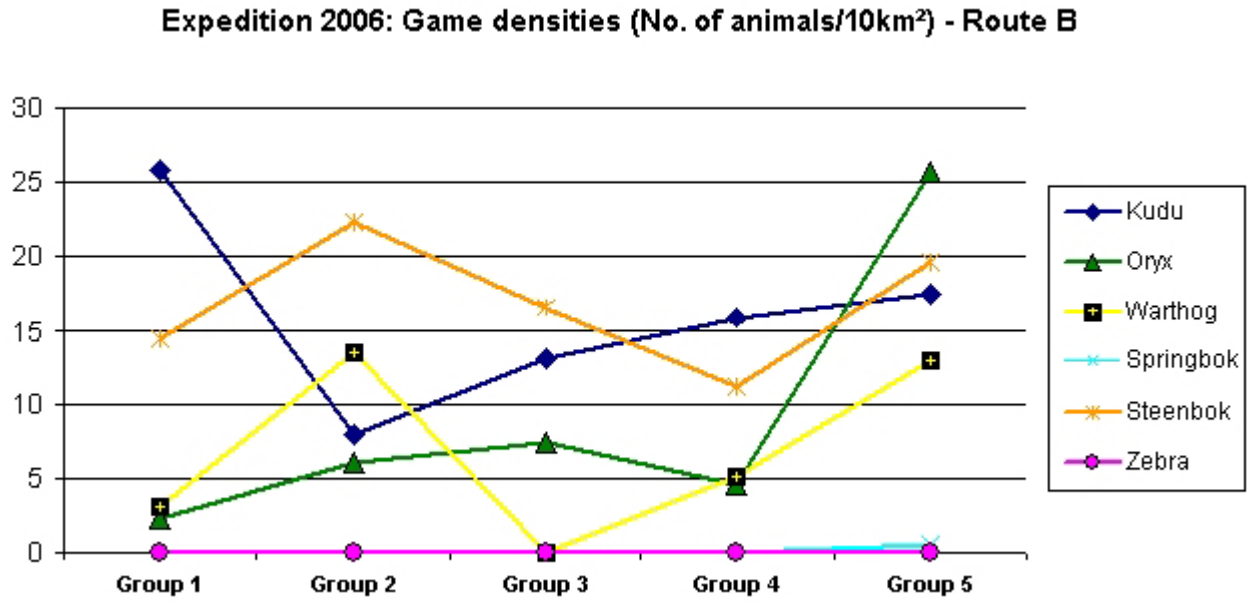


Figure 2.6.3f. Estimated dominant game species densities on open farmland in 2006.

A comparison between both parts of the farm shows that in 2006 population densities of all game species, except of warthog, were lower on open farmland (Route B). The warthog density was similar in both parts of the farm. It was 8.20 animals per 10 km² within the game-proof fenced area and 8.92 animals per 10 km² on open farmland.

On the basis of population densities, total numbers of dominant game species were calculated for the game-proof fenced area (95 km²), as well as for the open farmland (85 km²). Results are presented in Table 2.6.3i.

Table 2.6.3i. Total numbers of kudu, zebra, oryx, steenbok, springbok and warthog within the game-proof fenced area (95km²) and on open farmland (85 km²). Numbers are calculated on the basis of estimated population densities during the expedition in 2005 (31 counting days in eight weeks) and 2006 (36 counting days in ten weeks).

	Kudu	Zebra	Oryx	Steenbok	Springbok	Warthog	**TOTAL**
Game camp 2005	313	99	85	226	63	26	**847**
Open farm 2005	443	134	160	135	37	73	**984**
TOTAL 2005	**756**	**233**	**245**	**362**	**101**	**99**	**1831**
Game camp 2006	330	4	147	225	29	78	**813**
Open farm 2006	136	0	78	143	01	59	**417**
TOTAL 2006	**466**	**4**	**225**	**368**	**30**	**137**	**1230**

Usually game-proof fenced areas host a larger variety of game species than the common stock-proof fenced farmlands, albeit with lower animal numbers per species. In 2005 this was also the case for the dominant game species within our study area - except for springbok, which were introduced into the game camp, and steenbok, which can easily crawl through fences and disperse over the whole area.

This situation completely changed from our first to the second year at Okomitundu. In 2006 animal numbers per species were generally lower on open farmland than within the game-proof fenced area. This was due to the lack of (early) rains at the study site.

2.6.4. Discussion

Prey availability and its fluctuation throughout the year is one of the most important factors for migration patterns and habitat preferences of our study animals. Due to the very large size of the study area, it is not possible to conduct a census in which all animals in a given area are counted individually. What can be done is a survey, where a proportion of the individuals in the area is detected and recorded.

Game densities (number of animals per unit area) were estimated using the Distance Sampling Program (Buckland et al. 1993). The data collected are a set of distances of detected animals, which are distributed sparsely across a large area, and there is no competing method to analyse those data. One of the major advantages of Distance Sampling is that some, or even many, of the objects may go undetected. Central to the concept of this method is the detection function (Fig. 2.6.4a).

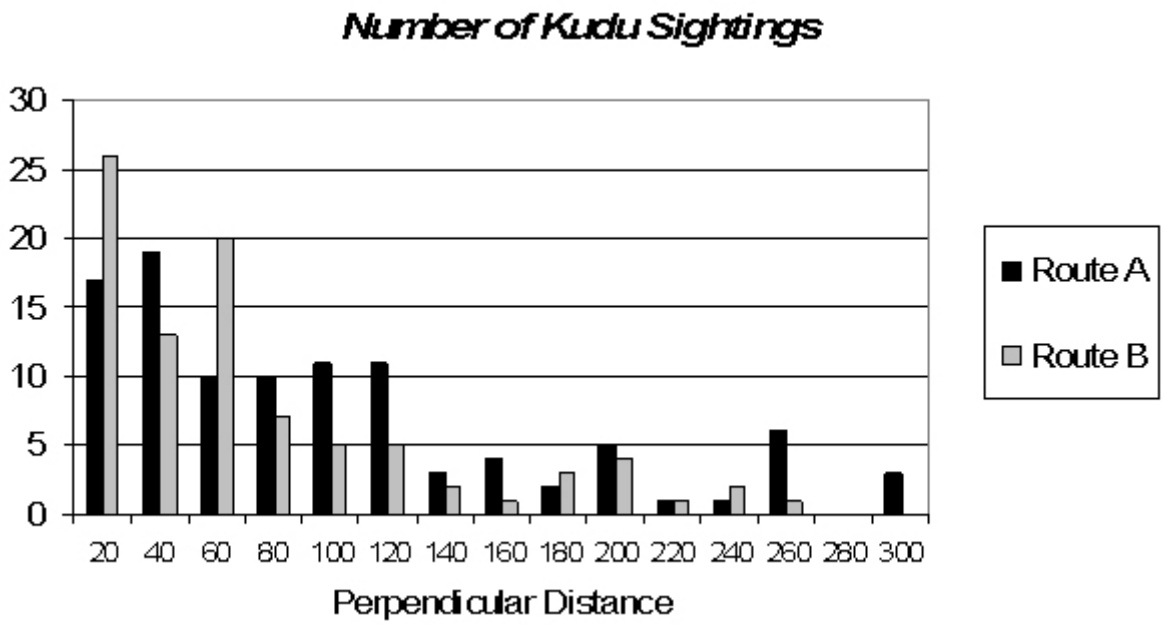


Figure 2.6.4a. Example of decreasing detectability: number of sightings of kudu clusters with perpendicular distances from 20 to 300 metres during the expedition in 2005.

The figure above shows the total number of sightings of kudu (single or in groups) within the game-proof fenced area (Route A) and on open farmland (Route B) during the expedition in 2005. As expected, detectability decreases with increasing distance from the transect line.

Distance sampling theory considers certain variables such as the average group size or the spatial distribution of the animals. These factors are different between species. This is why in 2005 steenbok density within the game-proof fenced area, for instance, is higher than the density of zebra although fewer steenbok were detected during the game counts.

Game count data reflect what happens to wildlife populations, i.e. natural incidents as well as management activities. This also applies to the results of the above game counts. Whilst most of the animals in the game-proof fenced area cannot react to natural factors such as rain or drought, the animals on open farmland are able to move to other regions. Sometimes they travel very large distances to reach areas where it has already rained and fresh vegetation is available. Since oryx are well adapted to arid conditions, they are one of the last species to leave an area. This is likely to be the reason for the relatively high proportion of oryx on open farmland in 2006. Whilst the drastic decline in the zebra population is mainly due to capture activities that took place at Okomitundu in June 2006, we believe that springbok numbers were reduced significantly through predation.

If the drastic decline in animal numbers on open farmland in 2006 was due to a lack of rainfalls, the animals should come back to Okomitundu once the rains return, i.e. when grazing and browsing capacity increases. At the time of writing we were not able to test this hypothesis because there was very little rain during the 2006/2007 rainy season.

Hopefully, the expedition in 2007 will experience some early rains and the hypothesis can be tested.

In general the amount of wildlife management required depends on the size of an area and restrictions of movement within it. Whilst game populations on open farmland are able to roam over large areas and require little management, populations within a game-proof fenced area must be monitored and managed frequently. During periods when no natural water is available, sufficient artificial watering places have to be provided and the condition of the animals monitored. In dry seasons some species may suffer and the manager/farmer will then live capture and sell some game, rather than letting all the animals starve to death. Another option is to feed the animals, but this has financial implications and many game species do not take any fodder. If management is done properly, game-proof fenced areas can be very good conservation tools, for rare species in particular.

In our previous study site (Seeis region) an average of 211 animals per transect were detected. This number is more than four times that of the new study site. This is because Okomitundu area is more arid than Seeis and therefore grazing and browsing capacity is lower. Assuming that large carnivore density is limited by the availability of prey animals it is not surprising that fewer carnivores are present at Okomitundu compared to Seeis. This is also supported by the Large Carnivore Atlas programme (Stander & Hanssen 2003) as well as our spoor data (see 2.5.3.).

Leopards mainly range in the western parts of Okomitundu, their prey availability within the game-proof fence did not change significantly from 2005 to 2006, and two male leopards were shot. This meant that territories were available for take-over, so it is not surprising that the number of leopards increased from five individuals in 2005 to eight individuals in 2006.

Regarding cheetahs, which mainly range in the eastern parts of the area, conditions deteriorated in 2006 as prey availability on the open farmland dropped to less than half that in 2005. Secondly the composition of prey species was dominated by oryx, which fight off predators easily. Thirdly the dominance of the male coalition makes it difficult for single cheetahs to move in. This explains why the number of individual cheetahs decreased from nine animals in 2005 to five animals in 2006.

2.7. Human-wildlife conflict (HWC)

2.7.1. Introduction

People in Namibia have lived in close proximity to wildlife and interacted with wild animals from time immemorial. Humans not only derive benefits from wildlife such as meat, hides and income security, but also suffer direct and indirect costs. These include damage to crops and water points, livestock losses, as well as threats to and loss of human life (Murphy et al. 2004). Namibia, like other countries across the world, continues to face challenges of human-wildlife conflicts, which mainly revolve around the use of natural resources and manifest themselves through the ensuing competition between wildlife and humans. Elephants and large predators were identified as important HWC problem animal species (Long 2004).

Conflict between farmers and large carnivores is mainly due to predation on livestock. It has resulted in large numbers of cheetahs and other carnivores being live captured and sold or killed (Marker et al. 1996, Marker et al. 2003b, Morsbach 1987). As a result, national and international conservationists tend to see farmers as a serious threat to the Namibian cheetah population (Marker 2003a, Nowell et al. 1997), but the farmers' impact on the population will remain speculative until it is rigorously investigated. Our belief is that the impact lions and spotted hyaenas have on cheetah populations living in conservation areas is much higher and part of this study is to investigate this notion empirically.

Cheetahs and leopards do kill livestock, but to date the extent of losses and financial damage to farmers has not been quantified properly. One aim of this study is to provide reliable information on the cheetah's and the leopard's diet and to quantify stock losses. Our hypothesis is that the proportion of livestock in the diet of large carnivores is much lower than it is perceived by the farmers. Particularly the cheetah has a highly specialised hunting method (Caro 1994, Estes 1997), and it must go through a certain sequence of predatory motor patterns to kill successfully (Eaton 1970b). An important point is that the prey animal must flee in a very specific way (Estes 1997) that is displayed by game, but not livestock species. We therefore hypothesise that cheetahs prefer natural game prey to livestock. Nevertheless, predators feed opportunistically (Nowell & Jackson, 1996), and accessible livestock is also vulnerable to predation. Since leopards are stalkers and pouncers they are more likely to prey on livestock than cheetahs. In terms of brown hyaenas, we hypothesise that conflict with farmers is insignificant, because brown hyaenas are scavengers, rather than hunters.

2.7.2. Methodology

Various methods are available to examine large carnivore diet (Mills 1984). Direct observation of kills may be the predominant method for large carnivores in East or South Africa, but is impractical on Namibian farmland, firstly because the carnivores live very secretive lives so that hunting cannot be observed directly and secondly because fresh kills are difficult to detect in bushy areas.

Thus investigation of prey composition is best conducted by analysing undigested prey remains in faeces. For example, by examining imprints of prey hair under a microscope (Marker et al. 2003b, Wachter et al. 2006). Each prey species can be identified due to its unique hair surface structure and several reference systems are available (Jauernig 2005, Keogh 1983).

Prey hair in faecal samples not only contains qualitative, but also quantitative information; the latter one is vulnerable to biases: different sized prey species are metabolised differently, and the amount of faeces excreted varies with the amount of food ingested. Controlling these biases makes assessment of prey composition more accurate and to achieve this, correction factors for the different prey species are needed. This is why the IZW (Institute for Zoo and Wildlife Research) in Berlin conducted 19 feeding trials with captive cheetahs over four months in collaboration with the AfriCat Foundation. Data processing is still in progress (Conradie 2006).

2.7.3. Results

Since this issue was taken over by the IZW, we are waiting for their results rather than duplicating studies. Preliminary results revealed that livestock, goats in particular, comprised only a small proportion (4%) in the cheetah diet (Jauernig 2005, Wachter et al. 2006). Further results from the IZW are expected in due course.

2.7.4. Discussion

Whilst wildlife in conservation areas benefits from government protection, the same cannot be said of wildlife on commercial farmland. It is therefore crucial to cooperate with farmers, assess their problems and include their questions into the research. Thereafter scientific results have to be presented to farmers to give them a better understanding of the ecological role of cheetahs, leopards and brown hyaenas on their land. Such information may help to overcome current misconceptions and mitigate human-wildlife conflicts. For example, farmers are pretty good at estimating how many individual cheetahs or leopards are present on their properties, but they overestimate carnivore densities due to not knowing how many individuals use a specific farm simultaneously (personal observation).

Marker et al. (2003b) have argued that cheetahs prefer common, indigenous game species, and that they rarely prey on livestock. We support their opinion that documentation of the cheetah's (and the leopard's) diet is an important component of any effective conservation plan. Both the CCF (Marker et al. 2003b) and the IZW (Wachter et al. 2006) showed that the main prey of cheetahs living on farmland in Namibia were small mammalian species such as the scrub hare and the springhare respectively. More accurate assessment of large carnivore diet by use of correction factors resulting from controlled feeding trials will contribute to a successful co-existence of large carnivores with people.

2.8. Ecological role of marking trees

2.8.1. Introduction

Transmission of information between solitary carnivores and between groups of social carnivores is important to maintain order in social systems and to ensure reproductive success (Clapperton 1989). While vision, hearing and tactile sense are mainly used for orientation and predation (Eaton 1970a, Estes 1997), the sense of smell is more important in the field of social interactions (Gorman & Trowbridge 1989, MacDonald 1985). Olfactory communication has several advantages over visual or auditory signals: odours can be used when other signals are difficult to detect, they can be deposited in the environment and they remain active for long periods of time (Gorman & Trowbridge, 1989). As social odours are a limited resource for an animal, they will be distributed with care and are therefore likely to be left at visually conspicuous and much frequented landmarks, rather than being distributed randomly.

Some authors (Hanström 1949, Joubert 1984, McVittie 1979) as well as many Namibian farmers (personal communication) report on so-called play trees that are frequently used by cheetahs. Play trees appear to be a poorly understood, but very important means of communication, especially through scent-marking. Male and female cheetahs mark the trunk as well as the branches with urine and faeces, they climb onto branches and rest there (Hanström 1949).

Because of their importance as marking, rather than playing sites, the current study renamed ‘play trees’ into ‘marking trees’. Furthermore, marking trees may be used as elevated points from which to spot potential prey. It seems the phenomenon of marking trees is specific to Namibia and the abundance of marking trees differs between different types of habitat. In some regions termite mounds also serve as cheetah marking spots (Caro 1994; personal observation).

From July to September 2005 the local scientists and interns found some cheetah marking trees, but due to lack of manpower no thorough exploration of the new study site was conducted until the expedition teams arrived.

2.8.2. Methodology

During the 2005 expedition, the core area of the new study site was surveyed systematically every afternoon in search of trees and termite mounds that were used by cheetahs for scent-marking. During the eight weeks of the expedition about 100 km² were covered on foot. Depending on the type of habitat, expedition team members walked 50-100 m from each other in a line through the bush and looked for marking trees. Often the survey group was joined by the spoor tracking group and the whole team was equipped with Motorola hand-held radios for communication. Once a team member had found a potential marking tree s/he called the others and the whole group investigated the tree. If the tree was confirmed as a marking tree, its GPS position was recorded using a Silva Multi-Navigator, and the tree was then double checked by the local scientists.

2.8.3. Results

Before start of the expedition in 2005 nine of these trees were identified (green on Fig. 2.8.3). The expedition found 14 (yellow on Fig. 2.8.3). In addition to the trees, two termite mounds marked with scratches and cheetah faeces were found (red on Fig. 2.8.3)

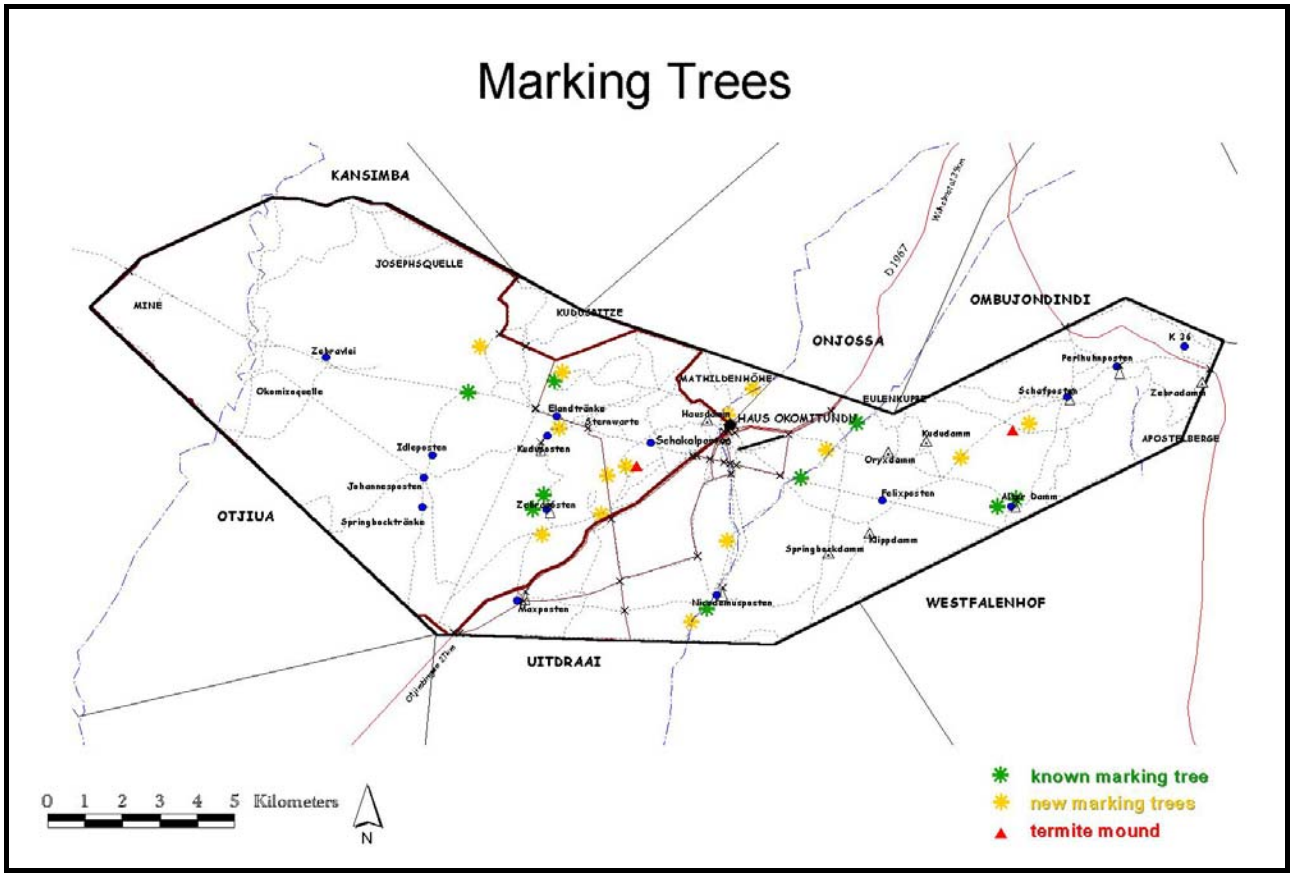


Figure 2.8.3a. Map of the study site with cheetah marking trees and termite mounds that were already known (green), or detected during the expedition in 2005 (yellow and red).

Capture data indicate that marking trees are used more frequently by males than by females (McVittie 1979). Usually 70% to 80% of cheetahs caught at marking trees are males (Marker et al. 2003a; personal observation).

2.8.4. Discussion

Much time and effort was spent to discover marking trees during the expedition in 2005 and this activity was a major contribution to the research work in the new study site. Since cheetahs are difficult to lure into box traps, marking trees are a very important tool for capturing this species successfully.

Data of this study confirm that male cheetahs use marking trees more frequently than females. One reason may be that female cheetahs predominantly act like “postwomen” who visit marking trees to leave a message, whereas the males go to the trees to fetch the messages. Checking incoming “mail” is done much more often than delivery. Secondly, male cheetahs not only need to receive messages signalling reproductive status of females, but they also have to mark their home range/territory and to look for rivals. It appears that female cheetahs visit marking trees in all reproductive states. In the previous study site they were caught whilst being in oestrus (either single or joining a male), whilst being pregnant or whilst they were accompanied by juveniles of different ages.

2.9. Additional surveys

2.9.1. Introduction

Investigation of cheetah, leopard and brown hyaena ecology requires sound scientific knowledge about the conditions of the respective study area. With this in mind the project also included general surveys to elucidate factors that drive migration patterns, habitat preferences and population regulation of large carnivores.

a) To work in a given study area it is essential to have a suitable map, for interns and others research assistants such as expedition team members in particular. Shortly after moving to Okomitundu in June 2005 mapping of new study site began.

b) During the first vegetation period (February to May 2006), a thorough vegetation survey of the new study site was conducted (Fig. 2.9.3a).

   Besides the vegetation map, a comprehensive field guide with 61 tree and shrub species was compiled. In addition to this a herbarium of 97 plant species was produced. A second sample of each species in this herbarium was given to the Botanical Institute in Windhoek.

c) Poaching activities are one of the most serious threats to wildlife populations. Usually poachers on Namibian farmland work with dogs and donkeys and they often destroy fences by cutting wires. Since Okomitundu borders onto Otjimbingwe (a housing estate of landless people) as well as two resettlement farms, the farm boundaries need to be checked regularly. Throughout the year this effort is not possible on a daily basis. First of all the total fence line is about 70 km, secondly some parts of the fence are difficult to access, and thirdly there is simply no time for the limited number of farm staff to do this. During expedition it is a great asset to the study site to have the manpower necessary to check parts of the border fence every day. Scientifically this activity aims to gather information about large carnivore tracks entering or leaving the core area and about poaching activity.

d) Whilst spoor counting is conducted to establish an index for true population density, spoor tracking provides important data on the behavioural ecology of the study animals. The spoor tracking team can detect new marking trees, mating or hunting activities, sleeping places, encounters with other individuals or additional information. Especially the discovery of marking trees or fresh kills raises the probability of target species capture, since these places are convenient spots for locating box traps. Finding those places is one of the foundations for a successful study.

e) Wildlife populations on Namibian farmland are influenced by various factors such as drought, disease, predation, live capture, trophy hunting and poaching. Each of these factors affect certain parts of a population, e.g. predators kill young, very old or sick animals; trophy hunting mainly takes old males, and live capture removes whole breeding units. Sustainable management of natural resources needs a scientific approach, and long-term monitoring of the population structure of the dominant game species is a very important tool to achieve this. This is why observation at waterholes are performed.

f) Since large carnivores on Namibian farmland live very secretive lives, investigations of their behavioural ecology require indirect sampling methods, rather than depending on direct observations. Nevertheless cheetah, leopard or hyaena sightings take place from time to time. Apart from being very exciting events these sightings also provide important scientific data that need to be recorded and analysed.

2.9.2. Methodology

GIS (Geographic Information System) software is a very useful tool to analyse and visualise geographical factors as well as biological findings. In this study ArcView 3.2 software was used for mapping and spatial data analyses.

a) Mapping of infrastructure such as fences, farm roads, watering places, buildings or the landing strip was performed with help of a Garmin GPS. Field data were a set of x and y coordinates (format: hd.ddddd°) in the WGS 84 system. Every day these data were transferred from the GPS to the computer. Raw data were downloaded as maps and saved as text files using the OziExplorer programme. Text files were then exported to Excel for conversion and from there to ArcView. After importing into ArcView 3.2 the text files had to be transformed into shape files for further processing.

b) To survey the vegetation at Okomitundu we first classified five different vegetation types. Two of them were subdivided into “open” or “closed” according to the density of cover.

- Woodland (open) trees and grass, no shrubs, less than 30% trees
- Woodland (closed) trees and grass, no shrubs, more than 30% trees
- Tree and shrub savannah mixture of trees and shrubs with grass
- Shrub savannah (open) shrubs and grass, no trees, less than 30% shrubs
- Shrub savannah (closed) shrubs and grass, no trees, more than 30% shrubs
- Montane vegetation typical community of plants that occur on and around mountains or rocky outcrops
- Watercourse woodland big trees along dry riverbeds

Field data were then sampled using a Garmin GPS. Boundaries between two different types of vegetation were traced with a Land Rover or on foot. Data storage and data processing was conducted in the same way as described for infrastructure mapping (see above).

c) During the expedition in 2006 the border fence line was divided into different sections to be checked every morning. These segments were checked irregularly to keep the poachers guessing (the poachers would see through a regular pattern easily). A Land Rover was driven at low speed (max. 20km/h), and the team was accompanied by a bushman. The tracker and observers were standing on the platform. Each riverbed crossing the border, as well as each crawling hole dug underneath the fence were thoroughly investigated. When a cheetah, leopard or hyaena track was detected the date, time, GPS position, species, number of animals, sex and age class, freshness and direction of the track, and further comments were recorded in pre-printed data sheets. All damage to the fence was also recorded on the data sheet and reported to the farm manager, so that repairs could be carried out. Spoor data were entered into Excel for further processing with ArcView 3.2.

d) Each carnivore track found during morning activities was marked with a marking flag, and spoor tracking was carried out every afternoon of the same day. The spoor tracking team followed a carnivore track, selected by the local scientists backwards and forwards on foot. To ensure good data quality, a bushman joined the team. All relevant information was collected in pre-printed data sheets. These data were also entered into Excel for further processing with ArcView 3.2.

e) Every morning animals were observed at one of the water places. For successful data sampling, the Land Rover was parked some hundred metres away from the observation post. Besides it was important for observers to place themselves against the wind, wear camouflage clothes, remain quiet and move as little as possible. When an animal or a group of animals approached, sexes, age classes and number of individuals was recorded. Data were recorded in pre-printed data sheets and entered into Excel for further processing.

f) Occasionally carnivore sightings take place while working in the field. When this was the case, all relevant information such as date, time, GPS position, observer, species, number of animals, sex and age class, distance to the observer, and a brief description of the observation were recorded.

2.9.3. Results

The new study site at Okomitundu differs in landscape types, geology and soils, annual rainfalls, composition of plant species, population densities of indigenous game species as well as large carnivores from the previous Seeis study site (Table 2.9.3a).

Table 2.9.3a. Differences between the previous and the current study areas.

	SEEIS	OKOMITUNDU
Climate	Semi-arid	Arid
Annual rainfalls	400 - 450 mm	200 - 250 mm
Landscape	Predominantly flat, with hills and little mountains.	Many hills and mountains, rock outcrops.
Geology and soils	Sand, sandstone, limestone, schist	Granite, quartzite, slate
Vegetation	Camel thorn and thorn bush savannah (dense vegetation)	Tree and shrub savannah (open - dense)
Prey base	High density	Low - medium density
Dominant species	Hartebeest, kudu, springbok	Kudu, mountain zebra, oryx
Additional species	Oryx, warthog, steenbok, duiker, hares	Warthog, steenbok, duiker, springbok, hares, dassies
Large carnivores	Many cheetahs, low leopard density, few brown hyenas	Low cheetah density, many leopards, medium brown hyena density

a) The central coordinates of Okomitundu study site are 22°09'S and 16°16'E. It is about 180 km² in size and consists of a game-proof fenced area (95 km²), which is the western part of the farm, and a cattle-proof fenced area (85 km²), which is situated east of the main buildings.

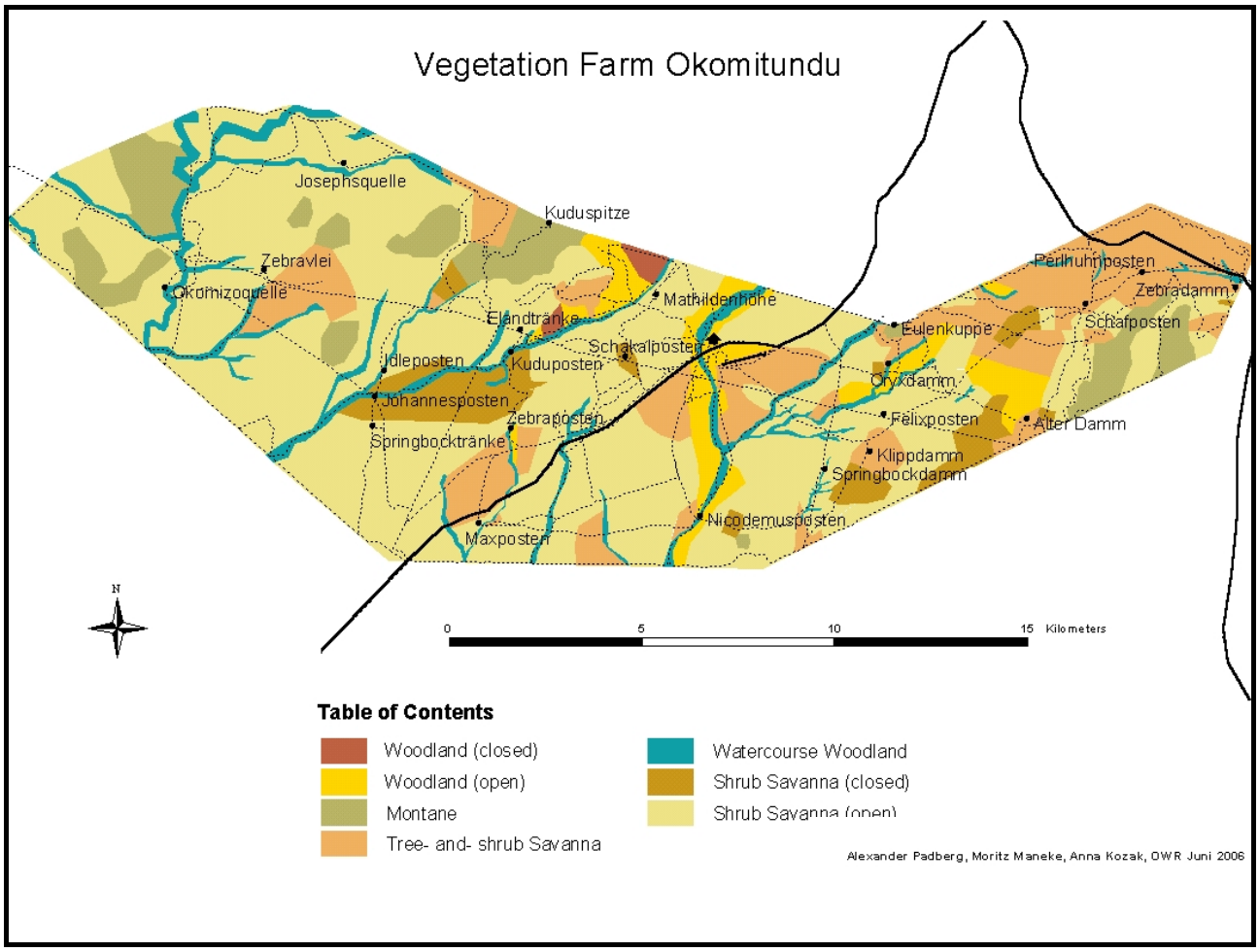


Figure 2.9.3a. Vegetation map of the study site. The two areas are divided by the district road (D1967) that runs from Wilhelmstal to Otjimbingwe. Okomitundu being is a game farm, so few internal fences exist. One camp in the eastern part of the farm is used to keep some goats and cattle, as well as about 20 horses. Another camp in the western part serves to habituate game animals that are introduced to the game-proof fenced area. A basic farm map of the infrastructure is presented in chapter 2.2. (Figure 2.2b).

b) Large parts of Okomitundu are covered with open shrub savannah, followed by tree and shrub savannah and mountain vegetation (Fig. 2.9.3a). The remaining parts are closed shrub savannah, open and closed woodland, as well as watercourse woodland. Characteristic plant species are shepherd's tree, trumpet thorn tree, grewia and justicia, as well as several acacia species like yellow-bark acacia, red thorn, black thorn and camel thorn.

c) During daily border fence checks in 2006 eight leopard tracks, five cheetah tracks and one hyaena track leaving or entering Okomitundu were found. These data are part of the spoors that were detected by chance and are already presented in chapter 2.5.3.

Regarding poaching, the first expedition group found several damages to the border fence in each of the six segments. Most of these damages were fixed within a few days. In the western part of the farm area very little damage to the border fence was detected during the following four expedition groups, whereas in the eastern part border fences were cut by poachers or destroyed by animals, zebra in particular, from time to time. Altogether the total number of poaching events declined from the first to the fifth expedition group.

d) In 2005 eight cheetah tracks, six leopard tracks and two hyaena tracks were followed on foot. In 2006 the expedition team followed 13 leopard tracks, 14 cheetah tracks and four hyaena tracks. In both years the average length of a track was about 400 m (range 70-900 m) before the track was lost in the grass or bush, but in some cases the carnivore spoors could be followed for up to 2 km. Spoor tracking predominantly revealed migration patterns of the study animals. In 2005 three new marking trees were detected, one hyaena dragged its prey over a long distance from the gravel road to the Apostle hills, and one meeting between a male leopard and a female with cub took place. In 2006 the male cheetah coalition hunted an adult kudu, but the hunt was not successful. One new marking tree was detected, and one resting place was found where a single male cheetah laid rolling in the sand in a dry river bed. In addition to this four drinking incidents could be recorded: one hyaena was drinking at the Nicodemusposten, one leopard used the water place at the Kuduposten, and the three cheetahs were found at the Zebraposten and at the Perlhuhnposten.

e) In 2005 the expedition team performed observations at water places or at elevated spots somewhere in the field on 33 days. Altogether 67 hours and 20 minutes were spent on this activity and the expedition team recorded a total of 427 sightings. The main species observed were kudu, oryx, hartebeest and warthog, followed by steenbok, springbok and zebra (Table 2.9.3b).

Table 2.9.3b. Observation data collected during the expedition in 2005.

	Kudu	Oryx	Warthog	Hartebeest	Steenbok	Springbok	Zebra	Other
Males	175	24	17	1	6	20	-	
Females	152	33	34	-	8	32	-	
Juveniles	31	20	42	9	-	14	1	
unknown	68	239	21	300	13	79	183	
Total no. of animals	426	316	114	310	27	145	184	
No. of observations	138	66	49	48	25	21	19	61

The expedition team collected useful data on kudu and warthog. From 426 kudu, 358 could be classified into males, females and juveniles, while 16% of the animals' sex remained unknown. Since sexes are easy to distinguish by their horns (or absence thereof) in adult kudu, unknown animals are considered to be subadults. The ratio between adult male and female kudu was 1.14:1 and 20.4% of the females were accompanied by youngsters. From 114 warthog, 93 could be classified into males, females and juveniles, while 18.4% of the animals' sex remained unknown. The ratio between male and female warthog was 0.5:1, and an average of 1.24 (range 1 to 4) youngsters per female was recorded.

In springbok and steenbok about half of the observed animals could be classified into males, females and juveniles, whereas the other half remained unknown. In some other species the expedition team was not able to distinguish between the sexes. From 316 oryx, 310 hartebeest and 184 zebra 75.6% to 99.5% of the animals' sex remained unknown. These data can not be used to draw any conclusion about the population structure of these species.

In 2006 observations at water places were performed on 33 days. Although the expedition team spent a bit more time (71 hours and 38 minutes) on this activity than in the previous year, a total of 121 sightings were recorded only. This is 71.7% less than in 2005. The main species observed were kudu (148 animals), oryx (68 animals) and warthog (58 animals). In addition to this 19 jackal, 10 zebra, 3 springbok and 2 steenbok were sighted. Again the ratio between male and female kudu was approximately 1:1 (47 males/53 females). More than half of the females (58.5%) were accompanied by youngsters, and only 18 kudu sexes remained unknown. In oryx and warthog one third of the observed animals (33.8% and 29.3% respectively) could not be classified, and data of the other species were not sufficient to conduct analyses.

f) In 2005 the expedition team recorded six large carnivore sightings. Cheetah, leopard and brown hyaena were observed two times each (Table 2.9.3c). In 2006 two leopard sightings and one cheetah sighting occurred during the expedition.

Table 2.9.3c. Carnivore sightings at Okomitundu during the expeditions in 2005 and 2006.

Date	Time	GPS position	Species	No. of animals	Sex	Age	Dist.	Comments
2005 10-07	17:08	22°09'422'' S 16°14'487'' E	cheetah	4	1 adult female + 3 juveniles		50 m	cheetahs were resting in the grass, became aware of the people and ran away
2005 10-09	11:17	22°11'061'' S 16°20'291'' E	cheetah	3 (or 4 ?)	1 adult female + 2 juveniles (possibly 3 juv.)		140 m	cheetahs were walking towards a termite mound, climbed onto the mound, disappeared in the bush
2005 11-11	11:00	22°09'089'' S 16°15'247'' E	leopard	1	male	old adult	15 m	leopard was resting under a tree, got up, came to the road and stood in front of the vehicle before walking away
2005 11-11	19:00	22°09'397'' S 16°15'360'' E	leopard	1	female	young adult	400 m	leopard was running through the bush (sex confirmed by spoor)
2005 11-17	23:30	22°11'113'' S 16°21'837'' E	hyaena	1	?	adult	60 m	hyaena came from NE to the watering place (Alter Damm), drank noisily for some minutes and left to NE again
2005 11-18	22:00	22°10'508'' S 16°19'439'' E	hyaena	1	?	adult	50 m	hyaena walked through the bush, looked at the vehicle and disappeared in the dark
2006 09-20	16:42	22°09'196'' S 16°16'302'' E	leopard	1	female	young adult	30 m	female sat next to box trap with a male in it, became aware of people, got up and walked away
2006 09-27	17:55	22°08'354'' S 16°16'214'' E	leopard	1	male	adult	60 m	leopard crossed farm path, crawled through fence and entered neighbouring farm
2006 11-14	18:31	22°10'675'' S 16°13'827'' E	cheetah	3	male	adult	1000 m	cheetahs walked along tree line, stopped at a tree, two looked at the vehicle (all 3 radio-collared)

2.9.4. Discussion

At first sight it may seem that the above research activities do not reveal any important results, but this appearance is deceptive. Generally, we find scientific studies being a kind of puzzle: some data and results are more spectacular than others, but the inconspicuous pieces are also needed to complete the puzzle. For example several surveys such as mapping the infrastructure and the vegetation are essential to work in the field and to interpret the data collected. Working in the field with a GPS and processing these data with GIS software require a large amount of time and manpower, but the result is "just" a map. In contrast to this, each encounter with a free-ranging carnivore is much more exciting.

Although observational data of some species such as oryx, zebra or hartebeest can not be used for analyses of population structure, they give us additional information on the abundance and availability of potential prey animals. They match with results of the game counts, and taken together they help to explain habitat preferences or migration patterns of the large carnivores. Nevertheless the training of interns and volunteers in recognizing differences between the sexes in 'difficult' species should be improved for further expeditions.

As a result of checking the border fence we assume that poaching is a serious threat to the study site, but quantification of game losses due to poaching activities seems to be nigh on impossible. Co-operation between the expedition in 2006 and the farm manager of Okomitundu worked quite well. Most of the damages to the border fence, which were reported to the manager, were repaired within a few days. Some of the fences were cut by poachers again. Nevertheless, daily checks of the border fence was considered to be successful, because the number of indirect signs of poachers such as spoors of dogs and donkeys or damage to the border fence declined from the beginning to the end of the expedition. At the same time it became clear that fighting against poaching activities is very time and cost consuming. We feel that effective and efficient control of poaching cannot be permanently guaranteed through the daily farm management and/or research activities. Thus we propose to employ a professional anti-poaching unit.

2.10. General discussion and conclusions

Capture activities in the Seeis region (July 2002 to April 2005) and at Okomitundu (July 2005 to November 2006) revealed a totally different composition of large carnivore species. In the Seeis region 70 cheetahs and four leopards went into the box traps, whereas at Okomitundu seven cheetahs, six leopards and two brown hyaenas were caught. This difference is most likely due to the different habitat conditions: Okomitundu is more arid and mountainous than Seeis and it harbours lower densities of potential prey animals. On Namibian farmland the leopard is the only inter-specific competitor to the cheetah and as a result cheetahs should prefer areas with low leopard density.

Data from this study, as well as results obtained by CCF and AfriCat (Conradie 2006, Marker et al. 2003a), reveal that the demography of Namibian cheetahs differs from their conspecifics in protected areas (Caro 1994, Laurenson 1995). Above all the Namibian cheetah population contains many more young animals than are found in the Serengeti. Looking at factors that drive population regulation, we find totally different situations: in national parks lions and spotted hyaenas kill a large proportion of the cheetah offspring (Laurenson 1995), whilst in Namibia farmers predominantly exert pressure on the adult population (Marker et al. 2003a; personal observation). The sex ratio between captured juvenile cheetahs was nearly 1:1, whereas the sex ratio between adult cheetahs was strongly biased to males. It is our belief that this bias is more likely to be an artefact of trapping the study animals at marking trees, rather than reflecting the true wild population demography.

Our investigation of the carnivores' use of space (with the aid of radio tracking) results show that cheetahs have very large home ranges and that the home ranges of individuals overlap substantially. Male cheetah coalitions of two to three animals use small home ranges (60 to 170 km²) and appear to hold territories, whereas single males roam over very large areas up to 2000 km² with an average of 837 km². Home range sizes of female cheetahs are 230 to 480 km² and they vary with the reproductive status. When the females are in oestrus they use larger areas, but when they have cubs they range in small areas. The bigger the cubs grow, the larger the home range becomes. In contrast to this leopard home ranges are relatively small (20 to 400 km²) and overlapping of home ranges is less than in cheetahs (Balkenhol 2004).

The above results demonstrate that cheetah ecology on Namibian farmland generally makes it difficult to use spoor counts as an indirect sampling method to determine true population density. Whilst it is relatively easy to determine how many different individuals range on a specific farm over a certain time period (e.g. 12 months), it is difficult to estimate the true population density (i.e. how many cheetahs live simultaneously in a defined area?).

Considering the statistically small sample size of all spoor data sets collected during the past and present expeditions, we may reach our goal to determine indices for population densities. In the Seeis region (2005) spoor data of 16 cheetahs led to the result that one individual cheetah produces a spoor density of 0.53 spoors per 100 km² and a spoor frequency of 188.8 km per spoor. At Okomitundu (2005) data of nine cheetahs resulted in similar figures: one individual cheetah produced 0.54 spoors per 100 km² and on average 185.4 km were needed to detect a spoor of this cheetah. Similar figures apply to the leopard: in 2005 spoor data of five leopards led to the result that one individual leopard produced a spoor density of 0.44 spoors per 100 km² and a spoor frequency of 228 km per spoor. In 2006 spoor data of eight leopards also resulted in a spoor density of 0.44 spoors per 100 km², and on average 229 km were needed to detect a spoor of this leopard. If we could underpin these figures at Okomitundu and in another study area, we might be able to estimate population densities for the entire commercial farmland in Namibia just by conducting spoor counts in different study sites. We would also be able to monitor trends in the population densities, which would be an invaluable asset for the conservation of large predators outside protected areas.

Most of the carnivore species live solitary (Nowell & Jackson 1996), but some of the large predators (e.g. lions, spotted hyenas and wild dogs) form groups (Estes, 1997). Caro (1994) described the cheetah as a species that contributes to a general understanding of sociality among carnivores. Eaton (1978) hypothesised that inter-specific competition suppresses grouping by cheetahs. This theory is based on the fact that cheetahs are disadvantaged by their morphology, which makes them vulnerable in confrontation with other, stronger, carnivores. The cheetah would never be able to defend itself, its cubs or its prey against lions, spotted hyaenas or wild dogs. In protected areas, where inter-specific competition is high, it appears to be the better strategy, especially for females, to avoid other predators by living solitary and secretive. If Eaton's theory is right, the absence of competitors may allow sociality in cheetahs. Accordingly, advantages of sociality like increased hunting efficiency and reproductive success are reassessed, due to a low inter-specific competition on commercial farmland in Namibia. Our results confirm this at least for male cheetahs, whereas females seem to prefer solitary lives.

Results from DNA analyses still outstanding from the IZW will provide information on genetic diversity, kinship, paternities, etc. For instance, they are likely to elucidate whether male cheetah coalitions are always brothers or whether these males are not necessarily related. If they are brothers, this would explain why Serengeti cheetahs live mainly solitary, rather than being social: since cheetah infants suffer high mortality caused by lions and spotted hyaenas (Laurensen et al. 1992), male cheetahs in national parks seldom, if ever have brothers.

Preliminary results of blood analyses revealed that free-ranging large carnivores on Namibian farmland are healthy and in a good to excellent condition. Furthermore, they reproduce well (Schulze & Lonzer 2006). More detailed information such as results of ultrasonography will be published by the IZW.

Conservation issues

Captive cheetah populations are faced with several health and reproductive problems: males were found to have high levels (71-76%) of abnormal sperm (Wildt et al. 1987), females conceived infrequently (Wildt et al. 1993), cub mortality was comparatively high (Marker & O'Brien 1989) and susceptibility to diseases is also high (Evermann et al. 1988, O'Brien et al. 1985). In the late 1980s it was recognised that the captive cheetah population in North American zoos was not self-sustaining (Marker & O'Brien 1989). Several molecular studies were conducted and a very low genetic variability of cheetahs was found (O'Brien et al. 1983, 1985, 1987).

Generally, inbreeding depression can result in poor reproductive performance in both sexes, high juvenile mortality and high susceptibility to diseases. O'Brien et al. (1983) suggested that the genetic monomorphism of cheetahs is the result of a so called demographic bottleneck. They further suggested that the more recent decline in the global cheetah population led to inbreeding between related individuals in small isolated populations. It was thought that these events were the reason for the observed inbreeding depression in captive cheetahs (O'Brien et al. 1985, 1987). Several studies cast doubt on the methodology applied and/or the results obtained by O'Brien (Caughley 1994, Lindburg et al. 1993, Merola 1994). Instead they proposed that many of the effects such as infertility, reduced litter sizes and increased susceptibility to diseases are limited to captive cheetahs and may be explained as artefacts of captivity. Merola (1994) suggested that the genetic make-up of the cheetah is a species-specific trait and not the result of a bottleneck. He states that terrestrial carnivores exhibit generally low genetic diversities (average 9%) and several carnivore species exhibit lower levels of heterozygosity and polymorphism than the cheetah does.

However, the cheetah's relative genetic monomorphism is potentially important to its conservation, but to date there is no evidence that the health and reproduction of wild populations are compromised. A study on free-ranging cheetahs in the Serengeti revealed that all adult females were reproducing and able to conceive within three weeks after the loss of a litter (Laurenson 1992). The current study shows supports the conclusions of Schulze & Lonzer (2006) in finding that the Namibian free-ranging cheetah population is healthy and reproduces very successfully.

Namibia is endowed with a variety of wildlife species living outside of protected areas on private farmland. Farmers do not take advantage of living with herbivore species only, but also carry the costs of living with large carnivores. In terms of conservation we propose that researchers frequently communicate their findings to the resident farmers to sensitise them to problem animal issues and discuss ways in which both parties can cooperate to reduce conflicts between farmers and large carnivores.

On the one hand factors like bush encroachment, a problem that applies to commercial farmland in Namibia (De Klerk 2004), have been considered to be detrimental to cheetahs (Mills 1991, Myers 1975), because hunting efficiency is reduced. On the other hand farming activities of European settlers led to permanent availability of food and water. Another crucial factor of the Namibian farmland habitat is the lack of lions and spotted hyaenas, which leads to a high survival rate of cheetah cubs (Joubert & Mostert 1975, McVittie 1979, personal observation). Our conclusion is therefore that at present we do not think that persecution by humans is a serious threat to the Namibian cheetah population. If this would be the case Namibia could not maintain, or even increase, the largest cheetah population in the world - but evidence shows clearly that it does.

Before moving to the Okomitundu study site we considered the density of the prey base to be medium (see 2.2.). After two years at Okomitundu we find that the availability of prey is low, especially on open farmland, compared to other regions in Namibia. Naturally, this also limits large carnivore densities. On the one hand Okomitundu is situated in a semi-arid climate zone, which results in a lower grazing and browsing capacity than in other regions. On the other hand frequent poaching activities put pressure on game populations. Results of the game counts conducted during the expeditions in 2005 and 2006 demonstrate that potential prey animals on open farmland react to environmental factors, whereas game densities within the game-proof fenced area did not change significantly. Game animals within this area can not move and they have to cope with the given conditions. As a result prey availability is maintained and large carnivores benefit from this. If the management of game-proof fenced areas is done well (see 2.6.4.), such areas may be very suitable conservation tools for rare or endangered species in particular.

Persecution of large carnivores by humans, which was considered to be low to medium at the new study site (see 2.2.), is at least medium, or even high. Okomitundu protects large carnivores, but it is surrounded by several farmers that conduct trophy hunting on cheetahs and leopards. None of us like the fact that someone should come and kill these animals for pleasure, but the phrase “what pays stays” is a truth that needs to be accepted. We therefore support sustainable management of large carnivores, which also includes non-consumptive (e.g. photo tourism) and consumptive (e.g. trophy hunting) utilisation. Trophy hunting is controlled and limited through international agreements such as CITES and we are of the opinion that it is an important conservation tool, rather than a threat to the Namibian cheetah or leopard population. Nevertheless, it may cause local problems to the population structure or social organisation of the animals, if too much hunting in certain areas takes place. Our recommendation is therefore to better co-ordinate and to distribute trophy hunting on large carnivores on a national scale. Okatumba Wildlife Research has communicated this recommendation to the LCMAN (Large Carnivore Management Association of Namibia) and from there it will be followed up together with the Permit Office of the MET (Ministry of Environment and Tourism)

Further research

Habitat use is an important variable that influences spoor counts on roads. In a homogeneous habitat large carnivores would use roads at random, but in a heterogeneous habitat, such as the Okomitundu study site, cheetahs, leopards and hyaenas prefer certain areas and therefore spoor frequencies are not random. In addition, sampling effort must be as high as possible, as it is a crucial point for data analyses (Stander 1998). The more transects are counted and the longer these transects are, the better the accuracy and precision of spoor frequency calculations. This is why spoor counts have to be conducted throughout the year and why data gathered during the expeditions in 2005 and 2006 are not analysed as single data sets, but will be included in long-term data analyses to determine an index for true population density.

Whilst leopards use comparatively small home ranges only, cheetahs range over very large areas. Therefore space use of leopards could be monitored by use of ground telemetry, but determination of cheetah home ranges requires aerial radio tracking. Since aerial tracking is very costly, it is only worthwhile when more than ten study animals are radio-collared at the same time. Since this prerequisite might not be reached at Okomitundu study site due to low cheetah numbers, it may be pertinent to switch to GPS collars. This technology would also provide additional useful information, to assess not only space use, but activity patterns of the study species too.

Cheetahs, leopards and other carnivore species are often blamed by farmers for stock losses (goats, sheep and calves up to eight months), which results in indiscriminate killing of these carnivores (Marker et al. 1996, personal observation). Continuous determination of life history and demographic parameters such as sex ratios, age and social structure, litter sizes and survivorship need to establish whether the level of removal threatens the long-term viability of the populations.

One important step in solving conflicts between farmers and large carnivores is to provide reliable data on feeding habits and diet. On the one hand we are looking forward to the results of the IZW (Institute for Zoo and Wildlife Research), on the other hand we may try to collect and analyse as many faecal samples as possible from captured study animals as well as from marking trees or elsewhere in the field. The respective large carnivore species can be determined by predator hairs that are ingested during grooming. The more often it will be revealed that large carnivores rarely prey on livestock, the better it is.

Collaboration with Biosphere Expeditions

Before start of the first expedition in 2002 we were sceptical about volunteer programmes, but after five years with Biosphere Expeditions we consider the combined team labour and funding approach to be an excellent concept. Each expedition team consisted of highly motivated people who came in their holiday time to support us as research assistants. The work they put in and their expedition contribution helped us to gather large amounts of data, which would not have been collected without them. Besides that we receive in-kind support such as, for example, the Land Rovers and this allows us to work with equipment or to employ sampling methods, which would not be possible without Biosphere Expeditions. The post-expedition questionnaires showed that the expeditions in 2005 and 2006 were a real asset for all concerned. Local scientists received important assistance for their conservation work and team members increased their knowledge about habitats and/or species and gained some real hands-on research experience.

Some field techniques like checking box traps or searching for marking trees are easy to learn, whilst others like game counts, spoor tracking or radio telemetry require the acquisition of some specialised skills. The kind of standardisation whereby one person always samples the same data is impossible during an expedition, because all team members understandably want to take part in all research activities. Some data are more vulnerable to errors and quality problems than others and each expedition data set needs to be assessed on a case-by-case basis. In general, however, this is not a significant problem, as we have to be aware that the carnivore project is a long-term study, and most of the key questions require continuous data collection over a time period of several month or even years.

Much money and effort is spent to get the expeditions off the ground and to collect a large amount of data. Entering these data into a database is crucial to the success of the expedition. If this is not done, parts of the research may be lost, and the money and the manpower to conduct it are wasted. Therefore, every afternoon all data collected by the expedition team from the morning and from the previous afternoon were entered into a laptop. Team members worked successfully and field data collected during expeditions will contribute to increase our knowledge about cheetah, leopard and brown hyaenas living in co-existence with Namibian farmers.

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Appendix 1: List of mammals at Okomitundu

1 Aardvark *Orycteropus afer* Erdferkel
2 Aardwolf *Proteles cristatus* Erdwolf
3 African wild cat *Felis lybica* Afrikanische Wildkatze
4 Banded Mongoose *Mungos mungo* Zebramanguste
5 Bat-eared Fox *Otocyon megalotis* Löffelhund
6 Black wildebeest *Connochaetes gnou* Weißschwanzgnu
7 Black-backed Jackal *Canis mesomelas* Schabrackenschakal
8 Blesbok *Damaliscus dorcas phillipsi* Blessbock
9 Blue Wildebest *Connochaetes taurinus* Streifengnu
10 Brown Hyaena *Hyaena brunnea* Braune Hyäne
11 Caracal *Felis caracal* Karakal (Wüstenluchs)
12 Chacma baboon *Papio ursinus* Tschakma-Pavian
13 Cheetah *Acinonyx jubatus* Gepard
14 Common duiker *Sylvicapra grimmia* Kronenducker
15 Eland *Taurotragus oryx* Elanantilope
16 Gemsbok *Oryx gazella* Oryx (Spiessbock)
17 Ground squirrel *Xerus inauris* Erdhörnchen
18 Honey Badger *Mellivora capensis* Honigdachs
19 Impala *Aepyceros melampus* Schwarzfersenantilope
20 Klipspringer *Oreotragus oreotragus* Klippspringer
21 Kudu *Tragelaphus strepsiceros* Großer Kudu
22 Leopard *Panthera pardus* Leopard
23 Mountain Zebra *Equus zebra* Bergzebra
24 Pangolin *Manis temminckii* Schuppentier
25 Porcupine *Hystrix africaeaustralis* Stachelschwein
26 Red hartebeest *Alcelaphus buselaphus* Kap-Hartebeest/ Kuhantilope
27 Rock dassie *Procavia capensis* Klippschliefer
28 Scrub hare *Lepus saxatilis* Buschhase
29 Slender Mongoose *Galerella sanguinea* Schlanke Manguste
30 Small-spotted Genet *Genetta genetta* Kleinfleckenginsterkatze
31 Springbok *Antidorcas marsupialis* Springbock
32 Springhare *Pedetes capensis* Springhase
33 Steenbok *Raphicerus campestris* Steinbock
34 Striped Polecat *Ictonyx striatus* Zorilla
35 Suricate *Suricata suricata* Erdmännchen
36 Tree squirrel *Paraxerus cepapi* Ockerfuss-Buschhörnchen
37 Warthog *Phacochoerus aethiopicus* Warzenschwein
38 Waterbuck *Kobus ellipsiprymnus* Wasserbock
39 Yellow Mongoose *Cynictis penicillata* Fuchsmanguste

Appendix 2: List of birds at Okomitundu

1 Acacia Pied Barbet *Tricholaema leucomelas* Rotstirnbartvogel
2 African Grey Hornbill *Tockus nasutus* Grautoko
3 African Hawk Eagle *Hieraaetus spilogaster* Habichtsadler
4 African Hoopoe *Upupa africana* Wiedehopf
5 African Red-eyed Bulbul *Pycnonotus nigricans* Maskenbülbül
6 Amethyst Sunbird *Chalcomitra amethystina* Amethystglanzköpfchen
7 Ant-eating Chat *Myrmecocichla formicivora* Termitenschmätzer
8 Barn Owl *Tyto alba* Schleiereule
9 Bearded Woodpecker *Dendropicos namaquus* Namaspecht
10 Black-breasted Snake Eagle *Circaetus pectoralis* Schwarzbrust-Schlangenadler
11 Black-cheeked Waxbill *Estrilda erythronotos* Elfenastrild
12 Black-chested Prinia *Prinia flavicans* Brustbandprinie
13 Black Eagle *Aquila verreauxii* Felsenadler
14 Black Harrier (?) *Circus maurus* Mohrenweihe
15 Black Kite *Milvus migrans* Schwarzer Milan
16 Black Korhaan *Eupodotis afraoides* Gackeltrappe
17 Black-shouldered Kite *Elanus caeruleus* Gleitaar
18 Black-throated Canary *Serinus atrogularis* Angolagirlitz
19 Blacksmith Plover *Vanellus armatus* Waffenkiebitz
20 Booted Eagle *Hieraaetus pennatus* Zwergadler
21 Bronze-winged Courser *Rhinoptilus chalcopterus* Bronzeflügel Rennvogel
22 Brown-throated Martin *Riparia paludicola* Afrikanische Uferschwalbe
23 Burchell's Sandgrouse *Pterocles burchelli* Fleckenflughuhn
24 Cape Glossy Starling *Lamprotornis nitens* Rotschulterglanzstar
25 Cape Sparrow *Passer melanurus* Kapsperling
26 Cape Turtle Dove *Streptopelia capicola* Kapturteltaube
27 Chestnut-vented Titbabbler *Parisoma subcaeruleum* Meisensänger
28 Common Ostrich *Struthio camelus* Strauß
29 Crimson-breasted Shrike *Laniarius atrococcineus* Rotbauchwürger
30 Crowned Plover *Vanellus coronatus* Kronenkiebitz
31 Double-banded Sandgrouse *Pterocles bicinctus* Nachtflughuhn
32 Dusky Lark *Pinarocorys nigricans* Drosslerche
33 Dusky Sunbird *Cinnyris fusca* Rußnektarvogel
34 Giant Eagle Owl (?) *Bubo lacteus* Milch-Uhu
35 European Bee-Eater *Merops apiaster* Europäischer Bienenfresser
36 European Swallow *Hirundo rustica* Rauchschwalbe
37 Fork-tailed Drongo *Dicrurus adsimilis* Trauerdrongo
38 Gabar Goshawk *Melierax gabar* Gabarhabicht
39 Golden-breasted Bunting *Emberiza flaviventris* Gelbbauchammer
40 Great Sparrow *Passer motitensis* Rotbrauner Sperling
41 Greater Striped Swallow *Hirundo cucullata* Streifenschwalbe
42 Grey Lourie *Corythaixoides concolor* Graulärmvogel
43 Groundscraper Thrush *Psophocichla litsitsirupa* Akaziendrossel
44 Helmeted Guineafowl *Numida meleagris* Haubenperlhuhn
45 House Martin *Delichon urbica* Mehlschwalbe
46 House Sparrow *Passer domesticus* Haussperling
47 Kalahari Robin *Cercotrichas paena* Kalahariheckensänger
48 Kori Bustard *Ardeotis kori* Riesentrappe

49 Lappet-faced Vulture *Torgos tracheliotus* Ohrengeier
50 Laughing Dove *Streptopelia senegalensis* Senegaltaube
51 Lesser Kestrel *Falco naumanni* Rötelfalke
52 Lilac-breasted Roller *Coracias caudata* Gabelracke
53 Marico Flycatcher *Bradornis mariquensis* Maricoschnäpper
54 Marico Sunbird *Cinnyris bifasciata* Bindennektarvogel
55 Martial Eagle *Polemaetus bellicosus* Kampfadler
56 Melba Finch *Pytilia melba* Buntastrild
57 Monteiro's Hornbill *Tockus monteiri* Monteirotoko
58 Mountain Chat *Oenanthe monticola* Bergschmätzer
59 Namaqua Dove *Oena Capensis* Kaptäubchen
60 Namaqua Sandgrouse *Pterocles namaqua* Namaflughuhn
61 Olive Bush Shrike *Telophorus olivaceus* Olivwürger
62 Ovambo Sparrowhawk *Accipiter ovampensis* Ovambosperber
63 Pale Chanting Goshawk *Melierax canorus* Weißbürzelsinghabicht
64 Pale-winged Starling *Onychognathus nabouroup* Bergstar
65 Pearl-breasted Swallow *Hirundo dimidiata* Perlbrustschwalbe
66 Pearl-spotted Owl *Glaucidium perlatum* Perlkauz
67 Pied Babbler *Turdoides bicolor* Elsterdrossling
68 Pied Crow *Corvus albus* Schildrabe
69 Pygmy Falcon *Polihierax semitorquatus* Zwergfalke
70 Pririt Batis *Batis pririt* Piritschnäpper
71 Red-backed Shrike *Lanius collurio* Neuntöter
72 Red-billed Buffalo-weaver *Bubalornis niger* Büffelweber
73 Red-billed Francolin *Pternistes adspersus* Rotschnabel Frankolin
74 Red-billed Hornbill *Tockus erythrorhynchus* Rotschnabeltoko
75 Red-billed Quelea *Quelea quelea* Blutschnabelweber
76 Red-crested Korhaan *Eupodotis ruficrista* Rotschopftrappe
77 Red-faced Mousebird *Urocolius indicus* Rotzügelmausvogel
78 Rock Kestrel *Falco rupicolis* Turmfalke
79 Rock Martin *Hirundo fuligula* Felsenschwalbe
80 Rosy-faced Lovebird *Agapornis roseicollis* Rosenpapagei
81 Rüppell´s Parrot *Poicephalus rueppellii* Rüppellpapagei
82 Shaft-tailed Whydah *Vidua regia* Königswitwe
83 Short-toed Rock Thrush *Monticola brevipes* Kurzzehenrötel
84 Southern Grey-headed Sparrow *Passer diffusus* Graukopfsperling
85 Southern Masked Weaver *Ploceus velatus* Maskenweber
86 Southern White-crowned Shrike *Eurocephalus anguitimens* Weißscheitelwürger
87 Steppe Buzzard *Buteo buteo vulpinus* Mäusebussard
88 Swallow-tailed Bee-Eater *Merops hirundineus* Schwalbenschwanz-Bienenfresser
89 Tawny Eagle *Aquila rapax* Raubadler
90 Violet-eared Waxbill *Granatina granatina* Blaubäckchen
91 Wahlberg's Eagle *Aquila wahlbergi* Wahlbergadler
92 White-backed Mousebird *Colius colius* Weißrückenmausvogel
93 White-backed Vulture *Gyps africanus* Weißrückengeier
94 White-browed Sparrow-weaver *Plocepasser mahali* Mahaliweber
95 White-faced Scops Owl *Ptilopsus granti* Weißgesichtohreule
96 Yellow-billed Hornbill *Tockus leucomelas* Gelbschnabeltoko
97 Yellow Canary *Serinus flaviventris* Gelbbauchgirlitz

Appendix 3: List of daily research activities

2005

Vehicle no	Morning	Afternoon
1	Spoor count + Western box traps	Game count
2	Eastern box traps + Transect 4	Data entry
3	(Springbok) Observation	Searching for marking trees
4	Radiotelemetry	Spoor tracking (on foot)

2006

Vehicle no	Morning	Afternoon
1	Spoor Count on Transects	Radiotelemetry
2	Checking Box Traps	Data entry
3	Checking Border Fence	Game Count
4	Observation at Water Places	Spoor tracking (on foot)

Appendix 4: 2005 expedition diary by expedition leader David Moore

24 September

Here's your first instalment of the Namibian "tales from the bush", not from your esteemed expedition leader David, but from me, Matthias Hammer, founder and Field Operations Director of Biosphere. David is still busy in Paris and I have arrived a few days ahead of him to set things up at the new study site.

This morning Harald, one of the lead scientists, and I went for a drive around the new study site. No prizes for guessing the weather (blue skies, bright sunshine and heat) and animals we came across (kudu, oryx, steenbock, ostrich), but the new site certainly is spectacular with rocky outcrops, acacia savannah and the odd mountain thrown in for good measure. The highest one is the "Kuduberg" (kudu mountain), with a hair-raising offroad drive to the top (and worse, down), and dramatic views over the study site and beyond.

At the moment base at Okomitundu is a hive of activity with supplies being shipped in, Land Rovers taken for a service, equipment inventoried and unpacked and all the many small bits that need to be organised before you all arrive.

The next diary entry will probably be David's, so I look forward to seeing the first team here in a few days and wish you all safe travels to Windhoek.

4 October

David, your expedition leader, here now: we have quite an international mix here for slot one and everyone is settled in to the farm. With the introduction talks and presentations now completed we're all split in to teams and ready to begin activities in the field from tomorrow morning.

Yesterday afternoon Matthias led the driving team out in to the field for their 4-wheel drive course whilst Hendrik took the non-drivers out for a reccee of the study site. Following the training course out in to the bush, along the sandy river bed and up through some stony terrain, we weren't back at base until past Dagmar's dinnertime. Whilst we had been in the vehicles getting to grips with the gear changes, Hendrik's team had spotted springbok, zebra, steinbok, kudu and hornbills.

This morning we covered the whole box trap route together, learning how to arm the traps and check for spoors. James had a nasty encounter with one of the many thorn bushes, but survived with all body parts intact. With the traps all in open position, we didn't have to practise any release techniques, but we did get a chance to familiarise ourselves with some different spoor we found on the way. Brown hyaena spoor were identified close to the box trap, which surrounds a tempting (at least for hyaena!) kudu carcass, and we also found really clear spoor from two (maybe three) cheetahs walking along the sand track, crossing the farm. Our route included the Apostelberge where the hyenas have their den. In general we'll leave these secretive creatures alone, not wanting to disturb them and cause them to leave the farm, but for today we stood for a few moments among their collection of baboon and jackal skulls just above their sleeping quarters.

Daniela will be leading the telemetry team this week, so I'll write the next instalment soon to let you know if we receive signals form any of our three already-collared cheetahs. If not I'm sure we'll content ourselves with the hornless oryx who hangs out near the swimming pool…

8 October

This afternoon completes the four-day cycle of activities, so by now all team members have had a chance to try their hand at all the activities and in the process uncover ample evidence of cheetah activity on the farm.

The most excitement was probably from Hendrik's game count team, which yesterday was lucky enough to observe a mother cheetah and her three cubs about 40 metres from the Land Rover on their afternoon route. This morning's telemetry team was then well rewarded for their climb up the rocky hill as they were able to pick up clear signals from the three collared male cheetahs that live and hunt together in a brother coalition and are currently on the neighbouring farm. In addition to this, every day throws up fresh reports of new cheetah, leopard and hyena spoor. Indeed today's spoor count team were able to follow a leopard track for 2 km, with the help of our local trackers, Alfred and Springhahn.

Yesterday some of the farm workers reported seeing a hyaena dragging a kill across the bush, though our afternoon follow-up failed to uncover any of the tracks. We did find plenty of donkey and dog tracks, however, a sign that poachers enter the farm at night (harmless for us, but not for the oryx).

Perhaps this disruptive poaching activity together with all the carnivore activity can explain the lack of springbok groupings for the springbok observation teams. The animals are present in small, distant numbers but never conveniently located for Stefan's observation programme!

On Wednesday we released a typically ferocious honey badger down by the dried-up damn who was more interested in clawing his liberator's shoes than making a hasty escape. Apart from that, traps have been empty, though fresh leopard and brown hyena tracks were found yesterday next to the river bed trap. Doubtless the animals are lured by the scent of rotting carcass, but are perhaps wary of passing through the box traps. We've undertaken some carefully thought-out box trap repositioning work, building up the thorn-bush kraals, which surround them and making them as enticing as possible for the local carnivore population!

11 October

With a large aardvark in the trap yesterday and a porcupine today (he was very reluctant to leave), there remains only the baboon and then we will have covered most of the non-study animals who are most likely to wander in to the traps during their night time foragings.

Though Sunday was our rest day, it didn't stop Liz and Jean-Luc from spotting themselves three cheetahs whilst out on their morning box trap round. Whilst some of the team chose to spend the rest of the day trying their hand at horse riding or resting at the farm, others were keen to be out in the bush so we took a drive down to a couple of waterhole observation points. Steenbok seemed to be order of the day, along with a cory bustard who demonstrated his impressive take-off technique. From her rocky lookout, Dagmar radioed in with news of a possible cheetah resting under a tree, but we were unsuccessful in uncovering tracks.

Yesterday afternoon we drove in convoy up to the top of Kuduberg, the closest mountain to the farm. Although we didn't receive telemetry signals from our three collared boys on this occasion, everybody enjoyed the stunning views across the African savannah with the farm buildings of Okomitundu the only signs of civilisation in sight (along with the small bushman drawings under the rocky outcrop on top of the mountain).

Today has thrown up yet more leopard and cheetah tracks, and by now many of the team members are getting familiar with the farm roads and the drivers are putting their off-road skills to the test!

It seems that the activity on the farm has also been successful in discouraging the poachers who have been active for the last two years from entering the property. Last Saturday's day time poachers were freaked by our responsive Land Rover, radio and binocular action and haven't been seen since.

I can hear the sound of chatter and laughter just outside as everybody is descending upon the patio fire area for dinner, so I'm going to join the team to hear the new tales from this afternoon…

16 October

The last week of slot one showed up countless spoor signs indicating a high cheetah presence on the farm. In fact a total of 13 different spoors were counted over the fortnight, some of which we were able to follow for kilometres down the river beds or across the bush. For those team members already familiar with the more common creatures, it was also an opportunity to add eland, dik-diks, jackals and caracal (caught in the river-bed trap on Thursday) to their sightings.

Several records have been set with Bob holding the 65s-and-over “ascent of telemetry hill” record and Jean-Luc being the presumed record holder for the largest amount of video footage ever taken on a Biosphere Expeditions study.

One of the most significant results from this slot for our scientists has been the spoor data indicating another coalition of three adult cheetahs on the farm. No telemetry signals were received this week from our existing collared coalition, but fresh spoor were picked up and followed across the site. It remains yet to be seen whether one of these animals will choose to visit a marking tree with a box trap and provide us with the opportunity to investigate them more closely. Perhaps the fact that the neighbouring farm is currently empty and therefore without water holes is encouraging movement on to our site and attracting the large carnivores.

The afternoon game counts have also shown great variation in results with some teams filling sheets of game on one afternoon and other teams barely seeing more than a smattering of steenbok.

Best wishes to our slot one team members off pursuing their own activities or back to their native countries and I’m looking forward to meeting the next team tomorrow morning…

22 October

A very active couple of days with our coalition of collared cheetahs currently on the farm.

Thursday's telemetry team picked up their strong signals from the top of Eulenkuppe, indicating that they were slightly to the south of the farm. The spoor and telemetry teams were out in force in the afternoon, though by the time their signals were picked up near Zebraposten it was too late to pull the teams together to attempt a closer follow-up. This opportunity presented itself on Friday afternoon as the morning activities showed that the cheetahs were still on the farm. In fact spoor showed that all three of them had been directly up to the Zebraposten box trap - unfortunately the trap had already been closed thanks to the night time activities of a curious mongoose whose offending spoor were also discovered entering the trap, triggering the mechanism and exiting through the bars.

Signals showed that the animals had moved 20 km or so during the night and were over in the Apostelberge by late Friday morning. We were also able to follow the spoors away from the Zebraposten trap and down to the fence line and off in the direction of these hills. With all teams pulling together in the afternoon the loud signals from the telemetry equipment indicated that we were within 500 metres or so of the cheetahs, but alas we had no success in spotting them or tracking them sufficiently to discover a new marking tree.

Our porcupine friend has however been back in the Alter Damm box trap and the meerkats seem to be more at ease with the passing Land Rover and are hence cooperating in providing photo opportunities. Most days also provide evidence of leopard spoor, yesterday's group finding fresh spoor just a few metres form one of the western traps. Infbact the databentry team, having finished their computer work, were busy preparing the bait when their bloody work was interrupted by the cheetah follow-up. Slot one's art-deco/minimalist box-trap design and positioning has (inexplicably) so far been unsuccessful in trapping any of the large carnivores, so we'll see if the slot two baiting technique will prove an opportunity to study one of these creatures more closely.

25 October

On Saturday afternoon we placed a large lump of kudu meat as leopard bait in a tree down near the driver training river bed. We had several buckets full of blood diluted with water which we trailed in several directions towards the bait. The idea is to allow the leopard to come and claim the bait and then follow its tracks to see where it takes it. Once the leopard then to feels comfortable with his possession of the meat we could place a trap around his meal. Hence we're checking the festering steak everyday to make sure it is still there!

There have been no more telemetry signals as the coalition we tracked last week must be a long way from the farm by now (perhaps we can expect them back in another ten days). There have been a couple of hyaena spoors located during morning spoor count and news has just come in of fresh leopard spoor this afternoon.

The game counts and observations show quite a lot of variety. This morning's springbok observation team saw one hundred animals from the hide at Alter Damm (41 kudu, 20 oryx, 20 springbok, 14 warthog, 2 steenbok, a jackal, a baboon and an ostrich) whereas Sunday's afternoon observation at the same place only threw up two timorous steenbok and a cory bustard!

Lots of animals in the traps, with baboons released from the Alter Damm trap three times since Saturday. Lorna is proving to be very able and willing when it comes to cleaning out the traps after the baboons. Yesterday's box trap team liberated an aardvark and two porcupines - the porcupines seem calmer now, perhaps they are getting used to it!

29 October

More carnivore spoors were uncovered in the course of slot two's second week here at Okomitundu with leopard spoor discovered on Wednesday morning leading directly up to the bait we had placed in the tree (the bait was left untouched, however). Also more cheetah and hyaena spoor on Wednesday as well as donkey and dog tracks from the poachers. Wednesday's box-trap team was also able to follow the spoor of a cheetah chase and see where the animal dug its claws in to the ground when gaining force.

Wednesday morning's Alter Damm observation again revealed a wide variety of animals with two fighting jackals and two copulating lizards stealing the morning show. We also had a porcupine in the trap down there on Thursday who refused outright to leave the trap and was still sitting there when we returned to rearm the trap in the afternoon. Some friendly prodding and he eventually made his escape and disappeared in a fury.

Thursday and Friday were quieter days with nothing from the telemetry and an absence of fresh spoors. There had been some rain about 20 km away, so it may be that the game moved away in search of water and pasture and that the carnivores have followed them. That's one theory. But the lack of activity in the field was compensated by extra action around the camp-fire and an opportunity for slot 2 to dazzle Harald and Birgit with their musical talents.

We also solved the 'Easter bunny mystery', with the identity of the unknown animals spotted by Alfred on the afternoon game count now established as a pair of pangolin.

With slot two now departed, I'm also off together with Stefan, Daniella, Hendrik and Sylvana to check out Swakopmund and Etosha during our one week break before the next team's arrival on 7 November. Looking forward to seeing you all then…

30 October

An exciting turn of events this morning, meaning we've delayed our departure for a few hours, so here's a quick diary entry to fill you in on the news:

Shortly after slot two's departure yesterday (as luck would have it ;-(), Harald received a call from the farmer on the neighbouring farm who had discovered two freshly killed young oryx, one of which had been partly eaten by a leopard. Harald, Hendrik, Silke and Meike, our new intern, drove over and placed one of our box traps around this kill (about 500 metres off our farm on the other side of the Apostelberge) in the belief that the leopard would come back to feed again. Such was the case - one leopard in the trap this morning!

Whilst Harald and Birgit have a lot of experience darting and collaring cheetahs, they preferred to have a fully qualified vet present for handling a large male leopard so a vet was called in to take charge of the intervention, flying down from Otjiwarongo and landing on the strip early afternoon. The leopard being a fully grown adult of 61 kg, we were able to dart and sedate him, take all the necessary swabs, measurements and blood samples and fit a radio collar. It was also discovered that the leopard had one leg which had been previously broken (perhaps from a snare) but that this had healed very well. Unfortunately he also chipped one of his front teeth in the trap. He was sedated for about half an hour before he was driven out into the bush where we were able to observe him through binoculars first moving his tail and then slowly waking up.

Over this next week those remaining on the farm will be able to monitor his movements through the telemetry signals to check that he has recovered from today's sedation. It should also make for interesting telemetry work over the weeks to come…

It’s Murphy’s law, I am afraid, that this has happened just as we are changing slots, but such is work out in the field with wild animals! I hope you won’t be too disappointed.

10 November

We're back in the swing here on Okomitundu farm with the twelve new team members now on their second full day out in the field. Yesterday proved quite a busy first day of activities with the morning throwing up tracks from three male cheetahs, tracks from a young leopard in the baited river bed and a baboon in one of the eastern traps.

The hill-top observation team didn't come across any springbok, but they did see just about everything else and they sprung in to crime scene investigation mode upon locating a two week old kudu carcass. Jackal and leopard tracks were found nearby, but cause of death unestablished.

Faint signals were picked up from the leopard on Tuesday with more success from the collared cheetah coalition by yesterday's telemetry team. The three brothers were moving around and the team were able to triangulate their movements and come up with a position on the neighbouring farm for the afternoon follow-up (they also found leopard tracks on the top of Eulenkuppe). The afternoon team approached close enough to get a strong all-round signal, but no sighting!

The afternoon spoor team also did well following a cheetah track off the road and in to the bush, leading to a marking tree with scat and cheetah hair about two kilometres away.

The Apostelberge trap set by slot one has now found a new position at a different water point (after it was removed to capture the leopard on the neighbouring farm), so we're waiting to see if its new position shows any favour.

So far all team members doing well, getting to grips with the driving and eager to see what other news the first week out in the field brings (no night-time gaming activity yet, but I think tonight might be the night).

12 November

Leopard encounters galore! First an exciting chance encounter with a leopard for yesterday's springbok observation team, giving Alan a chance to fill out a carnivore sighting sheet: 'Leopard resting under shade of dry tree. Animal moved to grass in front of vehicle when vehicle stopped. Behind grass for about a minute before walking away'. It seems the leopard was not too fazed by the vehicle, giving the team a chance to view him/her about 15 metres from the vehicle!

The afternoon provided yet another fleeting sighting when Harald led a group out in the field to follow up on the tracks where the sighting had taken place (a few hundred metres on the road past the driving practice riverbed). They were able to uncover tracks at several different locations, providing evidence of one male, one female and one juvenile leopard. These tracks were followed along the road before a big cat was spotted moving fast along the riverbed ahead. Today's spoor tracking team were able to reveal that this was a female leopard.

Alongside this exciting news, we've had almost daily baboon captures, new cheetah and leopard spoor and some good close-up sightings of the eland and their young. We've also moved a box trap to the new marking tree discovered last Wednesday. The cheetah coalition could still be picked up yesterday by the telemetry team on Eulenkuppe, though the collared leopard was quiet today despite extensive efforts around the Apostelberge.

17 November

A busy week with lots of action, highs and lows, mixed emotions. Our big news came on Tuesday. Harald and I were down near Windhoek meeting Trevor Nelson and his MTV camera crew, here to document Trevor's first trip to Africa, his 4 wheel drive experience and his time spent with us here on the expedition. Within an hour of meeting the film crew, we received a phone call from Birgit: news had just come in from the morning team, reporting a leopard capture in the eastern river bed box trap with the wildebeest bait.

The euphoria turned to disappointment when it was discovered that the particular individual captured was very old and in a very bad condition, thin and with many injuries from fighting with other leopards. He was clearly unsuitable for a radio collar and unlikely to survive the trauma of any darting / tranquilisation procedure. We decided to follow the advice of vets to simply release the animal. There are numerous reports of very sickly animals making unexpected recoveries and of course this way, nature would take its course.

This presented us with the challenging task of releasing a leopard from the cage. It cannot simply be released like any other animal, which would just run away, as the risk of a leopard turning and attacking is too high. So we used a kind of pulley system by which the door of the cage was raised by the force of a Land Rover driving away from behind the trap, thus giving the leopard, who was very reluctant to leave the trap, a chance to run free.

The rest of this week's trap activity would have been called a great success, if we were trying to capture baboons, who turned up daily inside the traps! The new vogue amongst them seems to be to dive back inside the kraal and up the tree upon release, meaning we need to leave the trap unarmed for a while so that the animal does not trap itself for a second time upon descent! We also had an unbelievable honey badger capture in which the crazed beast in the trap squeezed itself through the bars of the cage and made off whilst its liberator was on top of the trap and about to open the door!

Alongside all this we've been making night trips to the Alter Damm hide where visibility is good due to a full moon (aaaahh.full moon...this may explain lots of things.), but those left at base camp last night were not short of excitement as Trevor and his team were confronted by the largest-spider-in-the-history-of-Biosphere-Expeditions (at least in Namibia) whilst taking their turn in the dish washing room. Even the arachnophillic members of the team were impressed by its fangs and I wouldn't be surprised if it features prominently in their final programme!

20 November

More leopard news from the end of slot three with Thursday afternoon’s follow-up team getting close enough to our collared leopard to be able to identify on which Apostelberge outcrop it was sitting. Meanwhile we placed fresh leopard bait in both the riverbed location as well as at the spot where last week’s leopards had been spotted.

Success also on the brown hyaena front with Hervé, Laurence and Gill being our first to spot this species whilst on their evening observation at Alter Damm. Some of the team braved the cold to spend the night out on top of the hide.

Other good news has come in the form of a further two cheetah marking trees identified, Stefan and Lynne's breaking of the 'telemetry hill' record (6 mins 40 seconds), not to mention Alan and Janet's delight at their 25 cm millipede. This slot we've had seven baboons, one honey badger and a leopard in the traps. Axel and his team are accepting their zero capture rate with grace (and the large beetle trapped on Friday evening in Axel's trousers has been some compensation for his empty cages) – at least he is leading the way in the tortoise spotting department with two leopard tortoises among his surprise encounters.

On Friday afternoon it was discovered that the fresh bait placed in the location of last week's capture had already been taken and dragged up the riverbed by a female leopard. So more fresh meat has been placed there in a bid to familiarise the leopard with this place and allow her to take the meat before placing a trap there. With some important ground work covered over the past weeks, we're all feeling positive about more than just a baboon in the traps for the arrival of our fourth and final team tomorrow…

30 November

Sunday morning's blossoming so-called 'Queen of the Night' was the annual sure-sign of rains on the way and this was soon to be proved true by the afternoon's hail storm and thunder. Perhaps it forced the warthogs drinking at Alter Damm to take shelter as by mid-afternoon there was a large male awaiting release from the box trap under the tree there.

On Saturday afternoon we placed another bait in the trap, confident that a leopard or hyaena would return over the coming days. Each day the box trap team were disappointed by the empty cages, but at least encouraged by the fact that there was no spoor at all (meaning that at least the animal had not been put off by the presence of the trap round the bait). Today's box trap team had more excitement (and frustration) upon finding fresh hyaena spoor right up to the baited trap on both sides, even putting one of its paws inside the cage, before digging a hole under the cage. Still the trap was open. Spoor marks were then also found going directly up to the gate of the other baited trap.

Monday's drive up Kuduberg (or 49 minute walk in the case of Linda and Tim) was rewarded by signals from the cheetahs as well as numerous kudu sightings and a herd of mountain zebra. Although night vision was bad for Monday's Alter Damm sleep-out team, those who woke up early were able to see a scavenging jackal and a steenbok. The telemetry teams have also had success from the collared leopard, sometimes pursuing him on to the neighbouring farm. They have also been developing their new 'telemetry drive' method form the roof of the Land Rover. Observations vary from Monday's measly Egyptian goose and sand grouse offering to Tuesday's 23 sightings (with bonus Eland).
The slot three chameleon has not reappeared, but we've discovered a mini pearl-spotted owl who sometimes hangs out in front of the lodge.

Meanwhile group 4 continue to increase their knowledge of the farm's rotting carcasses and are now specialised in analysing which parts are missing and which are still there. Quite a few tracks to follow-up this afternoon and fresh bait to place.

5 December

With the hyaena showing interest in the baited cages, we placed fresh bait in both western cages on Wednesday afternoon. No results on Thursday, so by Friday morning the pressure on Dita and Karen to find an animal in one of the traps was enormous! They did find quite a mixture of traps: one closed with a porcupine and one closed, but empty with no spoor (perhaps due to wind or another alien abduction), but the same situation had occurred by the river bed bait – the hyaena had walked up to the trap, sniffed the blood, dug another hole despite the branches placed by the trap and left again.

Certain team members have decided that the animal is so smart, it must be a female of the species…

Exciting times also for the leopard trackers. Thursday morning's telemetry team received a strong signal, meaning they could locate the animal to a specific outcrop of the Apostelberge. At one moment there were outraged cries from baboons running away as well as warthogs scattering in to the bush – perhaps they were scared by the leopard on the move. The afternoon team were a little scared as well, as they found themselves stalked by the leopard. With the 360º signal getting stronger even when pointing the antenna away from the animal, they judged this a good moment to retreat to the Land Rover.

The 2005 expedition now at end, I'm sending our last diary entry from the chillier climes of Europe. Many of the students are also heading off on vacation or on to their next projects. I think Okomitndu will be a much quieter place over the Christmas period! (probably also a chance for Leica to take a rest from all the stick-throwing action, they've been feeding her double during the expedition). Alongside the two leopard captures (one collared, one released), two leopard sightings (thanks Alan), two cheetah group sightings (lucky slot 1) and two hyaena sightings (sorry you were asleep, Louise), it's been a great two months of discovery for everybody involved. Thanks to everyone who has contributed to this project and participated in the highs and lows of the expedition work. Happy Christmas and see you next time!

Appendix 5: 2006 expedition diary by expedition leader Clare Fothergill

28 August

It is a cold and wet day in Germany and Matthias and I are sorting out the last details of this year's Biosphere Expedition to Namibia. Tomorrow we fly to Windhoek to meet up with the rest of the scientific team who are preparing for the arrival of the first team on the 4th September. It is an exciting time as we will be embarking on Biosphere's fourth year conducting research on cheetahs in Namibia, with leopards and hyaenas recently joining in.

The weather in Namibia at the moment is hot and dry and a new fact that I have just learnt is that all areas of Namibia average more than 300 days of sunshine a year! So don't forget your suntan lotion! I am looking forward to meeting the first team members next Monday, so until then, safe travels.

Clare Fothergill
Expedition Leader

2 September

The sights and sounds of Africa have been filling my senses since I arrived here in Namibia. Together with the scientists Harald and Birgit, and their interns Steffi, Robin & Juergen we have been getting all the expedition equipment ready for the arrival of the first team. Land Rovers have been serviced, datasheets compiled, binoculars, GPSs, rangefinders and telemetry aerials all checked.

The 20,000 hectare study area still shows the effects of the heavy rains earlier this year with tall grasses everywhere. Although beautiful to see this poses a fire hazard to the site and we will have to be extra vigilant whilst working in the field. The scrub savannah is full of birdlife with guinea fowl, sandgrouse, korhans, hornbills and rollers common sightings. This morning close to base we have also seen blue wildebeest, kudu, impala and hartebeest grazing. According to Harald there are approximately 20 leopards and up to 15 cheetahs which move through the study area. How many of those we shall come across in the next few months is yet to be discovered, but the sound of a radio-collared leopard only 500 metres away from us this morning was certainly exciting.

I look forward to meeting the first team members on Monday morning and can't wait for this year's expedition in Namibia to begin!

7 September

The first team members of this year's expedition in Namibia have brought with them an incredible amount of good fortune. After two days of training on data collection techniques, completing data sheets, handling equipment and off road driving we began data collection for real on Wednesday.

One of our daily activities involves checking box traps at various locations throughout the study site. These box traps are located in strategic places which cheetahs frequent to mark their territory and leopards visit to take bait. If a new animal is caught it is sedated, samples are taken and the animal's condition recorded before it is fitted with a radio collar. It is one of the most rewarding activities that can occur for this type of study but happens rarely.

So, when on Wednesday morning we received a radio call stating that a cat was inside one of the box traps no one could believe it! It was an incredible experience for all the team members to be able to see a wild cheetah so close and only on our first day of data collection. The animal that was trapped had been radio collared 13 months previously along with two of his brothers and had not been seen since. Harald and Birgit co-ordinated an extremely controlled plan of action where we quietly moved the cat into the shade and gave it water. We then set two more traps in the hope that the two other brothers would also come.

This morning we were not disappointed – we now had three very large wild cheetahs in the traps. Harald and Birgit were so pleased to see the animals in such good condition and with their radio collars intact decided that we conduct a “hot release”. This means to let the cheetahs loose without any sedation. Again all of the procedures where done in such a way to minimise the stress on the animals who are obviously not used to being in a cage. With all the team members and staff safely on top of the Land Rovers, Birgit, Harald and myself set about releasing the animals.

It was an amazing experience and one that had my heart pounding as we each in turn released one cat. As we initially checked the traps the animals were demonstrating dominance behaviour by lunging at us and hissing. 60kg of wild animal bearing razor sharp teeth is not something I will forget in a hurry! As I walked to my cage however and climbed on top I could only be awed by the beauty of these creatures, their eyes so huge and markings so delicate. I slowly raised the door of the cage with the animal growling beneath me and within a moment he was gone, sprinting through the sandy river bed and into the camouflage of the open savannah. After 300m he stopped and turned to have one last look at his captors and then was gone. What an incredible morning.

9 September

The days following the cheetah release could easily have become an anticlimax for all of us. Fortunately we have had some really rewarding experiences and none of the momentum of data collection has been lost. Yesterday afternoon all the teams radioed in to say they needed more time in the field to complete their studies.

Harald, Karo, Jethro and Manuela had found fresh spoor of the three sibling cheetahs firstly at the Alter Damm watering hole and then in a dry river bed where there was clear evidence of a chase to catch an oryx. It seems that no kill was made, but following the tracks for nearly 1 km they were able to see the huge leaps and bounds the cats made as they tried to reach their prey. The non-retractable claw marks distinctively visible as they sprinted together.

The telemetry group was also successful in receiving frequencies from all three cheetahs and a female leopard from two vantage points. The specific locations, however, could not be found as on the third hill top (to enable a triangulation to be made) there were no signals at all.

Matthias, Dusty and Kathleen made 16 game count entries, which is the current record but could not disguise their disappointment when on the way back home (outside of the data collection route) they saw herds of impala, hartebeest, waterbuck, oryx and lots of warthogs, which could not be recorded. The stunningly beautiful sunset made up for this, however, as the sky was awash with hues of red, purple, blues and orange.

The night observation team were treated to a sighting of an aardvark who seemed to be naturally comical as he mooched around the water hole with his huge ears and nose. A jackal and a couple of impala also paid a visit to the moonlit site.

After a huge rainstorm (when I actually put on my waterproof jacket!) the weather has returned to being hot and incredibly dry. It is amazing that the savannah supports so many animals in such a hostile environment.

12 September

On Sunday afternoon the whole team ventured up to Kuduberg, the highest point in the study area (1650 m) to experience a stunning view of the 18,000 hectares we are working in. Later on sundowners were enjoyed on Mathildenhoehe as another beautiful African sunset took our breath away.

The team members who stayed on the farm on the day off from data collection diligently checked all the box traps, which had been set the previous day. Although all were empty the journey revealed some serious poaching activities. As we arrived at one of the box trap locations, we were alerted by the presence of more than 25 vultures flying overhead. On closer inspection by Matthias and Dominique, the intestines of an animal were found in the bush. Although at this point we could not identify what it was, the fact that the remains were still intact suggested that this was a fresh kill. After discussions with Horst, the farm manager, and another visit to the site it was discovered that it was a mountain zebra that had been killed. Biosphere's presence on the farm and the continued work throughout the year by Birgit and Harald has almost reduced poaching on the farm to zero. So this was a big blow to everyone's efforts. We are still monitoring the border fence to try and identify where the poachers left the farm with their trophy.

On a happier note Amanda, Krista and Dominique saw 10 young male kudu at the observation post at the Alter Damm along with warthogs and a male jackal. Whilst checking the box traps this morning Dusty, Kathy and Matthias found a baby baboon inside the cage. Dusty let it loose and it shot off into the bush towards the barks of the rest of its troop.

13 September

Yesterday afternoon saw a record number of game sightings with over 26 different encounters recorded by Jethro, Karo and Manu. This included sightings of kudu, mountain zebra, springbok, hartebeest, oryx and steenbok.

This morning Amanda, Krista, Springhaan and myself identified six different leopard spoors. The first was a group of three animals, a mother with two cubs. The clearest of the spoors, was over six days old. The other three leopard spoors were younger; perhaps only 12 hours old and the spoor tracking team will follow these this afternoon. Birgit suggested that the reason for such a high number of spoors in the one area was due to the death of two old leopards approximately a month ago. The territories once occupied by theses animals is now available and it is possible that new animals are moving into the area. It was almost unbelievable to see so many spoors on one stretch of dry river bed.

Stefan utilising his new tracking skills retraced Dominique's footprints in the dry river this morning. He successfully found her room key which she had desperately been searching for since yesterday afternoon! Leika, (the collie dog) also returned her lost glasses case in her mouth in the vain hope that someone might throw it for her!

17 September

The last days of data collection by the first Biosphere Team in Namibia were completed with loads of enthusiasm and lots of laughter.

Over the two weeks we managed to capture animals on eight different occasions in the box traps – only three were cheetahs of course but we also had three porcupines, one baboon and one guinea fowl.

The spoors found indicate that there may be two groups of three cheetahs in the study area but we had no sightings or box trap activity from the new group as yet. There are certainly a number of new leopards active on the farm and the spoor from the mother with two cubs was a hugely exciting find.

The first team have now left Okomitundu and gone their separate ways to continue travelling or to fly home and all will be sorely missed. The cries of 'yeah baby yeah' will no longer be heard and the Amarula stocks can now be replenished! Fortunately Stefan did not drive away with one of the Land Rovers and Dominique will continue her search for the elusive meerkats in the Kalahari!

I would like to say a big thank you to you all for a superb first two weeks of the expedition and for all your hard work collecting data. I hope the memory of the capture and release of three cheetahs will be etched in your minds for a long time to come. Don't forget the beautiful sunsets, full moon, crickets in the tall grass, one-eared steenboks, hot sunny days, the view from Kuduberg …….and well there is so much more. See you all again soon! Safe travels.

20 September

After a hectic Monday morning in Windhoek sorting out cars, tyres and general supplies Steffi, Robin and I met the new team members at Casa Piccolo. Over the weekend there had been an incident at the farm involving the energy company who are putting in new power lines and the 100 km long water pipe which runs from Swakopmund to Karibib. A miscalculation by the guys digging the holes for the new pylons had resulted in a 50 m high fountain of water spurting out of the pipeline for two hours. Whilst the pipeline is being fixed over 50 farms are now working with reserve supplies and we are all being careful to use as little water as possible. It just makes you realise how vulnerable we are in this hostile environment and also makes me realise how much I take for granted the water coming out of the tap every day.

In continuation of 'this is Africa' week, a bush fire broke out on a farm approx 40 km away from Okomitundu. The black smoke could be seen from the farm and Horst sent his farm staff along with a huge water blower to help fight the fire. There are no official fire brigades out here in the bush and all the farms help each other out wherever possible. Fortunately this morning we awoke to clear skies and little wind. The fire had been controlled last night by back burning and everyone is hoping that the smouldering ashes will not reignite this morning. Bush fires are part of the natural rhythm of the landscape here especially in the dry season. However, in the commercial farmland area a fire could destroy the livestock, game and habitats that exist on the farms and the livelihoods of hundreds of people.

The team members set off this morning to begin data collection after a day of training and lectures. Yesterday during the box trap checks we all visited the den of the brown hyaena. The stench from a rotting jackal lingered in the air and there were piles of bones and feathers everywhere. It was a strange sensation to realise that we were standing on top of 15 sleeping hyaenas who probably were wondering what was disturbing their morning sleep. Fresh spoor surrounded the den and Harald was reassured that the hyaenas were still using this site. It is only possible to visit the den once every month - otherwise the disturbance results in the whole pack moving to another area for at least six months before they feel comfortable to return. Although hyaenas are social animals, they hunt alone, travelling up to 50 km each night. With the last slot we identified their spoor on the other side of the farm and we are hoping for more evidence of their activities in the next two weeks.

Huge fresh leopard spoor were present around and right up to the gate of the box trap at Kuduposten yesterday and one of the baits has been taken. So everyone has fingers crossed for more leopard action in the next few days!

21 September

There must be something extremely lucky about the first day of data collection. I know that the first slot team members will not believe me when I say that yesterday morning we caught a leopard!! And you will definitely think I am making things up when I say we caught another one this morning!

The first leopard was a huge male that we found in the Mathildenhoehe box trap yesterday morning. It had no radio collar, which meant that we needed to dart it to take blood samples and fit it with a radio collar. To assist us with that Harald contacted Dr. Mark Jago a local vet who has a huge amount of experience with large cats. Fortunately Mark was available and flew in this morning in true African style piloting his Cessna 206 and landing extremely smoothly on our small landing strip despite the strong winds.

When Harald and Birgit had been to check on the condition of the leopard yesterday afternoon they spotted another leopard outside of the trap! Normally leopards are solitary animals so this was totally unexpected. The afternoon was then spent retrieving box traps from around the farm to set up another trap with the intention of catching the additional cat. No one could really believe that any of this was happening. With the caught leopard placed in the shade and doused with water to avoid dehydration and with the new traps in place we all returned to the farm to speculate on what the following morning would have in store for us.

After collecting Mark from the air strip this morning we all proceeded to the box traps. It was nerve-racking waiting to hear from Harald who went ahead to hear whether or not we had caught two leopards. Sure enough we had. The second cat was much smaller and appeared to be a female. Totally unbelievable!

The next two hours followed with a well executed plan which involved darting both cats and waiting until they were well and truly asleep. The animals were weighed (64 kg male and 32 kg female) and a variety of samples taken including blood, hair and ear secretions. Paws, limbs, tails and teeth were measured and recorded whilst the leopards were hooked up to drips to ensure that they did not dehydrate. It was incredible to see both cats lying next to each other seemingly peaceful when only an hour before they had been snarling, growling and lashing out. Once the radio collars were fitted the rest of the team were allowed a closer look. They were both magnificent creatures, tort with muscle and covered in beautiful spots and rosette markings. Their coats were in an excellent condition and their faces were relatively scar free (unusual for a leopard). It was an incredible experience to be so close to and actually touch an animal normally so secretive that a sighting of one never mind two would be rare. In the combined experience of Mark the vet, Harald and Birgit with over 300 leopard encounters and dartings none of them had every seen the combination of a male and female together.

This was another amazingly lucky, once in a lifetime experience. Just incredible!

25 September

After the release of the two leopards we have been closely monitoring their whereabouts with the telemetry kit. During the first 18 hours after we had radio collared them, we were continuously tracking them, which meant taking shifts during the night through to the early hours of dawn. Teams of four people armed with headphones, aerial and receiver sat on the back of the Land Rover in the darkness surrounding Mathildenhoehe whilst an incredible festival of stars shone down. With no moon in the sky, the milky white way (as Matthias used to call it) and a multitude of constellations shone down.

The following day Steph, Mark, Gill, Harald and Joseph (a San bushman) tracked the new young female leopard along the riverbed from where she had slept into the rocky outcrops on the edge of the farm. The leopard was so close that Steph said “we weren’t sure whether we were tracking her or she was tracking us!” Fortunately humans are too large for leopards to consider prey.

On the other side of the farm Jo, Jim, Peggy and Robin were searching for the spoor of six cheetahs, which Springhan and Adam (the farm labourers) had said they had seen when returning late to the farm the previous evening. They had spotted the cats sitting on the gravel road and the spoor had lead onto the farm property. It was later confirmed that the spoor reflected the presence of two adult females and four cubs. There must be something in the air as we are having record numbers of evidence of cats in the study site.

Poaching activity also reached a hiatus when the observation team and I spotted seven dogs and two poachers coming to the water hole. What followed was a speedy operation which involved Harald, Horst, the police, farm workers and the bushmen who tracked the poachers onto a neighbouring farm. Unfortunately no arrests were made as there was not enough evidence available. Just the presence of such a high profile quick response team, however, must have given the poachers a shock and we hope that the recent spate of poaching will now be halted.

The box traps have been relatively quiet since the leopards but Stefan (or is it Ray?) did have the excitement of releasing a huge angry warthog yesterday. We had no doubt in our minds though that after all his bush training Stefan was the man for the job and the warthog ran off relieved to be free. Everyone has decided that if we ever find a baboon in the trap that Stefan as the biggest and possibly hairiest man here will display enough male dominance to quell any signs of baboon aggression!

28 September

On Tuesday morning it became clear exactly which animal can break a man's spirit in Africa. It is not the fearsome lion or the cunning crocodile, but the seemingly innocuous honey badger! Harald, Jo, Jim and Peggy were checking box traps when they came across one honey badger in the trap and another just outside. All teams were called from the far corners of the farm to watch the release of this fearsome beast. Harald briefed us that honey badgers could be very aggressive when being released and that everyone should stay inside the vehicles. Harald seemed a little apprehensive which was strange for a man so used to dealing with large carnivores. He recalled tales of how the badgers could kill a man if provoked! He intrepidly approached the trap and lifted both gates carefully whilst the honey badger watched his every move.Then to our amazement ……..the honey badger crept timidly out of the cage and disappeared. Yep that was it - so quick that no-one even got a photo! Obviously we all took the opportunity to take the mickey out of Harald teasing him that he should be so scared of such a placid creature!!

Yesterday afternoon whilst spoor tracking Steph, Mark, Gill Joseph and I were incredibly lucky – again. Whilst driving along the fence line towards Kuduberg we saw, right there in front of us, a leopard!! It ran from left to right across the road and then crawled under the fence to the neighbouring farm. Steph and I were jubilant shouting "did you see that?!!" We found one spoor in the sand where it had crossed the road but nothing more than that. It just reflects how stealthily these animals can move around. We saw it less than 60 metres away from us and could identify where it went under the fence and yet there was only one spoor track and no other evidence of its presence. Amazing.

Stefan, Kerry and Daniella seem to have a good luck charm on the Pearlhuhnposten box trap and have so far released a warthog, porcupine and lastly a caracal!

14 October

Despite the fact that not one of the box traps has had anything in all week, things have been far from quiet at Okomitundu. The bush fires have continued to threaten the study area. With huge thunderstorms and lightening every day the chance of fires has increased. It may seem odd that we can be having rain and fire at the same time, but the weather here seems to get lost in the huge skies. Whilst it is raining on one side of the farm, the other side remains bone dry. In addition the strong winds carry the flames and hundreds of hectares are consumed in an astonishing amount of time.

For the past week Horst and the farm workers (Adam, and Springhaan included) have been fighting fires every night on other people's land. Two nights ago Harald, Oliver, Martin, and James also joined in to help put out a fire on the neighbouring farm to the south. Last night this fire had grown so big and close to Okomitundu that you could see the silhouetted bright orange flickers of flames from the farmhouse. There must have been over ten different teams and vehicles (from the surrounding farms), each with a water pump trying to dampen down the edges of the fire. In an attempt to reduce the risk to Okomitundu 1,000 hectares were back burnt, from the water pipe road south. Back burning is a risky activity which involves lighting managed fires ahead of the flames in an attempt to burn all the vegetation so that the original fire will die. This was done in case the wind changed direction and bought the fire closer to the farm.

Three Biosphere teams also went out in this morning to help extinguish the remains of the back burned area. This involved dousing down the smaller flames with water and digging smouldering trees stumps into the ground. Although the back burning was successful the original fire was still burning out of control until this afternoon when the best result occurred. A huge thunderstorm rumbled across the sky and at last a massive downpour of rain which soaked the entire farm and killed the fire. It really was such a relief for everyone but especially for the farmers who have been fighting fires everyday for the past week.

Data collection activities have now resumed as normal although things are a bit quiet on the animal front. On Friday the 13th however, whilst searching for telemetry signals Karin, Lutz Jenny and myself did hear the frequency of all three cheetahs from both Eulenkuppe and Felixposten. We were over the moon when we heard the third signal of 006 (Charlie) and could triangulate his position. Cheetah spoor of both male and female animals have also been tracked by Sally, Steven and Margot along the Kuduposten river bed.

Nora and Renate have been extremely patient with the film crew who are following them around on their activities. Nora is determined to walk at least part of the way up to Kuduberg this afternoon however in order to stretch her legs and I don't think the film crew will be following her there!

18 October

Well, the totally unexpected has happened – we have caught a brown hyaena! Unbelievable! In fact I didn't believe it at first and thought that Robin, Nora and Renate were joking when they radioed me yesterday to say there was a hyaena in the box trap next to the zebra carcass. Steve, Sally and Margot were over the moon that their kraal had successfully enticed the hyaena in. Needless to say there was no modesty involved in congratulating themselves (all in good humour of course)!

It was ironic that neither the film crew, James or Birgit and Harald were on the farm at the time of the capture. Obviously everyone was so excited and after we had provided the hyaena with water and shade we left him overnight to organise the plan for this morning. Initially because of the animals' size and demeanour we thought it was a large female. However on closer inspection by Birgit and Harald we discovered he was a juvenile male (so much for my identification skills!)

We all went to the box trap this morning to find an extremely timid animal with beautiful big brown eyes, soft features and a fluffy coat not what was expected of a scavenging carnivore normally renowned for their ugliness! According to Birgit these were all signs that the animal was still only a year old. After adjusting the dosage of the anaesthetic Birgit successfully darted him and we waited for 15 minutes for the drug to take effect. Once he was completely unconscious the hyaena was brought out of the cage into the shade where the examination table had been placed. Then, as with the leopards a series of samples were taken including fur, blood (thanks to Sally and Steve for their expertise) and saliva and a variety of bodily measurements made. Weighing only 25 kilos this really was a lightweight animal and too small for us to fit a radio collar. It was disappointing to know that we will not be able to track him any further but the risks of fitting a collar, which may later cause the animal some distress were too high. Instead he was fitted with an ear tag so if he is ever caught again we will be able to compare his size, weight and general health.

The health check and taking of samples took us about 45 minutes and after a few flickers from his enormous ears Birgit decided we should put him in the shade to wake up. This process took a lot longer than we expected and although he was awake and moving about he was in no hurry to move off. This was quite a different experience to darting the leopards because the hyaena was so timid, so much lighter and woke up very slowly. Once again however, the whole process was conducted in a very calm and quiet manner.

I personally can't believe what great fortune we have had on this expedition so far. Three cheetahs, two leopards and now a brown hyaena. Just mind blowing!

20 October

It is the last day of data collection for the 3rd Namibian Biosphere team. What a crazy two weeks it has been. With so many nationalities on the team (Australian, British, Canadian, Italian, Swiss, and German) it has been quite a hilarious cultural exchange as well as an excellent time in the field.

We have had a record number of sightings on game count with 26 different entries on one session and a record number of triangulations of the leopards and cheetahs - four in total. Apart from the great day when we found the hyaena in the trap we only had two porcupines for the whole two weeks which was surprising.

Wednesday afternoon Jürgen, Gill, Jane and Feda had to stop checking the border fence when they came across a herd of mountain zebra which were separated by the game fence. When they drove closer to the herd they realised that one zebra foal was trapped on one side of the fence whilst the mother on the other. Up until this point there had been no holes or damage to the fence at all and it is a mystery how they became separated. Not wanting to panic the animals by driving closer they left them hoping they would find their way back and this morning Harald, Nora and Renate could find no trace of the herd at all – so we are can only presume they were reunited.

Another unsolved mystery has been developing around the box trap at Kuduposten. There have been fresh leopard spoor there for the past three days, building our expectations. When Jenny, Lutz, Karin and I checked it yesterday the box was closed ….but empty with spoors of a female leopard outside it. However the trap had strangely reset itself, which although not totally impossible is extremely unlikely. So all sorts of stories were being suggested as possible reasons, even that the leopard let itself out!!

Another fire broke out yesterday and Harald was immediately on the case. It was incredible that even after two afternoons with huge downpours of rain that some trees within the back burnt area were still burning from earlier on in the week. The flames were already quite high and the fire was spreading to the surrounding bush. This was really close to the farm just off the water pipe road near Felixposten. So with Horst's team, Harald, Jane Gill and Feda, two water pumps and some spades the fire was thankfully extinguished immediately.

There have been quite a few classic quotes with this group many of them 'you had to be there' but the funniest of all must have been Margot saying to me whilst on observation at the water hole, "Gees I could never fall asleep in this position" (sitting upright in a safari chair) when two minutes later she was snoring! And just to clear up any confusion for anyone (Jane, Margot, Steve etc) spoor is another word for animal tracks not faeces!!

22 October

I am now back in Windhoek where the amazing purple blooms of the jacaranda trees are still out in force. The third slot has come to an emotional end with many tears shed as team members parted ways to travel home or to continue their adventures. It has been another great two weeks with the fantastic bonus of a hyaena capture and release. A big thank you to everyone for all your motivation and hard work with collecting data and for all the laughter that went with it. I hope you all take away some great memories and here are a few of mine: big bushfires, triangulation of the cheetahs from Eulenkuppe with team Fritz, the border fence drive with team zebra, the massive rainstorm on the game count, the first visit to the brown hyaena, and that beautiful final sunset on Mathildenhoehe. And of course let's not forget that 'P is for pleasure' and 'F is for fantastic friendships'.

So, tomorrow is the start of the fourth slot and I can't begin to imagine what surprises lie in store for us. Let's hope that the awesome good luck that we have had so far will continue.

25 October

Today we had a right touch! (According to Jocelyn that means we had a winner) Yes it was the first day of data collection and unbelievably we had another brown hyaena in the zebra carcass trap. Now it is just getting ridiculous – anyone would think that we plan it this way! Again Robin was checking the trap so he now feels as though he has the hyaena luck!

Unfortunately the animal was even smaller than the last one and roughly the same age (under a year old) so Harald and Birgit decided not to sedate it as it would not be possible to fit it with a radio collar. Instead we had the exciting alternative of a hot release. The hyaena was in good health and after he had been cooled off with some water Harald lifted the doors of the box trap for him to return to the wild. It only took a moment for the hyaena to jump up and gallop off into the bush with his long mane of 'hair' flowing behind him. He actually looked quite big outside of the trap and although we considered him to be small I personally would not like to meet him on a dark night!

There was obviously something in the air this morning not only because of the hyaena capture but also because there was a lot of game around. On the way to Johannesposten Tanya, Dagmar, Solene and I saw loads of Kudu and Oryx and even disturbed a Zebra and her foal as we arrived at the water hole. Whilst sitting at the observation point we were visited by 6 kudu, 2 hartebeest, 2 wart hogs and a jackal! Not bad for a morning's work.

Pilvi who is a vet in her normal life thought she had discovered a case of anthrax in a bloated kudu carcass before she realised that it was a wooden model! There also seems to be a lot of cheetah and leopard spoor out and about today so who knows what the box traps will hold in the next few days.

We have had mackerel skies for the past two afternoons so we are expecting a change in the weather – as yet nothing has changed and the daily temperature is gradually increasing, 32 degrees is now quite normal in the afternoons.

28 October

A huge thunder and lightening storm cleared the air yesterday afternoon but the temperature has now risen back to 32 degrees Celsius! We were hoping that the rain would dampen the sandy roads and river beds to enable us to see loads of clear carnivore tracks this morning. Unfortunately the only spoors we found were the 3 cheetahs leaving the farm!

Yesterday at the Alter damm, Nathalie, Celeste, Valentin and Lucca were lucky enough to find the clearest spoor I have ever seen of the cheetahs coming to the water hole to drink. Eva and Albert also heard the frequencies of the three radio collared cheetahs close to Eulenkoppe before the lightening made telemetry unsafe! We felt sure that today we would find more evidence of their presence but there was no such luck. Today seems to be generally quiet in terms of animal activity with empty box traps and no other spoors found anywhere.

The cicadas are buzzing away in the afternoon heat now and the mosquitoes conspicuous by their absence in the first month are now out in force. Fortunately the huge forks of lightening stabbing through the skies yesterday did not resume any bush fires especially as all the farm workers have been fighting one on the neighbouring farm for the past two days.

Everyone has been practising the procedures required for sedating a cheetah this afternoon so all we need now is to find one! Jocelyn says she has had a vision of one and is convinced we will see it before next Friday!

31 October

It was a beautiful cool and fresh morning to be sitting at the Alter Damm observation hide. When Eva, Albert and I arrived, there were already eight kudu making their way to the water's edge. There were two males who looked extremely majestic parading their symmetrically twisted horns.The rest were females, two of which were juveniles still suckling from one of the cows. They seemed to be totally unaware of us as they browsed on bushes and drank silently. Another eleven kudus visited the water hole over the following hours, which must be a record for a morning of observation.

Nathalie, Celeste, Valentin and Lucca whilst checking the border fence came across huge herds of kudu and zebra this morning and were pleased to announce there was no evidence of any damage to the fence. We have had no known poaching incidents for a while, however, Pilvi, Lindsey, Jocelyn and Joseph did find the spoors of two donkeys and six dogs inside the game fence area on Saturday.

The box traps continue to be empty with a few frustrating spoors of leopards found adjacent to the Mathildenhoehe and Kuduposten traps.

Jürgen, Tanja, Solene and Celeste decided to walk all the way from the farm to the top of Kuduberg on Sunday – no mean feat at all. We were all rewarded by fantastic views from the summit and an even more stunning sunset. Just before we got to the top we came across a small herd of Cape mountain zebra, which was a real treat and quite an amazing sight to see them bounding through the rocks.

Everyone enjoyed a day off from data collection yesterday and we are all now focussing on the next few days to bring us what everyone is hoping to see – a wild cheetah or a leopard – either will do apparently!

2 November

Be careful what you wish for because you might just get it – so the saying goes. Last night whilst sitting around the campfire we had a hysterical half hour retelling Harald's honey badger tale. What then followed was a series of funny predictions for today's box traps which concluded with there being a honey badger in all the traps which Harald then had to deal with. Renamed the 'psycho killers of the savannah', we really had quite a laugh at the badger's expense. Today however, there were a few shocks in store.

Firstly Lindsey, Jocelyn and Jürgen had an extremely close encounter with one whilst sitting on top of the rock adjacent to Felixposten. The animal (which sounded like a kudu walking on rocks?!) just appeared next to Jürgen and looked him straight in the eye before turning around to seemingly disappear. After a few shocked moments the badger then started snuffing around in the rock space underneath the observation team which was enough to send them packing with hearts pounding armed with rocks and a pen knife! The reputation of the honey badger is not something to be joked about as they can be extremely aggressive even when not provoked.

Back in the safety of the Land Rover there was disbelief when Steffi radioed to say that another badger had been caught in the Kuduposten trap! Once everyone had completed their morning's activities we all gathered at the one box trap to watch our intrepid scientist release the beast. After a few expletives Harald approached the trap to be greeted with growling and snarling from the badger who was reaching out to grab his leg. Just as Harald had explained with the last badger we captured (with slot 2) this one did jump up and was hanging underneath the roof of the trap desperately trying to get its teeth and claws into any part of Harald it could. Even when the gate was lifted it refused to leave the trap and tried to dig its way out of the closed end of the trap. Not taking any risks, Harald backed off the trap carefully and tried his luck with walking through the thorny kraal rather than walk anywhere near the open trap. Eventually after much jumping, thrashing snarling and biting the animal realised the trap was open and ran off into the bush. I think that was enough of a honey badger experience for everyone!

3 November

A cold morning of 8º C greeted us as the sun rose over Okomitundu today. As the moon has been waxing during this last week the team members were eager to have a night observation. So last night with clear starry skies every one went out to sit in the moonlight hoping for some nocturnal surprises. Unfortunately only an oryx turned up at the Alter Damm and only a few bats at Nicodemusposten!

The box traps this morning were also empty but there is still plenty of fresh leopard spoor around the study site. Yesterday the old female leopard was heard from two locations by Pilvi and Dagmar whilst conducting telemetry. The young female leopard (Alex) has been the most active of all the collared animals recently and has been triangulated on two separate days. Solene and Tanya could hear her frequency 360º around them which means that she was very close and they concluded with Jürgen that she was fewer than 100 m away from them! Quite an exhilarating experience by all accounts. On the following afternoon Eva and Albert also heard her extremely close and from six different locations. Despite these close encounters no one has had any sightings and it begs the question 'who is watching who?'!

Lindsay and Jocelyn after recovering from their honey badger experience have been marvelling at Josef's amazing tracking ability. Whilst spoor counting this morning we found a female leopard print, which was quite clear but when Josef showed us the following foot steps we could only see slight scuffs in the sand. From these scuffs Josef could easily track the animal for miles. He also wins the prize for the longest sighting on game count. He was adamant that he had seen a male oryx which was over 1 km away! These bush men are amazingly skilled…. or having a good laugh on us!

So, only three days before the final Biosphere team arrive on the farm. I can't quite believe how quickly it has passed and yet so much has happened. Every week has been totally different so I am looking forward to seeing what is in store for us still. Must be time for another carnivore capture…

5 November

So the end of the fourth slot was also concluded with tears and fond farewells. I think I will remember this one as the revenge of the honey badgers! A huge thank you again for all the effort everyone put into making these two weeks of data collection successful. Always with so much laughter – I think it must be something in the food!

We had a record number of triangulations – six in total, which meant that we tracked both the female leopards twice and two of the cheetahs. We also had the record number of activities being completed without interruptions. Unbelievably we managed to stick to the programme pretty well and this gave us the most data from all the slots so far. This was due to a lack of poachers, major fires and unfortunately only the one carnivore capture.

We were extremely lucky, however, to have the brown hyaena in the trap especially as it now seems as though the hyaena family have moved out of the den. The team went to observe the den on Friday afternoon and only found old spoor. Josef jumped a mile when he spotted a black mamba slithering off into the bush and this may be the reason for the lack of hyaenas. There also has been an increase in the number of hyaena spoor found on the other side of the farm – so we will have to be vigilant in the next two weeks to identify where they might be living.

So here are a few of my memories from this last two weeks – Lindsey's superb off road driving skills, the psycho killer of the savannah, bird calls with Jocelyn, the kudus drinking in the morning sun, observation with Tanja, Solene and Dagmar at Johannesposten, that great morning of animal activity with Celeste, Valentin, Lucca and Nathalie at the Alter Damm, French chocolate offered by a little French waiter, and sun downers at the pool with a thousand photos of the sun setting – I will never tire of that view!

No one has left Namibia yet from this group – so I hope you all have a great time in the next week visiting other parts of this stunning country and that you will take away some great memories form Okomitundu – we will miss you for sure.

9 November

The last team for the Namibian Biosphere Expedition 2006 arrived safely and are in full swing with data collection activities. To make full use of the current bright moonlight, half of the team went out to observe the water hole at the Alter Damm on Tuesday night. Not returning until 1.30 am they were lucky enough to have spotted two porcupines drinking, a couple of jackals, an oryx and possibly three bat eared foxes! Not bad for the first night.

The old female leopard (711) was heard with the telemetry receiver by Jane, Michele, Michael and Robin and a successful triangulation was made. All activities, however, were cut short yesterday afternoon when a huge thunderstorm rolled across the sky. Massive curtains of rain quickly surrounded the farm until there was a tremendous downpour and we all returned to base.

This morning the box traps were all empty and there were no spoors anywhere despite the fact that all the river beds were still wet from the rain. Obviously the cheetahs and leopards have taken cover from the weather elsewhere. Birgit, Angela and I were lucky enough to see a great performance by the meerkats outside their den and they hung around to give another show at lunch time for Shelley.

As I am writing another storm is brewing and I can hear the thunder rumbling as big black clouds are building in the sky. Not sure how long it will hold, but I think we will have more rain today. At least the rain reduces the risk of fires but it isn't much use for our data collection activities. Tomorrow morning one half of the team is going to start observation at 4 am (!) to try and catch some moon lit animal activity as well as to watch the sunrise over Alter Damm. Hopefully the weather will have improved by then!

12 November

We had a tantalising morning today when both the spoor tracking team and the telemetry team came across extremely clear and fresh spoor of three male cheetahs. The tracks were visible for at least 1km along the road towards Eulenkuppe and they reappeared where the Eulenkuppe river bed crosses the water pipe road. The spoors were definitely less than 15 hours old as Robin, Jane, Michael and Michele had walked the entire length of the river bed only yesterday afternoon. As yet we are unsure whether the coalition is the group we have radio collared or not, as we were unable to pick up any frequencies. If the animals had walked to the south of the farm last night, however, we would not be able to hear them. This afternoon we are going to the summit of Kuduberg, so we are hoping to hear their radio signals from there.

All groups have been having success on game count with up to 18 sightings of animals recorded on transect B and 26 on A. There was the additional bonus for Jane, Michael and Michele who saw at least 34 eland with over 10 calves! Yes, at last the eland have been found. It seems they have been grazing far in the western side of the farm whilst the calves have been born, but have now returned to areas closer to the farm.

We had a supper time visit from a coral snake the other night. The 30 cm juvenile slithered under the table as we sat down for dinner and Jane very calmly announced we had a visitor! It was quickly removed by Horst and relocated outside of the farmhouse fence.

13 November

Yesterday's visit to Kuduberg was stunning. It was such a clear day that we could see the summit of Spitzkoppe which is over 150 km away! Unfortunately we also made an upsetting discovery. The male leopard that we collared with group 2 had not been heard with the telemetry receiver since 20 October and we were beginning to wonder where he was. Yesterday from the summit of Kuduberg we heard the mortality signal from his collar. This means either he has removed the collar, or worse, that he has died. Birgit and Harald are now making plans to visit the neighbouring farm where the signal was coming from to see if we can actually find the collar and possibly find out what has happened. There were also no frequencies heard from any of the cheetahs so maybe we have a new coalition on the farm.

This morning, although it was our day off from data collection Jane, Birgit, Piet, Josef and myself all went to follow the spoor of the three cheetahs found yesterday. Although over a day old the spoors were still clear and we followed them for 2 km in total. Unfortunately they did not take us to any new marking trees or recent kills which is what we had been hoping for. The weather continues to heat up with 34ºC (in the shade) for the past four afternoons and the box traps continue to be frustratingly empty!

15 November

Yesterday afternoon Erin, Shelley, Veronique, Harald and Piet started off with their game counting activity. They also took the telemetry kit with them as Birgit, Birgit (the team member) and Angela had heard the old female leopard's frequency in the morning somewhere in the western part of the farm. So in an attempt to get a better triangulation, the game counting team were going to multi task. Half way through conducting the game count they stopped on a hill to use the receiver and surprisingly heard both the older and younger female leopards who we think are mother and daughter. A loud, slow intermittent beep from the receiver indicated that both leopards where incredibly close and resting. Harald then suggested that they check for the cheetahs, more out of following procedure than really believing they would hear them. Suddenly an astonishing loud signal came through for F006, Charlie (the cheetah I released eight weeks ago) followed by F005 and F007. This was our cheetah coalition. They were so close that the signal was similar to a loud heart beat and was pounding out of the receiver. Apparently Harald then became both excited and serious as he drove some fantastic off road routes and with Shelley holding the antennae aloft they followed the ridge line towards the signals. The cheetahs started to move, indicated by an irregular beeping, but they were still really close and the Land Rover continued through the bush.

Eventually Harald stopped the car, the receiver loudly thumping out the signal and peering through the binoculars announced that he could see the three cheetahs! This was followed by some intense frustration as the others desperately tried to focus on the same location. Finally they all could see the cheetahs approximately 500m away from the car, resting under a tree. A few long distance photos were taken before the animals crept away and disappeared into the undergrowth. I can only describe the message that came through on the radio from Shelley as pure jubilation. I could hardly decipher what she said but through the yelps of joy and screaming I gathered they had just experienced an incredibly scene.

This morning two teams have gone to the neighbouring farm to look for the male leopard's collar and try to solve the mystery of the mortality signal. The other team is out checking box traps. Everyone was on a high after yesterday's excitement and we are hoping the good luck will continue for the rest of the week.

19 November

So the final slot of this year's Biosphere Expedition Namibia has sadly come to an end. The last team managed successfully to retrieve the two 'lost' collars from the leopards and had mixed news when they returned to the farm. The collar which was sending out the mortality signal since before Biosphere arrived was found along with the remains of the leopard's skeleton. Harald and Birgit think that he died of natural causes.

The other collar of the newly trapped leopard was also found but without any traces of remains. This seemed to be good news that at least he wasn't dead but rather had somehow removed the collar. The mystery, however, was involved with how the collar was lost. It looked as though it had been cut possibly with a knife although Piet and Josef were adamant that it was not! Harald and Birgit are going to continue their investigations and have further talks with the farmer to see if he can shed some light on the situation.

Although the final team did not get a carnivore capture they did have an amazing cheetah sighting. The box traps were incredibly quiet with only two captures of porcupines and the hot release was renamed the 'tepid release'! The team did manage to complete three triangulations of the two female leopards who were found way out in the west of the farm.

Game count on the eastern side of the farm has seen an increased number of animals with eleven sightings being the average number. There have been loads of spoors everywhere except on the transect routes! There were five leopard tracks, five cheetah tracks and two hyaena tracks spotted just by chance.

I have just finished packing up all the equipment and am ready to leave Okomitundu. I would like to say a heartfelt thank you to everyone who has participated in this year's expedition. Thank you for all your hard work, ideas, enthusiasm and laughter. It has been extremely successful in terms of data collection and I am sure Harald and Birgit will be busy for the next couple of months analysing it all! A big thank you to you both for all your energy and passion. Also a big thanks to Steffi, Jürgen and Robin. It has been a fantastic three months here in Namibia and I leave with a heavy heart, but wonderful memories. Good luck to you all and hope to see you again soon.

Clare Fothergill
Expedition leader