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Centre for Wildlife Management

UNIVERSITY OF PRETORIA
CENTRE FOR WILDLIFE MANAGEMENT
WELGEVONDEN PRIVATE GAME RESERVE

Final report

April 2011

Inside this issue:

1) Introduction

In 2008 we embarked on a project to study leopard ecology at Welgevonden Private Game Reserve. We have now, after 3 and a half years, come to the end of this study. During this period our research was not just restricted to leopards, but also included African civets and Brown hyenas. In this report we will summarize the key results of each project.

2) Leopard research

The leopard research attempted to address the following questions:

1. What is the density of leopards on Welgevonden compared to other areas in the Waterberg?
2. What is the diet of leopards on Welgevonden compared to other areas in the Waterberg
3. Can we use GPS clusters to increase our knowledge on leopard diet and prey selection
4. What is the home range size of leopards in Welgevonden compared to other areas in the Waterberg

Four students were involved in the leopard research, each focusing on different aspects and questions that needed to be answered. These students include:

- **Lourens Swanepoel**, Centre for Wildlife Management, University of Pretoria. PhD student investigating the sustainability of leopard harvest in the Waterberg Biosphere
- **Esmarie Jooste**, Centre for Wildlife Management, University of Pretoria. MSc student investigating the feeding behavior and prey selection of leopards on Welgevonden
- **Ross Pitman**, University of Plymouth, Nature Conservation. Honors student investigating the feasibility of using GPS collars to locate kills made by leopards
- **Jason Mulvaney**, University of Plymouth, Nature Conservation. Honors student investigating diet of leopards on different areas in the Waterberg Biosphere using scat analysis

Leopard Research:
Progress report is prepared by
Lourens Swanepoel. Lourens is a PhD student from the University of Pretoria.

Phone: 082 817 4679
E-mail: s96162831@tuks.co.za

2.1) Leopard density

We used camera trapping in combination with a mark recapture framework to estimate leopard density at Welgevonden and various other areas in the Waterberg. We created capture matrixes for each study site and fitted a Heterogeneity model (Mh) to the data using the software package CAPTURE. We then used GIS to create a map with all the current study sites in relation to older leopard studies reporting density in the Waterberg. ***Please note that the current densities is based on preliminary analysis and should not be viewed as final densities***

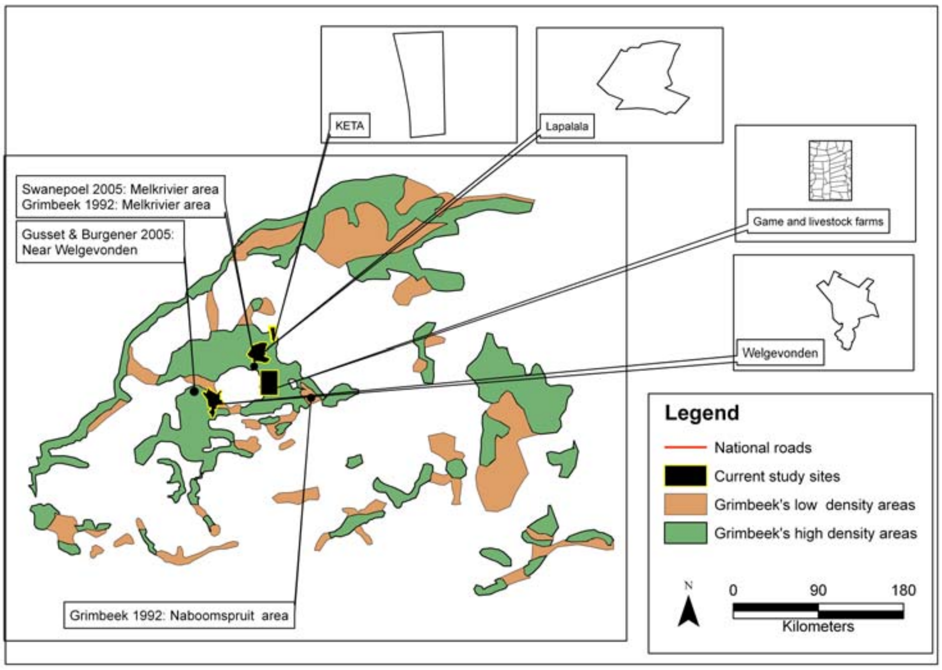


Figure 1 Left: Current study sites in relation to previous leopard density estimates in the Waterberg

Table 1 Below: Current and historic densities of leopards in the Waterberg (Biosphere). Current densities is based on a sampling effort of 3080 trap days for the reserves and 1104 for the game ranches which yielded 57 leopard photos for Lapalala Wilderness, 88 for Welgevonden and 51 for the game ranch areas. Historic densities is based on home range analysis and spoor density. Current density is for adult leopards only.

		No of individuals	Abundance[1]		Effective area (Km^2)*		Leopard density (no./100km^2)	
Current study sites	**Date**	**identified**	***N***	**$SE^2(N)$**	***W***	**SE(W)**	***D***	**SE(D)**
Private reserves								
Lapalala	2008	7	12	4.45	471.80	35.77	2.54	0.99
Melkrivier area	2009	10	13	3.34	426.45	25.35	3.05	0.85
Welgevonden	2008	9	16	6.38	518.64	163.75	3.08	2.17
	2009	16	23	5.33	531.40	71.25	4.33	1.48
Game ranch areas								
KETA *(Marken area/Melkriver area)*	2008	4	5	1.3	148.90	35.77	3.36	0.97
Game/Livestock ranches *Melkrivier area*	2009	11	13	3.46	431.80	46.03	3.01	0.94
Previous study sites in same area								
Swanepoel (2008): *Melkrivier area*	2005-6		*Based on home range analysis*				2.51	
Gusset & Burgener(2005): *Near Welgevonden*	2005		*Based on track counts and measurements*				3.20	
[3]Grimbeek (1992): *Melkrivier area*	1986-87		*Based on personal observation by Grimbeek*				3.00	
Grimbeek (1992): *Naboomspruit area*	1986-87		*Based on home range analysis*				1.90	

[1]Abundance: Number of leopards as calculated with software package CAPTURE by fitting data to the Heterogeneity model (Mh)

**For effective area each camera trap location was buffered with ½ the mean maximum distances moved by leopards*

[3] Grimbeek (1992) identified low density areas (1.9/100km^2) and high density areas (3.0/100km^2) within the Waterberg, see map above

2.1) Leopard densities : Field work by Lourens Swanepoel

The main conclusion from the density estimates is that the leopard densities in the Waterberg Biosphere is remarkably similar across study sites and over time, which hovers around ± 3-4 leopards/100km² (adults only). For Welgevonden we identified from camera trapping **17 adult leopards** and 3 sub adult leopards. See progress *Report 5* for more details on individuals identified during camera trapping. From tourist pictures we could identify 4 additional leopards which pushed up the tally to **21 adult leopards identified**. However, most of these is probably not resident and we concluded that there are probably 4 resident males and about 8 resident females. With the leopard capture it became apparent that the resident males are in a constant flux because we could not capture any other males, than the Shambala male (see *Report 8* for details on capture). There was also no male leopard pictures during the 2010 camera trapping (except the Shambala male), so we don't know if the proposed resident males are still alive or not.

Izingwe female and cub during 2009 lure survey

Large male near Andre's house during 2009 camera trapping. It is not known if this male is still alive or not

2.2) Leopard diet as determined by scat analysis : Field work by Jason Mulvaney and Ross Pitman

Scat analysis has been frequently used to determine the diet and prey selection of carnivores. We collected scats on Welgevonden from 2008 up until beginning of 2011. During the same period we also collected scats on Lapalala Wilderness, KETA game farm and on selected game farms in the Waterberg Conservancy. During this period we collected 80 scats at Welgevonden, 54 at KETA, 23 at Lapalala and 19 on the game farms. While the number of scats for sites were on the low side, it can still be used to estimate diet of leopards on these different sites.

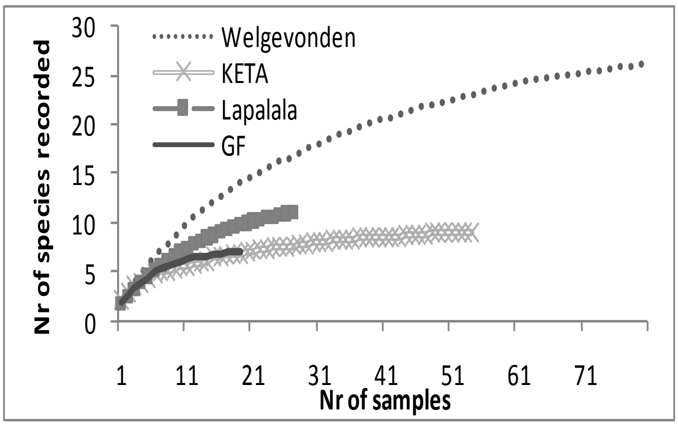


Figure above shows Sampling efficiency curves, suggesting that only on game farms we neared an asymptote

Jason and Ross busy with scat analysis, Jason is celebrating the fact that they are almost done!

2.2) Scat analysis continued

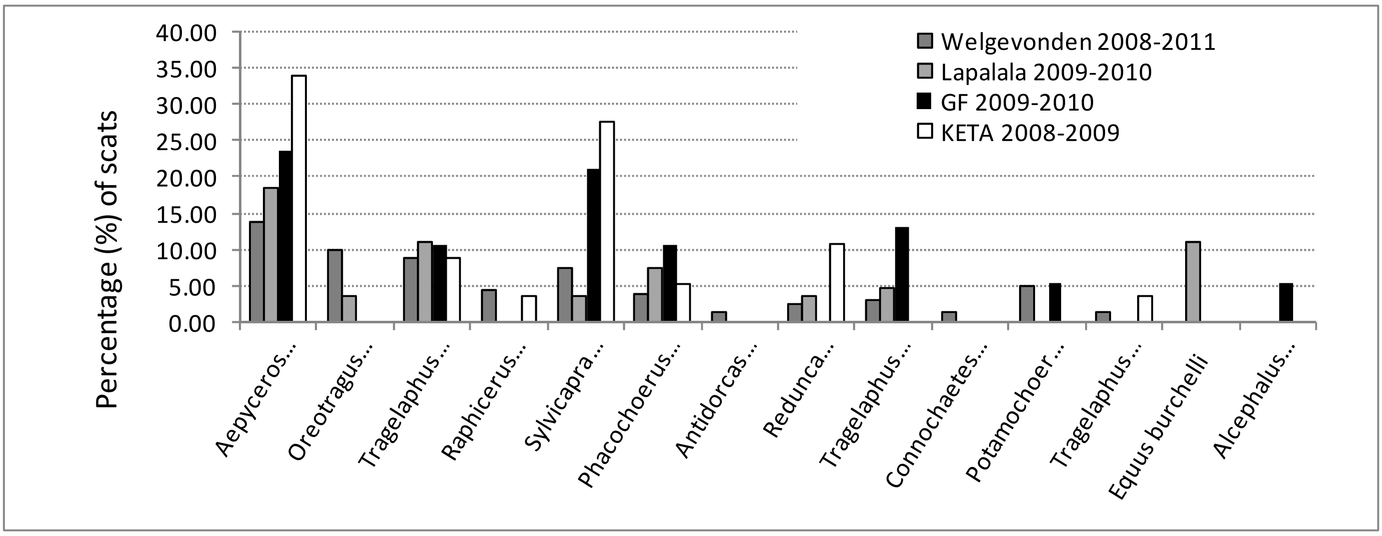


Figure above shows the diet of leopards on the 4 different study sites. Leopard were feeding on a wide variety of ungulates, but the most important prey was Impala, Kudu, warthog and klipspringer. At Welgevonden Bushpig was also important, while on the Game farms (GF & KETA) duiker was also important.

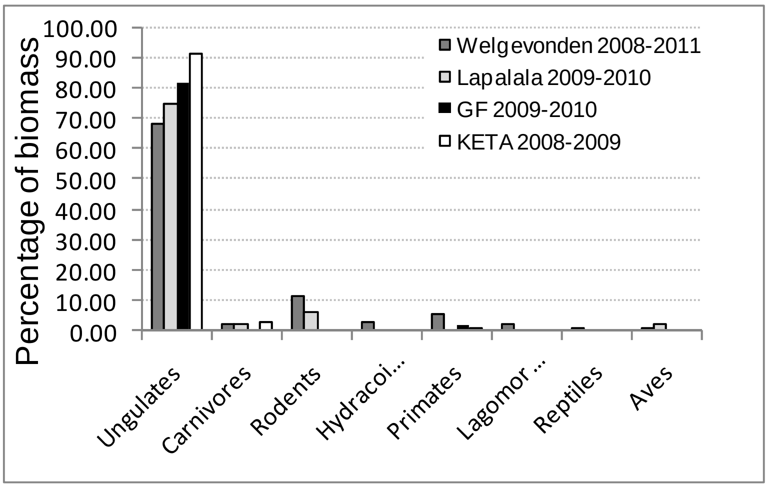


Figure on left shows different groups of animals being predated on. Ungulates were the most important across all study sites, but only on Welgevonden did rodents and primates play a important role in leopard diet. The main reason for this different is probably the seasonality of scat collections. We could not collect scats across all seasons on each site, therefore, we would expect these differences.

More results and discussion on scat analysis can be found in *Report 7*

Very first leopard scat I collected on Welgevonden, on 29 May 2008

Dassie foot pads

Impala hair

Klipspringer hooves

Baboon nails

2.3) GPS collars and finding leopard kills : Field work by Ross Pitman and Esmarie Jooste

We fitted 4 leopards with GPS collars in 2010. These collars were scheduled to capture a GPS location every 2 hours and transmit it via GSM to a website from were we could download it. Our aim was to use this technology to find kills made by leopards. See *Report 8* for detailed discussion on leopard capture, as we will limit our discussion here to the kills found and the collar performance.

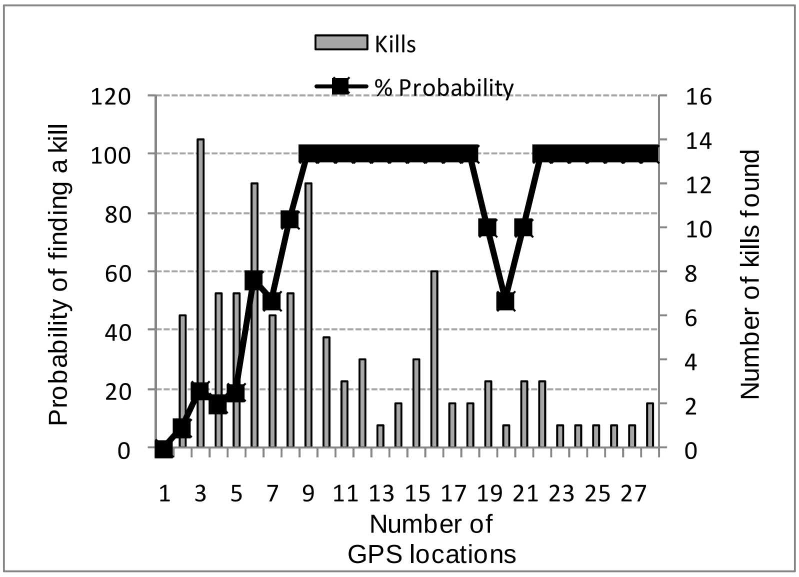


Figure on left shows that most kills were found with clusters containing between 3 and 16 GPS locations. This suggests that when leopards make a kills they consumed it in that day or following 2 days. Large clusters (> 20 GPS locations) always contained a kill, but not many of these types of clusters existed. The data shows that on large clusters the probability of finding a kill is very high (near 100%). The most important result here is that kills are also found on a 2 point cluster, even though the probability is low. This shows that it is important to investigate these points as there is about a 20% change of finding a kill.

	Number	%
Total number of clusters investigated	367	
Total number of kills found	133	36.00
Total number of clusters with hair	118	88.72
Total number of clusters with bone	53	39.85
Total number of clusters with jaw bones	45	33.83
Total number of clusters with sculls	10	7.52
Total Count of Scat	39	29.32
Total number of kills cached in trees	31	23.31

Table of left shows the results of investing the GPS clusters. Most of the clusters with kills contained hair (88%). Interestingly, only 23% of kills were cached in trees, which is similar to the game farms areas where 24% of the kills were cached (Swanepoel 2009). A fair number of jaw bones and skulls were collected which will enable us to determine weight and age of these kills.

Ross busy recording habitat variables at a kill site. Ross spend a total of 538 hours in the veld collecting data related to kills made by the collared leopards.

Jason looking for scats at kills sites, Jason managed to collect an additional 35 scats during his time at Welgevonden

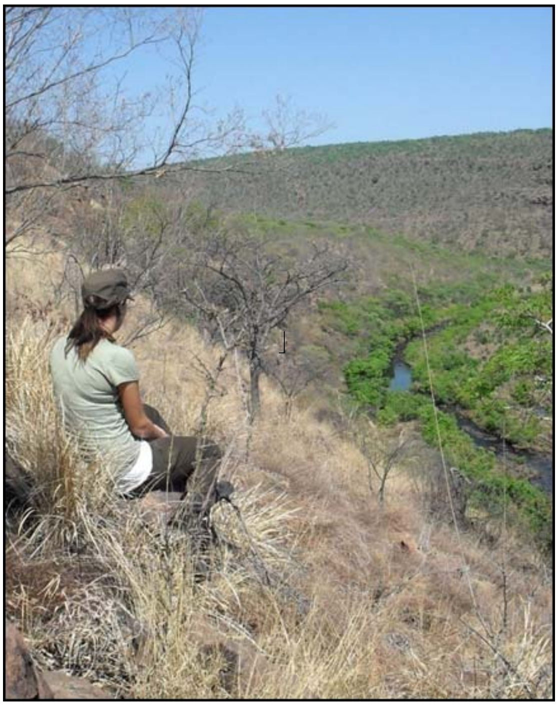
2.4) Characteristics of kills found at GPS clusters : Field work by Ross Pitman and Esmarie Jooste

Prey item remains located at leopard feeding sites using GPS location clusters

	Airstrip	Izingwe	Taaibos	Total	% of kills
Impala	10	4	1	15	**17.44**
Kudu	2	4	0	6	6.98
Common reedbuck	1	1	0	2	2.33
Mountain reedbuck	0	2	3	5	5.81
Klipspringer	3	5	2	10	**11.63**
Common duiker	0	1	1	2	2.33
Blue Wildebeest	2	3	0	5	5.81
Bushpig	1	0	1	2	2.33
Plains zebra	2	3	0	5	5.81
Baboon	8	4	5	17	**19.76**
Red Rock Rabbit	1	4	3	8	9.3
African Civet	2	0	0	2	2.33
Banded mongoose	2	1	1	4	4.65
Bird	0	2	1	3	3.49
Does not include all kills				**86**	

Adult baboon killed by Taaibos female

Table above comes from analysis done by Esmarie. Three species were important for these leopards. Most of the kills found were baboons, which is against all available data published. Second were Impala and third Klipspringer. Most of the kills (79%) were located on hill slopes while 12% were found in drainage systems. Age of prey suggested that most prey were sub adults, although the Taaibos female were able to kill two adult kudu. The high percentage of baboons makes for interesting speculation, because all these baboons were killed by female leopards, of which the Taaibos were still a sub adult. We are working of a few theories ranging from baboon feeding behaviour to special acquired skills by leopards.



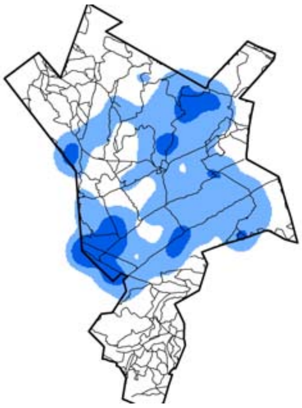
Esmarie nervously sitting on a rock whilst thinking about the baboon kills

Nobody said it was going to be easy, Ross!

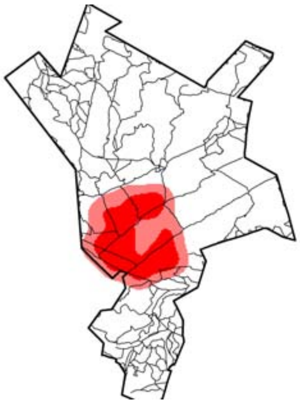
Impala

Klipspringer

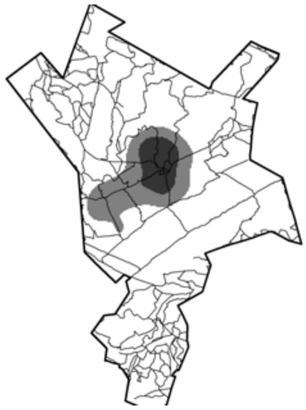
3.5) Home range and movement



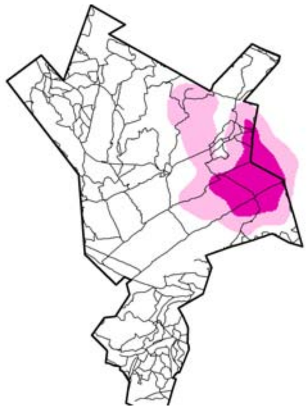
Shambala male : Dark colour is 50% (core areas), lighter is 95% kernel home range



Izingwe female : Dark colour is 50% (core areas), lighter is 95% kernel home range



Airstrip female : Dark colour is 50% (core areas), lighter is 95% kernel home range



Taaibos female : Dark colour is 50% (core areas), lighter is 95% kernel home range

Figures above gives a graphical illustration of the home ranges of the different leopards. The Shambala male used almost the entire reserve, which begs the question if he is the only male present? Both the Airstrip and Izingwe female can be considered adult resident leopards based on their stable home ranges. However, the home range size of the Taaibos suggests that she is still an sub-adult establishing a home range. Indeed, genetic analysis shows that only the Taaibos and Izingwe females are related, suggestion that they have been on the reserve for longer period.

Kernel Home range size (km²)

Leopard	50%	95%
Shambala	53	229
Izingwe	22	64
Airstrip	14	59
Taaibos	30	127

Table on left shows the sizes of the home ranges. The Shambala range size is similar to that of male leopards collared on game farms (avg. 225 km², from Swanepoel 2009), while the female home range sizes were marginally smaller (avg. 10 km², taken from Swanepoel 2009 *vs* 83 km² at Welgevonden). This suggests that the reserve leopards does not really differ in home range size and density from the game farm areas.

2.6) Removal of collars from leopards

All the collared leopards were fitted with remote, drop of collars. This allowed us to retrieve the collars on completion of the study. Ross tracked down all the collared leopards and activated the drop off mechanisms. All the drop off mechanisms activated and the collars transmitted recovering signals for dropped collars. However, the collar from the Airstrip female could not be found and tracking the signal suggested that the collar were still on the animal. We believe that the collar somehow got stuck and hope that it will fall off in the near future.

To our knowledge this is the first time collars were released with a remote device for collared leopards. We hope that researchers will use this technology in future to prevent collars left on study animals. On capture we removed a collar from the Shambala male which was already becoming to small for his neck (Shambala male was collared in 2005 by someone else). There are probably numerous leopards in the Waterberg with non functioning collars on their neck. The 75% recovery rate (3/4 collars) is far better than a 0% recovery rate (it is very difficult to recapture a leopard to remove the collar).

2.7) Other research

2.7.1) Civets Data analysis and text by Liza Isaacs, MSc student, Centre for Wildlife Management

Because of the number of photographs of other animal species captured during the camera trapping surveys, an opportunity arise to investigate and monitor these other species'. This is particularly useful in gaining insight into shy, nocturnal creatures. Very little is known about the African civet (*Civettictis civetta*) in the wild, due to its solitary behaviour, elusive nature and nocturnal habits. Civets are attractive and very distinctive animals, with spots on their bodies and stripes on their legs and bushy tail, making individual identification possible. We constructed a civet picture database and used the spatial mark recapture program DENSITY to estimated civet population sizes and densities. This is the first time densities are reported for civets and the **table below** shows a density gradient form the game farms to Lapalala with the highest density..

Reserve	Number of Photographs	Number of Individuals Identified	Estimated Population size	Estimated Density (#/100km^2)
Welgevonden	299	19	21.0 ± 2.1	7.8 ± 2.1
Lapalala	311	26	32.0 ± 5.9	19.7 ± 7.8
Game Farms	201	14	16.0 ± 2.7	4.4 ± 1.2

2.7.2) Brown hyenas Data analysis and text by Jeanelle Bashant, MSc student, Centre for Wildlife Management

Brown hyena scats were collected during leopard research in 2008/9. The scats were washed in a commercial washer. Clean, dried scats were quantified into 9 categories: **bone, hair, mammals, rodent, reptile, bird, invertebrates, edible plant matter (being seen as seed remains), and all plant matter (any plant item found).** Percentages were found in each group using the formula (V_{mp}) = sum of volumes of each category/total number of scats x 100. Once these percentages were found, a comparison was done based on the differences found for the 2 study sites (Table 1, next page). A further comparison was also done, using 2 seasons (wet and dry) in order to determine whether or not time of year influenced brown hyena diet (Table 2, Figure 2).

Images on left show Brown hyenas carrying carrion

2.7) Other research

2.7.2) Brown hyenas Data analysis and text by Jeanelle Bashant, MSc student, Centre for Wildlife Management

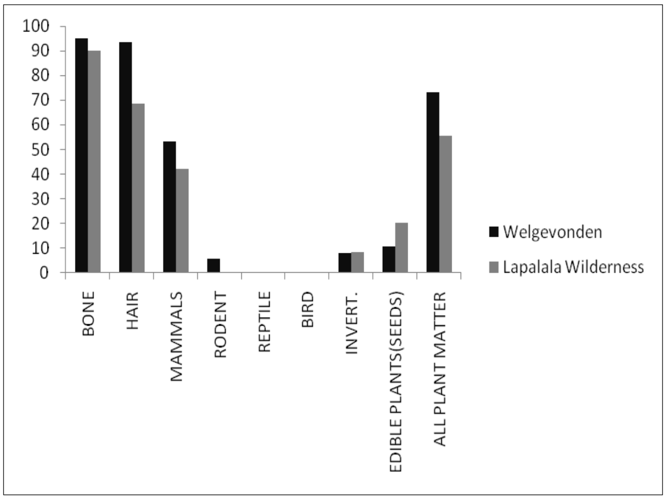


Fig.1 Percentage of feacal samples containing each quantified food group for all seasons in Lapalala (*n*= 213) and Welgevonden (*n* = 186).

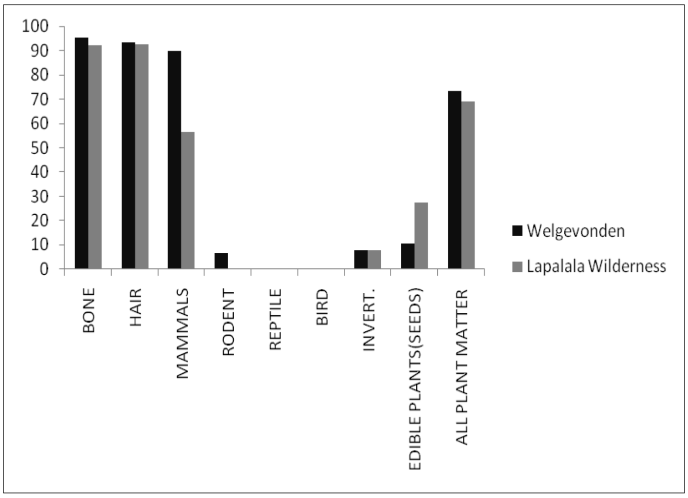


Fig.2 Percentage of feacal samples containing each quantified food group for the dry season in Lapalala (*n*=74) and Welgevonden (*n* =170).

QUANTIFYED FOOD GROUPS	LAP	WELG
BONE	90.141	95.161
HAIR	68.545	93.548
MAMMALS	42.254	53.226
RODENT	0	5.914
REPTILE	0	0
BIRD	0	0
INVERT.	8.451	8.065
EDIBLE PLANTS(SEEDS)	20.188	10.753
ALL PLANT MATTER	55.399	73.118
n=	213	186

Table 1. Percentage of fecal samples containing each quantified food group for all seasons.

QUANTIFYED FOOD GROUPS	LAPALALA		WELGEVONDEN	
	Dry	Wet	Dry	Wet
BONE	92.029	86.486	95.294	-
HAIR	92.754	22.973	93.53	-
MAMMALS	56.522	14.865	90	-
RODENT	0	0	6.471	-
REPTILE	0	0	0	-
BIRD	0	0	0	-
INVERT.	7.971	8.108	7.647	-
EDIBLE PLANTS(SEEDS)	27.536	6.757	10.588	-
ALL PLANT MATTER	68.841	29.73	73.53	-
n=	138	74	170	0

Table 2. Percentage of fecal samples containing each quantified food group for 2 seasons.

Welgevonden brown hyena scats shows that a higher percentage of bone, hair, mammals, rodent, and plant matter being consumed than at Lapalala. Lapalala, instead, shows a higher percent of invertebrates and edible plant matter being consumed (Fig 1, previous page). This could possibly be due to the absence of lion, which kill large prey species, resulting in less scavenging success of larger food items on Lapalala. To better quantify the results, the ‘mammals’ category will be broken down into ‘ungulates’ and ‘not ungulates’ categories, to better reflect the prey items that lions kill and hyenas scavenge. This will give more accurate results as to what Lapalala and Welgevonden hyenas scavenge in relation to the presence or absence of lion. These are thus the preliminary results for this project, with others to follow in the final MSc dissertation.

2.7) Other research

2.7.3) Leopard genetic analysis in the Waterberg and Limpopo

Genetic samples from all leopards at Welgevonden were genetically analysed to determine relatedness among the leopards. The results indicated that none of the leopards are related, expect for the Airstrip-female and the Izingwe-female which are cousins. They possibly had the same grandmother or grandfather. According to Dr. Cindy Harper from the Onderstepoort Veterinary Genetics laboratory, even in a small population like this the allele frequency data was very good and appear to be quite diverse.

I have also collected a large number genetic samples from other collared and hunted leopards over the years in the Waterberg. For the analysis of these samples I collaborated with Laura Tensen from the Vrije Universiteit in Amsterdam to investigate the genetic diversity of leopards in the Limpopo province. It is important to establish the population structure of leopards in the province to accurately model the impact of harvest on the population viability.

2.7.4) Anatolian dogs and cattle farmers Project done by Deon Cilliers from EWT

Deon has placed, with the help of Welgevonden land owners, Anatolian dogs at all cattle farmers who wanted to participate in this project. According to Deon all the dogs are in good condition and is ‘working’ hard to protect the livestock against predators. This type of project is very important because it reduces the conflict on Welgevondens borders. Research has shown that conflict on the borders of protected areas have negative effects on leopard survival inside the reserves.

2.8) Research effort

Researching nocturnal carnivores is notoriously difficult and we had to put in quite a substantial number of days and hours to collect the data. The table below show a break down off research effort for this project.

Break down of field work

Field work	Year	Nr days	Nr hours field work	Nr of hours in lab
Scat collection and Camera sites	2008	138	552	
Camera trapping	2008	47	188	
Lure test	2009	53	212	
Camera trapping	2009	98	392	
Camera trapping	2010	60	240	
Leopard capture: Cages	2009	120	480	
Leopard capture: Foot snares	2010	112	448	
GPS clusters / scats	2010/11	189	756	
Scat analysis: L Swanepoel	2010	14		112
Scat analysis: R Pitman	2010/11	*included in GPS cluster/scats*		240
Scat analysis: J Mulvaney	2010/11	*included in GPS cluster/scats*		240
Scat analysis: J Bashant	2010	90		540
Total		**921**	**3268**	**1132**

2.9) Research output

1. **Swanepoel, L. H.**, Dalerum, F., Somers, M. & Van Hoven, W. **2010.** Density of leopards (*Panthera pardus*) in the Waterberg Biosphere as determined by camera trapping. Southern African Wildlife Management Association 40th Anniversary Symposium. Buffelspoort, Marikana, North West Province. 19-22 September 2010 (Poster)
2. Isaacs, L., **Swanepoel, L. H.** & Somers, M. J. **2010**. Estimating African civet (*Civettictis civetta*) densities using camera trap data from other carnivore studies. Southern African Wildlife Management Association 40th Anniversary Symposium. Buffelspoort, Marikana, North West Province. 19-22 September 2010 (Poster)
3. Bashant, J., Dalerum, F., **Swanepoel, L. H**. & Somers, M. J. **2010**. Camera-trapping brown hyena in South Africa: Is abundance affected by the presence of lion. Southern African Wildlife Management Association 40th Anniversary Symposium. Buffelspoort, Marikana, North West Province. 19-22 September 2010 (Poster)
4. **Swanepoel, L. H**., Dalerum, F., Somers, M. & Van Hoven, W. **2009**. Density and sustainability of leopard populations in the Waterberg Biosphere, Limpopo, South Africa. Annual Savanna Science Networking Meeting, Skukuza, Kruger National Park, 19-24 April 2009 (Poster)

2.10) Conclusion

The preliminary results from the report study suggests that the ecology of leopards at Welgevonden is similar to the farming areas (non protected areas). The major differences being that the density at Welgevonden is marginally larger and some differences in prey animals. The ranges sizes is very similar. The question is now, did we expect differences between the different land uses or not. Based on leopard density predictions (Hayward *et al* 2007) the density at Welgevonden is higher than what is expected (2.8/100km² predicted vs 3.5 /100km² with camera trapping). However, the predicted density does not take into account the specific diet of leopards at Welgevonden and therefore can under estimate the density. Given the fact that leopards are harvested and illegally killed on the farming areas, we should expect a lower density on game farms than on Welgevonden. The similar density and home ranges suggest that the leopards' inside Welgevonden is also exposed to the same human induced mortality. This agrees with other studies (Balme *et al* 2010) and suggest that conservation in small protected areas is just as good as the neighbours attitudes towards conservation. The Anatolian dog conservation project is thus very important for conservation of leopards in Welgevonden.

2.8) References

Balme, G.A., Slotow, R. & Hunter, L.T.B. (2010) Edge effects and the impact of non-protected areas in carnivore conservation: leopards in the Phinda–Mkhuze Complex, South Africa. *Animal Conservation,* **13,** 315-323.

Hayward, M.W., O'Brien, J. & Kerley, G.I.H. (2007) Carrying capacity of large African predators: Predictions and tests. *Biological Conservation,* **139,** 219-229.

Swanepoel, L. (2008) Ecology and conservation of leopards, *Panthera pardus*, on selected game ranches in the Waterberg region, Limpopo, South Africa. MSc, University of Pretoria.

2.9) Acknowledgements

We would first like to thank Trisha Wilson (Izingwe lodge) who made the funds available for this research. For Marion and Angus Few for help and support during the research.

The Centre for Wildlife Management provided us with a bakkie and maintained it during the research period, and provided funds for the genetic analysis

The capture of the leopards was made possible with help from the Ingwe Leopard Project (ILP) and Darien Simpson (www.wildlifecaptureinternational.com). Anton van Loggerenberg (ILP) and Kirsten Hill (ILP volunteer) helped with the setup and monitoring of trapping sites.

David Powrie (Welgevonden Private Game Reserve) kindly assisted in providing bait on selected days. David and André Burger (both Welgevonden Private Game Reserve) also assisted in the collaring of leopards and were always there if we needed any help during the research period.

We would also like to thank Shaun and previous CEO, Andrew, for the support during this time.

Special thanks to Oom Hennie, Adam, Mariaan and all other staff for their support

We would like to thank the Oppenheimer family for letting us stay at site 51 during 2008/9

We would also like to thank Sibusiso Vilane for letting us share his home during the research period.

We would like to thank Thys at Berkla Welgevonden for his help with bakkie break downs.

I would like to thank Ross, Jason and Esmarie for all their hard work in the field.

The research was initiated by Hanno Kilian and I would like to thank him for his effort in getting this project of the ground.

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Dave and Sibu with bait at cage

Dairen, Dave and Lourens and with unexpected by-catch!

Dave, Andre and Lourens and with first leopard captured (Shambala male)

Karina and Lourens catching up on some sleep

Dairen, Albert, Lourens & Corrie

Compliance with legislation:

We conducted the research under University of Pretoria Animal Use and Care Committee ethics clearance protocol A022-06 with all its amendments and Limpopo provincial government leopard permit capture number CPM-004-00006