Predation Impacts on Livestock in a Communal Area of Namaqualand, Northern Cape, South Africa

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Abstract

The black-backed jackal (*Canis mesomelas)* and caracal (*Felis caracal)* commonly inhabit agricultural landscapes in southern Africa, threatening goat and sheep herds. The communal area of Paulshoek, in the Northern Cape of South Africa provided a model system to study this, as farmers in this region are dependent on livestock farming as a livelihood. 47 farmers were interviewed monthly from 1998-2013, to record the number of goats and sheep lost to predators and this formed the basis of the long-term dataset. Furthermore, predation levels for each animal age class and animal condition category were investigated, and predation levels were linked to rainfall, herd size and farmer herding strategies. On-farm personal interviews with 20 of the farmers were conducted in 2014 to evaluate perceptions of predation and to gain insight into their herding strategies. It was established that 1,495 animals were reportedly lost to predators over the study period whilst an average of 3.1% of goats and 5.4% of sheep in all Paulshoek herds were lost to predators each year. Predation levels varied annually, and were linked to annual rainfall patterns. There were differences in monthly predation levels with the highest predation occurring in the late autumn- early winter months (April-June). Herd size was an important variable affecting predation as larger herds were reported as having noticeably higher predation levels than smaller herds. Younger animals were also identified as prime targets of predators whilst few older animals were lost due to predation. There were significant differences between animal condition and rainfall for the five different animal condition classes as animals in poor condition were most highly predated. Little variation in predation levels was observed within and between farmers, and the number of hours worked by farmers did not affect predation levels. Herding was recognized as an ancient practice in Paulshoek and is perceived as a means of protection of livestock from predators. This study provides valuable insight into the impacts of

livestock predation in Paulshoek by investigating predator behaviour in communal areas and providing insight into farmer livelihoods, both of which could be useful for future research and communal farm management.

Introduction

Livestock predation by Africa's wide-ranging predators: jackal and caracal

Predation is one of the key components of natural systems and predators have a multitude of impacts on the dynamics of prey populations (Sih *et al*.1998). Globally, 0.2-2.6% of domestic livestock is lost per year due to predators (Meissner 2013), whilst in the Northern Cape, South Africa 2.8% of all small stock were lost to predators in just two years (Thorn 2013). Whilst a range of predators exist on the African continent, in southern Africa major livestock losses are due predominantly to black-backed jackal (*Canis mesomelas)* and secondly to caracal (*Felis* c*aracal)* (Blaum 2009). Kok & Nel (2004) have repoted the black-backed jackal to be more opportunistic than caracals, a likely reflection of their phylogenetic adaptations to prey acquisition (Avenant *et al*. 2008). Both jackal and caracal have been found to play a functionally important role especially in the absence of apex predators. Apex predators are large bodied and specialised hunters which control these smaller mesopredators. When these apex predators are removed, outbreaks of mesopredators lead to increased predation on smaller prey (Ritchie *et al*. 2009). This phenomenon is known as mesopredator release. Bagniewska *et al*. (2013) found that when all other apex predators were extirpated the jackal was the only dominant carnivore in the area and more than 95% of case studies by Ritchie *et al*. (2009) found evidence of the suppression of mesopredators by apex predators. An African example explored by Ritchie *et al*. (2009) indicated that hyenas and lions in Africa suppress wild dogs and cheetahs, that seek to inhabit areas of low predator density, especially in open habitats (Ritchie *et al*. 2009).

Black- backed jackals are the most common of the mesocarnivores in sub-Saharan Africa and are both abundant and wide-spread in the continent particularly in semi-arid regions (Skinner & Smithers 1990). It is suggested that their behaviour and range is restricted to these areas primarily due to a lack of specialization and an inability to adapt to environmental change (Kleiman & Eisenberg 1973). Caracal, another mesopredator, occur in northern Africa, Asia, and at least 36 sub-Saharan African countries (Marker *et al.*2005) and are often classified as problem animals in Namibia and South Africa (Nowell & Jackson, 1996). The role of these two mesopredators in ecosystems is an understudied topic in Africa, but has recently received increased attention. Aventant *et al*. (2008) highlights that approximately 15 scientific studies have been carried out on the ecology of the caracal whilst there are no more than 30 studies published on the ecology of the black-backed jackal (Loveridge & Nel in press).

In Africa, predators are a threat to both wild and domestic animals such as cattle, sheep, goats and game (Thorne 2013). Black-backed jackal in southern Africa are known to be generalist feeders with their diets comprising of mainly small and medium-sized mammals, fruits, insects and carrion (Kalmer *et al.* 2013). They are most commonly known to affect a number of smaller carnivores and prey (Bagniewska *et al.* 2013). Caracal are sometimes regarded as vermin due to predation on small stock (Nowell & Jackson 1996), but their general diets commonly include hyrax, rodents, birds and small antelope (Marker *et al*. 2005). Jackal and caracal have high dietary protein requirements (Treves & Karanth, 2003) and although they selectively consume different food items, wild prey is consistently selected over livestock (Kamler *et al.* 2012). However, it is when they inhabit agricultural landscapes that these carnivores have access to livestock as a prey option (Inskip & Zimmermann 2009). The seasonal diet and prey selection of jackal show that sheep are amongst their common but not dominant prey choices (Kalmer *et al.* 2012). Whilst most carnivores do not have livestock in their home ranges, predation on livestock can arise when carnivores begin to have a home range which overlaps with domestic animals (Linnel 1999). In times of low prey availability, caracals may move to the borders of their existing and dominant ranges, crossing onto agricultural land to prey on small livestock (Melville *et al* .2006). Kamler *et al*. (2012) revealed that small livestock (mainly sheep) comprised 21–72% of jackal diets, amongst native species which were the dominant prey items. Goats and sheep are both major targets of predators especially when they exist within unfenced boundaries of communal farms (Samuels 2013).

Livestock production in Namaqualand

Namaqualand is located in the north western corner of South Africa and is part of the Succulent Karoo biome in southern Africa. It is a semiarid region characterised by winter rainfall and is considered one of 25 internationally recognised biodiversity hotspots (Desmet 2007). In the past two centuries Namaqualand has undergone extensive and significant land use change and is used today primarily for small stock farming (goats and sheep). Hoffman and Ashwell (2011) found that communal farmland stocking rates are 1.85 times greater than those of commercial farms, exceeding the sustainable carrying capacity recommended by the Department of Agriculture. Herding practices are apparently different between commercial farms and communal farms where commercial farmers do not usually practice herding whilst communal farmers are known to be predominantly herding communities. Herding is a method of managing domesticated animals, by bringing individual animals into a group and moving them to and from a stock-post (kraal) to grazing areas and water sources on a daily basis. The area has undergone much change in the way livestock is managed, especially after colonial settlement (Hoffman & Rhode 2007).

The area was originally inhabited by Bushmen hunter-gatherers, however nomadic pastoralists, the Khoi khoi, moved into the region approximately 2000 years ago and began farming sheep, goats, and cattle (Webley 1992). Collectively, goats and sheep are referred to as small stock and are managed by herders, who are either hired or are the farm owners themselves. Samuels (2006) and Allsopp *et al*. (2007) suggest that the act of herding is a response to environmental and social drivers (Samuels 2013). Specifically, herding aims to contribute to an animal's well-being in that it provides protection from predators (Atkinson 2007).

According to Rhode and Hoffman (2008) the people of Namaqualand are amongst the poorest communities in South Africa relying on pension funds and grants, whilst the wealthier members of the community earn income from livestock sales (Samuels 2013). Livestock production in these communities does not only serve as an income, but livestock products such as meat and milk also contribute to their livelihoods, where the sharing of these form a social structure (Debeaudoin 2001). Rohde and Hoffman (2008) suggest that the livestock also provide a vital dietary supplement, whilst Ainslie (2013) highlights the cultural role that livestock plays in the lives of farmers (Samuels 2013). The loss of livestock due to predators could therefore jeopardise farming livelihoods and agricultural production, as well as hinder rural development and potentially threaten food security (Thorn,2013).

Paulshoek as a model communal area farming system

Paulshoek is a communal area in Leliefontein, Namaqualand, and is used largely for livestock (goat and sheep) farming. Predation has a significant impact on domestic livestock populations, and it is easier to detect and quantify this with intensively managed livestock (Thorn, 2013). It is also understood that predator attacks are intrinsically unpredictable, thus studying the natural movement of sheep may be difficult (King *et al.* 2012). Paulshoek serves as an ideal farming system to explore as the herding of livestock ensures a management tool that can be monitored. Herding strategies in Paulshoek are ancient practices and used primarily as predator deterrents. And monitoring this system could reveal long-term quantitative predation trends for southern Africa. Furthermore, there has not been sufficient research on the impact of predators on communal populations of goats and sheep in the Karoo region. This was a major motivating factor for this study, utilising a system where a fundamental difference of managing livestock could play a role in the survival of these animals. More specifically, the variation of predation in communal areas and questions relating predation to herd size, herd composition and climatic variables had not been adequately investigated.

Study Objectives

The study was built on a long term data set, from 1998 to 2013 of variables linked to predation in Paulshoek for both goat and sheep populations that are actively herded each day. The objective of this study was to investigate the number of goats and sheep lost to predation for each farmer and herd, on a monthly basis for the 16 year period. A further objective was to investigate the relationship between the number of goats and sheep lost to predators, as well as the relationship between predation and variables such as age class composition, animal condition and rainfall. Further variables that were explored were herd size and farmer herding strategies which included the number of hours herders spent with their animals as well as the times of year where herding may have been neglected. Interviews with farmers for the year 2014 were also conducted and provided context for the quantitative trends found for predation between 1998 and 2013. The hypotheses covered a range of factors to establish a link between predation and a number of variables for the period 1998-2013. Specifically, I hypothesized that predation levels changed within and between years and that there were differences in the predation levels between different age classes of goats and sheep and between different herds. In addition, I hypothesized that predation was linked to rainfall and animal condition. Lastly, I hypothesized that predation levels varied for different herd sizes and the amount of time farmers spent herding.

Methods

Study Site

Namaqualand is located in the Northern Cape province of South Africa. The region is characterised by Succulent Karoo vegetation, a biodiversity hotspot encompassing some of the most endangered vegetation types in the world. Communal lands occupy 30% of the area which is further divided into 6 communal areas, one of which is Leliefontein (Samuels 2013). Leliefontein contains ten unfenced villages with Paulshoek being one of them. This area is semi-arid and is marked by low precipitation (about 200 mm per annum) occurring primarily during the winter months of May to September and the mean annual precipitation in the lowland areas of Leliefontein is 145mm (Samuels 2013). Temperatures during the summer months of December to February can exceed 40 °C while winter months can experience temperatures below 0 °C (Samuels 2013).

Livestock farming contributes significantly to the livelihoods of many people from Paulshoek and 28-30 stock-posts are scattered around the region. The livestock on these farms is comprised of Boer goats and a variety of sheep breeds including Dorper, Damara, Karakul, Persian and indigenous Afrikaner breeds (Samuels 2013).

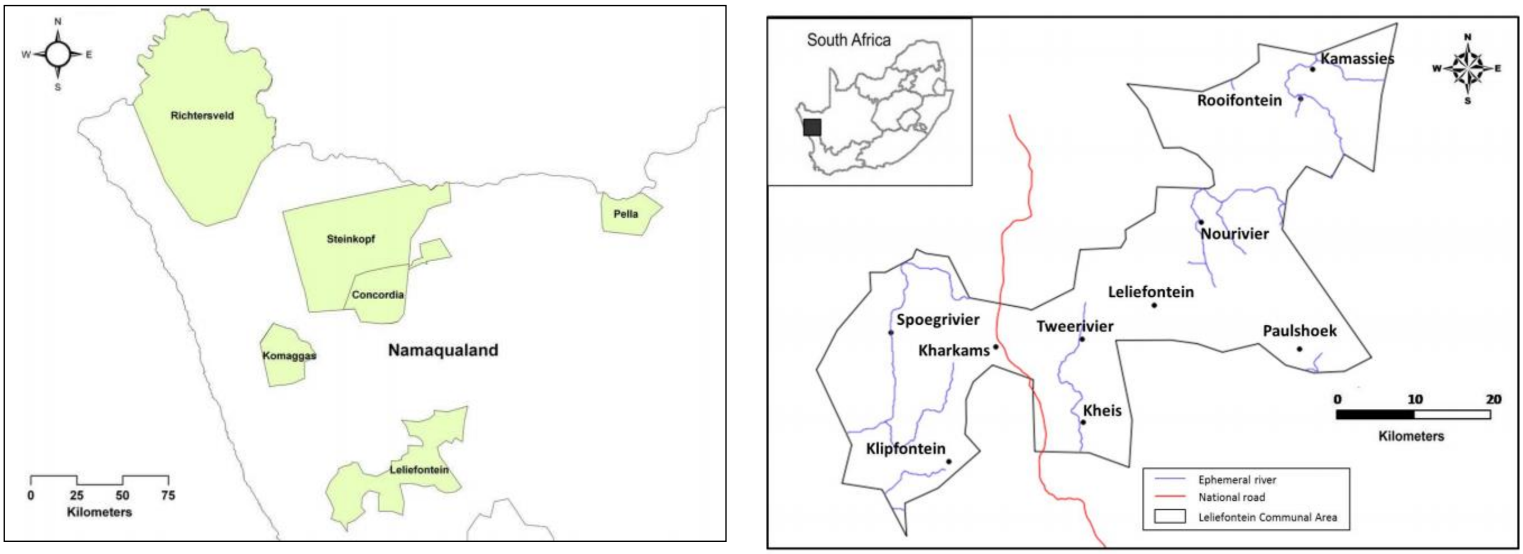

Figure 1. Map showing Namaqualand's six communal areas as well as Paulshoek situated in Leliefontein, Northern Cape, South Africa (Samuels,2013)

Data Collection

Data was collected by three separate research assistants from the village for every month from August 1998 to December 2013, i.e.185 months. The database is built on farmer names, surnames, stock-post locations and monthly totals of goats and sheep for each farmer since August 1998. Using this long term data set I examined 47 records of predation levels for both goat and sheep populations that are actively herded by farmers each day and returned to a stockpost each evening. Annual and monthly livestock deaths due to predation were related to the animal age class, animal condition and rainfall. Herd composition was also recorded in terms of age classes of both goats and sheep using the following categories: lamb (<4 months), weaner (>4months), ewe (adult female, 2-tooth & older), wether (castrated adult male, 2-tooth & older) and ram (reproductive adult male, 2-tooth & older). Animal condition of each herd was recorded monthly using relative condition categories standardized across farmers. Condition categories ranged from one to five (worst condition=1 and best condition=5). Notes were taken during data collection on other reasons for animal mortality, which include disease, drought and animal slaughter for local consumption. This information was not used in the study.

In addition to the long term predation record, rainfall data was also recorded. Daily rainfall amounts were recorded by the research assistants at a rainfall gauge located in the village of Paulshoek. For the analysis monthly and annual values were used.

Lastly, interviews were conducted in Afrikaans with 20 farmers in Paulshoek for the year 2014 to gain insight on their herding strategies and general perceptions of predation. These farmers were a subset of the farmers interviewed for the 1998-2013 period. The questionnaire used in the 2014 interviews is shown in Appendix 2. Ethics clearance was obtained for this data collection, from the University of Cape Town, Faculty of Science Research Ethics Committee: (Approval code FSREC 048– 2014).

Data Analysis

The total number of goats and sheep lost to predators for each year was reported for the period 1998-2013. The percentages of total goats and sheep predated were then calculated as the proportion of average herd size. The average percentage of goats and sheep reported as lost to predators per month was also determined. A boxplot was constructed to assess normality in the distribution of annual predation for goats and sheep. A Kruskal Wallis Sum Rank Test was then conducted to see whether a significant difference existed between goat and sheep predation. A histogram was created in Microsoft Excel, of the frequency of the total number of animals predated each month for all the herds in Paulshoek between 1998 and 2013. From the data used to generate this histogram the proportion of the 185 month study period in which animals were lost to predation was calculated.

A paired t-test was performed to determine whether the numbers of animals lost to predators differed significantly between months. To investigate whether predation is more frequent in certain age classes, a boxplot was done comparing numbers of goats predated for each age class. This was also done for sheep. Since the data were normally distributed around the mean a Kruskal Wallis Rank Sum Tests was used to test for significant differences in predation between each age class for both goats and sheep. Medians and interquartile ranges were summarised for numbers of goats and sheep in each age class lost to predation.

To explore the relationship between monthly predation and animal condition, the relationship between predation and rainfall was first examined. A boxplot was created to see how monthly rainfall and animal condition were related. The general trend observed from the boxplot was that animal condition deteriorates with less rainfall. Because the data were normally distributed around the means, a Kruskal Wallis Sum Rank test was used to test if there was significant difference in rainfall between the different condition categories during the period, 1998-2013. Animal condition was therefore used as a proxy for rainfall, and a boxplot for predation and condition was done to assess the degree of normality. A Kruskal Wallis Sum Rank Test was conducted to test if there was significant difference in the total number of animals lost due to predators between different condition categories. A pairwise comparison using the Wilcoxon Test was conducted as a post-hoc test along with Bonferroni correction, in order to compare predation levels between all condition categories.

Tests for normality were conducted and all assumptions for a one-way ANOVA were met. ANOVA was run to determine the significance of the following variables in relation to levels of predation: animal type, year, herd size, and average hours worked. Average working hours of herders were categorized into part of the day (<6 hours) or a large portion of the day (>6 hours). These two time periods provided a natural divide for the main herding strategies practised in Paulshoek. A random effects model was also generated using farmer as a random effect, to account for the differing time periods worked on each stock-post by farmers. Residual plots for each fixed variable (animal species (goat or sheep), year, herd size, and average hours) were also done and all normality assumptions were met in all cases. A pair wise correlation matrix was created for total deaths, average man hours and herd size, which showed no highly correlated inputs. The pairwise correlation therefore met the assumptions of a linear mixed effects model. The linear mixed effects model was carried out to see predation trends over time, for each year, as well as the changes in predation over time for both goats and sheep, independently. All data analysis was done in R (2012), Microsoft Excel (2003) and Sigma (2002).

Results

Total predation of goats and sheep in Paulshoek over the study period

Over the period of 185 months, from August 1998 to December 2013, a total of 699 goats and 796 sheep, giving a total of 1,495 animals, were reportedly lost to predators (Table 1). The percentage of animals in all herds in Paulshoek reported as being lost to predation over the study period ranged from 0.5-9.7% for goats and 2.3-19.4% for sheep. On average ($\pm$stdev), 3.1(2.4)% of goats and 5.4(4.2)% of sheep in all Paulshoek herds were reported as being lost to predators each year over the study period with no significant difference between goats and sheep in these values (χ^2 = 14.8015, df = 14, p = 0.3919). The total number of goats and sheep reported as being predated over the study period was significantly different between years (Table 1, Appendix 2). Results from the linear mixed effects model indicated that in the years 1999, 2001 and 2003 significantly more goats and sheep were reported as being lost to predation while in 2008, 2010 and 2012 significantly fewer animals were reported. A general decline in predation was observed from 2007 onwards. The average (±stdev) annual rainfall for the study period was 190(±68.6) mm (Table 1). Notable low rainfall years were in 1998, 2003 and 2010 while relatively high rainfall years were in 2001, 2007, 2009, and 2011.

Table 1. The average number of goats and sheep per year in all herds in Paulshoek and the total number (%) of goats and sheep reported as being lost to predators each year for the period 1998-2013. The total annual rainfall for Paulshoek is also included.

Year	Average number of goats per month	Average number of sheep per month	Total number (%) of goats predated	Total number (%) of sheep predated	Total annual rainfall (mm)
1998	1716	1401	18 (1.0)	69 (4.9)	62
1999	1394	865	74 (5.3)	168 (19.4)	166
2000	1749	822	46 (2.6)	39 (4.7)	177
2001	1704	905	84 (4.9)	40 (4.4)	235
2002	1943	1029	54 (2.8)	39 (3.8)	147
2003	1143	706	111(9.7)	77 (10.9)	130
2004	722	463	36 (5.0)	26 (5.6)	151
2005	1004	659	48 (4.8)	27 (4.1)	206
2006	1389	884	49 (3.5)	25 (2.8)	200
2007	1607	1091	24 (1.5)	42 (3.8)	320
2008	1882	1257	19 (1.0)	29 (2.3)	175
2009	1982	1333	39 (2.0)	41 (3.1)	251
2010	1529	1149	17 (1.1)	50 (4.4)	114
2011	1285	973	9 (0.7)	56 (5.8)	319
2012	1532	1016	7 (0.5)	38 (3.7)	216
2013	1764	982	64 (3.6)	30 (3.1)	178

No deaths due to predation were recorded in 42 of the 185 months (22.7%) of the study period (Figure 2). The most frequent total number of goats and sheep reported as being lost to predators per month in all the herds was between one and five animals. In only three months were more than 40 animals reported as having been lost to predators.

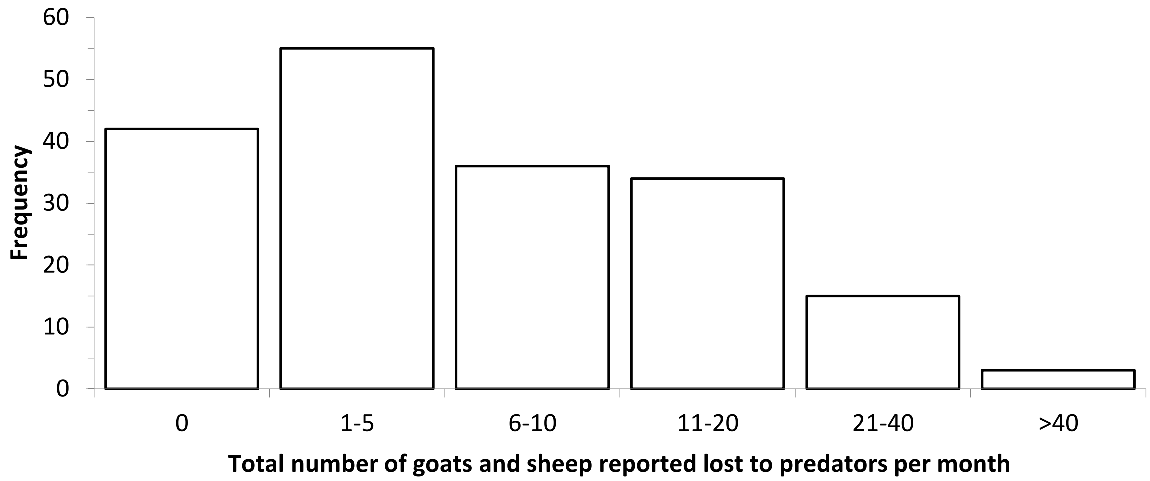

Figure 2. The frequency of the total number of animals predated each month within all herds in Paulshoek for the period 1998-2013.

Differences in predation levels between months

The highest reported levels of predation occurred in late summer (January) followed by the late autumn-early winter months (April-June) (Figure 4). Significantly higher levels of predation were reported in the first six months of the year (January-June) than in the last six months of the year (July-December) ($t = 5.09$, $df = 5$, $p < 0.01$) .

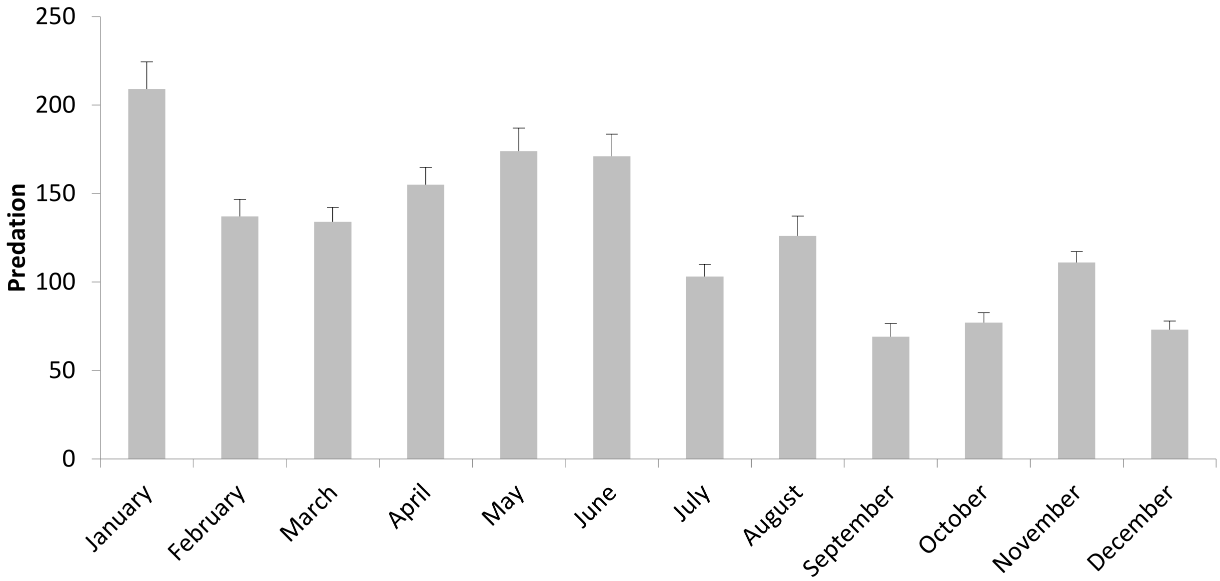

Figure 3. Total predation (±stdev) of goats and sheep combined, in Paulshoek for each month for the period 1998-2013.

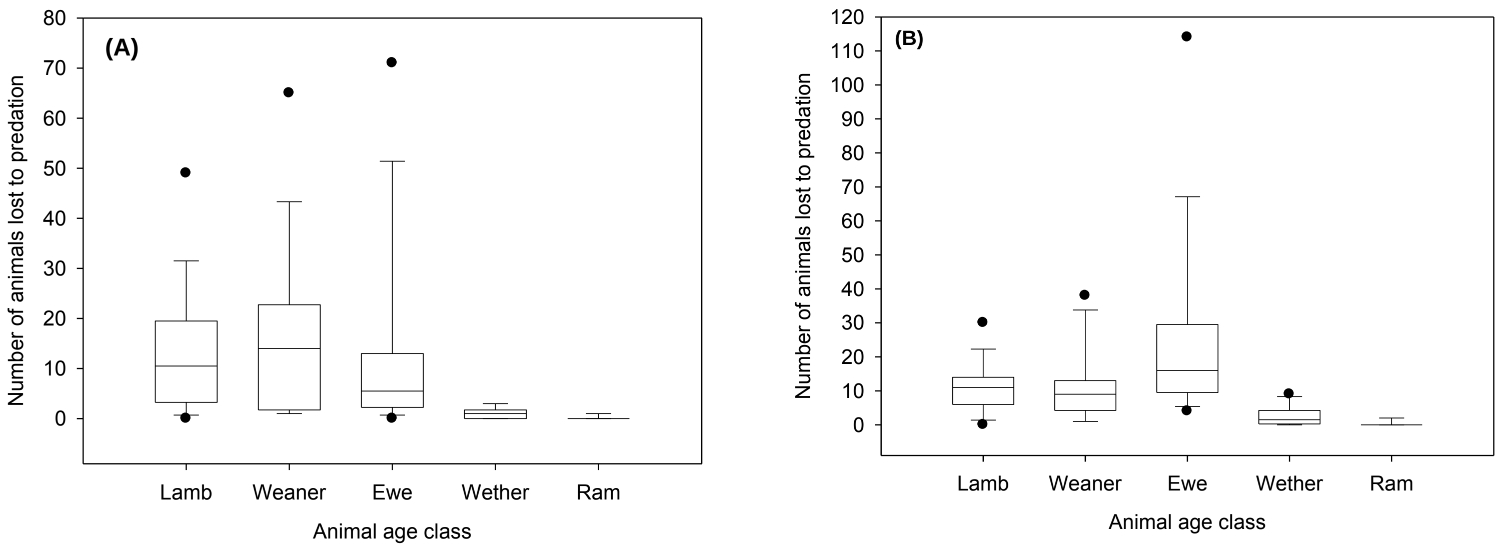

Figure 4. Reported predation levels between different age classes of goats (A) and sheep (B) herds in Paulshoek for the period 1998-2013

Differences in reported predation levels in different age classes of goats and sheep

There were significant differences in reported predation levels in the five different age classes analysed for both goats (χ^2 = 50.0681, df = 4, p<0.001) and sheep (χ^2 = 45.3395, df = 4, p<0.001) (Figure 3; Table 2). For goats, predation levels were highest in weaners (>4 months) followed by lambs (<4 months) and then ewes. For sheep, however, predation levels were greatest for ewes followed by lambs and weaners. Predation levels of male animals were very low for both goats and sheep with no reported predation of rams at all.

Table 2. Median and Inter Quartile Range (IQR) of the total number of goats and sheep of different age classes reported lost to predators in Paulshoek each year for the period 1998-2013.

Animal species	Lamb (<4 months)	Weaner (>4 months)	Ewe (2-tooth & older)	Wether (2-tooth & older)	Ram (2-tooth & older)
Goats	10.5 (14.8)	14.0 (17.0)	5.5 (10.3)	1.0 (1.3)	0 (0)
Sheep	11.0 (6.0)	9.0 (8.8)	16.0 (14.0)	1.5 (2.0)	0 (0)

Relationship between predation, rainfall and animal condition

There were significant differences in the relationship between animal condition and rainfall for the five different animal condition classes (χ^2 = 10.4691, df = 4, p<0.05) for goats and sheep combined. The poorest animal condition was associated with low rainfall periods whilst the best animal condition was found when rainfall was highest.

Reported predation levels were highest for animals assessed to be in the two poorest condition classes (Figure 5). The lowest predation levels occurred for goats and sheep in condition classes four and five, which represent animals that are in a good condition. There were significant differences in the number of animals reported lost to predation between each animal condition class (χ^2 = 24.7531, df = 4, p<0.001). Significant differences in predation exist between condition classes one and five, classes two and four, classes two and five, and classes three and five (Table 3). Similarities in predation levels between condition classes one, two and three are also evident.

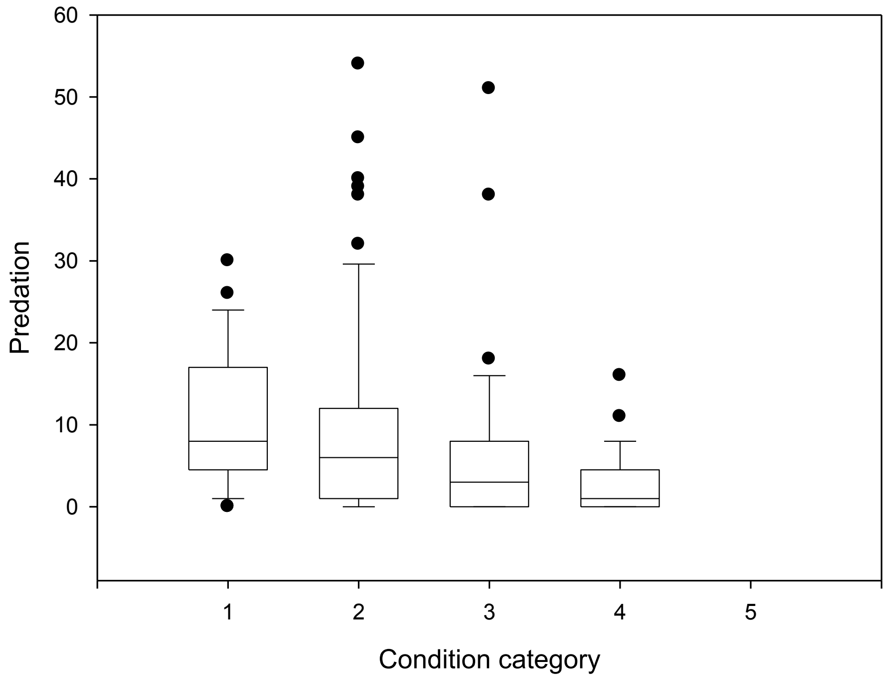

Figure 5. Reported monthly predation levels between different animal condition classes of goats and sheep combined, in Paulshoek for the period 1998-2013. An animal condition of 1 reflected animals in a relatively poor condition while a value of 5 reflected animals in good condition.

Table 3. Result of Mann-Whitney with Bonferroni correction showing p-values (* significant values i.e. <0.5) representing differences in monthly animal predation in Paulshoek, between each condition class for the period 1998-2013.

	1	2	3	4
2	1.0000	-		
3	1.0000	1.0000	-	
4	0.3816	0.0136*	0.5477	-
5	0.0261*	<0.001*	<0.001*	0.9236

Relationship between predation and farmer, animal type, herd size, year and labour inputs

The intercept from the random effects model between farmers shows that there is very little variation in the total number of animals predated between each farmer (Std dev of farmer =0.17(CI: 0.1,0.3)). The residual value explains very little variation in the total number of animals predated within farmers 0.92 (CI: 0.9 ,1.0). The linear model (deviance=4.8%) showed that reported levels of predation did not differ between goats and sheep or the number of hours spent herding (Table 4, Appendix 1). Significant differences existed in predation between years and with differing maximum herd size (Table 4). Pairwise correlations (Figure 6) between the explanatory variables showed a positive correlation between predation level in larger herds than in smaller herds (rho=0.35, $p<0.05$).

Table 4. ANOVA showing whether total reported number of animals predated in Paulshoek differs within each variable for the period 1998-2013

Variable	Degrees of Freedom	p-value
Animal species	1	0.879
Year	15	<.0001
Maximum Herd Size	1	<.0001
Average Man Hours	1	0.448

Figure 6. Pairwise correlations between variables used in the linear mixed model. Variables included total reported deaths due to predation, maximum herd size and average number of hours spent herding.

Discussion

South African statistics indicate that between 2006 and 2008, carnivores killed 3,755 game and livestock in the North West Province of which 1,412 were sheep and 1,055 were goats (Thorn 2013). This is a much larger region than the communal area of Paulshoek and the time period of this study is also very short. However, it can be contrasted with a relatively low numbers of 699 goats and 796 sheep that were lost to predators from 1998 to 2013, in Paulshoek (Table 1). The annual averages of 3.1% of goat and 5.4% of sheep having been predated in all herds, is also comparable to an annual 2.3% of domestic animals being lost to predators in central Bhutan (Wang and Macdonald 2006). In a South African context, farmers in the Western, Eastern and

Northern Cape, the Free State and Mpumalanga have reported losses of between 5.3% and 11.3% of their total stock per year (Avenant *et al.* 2003). This shows that the numbers of livestock lost to predation is relatively low in comparison. In our study the animal species predated did not emerge as an significant variable determining predation level, however only slight differences in predation of goats and sheep were observed (Table 4, Appendix 1). Many studies that involve both species pool data for goats and sheep, suggesting that they are similarly affected and equally prone to the impacts of predation. A similar finding was reported in a Kenyan study, where the median number of goats and sheep attacked by lions, hyenas, cheetahs and leopards were both 1. (Ogada *et al.* 2003).

The annual differences in predation are evident especially for high predation levels in the drought year of 1998 (Patterson *et al.* 2004). Annual variation (Year) was considered an important factor in the analysis (Table 4) playing an important role in increased predation, especially the drought impacted years (1998 and 2003), and the year that followed. In contrast, lower predation levels occurred during years with high rainfall (2001, 2007, 2009 and 2011) as well as the years following rainy periods (2008 and 2012). Climate variability has been reported to directly affect predators and their behaviour, although the mechanistic links and their consequences may prove to be complex (Stenseth *et al.* 2002). I propose that in dry periods predators may be left hungry thus increasing the vulnerability of resident livestock during this time. Furthermore, study on lions in Kenya showed that during dry periods the predators may spend time close to the water sources on which livestock also depend, therefore opportunistically attacking them upon an encounter (Patterson 2004). Interviews with farmers in 2014 revealed that drought was a major perceived cause of animal deaths, along with predation, as another primary threat to animal survival. Predation appears to have been a consistent effect spanning a larger time scale even though very few animals are killed at a given time. This can be compared to drought which affects large numbers of animals but within a short space of time. The two threats when combined produce a more devastating effect regarding numbers of animals killed, a scenario upon which many of the farmers agreed (Appendix 3).

The most frequent number of animals lost monthly to predation over the study period was between one and five which is very low (Figure 2). Nevertheless, it is the proportional effect of livestock losses which may lead to financial constraints on farmers (Davies 1999). In addition, the general collective behaviour of flocking could be one of the reasons why predation has not eliminated large numbers of animals. Animals commonly aggregate as more cohesive groups are better at detecting predators, and what often drives flocking behaviour is the fear of predation (King *et al.* 2012). King's study (2012) refers to the 'Many Eyes Theory', and the 'Selfish-Herd Theory' which contrast in their roles to potentially react to predation threats. The former theory assumes that larger groups that stay together may be safer while the latter suggests that only spatial benefits may exist if individuals in a large herd can move freely (King *et al.* 2012). It is common that goat and sheep herds follow the 'Many Eyes Theory' and the act of herding reinforces this flocking behaviour thereby deterring predators. In support of this Davies (1999) has claimed that the best way to reduce livestock losses is through herding. However, there are instances where individuals may stray especially during grazing and in the lambing season. Due to larger herds being potentially more difficult to manage, a threshold of average herd size seems to exist in which individuals are safe (Davies 1999). This could be explained by our finding that maximum herd size contributed to the extent of predation (Table 4). Our findings are in support of this as larger herds were at more at risk of predation (Figure 6) which could be attributed to a higher incidence of straying animals occurring in larger herd sizes that are difficult to control.

Monthly and seasonal predation levels

In terms of predation levels over time it can be concluded that predation levels differ between months, and are particularly high during festive seasons when herding may be neglected. The highest monthly predation in January (Figure 3) can be explained by the number of livestock that may have been killed over the Christmas period, when herding may have been neglected as farmers may have been on holiday. The high level of predation in January could also be explained by the dryness of this period though the former seems more likely as many livestock deaths have been reported to occur due to the absence of a herder (Wang 2010). More precisely, Wang & Macdonald (2007) attribute high predation levels to lax herding, and inadequate guarding practices. This is highly probable for the festive season of December, where livestock lost to predation at the end of the month were potentially recorded as January. In addition, the Easter month of April falls within this time when farmers may be on holiday and often neglect their livestock or may not invest as much time or energy technique in ensuring protection of the livestock. Davies (1999) further claims that farmers who employed shepherds reported no livestock losses during that time period.

With regard to seasonality, the highest records of predation in the late autumn-early winter months of March to June could be a result of exposure of livestock to low temperatures, making them vulnerable to predation during this period. Kamler *et al*. (2012) also found that the number of livestock lost to predators was highest in winter, followed by spring lambing time and lastly, in the autumn months. This is further supported by a US study by Nass *et al*. (1984) in that severely high losses of livestock were found to be in April , May, and June (late autumn-early winter). Spring lambing time is also said to be a time of high predator activity as lambs are in abundance and are considered to be very vulnerable (Davies 1999). Kamler *et al*. (2012) supports the notion that high predation is found during lambing seasons, as their study found sheep to be the main food resource for jackal. Furthermore, a Botswana study by Kaunda *et al*. (2003) found evidence for jackal range expansion in winter where there is an increase in territory maintenance by mated pairs during the jackal-mating season (late May to August) making livestock vulnerable during this time (Macdonald & Moehlman 1983; Skinner & Smithers 1990). An increase in predation of small stock may also occur by caracal, during the seasonal decrease in rodents and other natural prey, critical periods when caracal energy needs are high, and when young begin to disperse (Avenant *et al.* 2008).

Predation of different age classes

Predation levels differed significantly between different age classes of goats and sheep (Figure 4, Table 2). As expected, the younger animals comprising of weaners and lambs were predated the most together with ewes particularly in the case of sheep. Similar findings have shown that younger animals are most susceptible to predation. It is often difficult to accurately record this due to difficulty in detecting carcass remains of these small animals (Nass *et al.* 1984). Mech(1970), Pimlott(1967) and Kruuk (1972) further support that younger animals that were most highly affected by predation. Predation levels are also said to be heightened by drought, harsh winters, low birth weight, early growth rates and genetic factors which have been reported to decrease juvenile survival in ungulates (Lele *et al.* 2006).

It is also important to understand the level of parental care that goats and sheep display, as a form of protection when their young are small and vulnerable to predation. Hersher *et al*. (1963) explains that although goats and sheep generally identify their own young immediately after birth and repel any young that do not belong to them, natural young can also be adopted by foster ewes as well as by cross-species foster mothers. Weaners are also frequently attacked potentially because these young are slowly becoming independent of their mothers, which may place them at greater risk of predation. From the interviews conducted (Appendix 3), many of the farmers in Paulshoek explained that predation is highest during lambing season, as this period often coincides with the jackal breeding season. It was explained by most farmers that the ewes "weglam" which means that they often stay out in the open field, away from the herd in order to give birth and remain close to their young to feed and protect them. It appears that in these instances, not the only the lambs, but ewes too are prone to predation. In addition, it was commonly perceived by the farmers that jackal are most active at night, when individual animals stayed out in the field or got lost and did not get herded to the stock-post (Appendix 3). Woodroffe *et al*. (2005) support this claim as they found that livestock attacks occurred mainly in late afternoons and evenings.

Predation, rainfall and condition

With reference to the condition of livestock, it was assumed that rainfall may affect animal condition and that predators are more likely to attack animals that are in poor condition. Poor animal condition is potentially attributed to climatic conditions like low rainfall, which could decrease vegetation productivity (Levine *et al.* 2008). The finding that predation was lower in rainy seasons is a trend that is supported in the study by Schiess-Meier *et al*. (2007) on cattle predation by leopards, lions, wild dogs, hyenas and cheetahs. Predation by jackals also tends to be worst during droughts, when other food sources diminish and livestock are weakened (Beinart,1998). Studies by Mech (1970), Pimlott (1967) and Kruuk (1972) revealed that sick and vulnerable animals are predominantly killed. This is consistent with our findings that animals in a worse condition were highly predated (Figure 5) compared to those in good condition. Schiess-Meier *et al*. (2007) further explain that special care in the form of herding must be adopted for sick animals (animals in bad condition) as they easily become prime targets for predators. It appears that carnivores are able to easily overpower weak or starving lambs whilst healthy lambs are often secure from attack.

Herding strategies to prevent predation

Regarding labour inputs, some farmers remained with a herd all their lives whilst others only worked for a few months every year. Herders are often the actual owners of the stock-post, however in some cases herders were family members, or hired. The relationship between the herder and the owner may be an important factor as the owner may take greater care of livestock than a hired worker. These differences in herding effort and strategy may have also influenced the amount of predation for a particular herd (Appendix 3). These influences were not explored sufficiently however the numbers of hours worked by each farmer was not significant to predation levels between and within farmers (Table 4). I assume that statistically significant effects might have been masked by low sample sizes of herds that were attended to by herders.

It appears that the act of herding and the protection of livestock in a stock-post is a very important factor as jackal predation is most prevalent at night (Beinhart 1998). Irrespective of time spent with animals in the day, the high predator activity at night appears to be the major problem (Appendix 3). Interviews with farmers revealed that all farmers herded their animals into stock-posts (kraals) at night, which they referred to as the act of “kraaling”. The solution of herding livestock is an important deterrent to predators, in a way that it forces predators to acquire specialized behavior to adapt in these circumstances (Linnel 1999). Apart from reducing predation, the reintroduction of herding contributes to improving rural livelihoods, reviving customary practice, reducing stock theft, and improving biodiversity management (Solomon 2000). Some breeds such as mountain goats tend to avoid predators by escaping to elevated terrain (Gaillard *et al.*1998), however not all livestock have such unique abilities. Most confined goat and sheep breeds essentially lack anti-predator instincts, therefor herding has been proposed as a solution for livestock protection (Linnel 1999).

Farmers perceptions of predation

Human-predator interaction is also an issue, where conflict is provoked between livestock farmers when jackals enter home ranges of livestock. Predators in general are known to be frequently killed in an effort to prevent or reduce livestock losses (Treves 2003). Between the years 1931 and 1952, over 2,000 caracals were destroyed annually in South Africa's Karoo (Marker *et al*. 2005). Many other carnivore species have also undergone declines in distribution and population size over the last century (Thorn 2012). White (1978) explains that in the context of food shortage individual predators need to make numerous attempts through which the success of catching prey may vary seasonally. Similarly, the overall perception of farmers was that predators exist naturally in their environment. They realise that it is impossible to expect predation not to occur (Appendix 3). Farmers were at times angered by losses of their livestock due to predators, and they sometimes set traps or hunted jackal and caracal with their dogs. However, this does not solve the ecological problem that caracal and jackal numbers seem to recover and increase rapidly with the increase in hunting efforts (Avenant *et al.* 2008). Farmers appeared to live with a sense of acceptance that livestock deaths due to predators is inevitable. One of the interviewed farmers claimed that "die jakkal is die Here se hond" ("the jackal is the Lord's dog").

Conclusion

The findings were novel for Paulshoek but also more broadly for predation impacts on communal lands. The study found that predation levels for goats and sheep change over time, both annually and monthly/seasonally. Secondly, predation levels differed between different age classes of goats and sheep, with younger animals being most highly predated. Animal condition, which can be explained by rainfall amount, impacts the level of predation between each condition class, with higher predation being experienced in animals in a poor condition. Predation levels did not differ greatly between and within farmers, as well as with varying amounts of time spent with the animals. Herd size however was an important factor in predation, as higher predation occurred in larger herds that were possibly difficult to manage. Overall, herding livestock appeared central to livestock protection, especially during the vulnerable periods of the night, drought, and lambing season. By keeping animals in an enclosed stock-post at night, farmers ensured the safety of their animals.

The findings of this study can potentially be used in conjunction with spatial and temporal variables of future studies that could further explain predation impacts. The study of predation in a communal farming system could be beneficial in assisting with human-predator conflict prevention, contributing to increased livestock survival and predator conservation as well as improving farmer livelihoods. More scientific studies at the human-wildlife interface need to be conducted in communal areas, as the juxtaposition of quantitative data and indigenous knowledge seems promising in providing insight into livestock predation.

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APPENDICES

In Appendix 1 (below) the contribution of animal type, year, herd size and hours worked, to predation are shown. The random effect of "farmer" mentioned in the results section, underlies the linear mixed effects model. Estimates for annual predation show a general increase from 1998 until 2006. There is a decrease in the predation estimate from 2007 to 2013. The "Animal" estimate explains the positive effect (0.15) of total average deaths of sheep. The remaining estimates in the model output are for the reference animal, goats to which 0.15 must be added to calculate the equivalent sheep predation estimate. This means that in 1999 the estimate of goat predation is 0.77, whilst for sheep it will be 0.77+0.15. The value for Max Herd Size shows that with every unit increase of herd size, the average predation of goats will be 0.01. The predation for sheep as herd size increases is then 0.01 + 0.15. For the entire study period, herd size was a significant variable that contributed to the impacts of predation ($p<0.05$). Man hours however, was not a significant effect contributing to the level of predation.

Appendix 1. Fixed effects Linear Model of log(Total animal deaths due to predation) and the significance of each contributing variable to predation of livestock in Paulshoek for the period 1998-2013.

	Estimate (95% CI)	Std.Error	p-value
(Intercept)	-0.29 (-0.6 ,0.0)	0.142	0.041*
Animal	0.15 (0.0 ,0.3)	0.064	0.019*
1999	0.77 (0.5 ,1.1)	0.164	<0.001*
2000	0.10 (-0.2 ,0.4)	0.168	0.567
2001	0.42 (0.1 ,0.8)	0.171	0.016*
2002	0.23 (-0.1 ,0.6)	0.173	0.177
2003	0.69 (0.4 ,1.0)	0.168	<0.001*
2004	0.11 (-0.2 ,0.4)	0.171	0.510
2005	0.26 (-0.1 ,0.6)	0.176	0.140
2006	0.14 (-0.2 ,0.5)	0.172	0.403
2007	-0.02 (-0.4 ,0.3)	0.173	0.916
2008	-0.44 (-0.8 ,-0.1)	0.170	0.010*
2009	-0.09 (-0.4 ,0.2)	0.167	0.608
2010	-0.40 (-0.7 ,-0.1)	0.168	0.018*
2011	-0.27 (-0.6 ,0.1)	0.172	0.119
2012	-0.47 (-0.8 ,-0.1)	0.178	0.008*
2013	-0.31 (-0.7 ,0.0)	0.179	0.087
Max Herd Size	0.01 (0.0 ,0.0)	0.001	<0.001*
Average Man Hrs > 6	-0.06 (-0.2 ,0.1)	0.084	0.448

Appendix 2. Questionnaire developed for conducting interviews with farmers in Paulshoek for the year 2014. Afrikaans Questionnaire was used.

Investigator:	Date:	
Name of person being interviewed:	Age:	Gender:
Primary Occupation:	Education level:	
Name of person who owns the herd (if different from interviewee):		
Veepos ligging:	S: E:	
Approximate distance to village:		
How long have you been at this location?		

How many animals do you have at the moment? (taken from data base)

Goats		**Skaap**	
Lammers		Lammers	
Speenlammers		Speenlammers	
Ooi		Ooi	
Kapaters		Hamels	
Ram		Ram	
Total		**Total**	

Current veld condition (1=poor; 5=excellent):	Current animal condition (1=poor; 5=excellent):

HERDING PRACTICES

Are the animals herded by a herder?	How many herders are employed at the stockpost?

What is the relationship of the herder to the owner? (owner/herder; relative; hired hand (i.e. no relation)

How long has the herder(s) being working at this stockpost?

How are the animals herded?
(1) Herder stays with animals ALL day;
(2) Herder stays with animals for part of the day;
(3) Herder lets animals out in the morning and gathers them again in the evening;
(4) Other (explain):

Are all the animals kept in a kraal overnight?

Do the animals ever spend time in the veld overnight? If so, why does this occur?

During birthing season are there husbandry changes to protect offspring and mothers?

What are the main problems facing you as a livestock owner?		Rank Score
Drought		
Disease		
Predators		

Veld condition		
Access to markets		
Theft		
No herder		
Other (clarify):		
Are there any wild animals (roofdiere) in your area which you consider to be pests?		
Which wild animals (roofdiere) cause the most damage?		
Do you report your animal losses to anyone? If so, who?		

Species 1:
How do you identify this species? [e.g. spoor, faeces, call, from the carcass, etc.]
What is the type of damage caused by this species?
How often does this occur?
When does this occur (day or night)?
When does this occur (month or time of the year)?
Where do the attacks occur (distance from stockpost)?
What is the cost of the damage / year?
How do you control or manage this problem? Do you actively hunt this species? Do you set snares for this species?
Have the number of attacks of this wild animal increased or decreased over the last 10 years?
Would you like to see all of the individuals of this species killed?

General Notes:

Ondervraer:	Datum:	
Naam van wagter of einaar:	Ouderdom:	Geslag:
Primêre Beroep:	Opvoedings Vlak:	
Naam van einaar van die vee:		
Veepos ligging:	S: E:	
Afstand van die dorp:		
Vir hoe lank staan die veepos op *die* ligging?		

Hoeveel vee het u op die oomblik?

Bokke		**Skaap**	
Lammers		Lammers	
Speenlammers		Speenlammers	
Ooi		Ooi	
Kapaters		Hamels	
Ram		Ram	
Totaal		**Totaal**	

Heidige veld condisie (1=swak; 5=uitstekend):	Heidige vee condisie (1=swak; 5=uitstekend):

Praktyke gebruik om die vee op te pas

Is die diere opgepas deur die wagter?	Hoeveel wagters is daar op die veepos?
Wat is die verwantskap tussen die wagter en die einaar? (einaar/wagter, familie lid, gehuurde wagter (dws geen verwantskap))	
Vir hoe lank werk die wagter(s) by die veepos?	
Hoe word die vee opgepas? (1) Wagter bly by vee HEEL dag; (2) Wagter bly by die vee vir 'n deel van die dag; (3) Wagter maak die hek oop in die oggend en bring hulle weer bymekaar in die aand; (4) Ander (verduidelik):	
Word die vee in 'n kraal oornag gehoe?	
Bly die vee ooit in die veld oornag? As dit gebeur, hoekom?	
Word daar iets spesiaal gedoen tydens die lam tyd om die ooi en lammers te beskerm van wilde diere?	

Wat is the grootste problem wat jou vee besigheid bedreig?		Mees belangrik
Droogte		
Siekte		
Roofdiere		
Vee condisie		
Bemarking		

Diefstal		
Geen wagter		
Ander (verduidelik):		
Is daar roofdiere in jou area wat jy beskou as 'n pes?		
Watter roofdiere veroorsaak die grootste verliese onder die vee?		
Rapporteer jy jou vee verliese aan iemand? Aan wie?		
Spesies 1:		
Hoe identifiseer jy die species? [e.g. spoor, fekalieë, roep, van die karkas, ens.]		
Watter skade word deur hierdie species veroorsaak?		
Hoe gereeld bebeur dit?		
Wanneer gebeur dit (dag of nag)?		
Wanneer gebeur dit (maand of tyd van die jaar)?		
Waar gebeur die verliese die meeste (dws afstand van die veepos)?		
Wat is die jaarlikse onkoste van die verliese?		
Hoe word die probleem beheer? Word die species gejag? Word snare gebruik teen die species?		
Oor die laaste 10 jaar het die getal verliese van die species gestyg of gedaal?		
Wil jy hê dat alle individue van die species doodgemaak word?		

Algemene Notas:

Appendix 3. Summary of main findings from interviews with farmers in Paulshoek for the year 2014.

The key findings from the 20 interviews with Paulshoek farmers have been grouped into three main themes and follow the broad structure of the questionnaire (Appendix 2). These themes are: Predator profiles, herding strategies and the history of hunting predators in the region.

The main emphasis is on providing qualitative information of predator behaviour and farmers' responses to predator threats to livestock at present, as well as in the past.

Predator Profiles

Jackal

Identification of predator

Farmers were able to identify that livestock were killed by jackal through their spoor. They also looked at the way in which the animal was attacked and eaten. Compared to other predators, jackals attacked animals from the front and often consumed the entire animal, and jackals devoured the animal as soon as it was caught, although sometimes deserting the animal and returning to the scene later. Jackals also made their presence known through their calls that scared the livestock.

Location/Range

Jackals dominated the plains of Paulshoek rather than the mountainous regions. They attacked livestock in relatively close proximity to stockposts ranging from 500m to 3km, however very few attacks at the actual stockposts were recorded for the year 2014. When lambs were left out in the field they were most vulnerable to predation.

Impact of predation

Jackals caught the animals and killed them most times, whilst only biting parts of the animals sometimes. The number of livestock killed in 2014 ranged from 1 to 17. Most of the kills comprised of younger animals. Younger goats were said to be more unaware of predators whilst older goats were more protective. Jackals are said to be able to kill 4 to 5 animals at a time, however not consume them all. It was explained that the breed of sheep plays a role in predator awareness in that Damere are more aggressive and protecting of their young whilst Dorpe remain unprotected and vulnerable.

Timing of predation

Predation by jackals occurred mainly at night however few cases of animals lost to predation occurred in the day. If livestock were out in the fields at night they were also more vulnerable and there was a greater predation risk. Jackals were described to be opportunists that attack whenever they get a chance. The livestock breeding season in winter (May-September) are perceived to be times of high predation. The livestock (weglam) go out into the field to give birth and care for their young there, rather than being confined to the stockpost. At this time livestock may be hungry and in search of food, otherwise they would otherwise not be in the field for prolonged periods. This period also coincides with jackal breeding and consequently, the requirement for food.

Control and Mitigation

Herders actively hunt with guard dogs and in some cases traps are set. A range of 1 to 30 jackals were killed per farmer in order to mitigate the problem. The common perception is that jackal numbers have increased perhaps due to the absence of hunting, although a few farmers believed that jackal numbers have remained the same. Farmers said that jackals were ruthless, cunning and clever. They also admitted that although hunting these predators was once a popular and admired profession, it is no longer perceived as admirable in communal farms.

Caracal

Identification of predator

Farmers were able to identify that their livestock were killed by caracal through spoor. They also looked at the way in which the animal was attacked and eaten. Compared to the jackal, caracal waited for some time after attacking the animal, before consuming it as they prefer rotting/fermented meat. Caracal also attacked the animal from behind, in comparison to the jackal, and only consumed parts of the animal. Caracals were found to ambush their prey.

Location/Range

Caracal dominated the mountainous regions approximately 500m away. They attacked livestock further away from stockposts rather than on nearby plains. Caracals were often seen in nearby bushes however rarely come close to stockposts. They were also perceived to not be as clever as jackals.

Impact of predation

Caracals prey on both goats and sheep and one reported case showed that 5 livestock were killed by caracals in the year 2014. The number of animals lost to caracal was said to be much lower than livestock losses due to jackals.

T*iming of predation*

Predation due to caracals occurred mainly at night however few cases of animals lost to predation occurred in the day. Similar to jackals, instances of high predation coincided with livestock being out in the fields at night, and during the winter breeding seasons (May-September). When livestock are mistakenly left out at night or when livestock gave birth further from stockposts, predation was also an increased risk.

Control and mitigation

Herders often chased jackals with guard dogs. This was usually done in defence when caracals were nearby. One of the farmers reported that he had killed 5 caracals in his lifetime. Usually caracals were not actively hunted. Many farmers said they owned traps but rarely used them. Similar to the case for jackals, some farmers believed that caracal numbers have increased whilst others perceived the numbers to have remained the same.

Other reported predators

The Cape fox was also reported to be a popular threat to livestock, and these were referred to as "Draaijakkals". These predators were said to differ from a common jackal and the African wild cat in their spoor as well as their call. The Cape fox targeted lambs especially if they did not return to their stockposts at night. They were reported to attack livestock further from the stockposts, as well as being most active in the evenings and in the winter months. Farmers revealed that they occasionally hunted the Cape fox, with their dogs.

Farmers also reported other predators in Paulshoek that did not have as large an effect on livestock; Black-eagle, crow, leopard, baboon, dog, African wild cat, falcon, owl, and bat-eared fox. On one occasion a bear and wolf were seen in the surrounding area, however these had escaped from Reserves.

The black eagle was said to attack and catch lambs while they were asleep, as well as goat kids, dassies, rabbits, chickens. They were also seen on one occasion to encircle baboons. They are known to be active primarily in the day and breed in the mountainous areas, where their calls are often heard. Livestock attacks are said to occur close to the stockposts. In one instance an eagles attacked two lambs, whilst another case reports the loss of four lambs in 2013. A third farmer reported the loss of three goat kids in the year 2014. In the past, traps were used to catch the black eagle, however it is illegal to do so today. One case was reported where two lambs were also attacked by crows, in 2013. It is believed that crows attack the eyes of their prey. Leopards were identified as a livestock predator through their spoor. No livestock deaths due to leopards were reported for 2014, however in 2011 a calf was attacked. Leopards are known to attack at night, as far as 20km from the stockposts. One particular farmer reported that a leopard once attacked/bit 25-30 livestock as they passed through the field. Farmers use traps as well as hunt problem leopards when circumstances permit. Baboons were reported to have killed only one of the farmer's animals in 2014, as well as attacking a dog in the neck. Baboons were said to attack their prey in the head, eye and neck regions. Domestic dogs were also identified as predators through their spoor as well as what part of their prey they attack. They are aware of when livestock are in their environment and usually attack/bite lambs especially when they are hungry. One such case reported 20 lambs attacked by domestic dogs. During lambing season, livestock are at higher risk of being attacked by dogs that belong to farmers in Paulshoek. Attacks usually happen at the stockposts as well as in the mountainous areas and are said to occur during the day as well as the nights. Most farmers revealed that the numbers of domestic dogs have increased, whilst others thought the numbers to remain the same. Despite domestic dogs being an occasional threat to livestock, farmers do not hunt or trap them. The African wild cat was also seen occasionally escaping with prey that they had caught. They are known to target both goats and sheep, as well as chickens and are observed to attack in the day as well as the nights. During lambing time, predation risk is heightened. Additionally, they do not fear to approach stockposts. One farmer reported that tens of livestock were killed by an African wild cat, most of these being goat kids and lambs. Similar to jackals, they are also a threat to livestock that are left out in the field in the night. Falcons have been reported to target chickens, whilst owls too were reported to prey on chickens, especially at dawn and dusk. The bat-eared fox (Bakoor) was also mentioned by a few of the farmers and these predators were observed to have attacked younger livestock.

Table 1. Identification, behaviour and diet of other predators sighted by Paulshoek farmers
Information obtained from Web based Biodiversity Explorer. The Web of Life in Southern Africa. Iziko Museums. http://www.biodiversityexplorer.org

Common Name (Afrikaans)	Scientific Name	Identification	Behaviour	Diet
Draaijakkal (Cape fox)	*Vulpes chama*	Black or silver gray fur with light underside & dark, bushy tail	Nocturnal. Solitary or in pairs. Runs as it twists & dodges. Can turn quickly on its own track.	Insects, rodents, birds, carrion, wild fruit
Black/ Verreauxii Eagle (Tiervoel)	*Aquila verreauxii*	Jet-black plumage with distinct yellow bill & eye rings	Territorial, solitary nester	Mammals, especially hyraxes, reptiles, birds
Cape/ Black Crow (Kraai)	*Corvus capensis*	Black plumage with slight purple gloss	Nests in trees	Plants and insects
Leopard (Leiperd)	*Panthera pardus*	Dark rosette shaped spots on the coat of the back	Solitary. Climbers. Stalk prey before pouncing	Insects, rodents, birds, reptiles. medium sized antelope, carrion
Chacma/Cape Baboon (Bobejaan)	*Papio hamadryas*	dark brown to gray in color, with a patch of rough hair on nape of neck	Live in groups. Dominant alpha male leads foraging	Fruit, insects, seeds, grass, small vertebrates, occasional scavenger
African Wild Cat (Groukat)	*Felis silvestris cafra*	Similar in appearance to a domestic cat. Body is marked with vertical stripes	Nocturnal & territorial. Stalk prey before pouncing	Small mammal prey, rodents, birds, reptiles, amphibians, insects
Peregrene Falcon (Valk)	*Falco peregrinus*	Black-tipped tail with white band	Aerially hunts and dives down to catch prey	Birds, bats , flying insects
Spotted Eagle Owl Uil)	*Bubo africanu*	Pale ochre face with yellow eyes and prominent ear tufts	Nocturnal. Usually swallows prey whole	rodents, small birds and shrews, carrion
Bat-eared Fox (Bakoor)	*Otocyon megalotis*	Small and jackal like, sharp-pointed muzzle. Light band runs across forehead to base of ears	Nocturnal. Active diggers. Locate prey by hearing	Insects, scorpions, spiders, fruits, amphibians, occasional small mammals, birds, soft tubers & roots.

Herding Practices

Over 70% of farmers reported having only one herder per stockpost, whilst only few farmers had two or three herders. Just under 50% of the farm owners were herders themselves whilst other herders were hired or family members that had been employed. The amount of time the herders worked at each stockpost varied greatly from 3 months to 20 years, however one farmer revealed that he had remained at his stockpost for 50 years. Livestock were herded from the stockpost every morning, to grazing and watering sites and then brought back to the stockposts later in the day. For the two specific categories of working hours defined, (>6 hours and <6 hours) all but one of the farmers admitted to herding their livestock for only a part of the day (<6hours) as opposed to the entire day. This means that they would herd the livestock 1-2 km away in the mornings, possibly remain with the animals for a few hours and return back to their stockpost, leaving the animals out to graze in the field. They would then return in the afternoon to herd livestock back to the stockpost.

The farmers were aware of vulnerable periods where livestock would be prone to predation. In all interviews, farmers expressed that they kept their animals at the stockposts in the nights, as this is when predators were most active. The farmers also admitted that when animals were sometimes accidentally left out in the field at night, they were immediately brought back to the stockpost. Some animals may have also gone missing in the field, in which case predation risk was high for these individuals. When animals gave birth to their young in the field (weglam), they would often remain in the field overnight. When farmers identified missing animals, they would then search for these individuals. It was also a common perception that missing animals were easier to find in the moonlight. During the lambing season, extra precaution was taken by all farmers to protect the younger animals by keeping them at the stockposts. In some cases, shelters were made for the lambs and goat kids.

When asked to rank the greatest threats to livestock, farmers believed that drought was the greatest threat, followed by predation and lastly by disease. They also explained that drought and predation contested closely in terms of the number of animals lost through each, especially because drought is a large and long term effect, whilst predation is a small, yet long term effect.

History

Between the 1940s and 1960s, farmers were paid to hunt jackals and caracals to prevent livestock predation on commercial farms. On presentation the skin of a dead jackal, farmers could receive R1.50 whilst they were paid R1.00 to kill a caracal. This was an exorbitant amount considering the monthly income of a communal farm worker was R2.00. Farmers therefore took up hunting as a means of income and lived out in the fields for as long as a month, along with traps in their backpacks, in search of these predators. They would identify the jackal and caracal using their spoor. Farmers were only paid if the animals were caught on commercial farmland, whilst they were not paid by the commercial farmers who employed them, if the predator was caught on a communal farm. Commercial farmlands still employ hunters today, who can get paid R600.00 for the skin of a jackal and R500 for a caracal's skin. In addition to this, for each day of hunting, R40 is paid to farmers as well as a provision of food for themselves and their hunting dogs. In commercial farms it has become a status-seeking act to hunt predators and display their skins. In communal areas today however, farmers are not admired if they are to catch a predator and the act of hunting predators to sell their skin and earn an income is no longer practiced. It is perceived that jackals are too clever to be eliminated completey. In commercial farmlands, electric fences are erected to protect livestock from predators. Active hunters are also employed in commercial farms, but not in communal farms. It is believed that at the boundaries of commercial farmlands there is less predator spill-over into neighbouring communal farms. Farmer's reported that more livestock deaths may have occurred in sections of commercial farmlands that are in close proximity to communal farmlands, where no hunting and electric fences were in place.