Chapter 1: Introduction

Humans and carnivores have coexisted for eons (Graham *et al*. 2005; Woodroffe 2000) and human-carnivore conflict has played a major role in shaping carnivore populations worldwide (Wang & Macdonald 2006). According to Kruuk (2002), human-carnivore conflict over livestock has been in existence since humans domesticated wild ungulates. However, in recent times there has been a dramatic increase in human-carnivore conflict. These conflicts happen because of competition between humans and carnivores for shared, limited resources (Graham *et al*. 2005). For example, many carnivore species kill prey species that humans hunt, harvest or farm for consumption or recreation, and occasionally they may even kill people (Kaczenskey *et al*. 2004; Treves 2003). The conflict can be particularly contentious when the predators involved are protected and the resources concerned are of high value to humans (Thirgood *et al*. 2000). The factors contributing to the increase in human-carnivore conflict vary according to local socio-economic environment and the biological and ecological attributes of the predator involved. These factors can be grouped into three broad categories (1) Biological factors, (2) Direct impacts, and (3) Indirect impacts (Mattson 2004). All these factors are interlinked and equally important in order to assess the severity of human-carnivore conflict. This dissertation will attempt to address these factors in terms of leopard-stock farmer conflict in the Baviaanskloof Mega-Reserve (BMR), Eastern Cape, South Africa. The BMR is a World Heritage Site and is situated in the south-western part of the Eastern Cape. This area consists of the Baviaanskloof Nature Reserve as well as the surrounding non-conservation areas.

1.1 Biological factors

Biological factors are the attributes of the specific carnivore involved, which will increase its chance of encountering humans, their livestock or compete directly with humans for wild ungulates. According to Mattson (2004), the three biological factors that contribute most to carnivore-stock conflict are body size, range size, and prey specialization.

1.1.1 Body size

One of the most important factors governing human-carnivore conflict is the body size of carnivores. According to Mattson (2004), an increase in predator body size is positively correlated with an increase in home range size and prey weight range. This increase in prey size thus determines which predators will be able to take livestock. In other words, large predators such as lions (*Panthera leo*), spotted hyaenas (*Crocuta crocuta*), brown hyaenas (*Parahyaena brunnea*), cheetah (*Acinonyx jubatus*), African wild dogs (*Lycaon pictus*) and leopards (*Panthera pardus*) are more likely to come into conflict with humans because they readily take livestock. Preferred prey weight ranges gives a good indication of whether a carnivore is capable of preying on domestic livestock, and all the large African carnivores have preferred prey weight ranges that incorporate livestock body size (lion, Hayward & Kerley 2005; spotted hyaena, Hayward 2006; leopard, Hayward *et al*. 2006a; cheetah, Hayward *et al*. 2006b).

1.1.2 Range size

Carnivore range size plays an important role in human-carnivore conflict. Carnivores with a wide-ranging habit are more likely to have home ranges occurring partially outside protected areas (Woodroffe 2000). This thus increases the chance of predators encountering humans and livestock, and inevitably leads to recurrent resource competition with humans (Graham *et al*. 2005). This conflict with farmers at reserve borders can develop into a potent edge effect leading to local extinctions of carnivore populations, if the reserve is too small to include the entire home ranges of carnivores (Woodroffe & Ginsberg 1998).

1.1.3 Prey specialization

Specialized predators are more vulnerable to extinction than generalist predators (Mattson 2004; Hayward & Kerley 2008). This is because specialists cannot switch prey species when the density of their natural prey is reduced. A classic example of this, which is used in most ecology textbooks (Stiling 2002), is the case of the snowshoe hare (*Lepus americanus*) and the Canadian lynx (*Lynx canadensis*). Generalists on the other hand are able to adapt by switching to other food sources when there is a reduction in natural prey, for example jackals (*Canis* spp., Mattson 2004). These carnivores come into conflict with livestock farmers, simply because they are able to switch to domestic livestock when the availability of their natural prey is reduced (Mizutani 1993). All of the African large predators (lion, hyaena, cheetah, African wild dog and leopard) have come into conflict with landowners, and all of them are generalist predators (Graham *et al*. 2005). This increases the possibility of switching to domestic ungulates for prey.

1.2 Direct impacts

Direct impacts are defined as human impacts that have a direct affect on the carnivore population. Many factors should be considered when investigating the anthropogenic impacts involved in human-carnivore conflict. These are the harvesting of body parts, retaliatory killing of carnivores, collisions with motor vehicles, decrease in prey base, destruction of natural habitat, and disease (Mattson 2004). Of these factors, only three are applicable in the BMR. They include destruction of habitat, the reduction in natural prey, and retaliation for depredation.

1.2.1 Habitat destruction and reduction in natural prey

Humans alter their natural environment in two main ways: they alter the habitat to create pastures for livestock, and they overexploit the natural vegetation by using it as grazing for livestock, and overexploit herbivores for food or recreational purposes (Breitenmoser 1997). This process of habitat destruction and the reduction in natural prey often go hand in hand. For example, introduced livestock outcompetes the natural herbivores and has a large impact on the vegetation, which decreases the natural prey base of the area (Breitenmoser 1997). The high density of livestock prevents the regeneration of the natural vegetation (Breitenmoser 1997) and consequently decreases the carrying capacity for native prey. In these unnatural settings, carnivores are forced to prey on livestock (Breitenmoser 1997). Thus, the recent increase in carnivore-stock farmer conflict is partially due to the destruction of natural habitat (Treves & Karanath 2003), but also to the overexploitation of the natural prey in the area. According to Mishra (1997), this overexploitation of natural herbivores by humans can reduce the availability of natural prey to predators to such an extent that they are forced to take domestic livestock.

1.3 Indirect impacts

Indirect impacts are defined as factors that increase the likelihood of human-carnivore conflict. These factors can be seen as a catalyst for conflict between humans and carnivores. Of these factors, human population growth (Woodroffe 2000) and conservation efforts (Breitenmoser 1997) are two of the most important factors augmenting human-carnivore conflict.

1.3.1 Human population growth

The rate of conflict between carnivores and humans has grown in the last decades and is largely attributable to human population explosion in the last century, which has lead to an increase in urbanization and development into previously secluded carnivore habitats (Graham *et al*. 2005; Kaczensky *et al*. 2004; Treves 2003). This in turn increases the frequency of encounters between domestic stock and carnivores (Woodroffe 2001; Naughton-Treves *et al*. 2003), and hence an increase in the severity of the factors that shape human-carnivore conflict. This is because human population expansion is at the core of carnivore extinctions. According to Woodroffe (2000), there is a significant linear relationship between human density and carnivore extinction. Thus, with an increase in human population there is an increased probability of the local extinction of carnivore populations. This is due to humans modifying the environment in such a way that it becomes hostile towards carnivores (Woodroffe 2000). Large carnivores are very sensitive to this human population explosion, because this increases their chances of encountering humans and livestock. This leads to an increase in the amount of livestock or even humans killed by predators (Woodroffe 2000), which generally results in retaliatory killing of carnivores.

1.3.2 Conservation efforts

Conservation efforts within protected areas have led to an increase in predator numbers. These predators ultimately disperse from the protected areas onto the neighbouring farmlands, where conflict inevitably arises. This gives rise to a situation that shares similarities with source-sink dynamics (Larivière *et al*. 2000). Here, the reserves with their relatively high carnivore densities act as sources and the neighbouring farmlands as sinks. The reason for this is that these reserves often lack adequate fencing. The factors that exemplify this population increase are, successful reintroduction programmes and habitat restoration accompanied by a higher conservation status for the predator in question. This was the case for the ‘Big Three’ (analogous to the African ‘Big Five’), which includes the brown bear (*Ursus arctos*), wolf (*Canis lupus*) and the Eurasian lynx (*Lynx lynx*) populations in the Swiss Alps (Breitenmoser 1998). Here the carnivore decline mirrored human expansion. Wherever humans settled the carnivore population was exterminated due to their threat to livestock and as competitors for game species (Breitenmoser 1998). However, this is not the sole reason for their decline. According to Breitenmoser (1998), the alteration of the natural habitat, reduction in natural prey items and the expansion of agricultural farmlands played important roles. The recovery of the ‘Big Three’ started with the restoration of natural habitats. This, in combination with a retraction of human populations towards city centres, due to industrialization, led to the recovery of the forests (Breitenmoser 1998). This facilitated the immigration of ungulates to these areas, which was also augmented by reintroduction programmes, and ultimately led to an increase in the carnivore population (Breitenmoser 1998). The increases in carnivore populations lead to an increase in carnivore-stock conflict, which in turn leads to the retaliatory killing of lynxes and wolves outside the boundaries of protected areas in the Swiss Alps (Breitenmoser 1998).

1.4 Carnivore-stock farmer conflict

According to Graham *et al*. (2005), livestock depredation by carnivores is one of the main reasons for conflict between carnivores and humans. Several factors play a role in human-carnivore conflict. All of these factors combine to create a unique situation where carnivores compete with livestock farmers for the same resources.

In general, farmers that farm next to protected areas generally have the greatest depredation rates. In areas where livestock farming is the predominant landuse, carnivore populations will suffer most from direct persecution due to retaliatory actions by the farmers (Mazzolli *et al*. 2002). This depredation of livestock by carnivores is exacerbated by habitat destruction and the reduction in natural prey, which forces carnivores to prey on domestic livestock (Mizutani 1993). The conflict arises because carnivores are adapted to take ungulate prey and therefore they will take domestic ungulates when the opportunity arises (Treves & Karanath 2003). The exact reasons why carnivores prey on domestic stock are poorly understood. In some areas, it is thought that it is a learnt behaviour, in other words, predators have learned that livestock are easy prey (Maddox 2003). In this case, there may be the existence of a few “problem individuals” that specifically target livestock as prey. Other factors, such as age and sex of the predator may also play an important role. Saberwal *et al*. (1994) showed this for lions and Sukumar (1991) for tiger (*Panthera tigris*) in India. For whichever reason, the fact remains that carnivores prey on domestic livestock, which leads to serious economic losses to farmers due to livestock losses and the increased costs and work effort to adapt farming methods (Kaczensky *et al*. 2004). According to Treves and Karanath (2003) there is an increase in the frequency and economic cost of the conflict between humans and carnivores in many areas. These perceived economic losses lead to carnivore persecution by farmers (Graham *et al*. 2005). This effect has lead to the extinction of several carnivore species worldwide (Woodroffe *et al*. 2005).

1.5 Leopard (*Panthera pardus*)

1.5.1 Distribution and status

Leopards have the widest geographical range of all felids (Skinner & Chimimba 2005). They occur from the southern parts of Africa through the Middle East to the Far East, and their range extends north as far as Siberia and south as far as Sri Lanka and Malaysia (Mills 2005). Globally, leopards are not considered to be threatened with extinction, and are classified on the IUCN Red List as Near Threatened (Breitenmoser *et al*. 2008).

In a South African context, the two largest leopard populations occur within the Kruger National Park and the surrounding areas (over 1000 individuals) and the Kalahari Gemsbok National Park (over 150 individuals shared between South Africa and Botswana; Mills 2005). In Kwa-Zulu Natal, leopards occur mainly in the north-east with few individuals occurring in the rest of the province (Skinner & Chimimba 2005). They occur throughout the Limpopo Province as well as in Mpumalanga, the North-West Province (there are reported viable populations in the Magaliesberg, Waterberg, and Soutpansberge – Mills 2005), and Gauteng (Skinner & Chimimba 2005).

In the Western Cape, they occupy the mountains (Cape Fold Mountains, CFM) and forests of the south and south-western Cape (Stuart 1981). There is no exact estimate of the population size for the CFM leopards, but it is considered very small and extremely insecure (Norton 1986; Turnbull-Kemp in Stuart & Heinecken 1977). According to Stuart (1981), the Cape Mountain leopards attain their highest densities in the Mountain Fynbos of the south-western, southern portions of the Western Cape as well as eastern and southern part of the Eastern Cape. Although leopards are not considered endangered in a global context, nationally they are considered to be threatened with extinction in the medium term future by the National Environmental Management and Biodiversity Act of 2004.

1.5.2 Cape mountain leopard

According to Henley (2000) there is a possibility that the leopards occupying the mountainous areas in the Western and Eastern Cape Provinces are a subspecies distinct from the leopard populations occurring further north. This is primarily based on morphological differences between this leopard and the savanna leopard (Martins & Martins 2006). Firstly, the Cape leopards have a longer, softer and more vividly coloured coat (Henley 2000). Secondly, these leopards tend to be smaller than savanna leopards, with males averaging 31 kg and females 21 kg (Stuart 1981), whereas male savanna leopards average between 58 and 63 kg and females between 32 and 38 kg, depending on the location (Skinner & Chimimba 2005). This differentiation is probably due to the differences in diet (Henley 2000), with the mountain leopards preying on smaller prey (e.g. rodents and small antelope) compared to the savanna leopards. However, there is no genetic evidence to support the taxonomic separation of the "Cape Mountain leopard". Irrespective of this, several factors make the Cape leopard population unique and of special conservation concern. This population forms the southern extreme of the global distribution of leopards (see Skinner & Chimimba 2005; Figure 1.1) and it has become progressively more isolated from other leopard populations since the early 1900s (Norton 1986; Figure 1.2). The Cape leopard population also occupies a unique biome, namely Fynbos, which has a discrete prey base compared to other more productive systems such as savannas (Henley 2000).

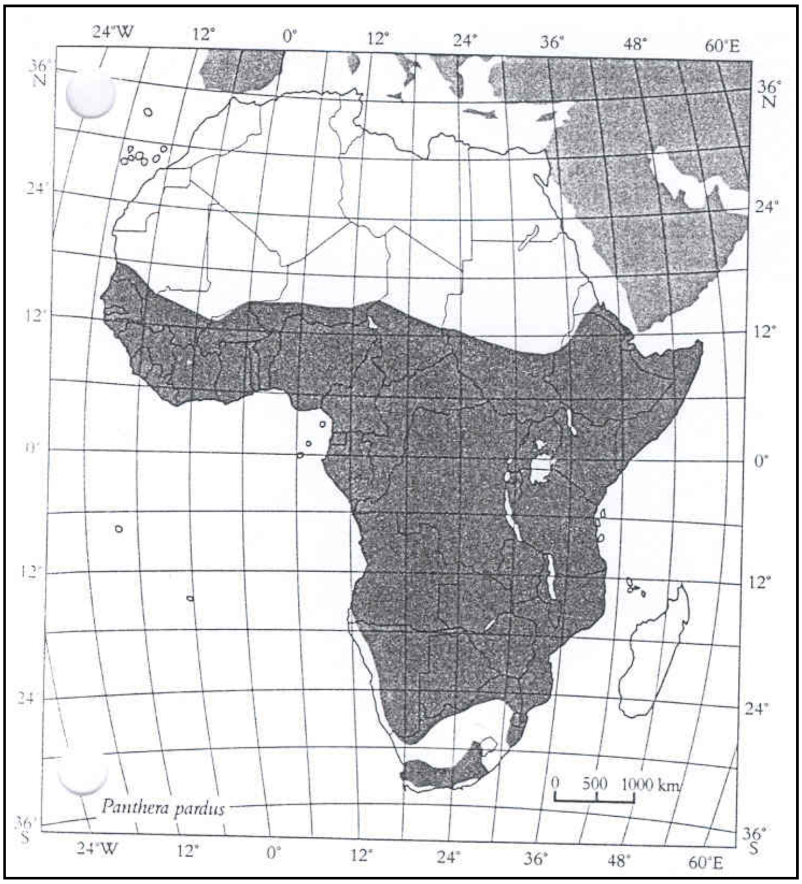

Figure 1.1: The distribution of leopards in Africa (from Skinner & Chimimba 2005).

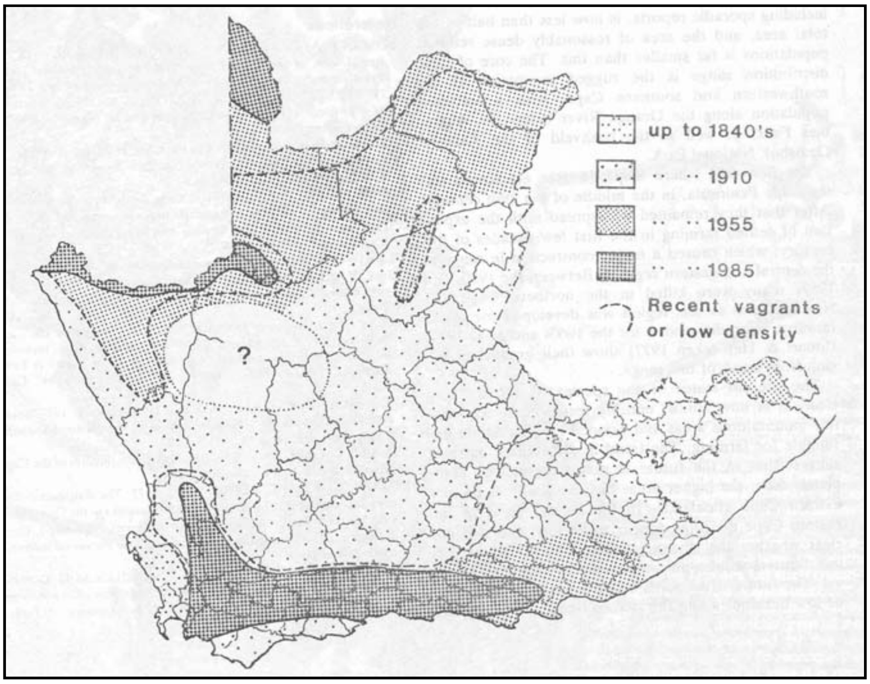

Figure 1.2: The patterns of historical range retraction of southern African leopards (from Norton 1986).

1.5.3 Diet of leopards in the Baviaanskloof Mega-Reserve

Leopards are opportunistic and prey on a wide range of animals (Bothma & le Riche 1984) and have been known to scavenge when the opportunity arises (Bailey 1993). This together with their secretive and nocturnal habits allows leopards to persist in areas close to human habitation (Ott *et al.* 2007). Conflict with stock farmers inevitably arises because leopards prefer prey between 10 and 40 kg (Hayward *et al.* 2006a), which includes livestock.

Ott *et al*. (2007) described the diet of leopards in the Baviaanskloof Nature reserve and adjacent rangelands. Leopards preyed predominantly on small mammals including vlei rat (*Otomys irroratus*), rock hyrax (*Procavia capensis*), African wild cat (*Felis silvestris*), short-tailed gerbil (*Desmodillus auricularis*), Namaqa rock mouse (*Aethomys namaquensis*), and multimammate mouse (*Mastomys* sp.; Ott *et al*. 2007). The diet also included nine ungulate species including mountain reedbuck (*Redunca fulvorufula*), bushbuck (*Tragelaphus scriptus*), grysbok (*Raphicerus melanotis*), common duiker (*Sylvicapra grimmia*), steenbok (*Raphicerus campestris*), grey rhebuck (*Pelea capreolus*), klipspringer (*Oreotragus oreotragus*), kudu (*Tragelaphus strepsiceros*), and the alien nyala (*Tragelaphus angasii*; Ott *et al*. 2007). Most importantly, two breeds of domestic stock, Angora goats (*Capra hircus*) and sheep (*Ovis aries*) was recorded in the diet (Ott *et al*. 2007). Although livestock only forms a small part of the leopard's diet, it still indicates that leopards prey on domestic stock in the BMR. This causes economic losses to the farmer and hence the retaliatory killing of leopards.

1.5.4 Leopard-stock farmer conflict in the Baviaanskloof Mega-Reserve

Relatively little information is available regarding the effects of retaliatory killing on leopards in the BMR. Most of this information relates to the then Cape Province and does not specify how many leopards were killed in the BMR. For example, Stuart & Heinecken (1977) determined the amount of known leopard mortalities in the then Cape Province between 1952 and 1977. A total of 189 leopards were killed in this period. This translates to an average of 7.3 leopard killed per year. Esterhuizen & Norton (1985) also determined the amount of leopard removed in the then Cape Province from 1977 to 1982. However, they determined the amount of leopard mortalities for each divisional council of the then Cape Province. It was thus possible to determine how many leopards were killed in the BMR. A total of 46 leopards were killed in the BMR over this period (Esterhuizen & Norton 1985). This translates to an average of 7.6 leopards killed per year (Esterhuizen & Norton 1985). More recent records suggest that the amount of leopards killed due to the retaliatory response of farmers is on the decrease. Only four leopards were legally killed in the BMR from 2004 to 2007 (G. Ferreira, DEDEA, *pers. comm*.). There is thus a substantial decrease from 7.6 leopards per year from 1952 – 1977, to 1.3 leopards per year from 2004 - 2007. However, these figures are likely to be underestimates of the actual leopard mortalities in the BMR. This is because not all leopard kills are reported to the authorities (Martins & Martins 2006). Therefore, the actual number of leopard killed in the BMR and the affect of this on the leopard population cannot be determined. Thus, the possibility still exists that the retaliatory killing of leopards in the BMR can lead to the local extinction of these carnivores, as was the case for many carnivores worldwide (Woodroffe *et al*. 2005).

1.6 Rationale and objectives

The future conservation of carnivore populations depends partially on the understanding of human-predator interactions (Woodroffe 2000). Thus, in order to facilitate carnivore conservation, the major factors that influence carnivore-stock conflict needs to be investigated.

This study addresses three broad categories that influence leopard-stock farmer conflict in the Baviaanskloof Mega-Reserve, Eastern Cape, South Africa. Firstly, the ecological factors (Chapter 3) contributing to leopard-livestock interactions are assed. Here, I describe habitat selection of leopards based on livestock losses attributed to leopards, I determine if leopard predation on livestock is focused in areas that border the Baviaanskloof Nature Reserve (BNR), and then I compare the livestock losses attributed to various causes of livestock mortality and assess the effects leopards have on these predators. Secondly, the socio-economic factors (Chapter 4) that influence leopard-stock farmer conflict are examined. Here, I asses the attitudes of farmers towards leopards and the factors influencing these attitudes, and I also assess the effectiveness of the livestock management techniques and predator control strategies employed by farmers in the BMR. Finally, a prey-density based model is used to estimate the potential leopard abundance and density in the Baviaanskloof Nature Reserve (Chapter 5). This information will contribute to reducing leopard-stockfarmer conflict through the drafting and implementation of appropriate management strategies derived from this study.