A socio-ecological approach towards understanding conflict between leopards (Panthera pardus) and humans in South Africa: Implications for leopard conservation and farming livelihoods

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Abstract

The thesis investigates the socio-ecological factors driving human-leopard conflict due to livestock and game depredation in the Blouberg Mountain Range, South Africa. Local people's perceptions of conservation are shaped by historical and contemporary relationships with protected areas and particularly, by conflicts of land and natural resource use. Legacies of disempowerment, marginalisation and stigmatisation manifest through people's conservation discourses, social conflict and resistance towards protected area establishment, a process defined as traumatic nature. Traumatic nature elevates distrust of local people towards wildlife authorities and decreases support for wildlife conservation, aggravating human-leopard conflicts. Leopard predation on livestock and game is most strongly influenced by distance to village and distance to water, respectively, in addition to seasonal grazing patterns, the calving season and poor livestock husbandry practices. Livestock depredation represents significant economic costs for subsistence communal farmers', which is exacerbated by the erosion of traditional cattle sharing systems and a lack of alternative livelihood strategies. Livestock depredation results in the loss of functional and material benefits, social capital, a spiritual resource, diminished wellbeing and perceived cultural decay. Camera trap results showed a lower leopard density of 0.7 leopards per 100km^2 on commercial farms compared to the Blouberg Nature Reserve of 5.4 leopards per 100km^2. Commercial farms may function as ecological traps because they represent areas with disproportionate leopard mortality that otherwise provide a high abundance of prey species for leopards. A male-biased sex ratio and a high number of sub-adult male leopards indicate high leopard mortality rates in the population. Camera trap results show low occupancy rates on communal land that may reflect a low large prey biomass, potentially caused by overhunting and habitat conversion. Farming communities ascribe a wide range of environmental values to the leopard that provide barriers and support for leopard conservation. Environmental institutions need to improve responses to reports of human-leopard conflicts and build trust and legitimacy in the eyes of local people by developing stronger working relationships with farming communities. The decentralisation of authority to local government actors to manage human-leopard conflicts and the devolution of responsibility to farmers to improve livestock husbandry practices is necessary to reduce depredation incidents. Incentive and education schemes are important for reducing lethal control measures and to improve tolerance of depredation incidents and leopard conservation.

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List of Abbreviations

AIC	Akaike Information Criterion
AUC	Area under the curve
BNR	Blouberg Nature Reserve
CITES	Convention on International Trade in Endangered Trade in Endangered Species
DEA	Department of Environmental Affairs
DEM	Digital Elevation Map
GIS	Global Information System
GPS	Global Positioning System
HMMDM	Half Mean Maximum Distance Moved
IUCN	International Union for Conservation of Nature
LEDET	Limpopo Department of Economic Development, Environment and Tourism
LNR	Lanjan Nature Reserve
MMDM	Mean Maximum Distance Moved
MNR	Maleboch Nature Reserve
NDVI	Normalised Difference Vegetation Index
NGO	Non-Governmental Organisation
RAI	Relative Abundance Index
UNESCO	United Nations, Educational, Scientific and Cultural Organisation
WNBR	World Network of Biosphere Reserves

Definitions of Organisations

Bahananwa Traditional Authority: From the 1940s the institution of traditional authorities served as a local government, which exercised governmental functions from the provisioning of services to the preservation of law and order, the settling of local disputes and the allocation of tribal land. Currently the Bahananwa Traditional Authority is a council comprising the Chief of the Bahananwa tribe and his advisers that represent the interests of the Bahananwa people.

Blouberg Tourism Association: Established in 1999 to manage community based tourism initiatives on behalf of the Bahananwa Traditional Authority.

Bro Brak Farming Association: An association of commercial farmers living and working in the Vivo area of the Limpopo Province, which was established to represent local farming interests.

Convention on International Trade in Endangered Trade in Endangered Species: An international agreement between governments to ensure that international trade of wild animal specimens and plants, does not threaten their survival.

Limpopo Department of Agriculture: A sector of the Limpopo Provincial Government, which falls under the Department of Economic Development, Environment and Tourism and is responsible for overseeing and supporting agriculture activities in the province.

Limpopo Department of Environmental Affairs: A sector of the Limpopo Provincial Government, which falls under the Department of Economic Development, Environment and Tourism and is responsible for the management and conservation of natural resources in the province.

DeWildt: A cheetah centre in South Africa, which was established in 1971 and used as a cheetah breeding project and a platform to initiate a wide range of conservation programmes.

Earthwatch: Established in 1971 as an environmental charity, with a mission to engage people worldwide in scientific field research and education and to promote an understanding, awareness and need for a sustainable environment.

Endangered Wildlife Trust: A South African NGO founded in 1973, which conducts research, fieldwork and engages with stakeholders to support the conservation of threatened species and ecosystems.

International Union for Conservation of Nature: Founded in 1948 as the world's first global environmental network for governments, NGOs, scientists, businesses and local communities to find solutions to conservation and development challenges.

Kune Moya: A private organisation, which provides support and development services to communities that are beneficiaries of land restitution and redistribution in South Africa.

Limpopo Department of Economic Development, Environment and Tourism: A sector of the Limpopo Provincial Government, responsible for the implementation and management of economic development initiatives and environmental and tourism activities in the province.

Limpopo Tourism Agency: A parastatal of the Limpopo Department of Economic Development, Environment and Tourism, responsible for the management of tourism activities and protected areas in the Limpopo Province.

South African Development Trust: A trust created in 1936, which owned and controlled areas of land for the settlement of Black South Africans during apartheid.

United Nations, Educational, Scientific and Cultural Organisation: Established in 1945 as a specialised agency of the United Nations to contribute peace and security by promoting international collaboration through education, science and culture and to promote universal respect for justice, the rule of law and human rights.

Village Trusts: Consists of representatives from the villages Ga-Kgatla, Setloking, Burchrecht and My Darling to promote the views of the local people on issues relating to the management of the Maleboch Nature Reserve.

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Statement of Copyright

For Poppy

Chapter 1

Introduction

1.1 Human-carnivore conflict: A global problem

Conflicts between humans and wildlife arise "when the needs and behaviour of wildlife, impact negatively on the goals of humans or when the goals of humans, negatively impact the needs of wildlife" (Madden, 2004, p. 248). The extension of human presence into wildlife habitats results from human population growth and land use transformation, driving species' habitat loss, degradation and fragmentation (Sillero-Zubiri et al., 2007, Inskip and Zimmermann, 2009). Conflict occurs between humans and wildlife when animals attack livestock, managed game populations, raid crops and threaten human safety, livelihoods and wellbeing (Knight, 2000). The literature reports conflict between humans and a plethora of terrestrial species including invertebrates, birds, reptiles, small mammals and large charismatic mammals, with the latter group being most widely documented (Knight, 2000, Inskip and Zimmermann, 2009). The term human-wildlife conflict has also frequently been used to describe disputes between people about the management of wildlife. This form of "human-human conflict" results from "disagreements among people who see incompatible goals and potential interference in achieving these goals" (Redpath et al., 2012, p. 1). Human-human conflict emerges because different people have different interpretations of a situation and often have opposing value systems (Peterson et al., 2010, Redpath et al., 2012). Human-human conflicts are thus political in nature and linked to power relationships (Peterson et al., 2010, Redpath et al., 2012). Human-wildlife conflicts involve two dimensions: interactions between humans and other species and human interactions between those seeking to protect wild animals and those affected by wild animals (Redpath et al., 2012).

Conservation efforts in the 21st century represent unique challenges, reconciling the needs of human activities with the needs of wildlife in evolving ecological, socio-economic and political landscapes (Barua et al., 2013). Protected areas comprise 14% of the Earth's surface and provide the last few refuges for some threatened species (UNEP, 2013). However, large carnivores frequently inhabit areas that extend beyond these boundaries, drawing them into conflict with people (Woodroffe and Ginsberg, 1998, Woodroffe, 2001, Woodroffe and Frank,

2005, Inskip and Zimmermann, 2009). Conflicts involving large carnivores result from their protein-rich diets and extensive home ranges, which draw draw them into competition with humans (Treves and Karanth, 2003). Whilst carnivores are specialised to feed on ungulates, livestock are also rendered vulnerable to attack due to inadequate anti-predator responses diminished by domestication (Bagchi and Mishra, 2006). Livestock depredation by large carnivores occurs worldwide. Wolves (*Canis lupus*) and bears (*Ursus spps*) in North America kill sheep, pumas (*Puma concolor*) and jaguars (*Panthera onca*) attack cattle in South America, tigers (*Panthera tigris*) and leopards (*Panthera pardus*) kill livestock in Asia and other carnivores prey on cattle and goats in Africa (Nowell and Jackson, 1996, Madhusudan and Karanth, 2002, Treves and Karanth, 2003).

In this thesis I adopt an interdisciplinary approach, integrating perspectives from biology and anthropology to identify the key determinants of human-leopard conflict and to assist in the development of recommendations to manage human leopard conflicts and promote leopard conservation in the Blouberg Mountain range, South Africa. In this chapter, I provide a literature review of current approaches undertaken by researchers to investigate the complexities of human-wildlife conflict, provide context on the population status and distribution of the South African leopard, discuss the interdisciplinary research approach adopted, provide an outline of the thesis structure and set out the aims of the study.

1.2 Considering the complexities of human-wildlife conflict

1.2.1 Conservation ideology and relationships between people and protected areas

The origins of conflict are deep-seated and often originate from cognitive processes, power relations, changing attitudes and values derived from specific historical and cultural contexts (Dickman, 2010, Redpath et al., 2012). Other conflicts arise as a result of complex social histories, which make people hostile towards conservation when people are excluded from conservation planning procedures, marginalised from negotiations and management decisions (Redpath et al., 2012). Human-wildlife practitioners advocate a need to understand the human dimensions of human-wildlife conflicts by investigating the complex historical, cultural, social

and personal factors driving people's perceptions and behaviours towards wildlife (Madden, 2004, Treves et al., 2006, Treves et al., 2009, Dickman, 2010).

Perceptions of wildlife and conservation are shaped by historical and contemporary interactions with environmental institutions such as protected areas and of the costs and benefits derived from conservation programmes (Conforti and de Azevedo, 2003, Htun et al., 2012, Van Assche et al., 2012). Historically, nature conservation ideology was dominated by an exclusively protectionist approach, manifested through the creation of protected areas (Gandiwa et al., 2013). Protected areas were established to maintain areas of "pristine wilderness" in order to maintain the integrity of ecological populations and habitats (Gandiwa et al., 2013). However, protected areas impose significant social impacts on rural people including displacement from land, restricted access to natural and cultural resources and increased threats from damage-causing animals (Hill, 2004, West et al., 2006, Anthony and Szabo, 2011). Whilst traditional livelihood based strategies such as slash-and-burn, livestock grazing and hunting induce negative impacts on species abundance, soil properties and forest resources, local practices have also depended on traditional ecological knowledge of the land and its resources (Liu et al., 2010). This type of environmental knowledge is of benefit to biological research and to wildlife conservation by supporting an equitable and culturally sensitive approach towards the management of natural resources (Liu et al., 2010). In the 1980s, the protectionist paradigm to nature conservation was challenged by the recognition of the social impacts of protected areas and the relationship between land dispossession, poverty, cultural change and subsistence loss for people living close to protected areas (West et al., 2006, Gandiwa et al., 2013).

Current nature conservation ideology recognises that local people play a significant role in securing natural resources for the future and their involvement in conservation programmes is critical for their success (Robinson and Sasu, 2013). The transformation of protected areas and conservation programmes to improve the involvement and participation of local people has manifested through the emergence of community-based natural resource management, co-management and participatory conservation initiatives (Knight, 2000, Phillips, 2003, Robinson and Sasu, 2013). These programmes allow local people access, partial or direct control over natural resources and develop incentives or benefits from wildlife to encourage support and tolerance for wildlife conservation (Robinson and Sasu, 2013).

However, where the inclusion and devolution of benefit sharing systems to local people have not occurred, relations between local authorities and surrounding communities have become

increasingly strained (Dickman, 2009). In many cases local communities emphasise that the losses induced by the presence of protected areas exceed the benefits (Dickman, 2010). Human-wildlife conflict presents a challenge for protected areas, particularly, where a lack of suitable compensation negatively impacts the quality of life for local people (Bajracharya et al., 2006). Societal distribution of conservation-related benefits is often restricted to the general public, scientists, wildlife authorities and local government with no link being made between the benefits and those receiving the highest costs (Bell, 1987, Leader-Williams and Hutton, 2005, MacMillan and Leader-Williams, 2008). These factors increase opposition and undermine support for conservation efforts. The real and perceived costs imposed on rural communities by conservation agencies may be significant. People are more likely to tolerate risks that are undertaken voluntarily rather than enforced upon them (Starr, 1969, Skogen et al., 2008). For example, public resentment against wild animals in Kibale National Park in Uganda originated out of feelings of frustration that animals were the state's property that local people had no ownership or control over (Naughton-Treves and Treves, 2005). Local people have used human-wildlife conflict as a "lightning rod" to express dissatisfaction with wider issues related to relations with conservation agencies due to restricted access to resource use and the perceived inability of environmental institutions to manage damage-causing animals (Treves et al., 2006). Few human-wildlife conflict studies to date have extended their studies to investigate local people's relationships with protected areas and as a context for understanding the determinants of human-human conflict, although there are notable exceptions (Dickman 2008, Ogra et al. 2008, Anthony et al. 2011 and Karanth et al. 2013). However, none of these studies have assessed the root cause of the construction of these ideas by adopting a historical and cross-cultural comparison. Understanding the historical and cultural factors influencing local perceptions of protected areas and wildlife conservation is crucial for improving human-wildlife conflict and protected area management.

1.2.2 Extent of livestock depredation and bio-physical factors influencing the risk of predation

The extent of livestock depredation serves as a motivating force for hostility towards large carnivores. Often responses to wildlife damage are not proportional to the level of wildlife damage caused such that minimal damage can elicit extreme responses. For example, in the 1980s, 7000 cheetahs (*Acinonyx jubatus*) were killed in Namibia to protect livestock, even

though reports of livestock depredation were rare (Marker, 2002, Marker et al., 2003). Perceptions of risk are influenced by a number of factors. A deep-seated fear of wild animals due to a lack of familiarity and previous devastating events and stories associated with the animal may drive hostility towards wildlife (Knight, 2000, Hill, 2004, Prokop and Fancovicová, 2010, Herrmann et al., 2013). Socio-economic factors influence an individual's vulnerability and ability to manage risk for example, where livestock are the main livelihood strategy, local people are more likely to be antagonistic towards wildlife (Dickman, 2010). Wealth, income diversification and social reciprocity within families and communities may provide adequate coping mechanisms for buffering the impacts of damage-causing animals (Naughton-Treves et al., 2003, Naughton-Treves and Treves, 2005). High rates of depredation in Nepal by snow leopards (*Panthera uncial*) encourage local pastoralists to perceive the extermination of the snow leopard as the only solution to mitigate conflict (Oli et al., 1994). Reports of livestock depredation can lead to exaggerations of the extent of damage caused, because local people affected by livestock loss, fail to take into consideration other threats to livestock including disease, accidents, theft and depredation due to other carnivore species (Holmern et al., 2007, Kissui, 2008, Dar et al., 2009, Dickman, 2009, Atickem et al., 2010, Harihar et al., 2014).

Researchers have explored the factors driving variation in predation rates between households, villages, farms, livestock enclosures (Ogada et al., 2003, Kolowski and Holekamp, 2006, Michalski et al., 2006, Dar et al., 2009, Kaartinen et al., 2009, Mattiello et al., 2012). In Kenya, close to the Massai Mara National Reserve spotted hyaenas (*Crocuta crocuta*) were more likely to attack large villages and enclosures constructed of bush material, whilst leopards attacked villages that were spatially isolated from one another and enclosures made from study materials such as pole timbers (Kolowski and Holekamp, 2006). Livestock losses are associated with the characteristics of livestock husbandry such as the age and type of livestock species, herd size and peak calving seasons (Knarrum et al., 2006, Michalski et al., 2006, Dar et al., 2009, Kaartinen et al., 2009, Mattiello et al., 2012). Lax herding, poor guarding practices and not penning livestock in kraals at night increase the risk of predation (Sangay and Vernes, 2008). Overall livestock predation by a range of carnivore species in Bhutan was highest in the summer and autumn months, coinciding with the peak agricultural cropping period when livestock are turned out to pasture (Sangay and Vernes, 2008). Lion attacks in Tsavo National Park, Kenya, increased during the rainy season and were linked to seasonal movements of game species (Patterson et al., 2004). High stocking densities of livestock on open rangelands in the Trans-Himalayas, India, compete with wild prey for common resources leading to a decline in the abundance of wild prey, large carnivores to predate on livestock (Mishra et al.,

2003, Bagchi and Mishra, 2006). Livestock predation risk depends on the characteristics of livestock husbandry, the temporal characteristics of livestock attacks and the availability of wild prey species.

Landscape features such as steep, rocky slopes (Stahl et al., 2002), cliffs (Jackson, 1996), water bodies (Michalski et al., 2006) and distance to riparian corridors and forested areas (Michalski et al., 2006, Palmeira et al., 2008, Thorn et al., 2012) also influence rates of predation on livestock. Depredation rates may also decrease with increasing proximity to human habitation including urban centres (Michalski et al., 2006) and villages (Kolowski and Holekamp, 2006). Large carnivores also adopt different predatory behaviours in relation to distance from protected areas (Azlan and Sharma, 2006, Holmern et al., 2007). Ecological niche models relate environmental data to spatial processes to predict the probability of occurrence of species and have been applied to predict species richness, distributions and the invasive potential of exotic species (Zarco-González et al., 2013). Ecological niche models have also been applied to predict the impact of environmental predictors on the risk of puma and jaguar predation on livestock in Mexico, based on the collection of presence only data from the location of livestock attacks (Rosas-Rosas et al., 2010, Zarco-González et al., 2013). Different geographical areas experience dissimilar levels of conflict, leading to the identification of conflict hot spots (Breck and Meier, 2004, Bagchi and Mishra, 2006, Michalski et al., 2006, Sangay and Vernes, 2008). These risk maps can assist in the development of mitigation strategies to prevent livestock depredation and so have significant potential for minimising human-wildlife conflicts (Treves et al., 2011). These studies offer opportunities to assess common themes and patterns, but understanding the extent and factors influencing human-wildlife conflict depends on an examination of local conditions and species behavioural ecology.

1.2.3 Visible and hidden impacts of human-wildlife conflict

Human-wildlife conflicts produce visible costs to humans including injury, fatalities, damage to crops, livestock and game losses and economic impacts (Barua et al., 2013). Economic impacts may be small at the group, village or district level, whilst economic impacts for households, families or individuals are significant (Hill, 2004). For example, the mean annual livestock per household lost to carnivore depredation outside the Serengeti National Park equated to two thirds of the average annual cash income (Holmern et al., 2007). Hidden impacts are defined as

"costs uncompensated, temporally delayed, psychological or social in nature" (Barua et al., 2013, p. 311). These include diminished states of wellbeing due to injury or fatality and negative impacts on livelihoods and food security through crop or livestock loss. Opportunity costs arise from restriction of movement due to increased guarding effort to protect livestock from predators (Barua et al., 2013). Transaction costs result from the need to pursue compensation for human-wildlife conflicts due to bureaucratic inadequacies and delays (Barua et al., 2013). Mental stress factors also result from diminished wellbeing, social ruptures and loss of paid employment (Barua et al., 2013). Hidden costs are rarely investigated in studies involving human-wildlife conflicts (some exceptions being: Inskip et al. 2013; Dickman et al. 2008; Ogra et al. 2008 Huzzah et al. 2006; Hill 2004)

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1.2.4 Impacts of human-wildlife conflict on carnivore ecology

Conflict elicits a variety of human responses including legal and illegal killing by individuals, organised communities, hunters and local and national governments (Woodroffe, 2001, Woodroffe and Frank, 2005, Woodroffe et al., 2005). For example, harvest quotas designed to reduce the negative economic and ecological impacts of lynx (*Lynx lynx*) in Norway are regulated according to the magnitude of predation on the semi-domesticated reindeer (*Rangifer tarandus*) and domestic sheep (*Oves aries*) (Sunde et al., 1998). However, lethal control of carnivores results in species extinctions, geographic range contractions, population declines and localised extinctions (Woodroffe et al., 2005). Historically, lethal control measures induced by carnivore depredation on sheep led to the extinction of the Thylacine (*Thylacinus cynocephalus*) in 1930 in Tasmania and the Falkland Island Wolf (*Thylacinus cynocephalus*) in 1876 (Woodroffe et al., 2005). Government sponsored poisoning campaigns resulted in the collapse of the black-tailed prairie dog (*Cynomys ludovicianus*) range in North America by 2% of its former distribution (Woodroffe et al., 2005). Lions and cheetahs also occupy reduced distributions in Africa and jaguars have shown similar range contractions in central and South America (Woodroffe et al., 2005).

The results of lethal control of carnivores can impact populations over large spatial scales leading to localised extinctions, where species occupy discrete populations maintained through a source-sink dynamic (Woodroffe and Ginsberg, 1998). Isolated populations may function as either source or sink populations with the former representing good quality habitat

patches with births exceeding rates of mortality and the latter yielding a demographic deficit where mortality exceeds birth rates (Delibes et al., 2001). Lethal control of livestock killing lions has generated a population sink extending over 2000 km^2 in Tanzania (Woodroffe and Ginsberg, 1998). Source-sink dynamics can also affect carnivore species where people use adjacent land close to protected areas. The abundance of tiger populations in the Nam Et-Phou Louey protected area on the Lao-Vietnam border was significantly lower in areas where human population and disturbance were greater (Johnson et al., 2006). The over-hunting of large wild prey species available for tigers and human-induced mortality due to commercial poaching of tigers, negatively impacted local population densities (Johnson et al., 2006).

The persecution of problem animals also exerts indirect effects on carnivore behaviour and cascading effects on prey populations, habitat structure and community ecology (Estes et al., 1998, Berger et al., 2001). For example, small to medium carnivore species often benefit from reductions in large carnivore abundance a phenomenon known as mesopredator release, leading to population increase and release of other "nuisance predators"(Treves and Karanth, 2003, Brashares et al., 2010). Human-wildlife conflicts negatively impact large carnivore populations across finite and regional scales and require an understanding of species ecology and behaviour in order to develop management strategies to mitigate there effects.

1.2.5 Values and attitudes associated with wild animals

Conflicts between humans and large carnivores can be understood by measuring the values and attitudes local people associate with these animals (Vaske and Manfredo, 2012). S.R Kellert pioneered research on understanding the human dimensions of wildlife problems during the late 1970s by developing a typology of nine different domains of thought including utilitarian, naturalistic, ecological-scientific, aesthetic, symbolic, humanistic, moralistic, dominionistic, and negativistic evaluations of wildlife (Kellert, 1976). Kellert's typology suggests that the widespread applicability and occurrence of these values is indicative of a universal tendency for human-beings to affiliate with nature (Kellert, 2005). Kellert's typology is of importance because it recognises that human beings operate with a full array of environmental values that extend beyond a purely utilitarian view of nature a premise, which has formed the foundation for many conservation programmes that use economic incentives as a mechanism for conservation success. For example, payments for ecosystem services are

anticipated to generate significant conservation benefits (MacMillan and Leader-Williams, 2008, MacMillan and Phillip, 2010, Robinson and Sasu, 2013). The preoccupation with economic values as an incentive for conservation is rooted in western concepts and the ongoing debate about whether nature has instrumental or intrinsic value (Robinson and Sasu, 2013). Instrumental values assume that biodiversity is worth preserving as a means of achieving something. For example, economism assumes that all elements of nature have economic value and should be measured as such to incentivise conservation efforts (Norton, 2000). In contrast, intrinsic values regard nature as having inherent value independent of other human values. However, both of these value systems may not easily conform to local conceptions of nature particularly, in situations where strong cultural or ritual factors predominate (Norton, 2000, MacMillan and Phillip, 2010).

Wildlife products are important for traditional medicine in southern Africa because traditional healers make use of the magical properties of plants and animals (Whiting et al., 2013). The skins and body parts of lions (*Panthera leo*), leopards and cheetahs confer strength to the bearer, while other animals are used to provide protection against enemies, and to seek prosperity and good fortune (Whiting et al., 2013). Social taboos, defined as a "prohibition by social custom or as a protective measure" (Colding and Folke, 2001, p. 584), are associated with wild animals and are often linked to the spiritual beliefs of local people and, in effect, have conservation functions. Instrumental and intrinsic values may serve as an important basis for the appraisal of wildlife. However, the spiritual values associated with wildlife are also motivating factors for wildlife utilisation and preservation. Perceptions and values associated with wildlife may depend on a combined effect of historical and social factors and differ significantly between different cultural groups (Knight, 2000).

Wild animals evoke strong negative symbolism and are often anthropomorphised with immoral human traits (Campbell, 2000, Knight, 2000, Knight, 2008). For example, bears (*Selenarctos thibetanus japonicas* and *Ursus arctos yezoensis*) are relegated as criminals in Japan, wolves (*Canis lupus*) are likened to thieves by Saami reindeer herders in Norway and foxes (*Vulpes vulpes*) in England are described as assassins and murderers, driving fear and antagonism towards these species (Knight, 2000). Historical conceptions of large carnivores associated with early Euro-American colonisers of North America depicted wild animals as objects to be subdued and conquered (Kellert et al., 1996). In the past, wolves have been used as scapegoats by cattle ranchers for persecution where other external events such as droughts, disease and the high costs of beef have led to financial losses (Kellert et al. 1996). Large carnivores serve as indicators of changing attitudes and values towards wildlife in North

America. For example, the status of the wolf has changed from a wildlife pest to a "potent symbol of wilderness and lamentable destruction of the continent's wildlife" (Kellert, 1996, p. 797). Cultural values associated with the grizzly bear (*Urus arctos horribilis*) among the indigenous people of southwest Yukon convey new forms of knowledge that are relevant for managing human-bear interactions (Clarke and Slocombe, 2009).

In other contexts, human-wildlife conflicts symbolise wider conflicts occurring between people. In Mozambique, *dimika* tree twigs are turned into "spirit lions" to attack a sorcerer's enemies (West, 2001). Real lions are often killed when encountered due to their association with these beliefs (West, 2001). The perceived number of spirit lions increases during times of intergroup tensions for example, when different tribes live in close proximity to one another (West, 2001). Attacks on people by chimpanzees (*Pan troglodytes verus*) in Sierra Leone are referred to as "chimpanzee business" undertaken by shape-shifting "Mandingo" chiefs, who historically sold local people into slavery (Richards, 2000). The campaign to remove the North American ruddy duck (*Oxyura jamaicensis*) from Europe is condemned as "ethnic cleansing," "xenophobia" and "genocide" by animal rights protestors (Milton, 2000). Recognition of the underlying social tensions between different social groups forms an essential component of conflict management. The values and perceptions associated with wild animals require an understanding of the historical and wider cultural and social context from which they have evolved.

1.2.6 Strategies for mitigating human-carnivore conflict

Many species involved in human-wildlife conflicts are often threatened and legally protected therefore, lethal control measures raise political issues that overlap with wildlife conservation (Treves et al., 2009). Lethal control measures have become illegal or socially unacceptable in some countries (Treves et al., 2006). These conservation policies can alienate local people, leading to a loss of ownership and control over wildlife management decisions and undermine public support for conservation initiatives (Hampshire et al., 2004, Bell et al., 2007, Treves et al., 2009, Anthony et al., 2010). Alternative forms of wildlife management that involve non-lethal control are important (Treves et al., 2009). Several studies have evaluated the feasibility of different mitigation strategies in terms of their cost-effectiveness, socio-political acceptability, impact on target and non-target wildlife populations and their ability to

simultaneously save human, livestock and carnivore lives (Treves et al., 2009, Barlow et al., 2010). Several strategies for mitigating human-tiger conflicts in the Bangladesh Sundurbans were identified using this framework (Barlow et al., 2010). The development of tiger-response teams and monitoring problem tigers were identified as the most feasible methods for mitigating human-tiger conflict, because both strategies delivered high impacts for reducing tiger attacks and were cost-effective (Barlow et al., 2010). Response teams were designed to treat and transport individuals injured by tigers, patrol attacks sites, keep people away from tigers and monitor tiger movements (Barlow et al., 2010). Tiger monitoring activities involved following the movements of GPS collared tigers on a daily basis to warn forest users of their proximity to tigers (Barlow et al., 2010).

Historical and socio-economic conditions influence government approaches to mitigating conflict. For example, where carnivore eradication programmes have been terminated these strategies have been replaced by selective removal initiatives, compensation schemes and improvements to livestock husbandry (Graham et al., 2005). The long-term sustainability of compensation schemes relies on the extent of political support, which, in turn, is influenced by changing government priorities and budgets (MacMillan and Leader-Williams, 2008). Employing shepherds and livestock-guardian dogs and penning livestock inside enclosures at night produce opportunity costs for people including loss of sleep, reduced school attendance, employment opportunities and greater exposure to disease (Barua et al., 2013). Other protective measures against carnivore depredation include aversive stimuli, protective stock collars and electric fencing, but many are inaccessible to poor communities because they are costly to maintain (Brieitenmoser et al., 2005).

Trophy-hunting problem individual carnivores leads to a sense of ownership over the management of wildlife and may raise tolerance for problem species if people benefit economically from hunting (Holmern et al., 2007, Chase-Grey, 2011). Similarly, compensation schemes provide payments to reduce the economic impacts of depredation. However, transaction costs can arise because bureaucratic inadequacies, including fraud and corruption, prevent the equitable distribution of economic payments to affected people (Johannesen and Skonhoft, 2005, Anthony et al., 2010, Chase-Grey, 2011, Barua et al., 2013). The processes for submitting claims are complex, marginalise rural people and introduce additional costs such as travelling long distances to report claims (Johannesen and Skonhoft, 2005, Anthony et al., 2010, Chase-Grey, 2011, Barua et al., 2013). In Kenya, compensation schemes have contributed to the abandonment of traditional husbandry practices previously used to guard livestock (Hazzah et al., 2009).

In Kruger National Park, South Africa, government procedures for managing damage-causing animals are ineffective due to the ambiguity of species movements, inadequate reporting and response times, overlapping responsibilities of competing institutions, undelivered compensation and corruption creating further resentment among local people (Anthony et al., 2010). The management capacity and governing structures of environmental institutions impose their own set of constraints on the feasibility of different mitigation strategies. Researchers advocate a need to adopt participatory approaches when developing mitigation strategies that draw on the experiences of local people affected by wildlife (Naughton-Treves et al., 2003, Hill, 2004, Treves et al., 2006, Treves et al., 2009). Local people may expect governments and outside agencies to provide adaptive solutions to conflict problems. However, environmental institutions may lack the management capacity to effectively manage human-wildlife conflicts (Hill, 2004, Treves et al., 2006, Anthony et al., 2010). Participatory approaches assist in improving perceptions of the management of wildlife conflicts and provide insights into the expectations and perceptions of different stakeholders (Hill, 2004).

1.3 The African Leopard: Population status and distribution in South Africa

Leopards are the most widely distributed of Africa's large felids and inhabit a broad range of habitats from mountainous areas, woodland savannah and forest ecosystems, to deserts (Nowell and Jackson, 1996, Henschel, 2008). The leopard's catholic feeding ecology allows it to persist in areas with a suitable prey base and adequate hunting cover (Henschel and Ray, 2003, Henschel, 2008). The population density and distribution of leopards in South Africa are driven by a multitude of factors including prey availability, habitat type and the degree of anthropogenic pressure (Friedman and Daly, 2004, Daly et al., 2005, Swanepoel et al., 2012). High leopard densities of 30.3 leopards per 100 km^2 have been found in areas of high prey availability in the Sabie riverine area of the Kruger National Park (Bailey, 1993), with 12.7 leopards per 100km^2 in the N'wanetsi concession of the park (Maputla et al., 2013) Lower densities of 0.6 leopards per 100 km^2 have been reported in the Kalahari Gemsbok National Park, with 0.6-2 leopards per 100km^2 in the Cederberg Wilderness Area, where the abundance of prey species is limited (Bothma and Le Riche, 1984, Martins, 2010). Leopards have experienced a 37% reduction in their range throughout southern Africa over the past 100-150 years (Ray et al., 2005). Habitat degradation and fragmentation, depletion of natural prey

species, poorly managed harvests and persecution due to human-leopard conflict and illegal trade of leopard skins contribute to the decline in leopard populations (Ray et al., 2005, Balme et al., 2010a, Henschel et al., 2011, Packer et al., 2011). Twenty percent of the land mass in South Africa provides suitable habitat for leopards, with leopard distribution strongly influenced by the conversion of land to livestock farming, which is also a key driver of habitat fragmentation (Swanepoel et al., 2012) (Fig. 1.1). The reclassification of the leopard by the International Union for Conservation of Nature from "Least Concern" to "Near Threatened" reflects the changing population status of leopards worldwide (Henschel et al., 2008).

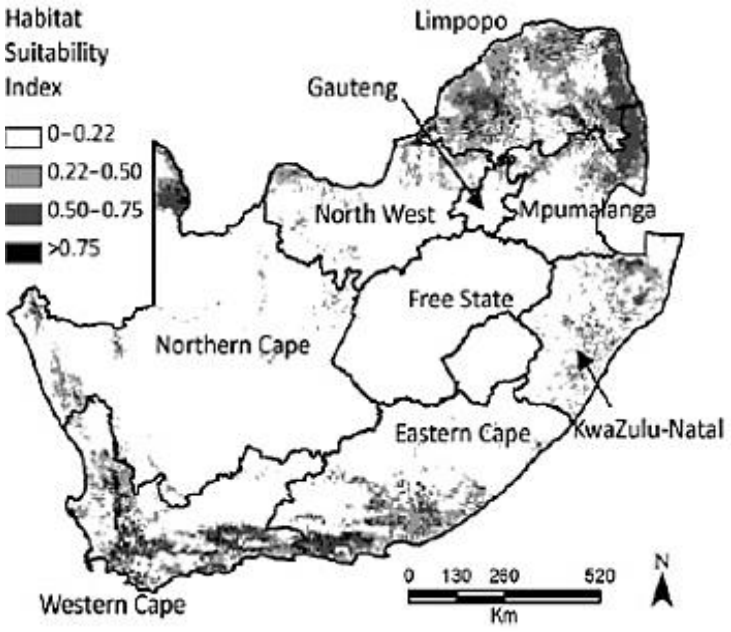


Figure 1.1: Suitable leopard habitat in South Africa, taken from Swanepoel et al. (2012). Habitat suitability indices > 0.22 indicate suitable leopard habitat.

The need for reliable estimates of leopard numbers in South Africa was highlighted by the 2005 increase in annual Convention on International Trade in Endangered Trade in Endangered Species (CITES) hunting quotas for the export of leopard skins and trophies from 75 to 150 (Daly et al., 2005). A Leopard Population and Habitat Viability Assessment Workshop, carried out in 2004, stressed the need for a countrywide index to determine sustainable leopard off-takes (Daly et al., 2005). Currently 150 hunting permits in South Africa per year are based on 1.5% estimate of 10,000 leopards in the country, taken from the Red Data Book of the Mammals of South Africa (2004) and projected population numbers based on suitable habitat

available within the country, reports of leopard sightings and conflicts with people (Daly et al., 2005). The hunting quotas for South Africa were criticised by conservationists due to a lack of scientific input on the quota setting and research on leopard population trends within hunting areas (Balme et al., 2010a). Balme et al. (2010b) developed a regulatory framework for hunting leopards in Kwa-Zulu Natal, based on an understanding of leopard ecology and the impacts of hunting on leopard behaviour. To date such approaches are lacking in Limpopo Province, where leopard hunting permits are the highest in the country, with 50 permits issued annually (Daly et al., 2005).

The expansion of game farming in South Africa has increased the biomass of natural ungulate allowing leopards to recolonise and recover outside protected areas (Lindsey et al., 2009). Game farming introduces a new form of conflict as a result of depredation on expensive game species (Lindsey et al., 2009). Leopards are often considered as damage-causing animals by farmers and are actively persecuted both illegally and legally (Balme, 2009, Balme et al., 2009, Balme et al., 2010b). Local provincial governments issue damage-causing animal permits to landowners to remove large carnivores that represent a problem to life or property. Currently 50 damage-causing animal permits are allocated throughout South Africa per annum (Daly et al., 2005).

Few studies in South Africa have explored the population status of leopards outside protected areas, where the majority of conflict incidents take place (Balme et al., 2014). The Lajuma Environmental Research Centre in Limpopo, South Africa run by Professor Ian Gaigher at Venda University has formed the site for a recent PhD project in the Soutpansberg Mountains conducted by Julia Chase Grey on leopard population ecology and conservation under the supervision of my supervisor Dr R.A Hill at the University of Durham. Leopard density estimates of 10.7 leopards per 100km^2 were predicted from camera trap surveys in a non-protected area of the Soutpansberg Mountains (Chase-Grey et al., 2013). The Soutpansberg Mountains lies 30km to the west of the Blouberg Mountain Range, a multi-use land system composed of a small network of protected areas surrounding by areas of human settlement, agriculture and livestock farming. The Soutpansberg-Mapungubwe Leopard Forum was initiated to discuss the management of leopards with other researchers and local stakeholders within the Limpopo Province. Julia conducted a preliminary interview in the Blouberg Mountain Range to find that leopards are a significant problem for subsistence and commercial farmers due to livestock depredation. The Leopard Forum highlighted this study as a research priority to identify the population status of leopards within and outside protected

areas compared to the Soutpansberg and to address human-wildlife conflict issues relating to livestock depredation.

1.4 A socio-ecological approach towards understanding human-leopard conflict

Human-leopard conflict represents a wildlife management problem that can only be understood by adopting an interdisciplinary framework that investigates the underlying ecological and social factors driving conflict (Fig 1.2). Biology contributes knowledge of leopard ecology and behaviour to determine ecological factors influencing leopard predation risk and population status of leopards across a range of land use types. The contribution of anthropology to understanding human-wildlife conflict is critical because human values, perceptions and behaviours towards wildlife and conservation are complex and driven by a myriad of historical, political and cultural factors. Anthropology applies a range of appropriate methodologies for investigating and measuring the values and perceptions of local people. The complexity of human-leopard conflict can be illustrated by considering the diverse social and ecological factors that influence conflict. These factors can be grouped into two spheres of influence:

1. Ecological Sphere: Factors associated with leopard and prey biology, including characteristics and management of livestock and game species, temporal characteristics of depredation events, bio-physical factors and their influence on the risk of leopard predation and leopard population status across land use types. An understanding of these factors depends on knowledge of leopard ecology and behaviour.

2. Social Sphere: These include historical, political, cultural, socio-economic, knowledge, institutional and individual factors influencing perceptions, values and behaviours of people towards protected areas, conservation, leopards and the feasibility of different mitigation strategies. Bio-physical factors influencing the risk of leopard predation can include anthropogenic related factors such as distance to village and roadways. Anthropogenic effects such as the extent of illegal and legal offtake can also influence the viability of leopard populations.

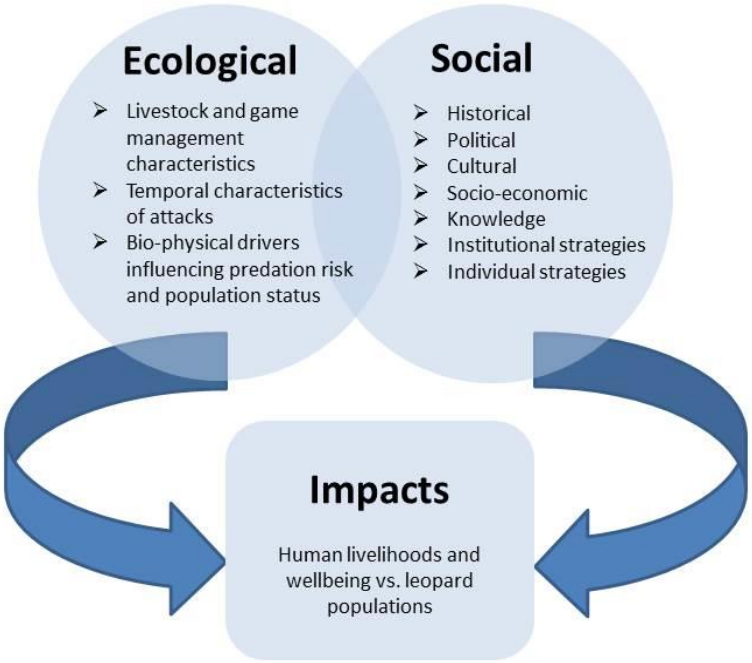


Figure 1.2: The social and ecological factors influencing human-leopard conflict and their associated impacts on human livelihoods, wellbeing and leopard populations.

Interactions occur between leopards and humans and between the ecological and social spheres. The factors that make up each sphere of influence drive the nature of human-leopard conflict, for example, low wild prey availability may cause leopards to predate on readily available livestock species, in turn, livestock depredation induce economic costs for farmers. Historical interactions with leopards may influence the tendency to engage in lethal control measures against leopards, which, in turn, negatively influence leopard numbers. Interactions can also occur between individuals, groups and institutions and between different social structures and cultural systems (Leong et al., 2012). The outcomes of these interactions produce a series of effects or impacts (Leong et al., 2012). Impacts can produce desirable or undesirable consequences for human livelihoods, wellbeing and the viability of leopard populations. Impacts can manifest in different forms for example, economic costs or benefits, increased health risks and decreased leopard density. An impact based assessment of wildlife management problems links the ecological and social spheres because their combined effects create a series of impacts that need to be mitigated or enhanced in order to to achieve management solutions that protect human welfare and abate the threats to leopard

populations (Leong et al., 2012). The factors that underpin the ecological and social spheres form the main topics of research interest (Fig. 1.2).

1.5 Chapter outline

In Chapter 2, I apply historical ecology to contextualise the socio-political histories of the indigenous people and European settlers in South Africa, including their perceptions of the land, wildlife and conservation. In turn, a historical approach documents changes in nature conservation ideology through the colonial and apartheid periods and into the twenty-first century. In Chapter 3, I provide a description of the study area including a history of the settlement of the Bahananwa and Afrikaner populations into the Blouberg Mountain Range, the current socio-economic characteristics of the contemporary Blouberg population, the conservation and ecology of the Blouberg and a description of local farming systems. In Chapter 4 to investigate the impacts of protected area establishment and the management structures governing protected areas on contemporary perceptions of nature reserves and wildlife conservation. I argue that historical and contemporary interactions between local people and protected areas contribute to the perceived marginalisation, disempowerment and stigmatisation of local people, manifested as traumatic nature. Traumatic nature is the outcome of these processes driving negative perceptions of local nature reserves and wildlife conservation.

In Chapter 5, I measure the extent of livestock depredation relative to other causes of livestock use, mortality and carnivore depredation, investigate livestock husbandry practices and explore the temporal and bio-physical drivers influencing the risk of leopard predation. I investigate the joint impact of ecological and anthropogenic landscape features (bio-physical factors) on the risk of leopard predation. To my knowledge, this is the first time that the ecological niche model, Maxent, has been applied to map leopard predation risk on livestock and game. I develop predation risk maps for livestock and game predation to assist in developing mitigation strategies for managing depredation incidents at finite scales. In Chapter 5, my research overcomes a deficit in the literature by exploring both the visible and hidden impacts of livestock and game depredation on farming livelihoods and general wellbeing. I evaluate the economic impacts of livestock and game depredation at the community and household level and social factors influencing farmers' ability to cope with depredation incidents.

In Chapter 6, I determine leopard density, population structure and occupancy by conducting camera trap surveys across a range of land use types including a protected area, commercial farms and communal land. I investigate the combined effect of ecological and anthropogenic landscape features (bio-physical factors) influencing leopard occupancy. I compare leopard density estimates with those for the nearby Soutpansberg Mountains. In doing so I address several deficits on leopard research in South Africa identified by Balme et al. (2014) by: (1) evaluating the population status of leopards outside protected areas; (2) adopting an applied approach to leopard research that simultaneously applies research approaches from biology and anthropology to identify the drivers of human-leopard conflict; (3) developing practical mitigation strategies for managing conflict and recommendations for leopard conservation; and (4) investigating the values and perceptions of farming communities of leopards.

Investigating local perceptions of wildlife is essential to gauge support for conservation initiatives and tolerance for leopards, which is central to developing mitigation strategies that facilitate positive changes in human behaviour. The tendency for farming communities from both the Afrikaner and Bahananwa communities to engage in lethal control measures and to support leopard conservation is intrinsically tied to the environmental values farmers associate with the leopard. In this chapter, I provide historical, cultural, socio-economic context to underpin the development of these core values and provide examples of different types of "knowledge," both scientific and non-scientific, generated from these values. In Chapter 7, I apply an evolved typology of Kellert's work, defined by Herrmann et al. (2013), to assess the broad array of values, both farming communities, associate with leopards. I discuss the implications of these values as barriers and support for leopard conservation.

In Chapter 8, I investigate potential solutions to mitigate human-leopard conflict in the Blouberg. I draw on the knowledge and perceptions of a wide range of stakeholders to identify factors that need consideration in the design of future mitigation strategies. I assess the feasibility of individual strategies employed by local people and government institutions to mitigate human-leopard conflict. The impacts of different strategies are assessed in relation to a management framework identified by Treves et al. (2009) that evaluates feasibility in terms of cost-effectiveness, wildlife specificity and socio-political acceptability. Finally, in Chapter 9, I summarise the key conclusions of the study and provide recommendations for improving relationships between local people and protected areas, perceptions of leopard conservation, and human-leopard conflict. I conclude with a reflection on the interdisciplinary process.

1.6 Research aims

- **Aim 1**: Explore the socio-political histories of indigenous people and European Settlers in South Africa and the evolution of conservation ideologies and perceptions of the land, wildlife, and conservation, from the pre-colonial era to the twenty-first century.

- **Aim 2**: Investigate the social impacts of protected area establishment and governance systems, on local people's understanding and perceptions of nature reserves and wildlife conservation.

- **Aim 3**: Assess the extent, temporal characteristics and bio-physical drivers of human-leopard conflict and the impacts of livestock and game depredation on farming livelihoods and wellbeing.

- **Aim 4:** Determine the population density, occupancy and sex ratio of leopards in a multi-use land system, composed of a protected area, commercial farms and communal land.

- **Aim 5:** Assess local values associated with the leopard and their implications for providing barriers and support for leopard conservation.

- **Aim 6:** Evaluate the feasibility of different mitigation strategies for managing human-leopard conflict, according to the perceptions and experiences of a range of stakeholders.

Chapter 2

Historical and political narrative of wildlife conservation and land dispossession in South Africa

2.1 Introduction

Historical ecology offers an approach towards understanding "the ongoing dialectical relations between human acts and acts of nature, made manifest in the landscape" (Crumley, 1994, p. 9). The landscape is where people and the non-human environment mutually affect one another through time and space. Historical ecology depicts landscape as a holistic unit for study and analysis in order to observe these cumulative effects through time. Landscape is fluid, perpetually changing through the unfolding stream of history. Culture is "physically embedded and inscribed in the landscape as non-patterning, often a palimpsest of continuous and discontinuous inhabitation by past and present peoples" (Balée, 2002, p. 2). Landscape is the holistic unit of study that bridges the artificial divide between nature and culture, a division which is produced by the historical tendency for Euro-American societies to bifurcate reality in this way. From the perspective of historical ecology and as is commonplace in many non-Euro-American societies, nature and culture are perceived as mutually intertwined.

Historical ecologists envisage humans as active agents in environmental transformation of the landscape; this differs significantly from approaches adopted by biologists in the field of landscape ecology (Balée, 2002). Landscape ecology addresses pristine mythologised landscapes without human influence or landscapes degraded or simplified by human presence (Redford and Padoch, 1992, Redford and Stearman, 1993, Soulé, 1995, Denevan, 2001). Historical ecology gives human actions and intentions an active role in the creation of its landscape history rather than envisaging humans as passive variables in the equation. The human species is understood as a keystone species, as a mechanism of environmental change through disturbance or generating species diversity and landscape richness (Balée, 2002, Mann, 2002). The latter process is rarely acknowledged by natural scientists that usually tend to associate people as agents of destruction. Fairhead and Leach (1996) research on misreading the African landscape has shown that, over many years in Guinea, French colonial officials interpreted patches of forest found in savannah zones as evidence of deforestation. Officials imposed harsh interventionist policies on rural communities living in these areas, as they were thought to be the causal factor, degrading the forest environment. In contrast,

Fairhead and Leach's (1996) found that elders living in the forest areas had different readings of the landscape, understanding it as "filling with forest, not half emptied and emptying of it" (ibid, p. 2). Fairhead and Leach (1996) discovered that the forests of Guinea were created through the settlement processes, as opposed to being denuded by it.

I adopt a historical ecological approach as a framework because it is "integrative and comparative, inclusive of temporal, spatial and cultural dimensions and dynamic" (Crumley 1994, p.2). Anthropology encourages the incorporation of historical factors to reveal the forces that shape human-environmental relations throughout time and continue to influence present-day conditions. A historical approach is essential to contextualise contemporary environmental perceptions, as it allows one to understand the "impact of changing social formations in the environment" (Huckle, 1985 in Khan, 1990, p.15) and provides a penetrating examination of changing events through time. A comparative historical approach is adopted to chart the socio-political histories of the indigenous people and early European settlers of South Africa from the colonial period through to the twenty-first century. In South Africa, the concept of landscape is used as medium for drawing comparisons between these cultural groups. The definition of landscape is adaptive and takes on meaning through the eyes of diverse actors: "Landscapes are created by people – through their experience and engagement with the world around them. They may be close-grained, worked-upon, lived-in places, or they may be distant and half fantasised" (Bender, 1993, p. 1).

South Africa has moved from an authoritarian society from the end of colonial rule until the formal end of apartheid in 1994, a time which enforced racial segregation and established white superiority, to a democratic society, with a constitution that advocates racial equality and justice (Fabricius and de Wet, 2002). The ideological premises that underpin the practices of nature conservation ideology have undergone similar changes (Carruthers, 1993, Carruthers, 1994). The demarcation of the first game reserves in 1889 and the establishment of the Kruger National Park in 1926 resulted in the physical alienation of indigenous people from their land and restricted access to important natural and cultural resources. Currently nature conservation ideology integrates human dimensions into its policies by recognising that local people play a significant role in securing natural resources for the future (Robinson and Sasu, 2013). Community-based natural resource management, co-management and participatory conservation initiatives were developed to improve the involvement and participation of local people in conservation initiatives (Knight, 2000, Phillips, 2003, Robinson and Sasu, 2013). Nevertheless, South Africans have had their environmental perceptions of conservation shaped by the political forces of the past (Khan, 1990). Contemporary

conservation discourses and perceptions of local nature reserves and wildlife conservation in the Blouberg Mountain Range are rooted in historical legacies and experiences with government regimes due to conflicts surrounding land and natural resource use (Chapter 4). Historical ecology is adopted in this chapter to understand how colonialism, apartheid and the establishment of protected areas have shaped past and present conservation ideology and environmental perceptions of the land, wildlife and conservation.

2.2 Indigenous perceptions of the environment

The first indigenous people of South Africa were the San, who were hunter-gatherers and the Khoekhoen, who were nomadic pastoralists. The Khoekhoen migrated southward into the Cape from south-central Africa along several hypothesised routes (Fig. 2.1). The first route extended from the Kalahari in eastern and central Botswana to the Orange River and then branched eastwards towards central Namibia (Eastwood and Eastwood, 2006). The second migration occurred from eastern Botswana and western South Africa towards the Orange and Vaal rivers. A third movement drove west into Namibia across the north of the Kalahari by the third century AD (Eastwood and Eastwood, 2006). Bantu groups later migrated into South Africa from Nigeria and the Congo and included the Nguni and Sotho speakers, who were settled agricultural farmers (Eastwood and Eastwood, 2006). Bantu farmers came to settle in the North-east of South Africa along the Limpopo Rivers by 300 AD (Eastwood and Eastwood, 2006).

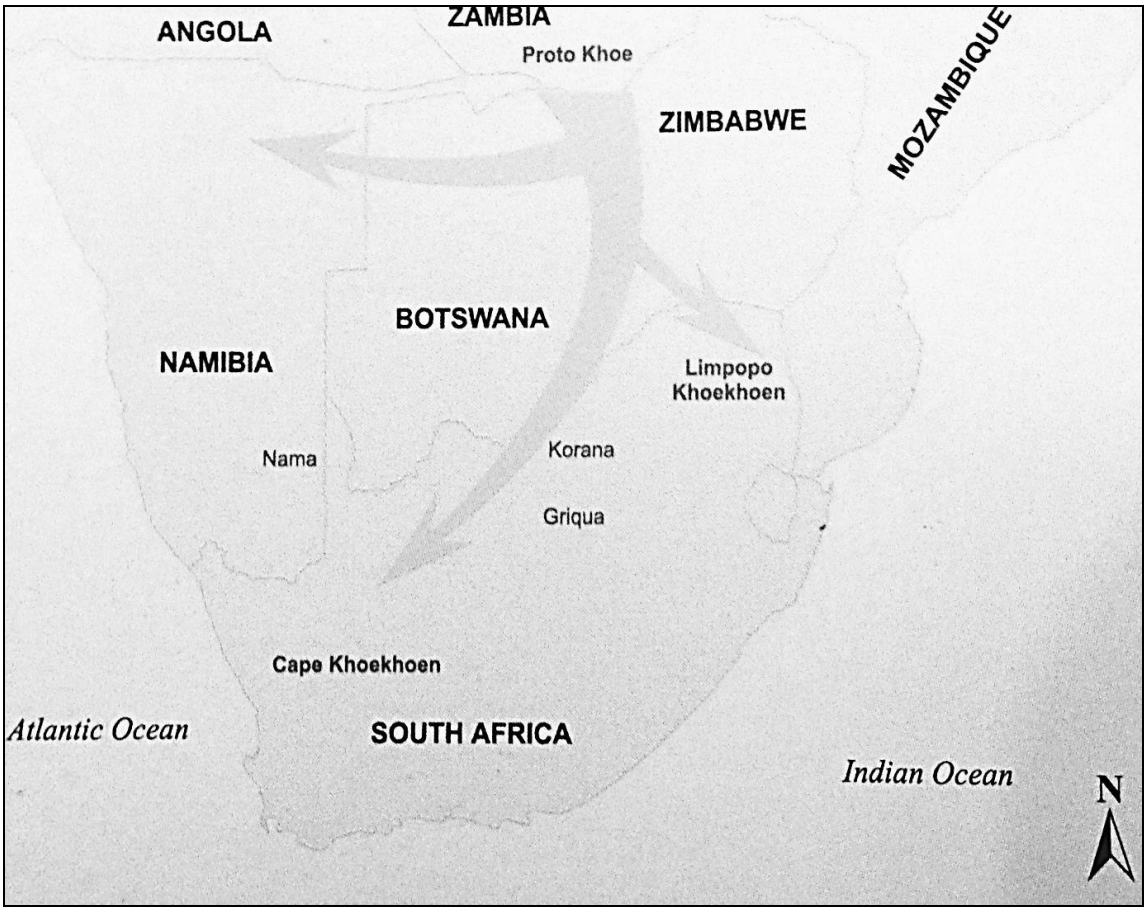


Figure 2.1: Map showing the possible migration routes of the Khoekhoen into South Africa taken from (Eastwood and Eastwood, 2006).

Historical accounts of natural resource management by indigenous people in South Africa only began to emerge from the late twentieth century, since the majority of environmental histories focused on the first formal conservation legislation (*plaacaaten*), introduced by the European settler Jan Van Riebeeck (Khan, 1994). All groups lived in close contact with the land, a relationship which conferred a detailed knowledge of its natural resources. The naming of places in the landscape by the !Kung of the Kalahari illustrates this point:

"Each group knows its own territory very well; although it may be several hundred square miles in area, the people who live there know every bush and stone, every convolution of the ground, and have usually named every place in it where a certain kind of veld food may grow, even if that place is only a few yards in diameter, or where there is only a patch of tall arrow grass or a bee tree, and in this way each group of people knows many hundred places by name" (Thomas, 1989, p. 10).

The Sotho used the land's resources for "plant science" (Makhura, 1993). Mental illness and constipation were treated using the root of a tree, grasses poisonous to livestock were well known, and the call of the honey-bird was used to lead boys to a beehive (Makhura, 1993). The landscape provided important natural resources for survival and took on meaning through the "spiritual and mystical bond between the soil and its users, around which so much of their folklore, poetry, religion and language was constructed" (Letsoalo, 1987, p. 1). Agricultural activities were intrinsically linked to the natural cycles and seasons of the environment, which were governed by the ritual laws of "*go phasa badimo,*" to sacrifice to the ancestors, during different stages of the agricultural cycle (Mönnig, 1967). Similarly, the Khoekhoen attached great significance to the moon, which dictated rainmaking rites and reinforced their religious, productive and social behaviour (Eastwood and Eastwood, 2006). Rock art paintings of animals by the San depicted supernatural potency or power, which were harnessed by shamans to contact the supernatural worlds for healing, rain-making and hunting success (Eastwood and Eastwood, 2006).

In Sotho culture important customs and taboos were followed, which to an extent promoted protection of select species for example, the totem animal of a particular group was often prohibited from being killed and eaten (Khan, 1990, van Schalwyk, 2002). For the Sotho, the totem group includes all members of an extended family and a person inherits his or her totem from their father (van Schalwyk, 2002). Among the Bahananwa, the baboon (*Papio ursinus*) is revered as their totem animal and is usually not eaten or killed (van Schalwyk, 2002). Other Sotho cultures refrain from killing the hamerkop bird (*Scopus umbretta*) due to its close association with rain; killing the animal results in the imposition of supernatural sanctions manifested as storms and floods (Mönnig, 1967, van Schalwyk, 2002). Places demarcated for specific use including sacred forests, burial sites and for ceremonies and rituals, may have also provided a form of protection of specific sites (Mönnig, 1967, van Schalwyk, 2002).

The land was highly valued by all groups and was used as a resource for hunting, livestock grazing and agriculture. The San regarded the land, along with its natural resources, as belonging to all (Khan, 1990, Eastwood and Eastwood, 2006). The Khoekhoen pasture land belonged to the tribe and natural resource use was managed by select members of a band or group (Khan, 1990)**.** For the Sotho the land was possessed communally by virtue of its original occupation and conquest, and administered by the chief (Mönnig, 1967). The Northern-Sotho speaking Bahananwa allowed outsiders to use their land and natural resources in compliance with the Bahananwa custom: firstly, through the greeting of the ruler (*go lotšha Kgoši*) and, secondly, the thanking of the ruler (*go leboga Kgoši*) and the offering of gifts (Sonntag, 1983).

Communality of land and access to natural resources symbolised an egalitarian society and promoted cohesion and stability within a tribe (Eastwood and Eastwood, 2006). The indigenous environmental perception of the land was affective; humans and the earth were inextricably connected via interwoven ecological, spiritual and cultural links. The landscape took on meaning beyond the surface of its physical reality; it connected the people with the supernatural, dictated natural resource use and in effect promoted protection of particular species or places.

2.3 Colonisation: The Europeans setters and their hunting activities

The first Europeans colonised South Africa in 1652 when the Dutch East India Company (Vereenigde Oost-Indische Compagnie) established a permanent settlement in the Cape. The Cape served as one of the main European trading centres along the spice route to the East Indies (Worden, 2007). The Europeans were of Dutch and German descent and were later joined by French Huguenots escaping persecution by King Louis XIV in 1688 (Keegan, 1996, Worden, 2000, Worden, 2007). The Europeans represented a nomadic and adaptive culture, consisting of small nuclear groups that lived pastoralist lifestyles supplemented by hunting game for food and trade. These settlers were the first Trek Boers, later named the Voortrekkers and then the Boers (Beinart and Coates, 1995). The Voortrekkers' lives during the early part of the nineteenth century were not dissimilar to those of the African people[1]. These groups interacted through hunting partnerships, whereby Europeans obtained and used local knowledge in exchange for material goods, including products of the hunt, ammunition and transportation (Makhura, 1993, Beinart and Coates, 1995). Through the interpenetration of settler and indigenous ideas, the Voortrekkers developed the intimate knowledge of their environment essential for survival, including tracking wild animals, hunting and horsemanship and herding, which necessitated knowledge of predators, plants, water, disease, drought and climate (Beinart, 2008). In navigating their new lands, local knowledge gained from the "Khoekhoen presence in the interior undoubtedly contributed much to making the migration into the country possible" (van der Merwe, 1938 in Beinart, 2008, p. 31). The adoption of the indigenous fat-tailed hairy sheep by the Voortrekkers and the intermingling of indigenous oral literature and folklore into settler literature and children's stories are indicative of the integration of their respective cultures (Beinart, 2008).

[1] I refer to African people as the black indigenous population of South Africa.

The British acquired the Cape in 1775 as a result of the French revolutionary wars and the disintegration of the Dutch East India Company due to financial hardships (Worden, 2000, Worden, 2007). Attempts were made to imitate English settlement patterns, whereby land was bounded and enclosed: "the hedges and ditches, and walled fences, presented home-looking pictures of neatness and industry, very different from the rude and slovenly premises of the back country Boers" (Thompson, 1967 in Beinart, 2008, p. 47). The British perception of the landscape was based on improvements judged to bring law and order to the world, as well as the subjugation of the indigenous people and Voortrekkers, both of whom the British deemed uncivilised and likely to hinder progress in the name of civilisation (Khan, 1990). Crais (1992) demonstrates the British conceptualisation of landscape as being segregated into distinct areas of space that convey British power, colonial (rationally organised) space and African (sensual and inferior). This way of seeing and organising their new environment was indicated in "large British buildings opening out increasingly into less anglicised landscapes of pastures and fields tended by workers" (Crais, 1992, p. 136).

Sports hunting, introduced by the British, was a masculine activity, "surrounded by ideology and ritual objectives such as the collection of trophies and natural history specimens, (as well as) the pursuit of manliness through sportsmanship" (MacKenzie, 1987, p. 41-42). The hunting exploits of Captain C Harris, F.C. Selous and A.H. Neumann provided popular reading material and gave rise to a "romantic, myth of the hunter living a carefree, unfettered existence in the wilds of Africa" (Khan, 1990, p. 21). The late nineteenth century was characterised by the widespread decimation of game species throughout South Africa for food, trade, domestic products and also sports hunting (Beinart, 2008). Nature was viewed as an adversary, wild and untamed, likened to the adjacent indigenous people, all regarded as objects that required sequestering, in a yet to be tamed and controlled environment.

"During the first years of our settlement, as well as during our wanderings, it was our task to clear the recently-acquired land of wild animals, which had hitherto roamed about, unrestrained, side by side with the wild races, and thus protect our pastures. Every Boer took an active part in this work, and the rising youth to make the country habitable" (Kruger, 1902 in Carruthers, 1994, p. 266).

The colonising process, like the clearing of the landscape of wild animals, resulted in a clearing of the indigenous people from their ancestral land. As in other southern African countries, including Zambia, Angola and Namibia, European conquest and expansion resulted in the dispossession and physical alienation of the indigenous people, who were enslaved or co-

opted into enforced labour (Khan, 1990). European perceptions of the land and its wildlife were predicated on the view of the white conqueror, which contributed to the widespread decimation of game throughout southern Africa:

"As these processes [of wildlife destruction] accelerated in the latter nineteenth century, it was not just the Africans who found it increasingly difficult to gain access to the faunal resource... By this time whites had become acutely aware of the decline of big game stocks. Two species, the blaaubok and the quagga, had become extinct while others no longer survived in vast tracts of southern Africa where formerly they had been abundant" (Mackenzie, 1987, p. 21).

2.4 Game reserves

The first game legislation policies were initiated as a result of economic concerns over the decline in the sports hunting industry (Griffiths and Robbins, 1997). The first game reserves (Pangola Game Reserve, 1889; Sabi Game Reserve, 1895; Singwitsi Game Reserve, 1903 and the Rustenberg Game Reserve, 1909) emerged in the Transvaal during the late nineteenth century (Carruthers, 1989). Game legislation promoted the extermination of "vermin" species, namely carnivores that predated on economically viable game species, and advocated the interests of British sportsmen at the expense of other groups by restricting access to wildlife (Griffiths and Robbins, 1997). A significant class divide existed between sports hunters and the "poor" Afrikaner subsistence hunters such that harsh penalties were imposed on both African people and the poorer Europeans that hunted on state land (Carruthers, 1989). Game legislation reflected European cultural superiority during a time when African people were scapegoated as the cause of environmental degradation due to their insatiable lust for meat (Khan, 1990, Khan, 1994). The shift in their role from hunting partners to trespassers or poachers on private property created mutual antagonisms (Carruthers, 1989). African people and the poorer Afrikaner communities, were denied access to wildlife, restrictions were imposed on firearm and dog ownership, while wildlife trapping was banned and enforced through punitive policing systems (Carruthers, 1994). Incidents of snaring were widely reported entrenching the perception that African people living close or near to parks could not be trusted (Beinart and Coates, 1995). The creation of protected areas for conservation resulted in new spatial boundaries disrupting the relationship between the African people and the game they had previously accessed for subsistence. This instilled conflict where indigenous

communities abutted protected areas and private lands; hand to hand battles and gunfights were commonplace (Beinart and Coates, 1995). The creation of the first game reserves paved the way for the way for the exclusion of the African people from important natural resources that had previously supported local livelihood strategies and entrenched the view of African people as environmentally destructive.

2.5 Kruger National Park and "human reserves"

The association of natural beauty with wilderness began to permeate conceptualisations of nature, which were linked to ennobling human sentiments (Beinart and Coates, 1995). Protected areas in South Africa were a way of romanticising nature, analogous to similar processes in North America, where the protection of areas of outstanding beauty was attributed to national feelings that served to "distinguish North America and Europe" (Carruthers, 1989, p. 189). The establishment of the Kruger National Park in 1926 was associated with the rise of Afrikaner nationalism during a time when South Africa was slowly loosening ties with Britain (Carruthers, 1989). The Union of South African in 1910 resulted in the unification of the previously independent Cape, Natal, Transvaal and the Orange Free British state colonies (Carruthers, 1989). Afrikaners revered their pioneering past, which resurged during the 1920s. The Minister of Lands eulogised the national park as the realisation of "Paul Kruger's dream" asserting that it was a national duty to preserve the landscape of the park "just as the Voortrekkers saw it" (Reitz, 1929, in Carruthers, 1989, p. 208). Consequently, the naming of the park to represent the pioneering hero Paul Kruger proved to be a useful political gesture in gaining support from the Afrikaner community (Carruthers, 1989). The formation of the park was effective in unifying the English and Afrikaner speakers through their shared perspectives on game protection. However, in their search for common ground, park authorities and their supporters contributed to the proliferation of white rule at the expense of the African people who were excluded from the park. The formation of the park led to the forcible removal of over 3000 Tsonga people in 1926, the Mphaphuli and Venda community in 1968 and later the Makuleke community in 1969 (Bulpin, 2001, Lubbe, 2003). Similar to the game reserves, the African people were evicted from their land to make way for conservation. The impacts on the African population are aptly summed up by Khan (1990): "If conservation means losing water rights, losing grazing and arable land and being dumped into

a resettlement area without even the most rudimentary infrastructure, this can only promote a vigorous anti-conservation ideology among rural communities" (ibid, p. 25).

Protected areas in South Africa served as instruments of dispossession and subjugation parallel to the land evictions of the colonising process, because they estranged indigenous people from important natural, cultural and spiritual resources (Khan, 1990). The implementation of protected areas created colonial conceptualisations of the landscape as a mythologised pristine wilderness devoid of human activity. Remnants of previous human settlement in the Kruger National Park were removed, "Skukuza destroyed our mango trees, because they wanted to stop people from knowing that anyone had lived there" (Botha and Venter, 1994 in Spenceley, 2003, p. 272). Kruger National Park continued to exert segregationist policies throughout the apartheid era through the implementation of separate areas in the park for "whites" and the "Bantu" (Griffiths and Robbins, 1997).

Throughout the colonial period the African people were dispossessed of their land and translocated into human reserves. The passing of the Natives Land Act of 1913 was intended to restrict indigenous land ownership to 7% of the total land. This was later enlarged to 13% of the total available land in the Union, but had created a system of land tenure that deprived the majority of people the rights to own land (Ramphele, 1991). The landscape of South Africa was physically divided into European settlement areas, African reserves and the demarcation of conservation areas.

2.6 The apartheid era: African Bantustans

The Group Areas Act of 1951 came into power with the new apartheid government (the National Party), creating separate residential areas and business sections in urban areas for different races (May and Govender, 1998). The Abolition of Passes and Co-ordination of Documents Act of 1952 required non-whites to carry reference books to enter white areas of the country, to limit the movement of non-whites (O'Malley, 2014b). The later promotion of the Bantu-Self Government Act of 1959 created a legal basis for the later deportation of non-whites into designated Bantustans (homeland) areas, an adaptation of the former native reserve areas, laying the groundwork for political and economic segregation (Augustinus, 2000). The Bantustans were ten distinct territories created out of the existing reserve structure where people were grouped according to their ethnic background (Fig. 2.2). The Act created a

hierarchy of local government for each Bantustan, through the establishment of tribal, territorial and regional authorities (O'Malley, 2014a). The Bantu Homelands Constitution Act of 1971 made local people involuntary citizens of the Bantustans resulting in their loss of entitlement to South African Citizenship (May and Govender, 1998).

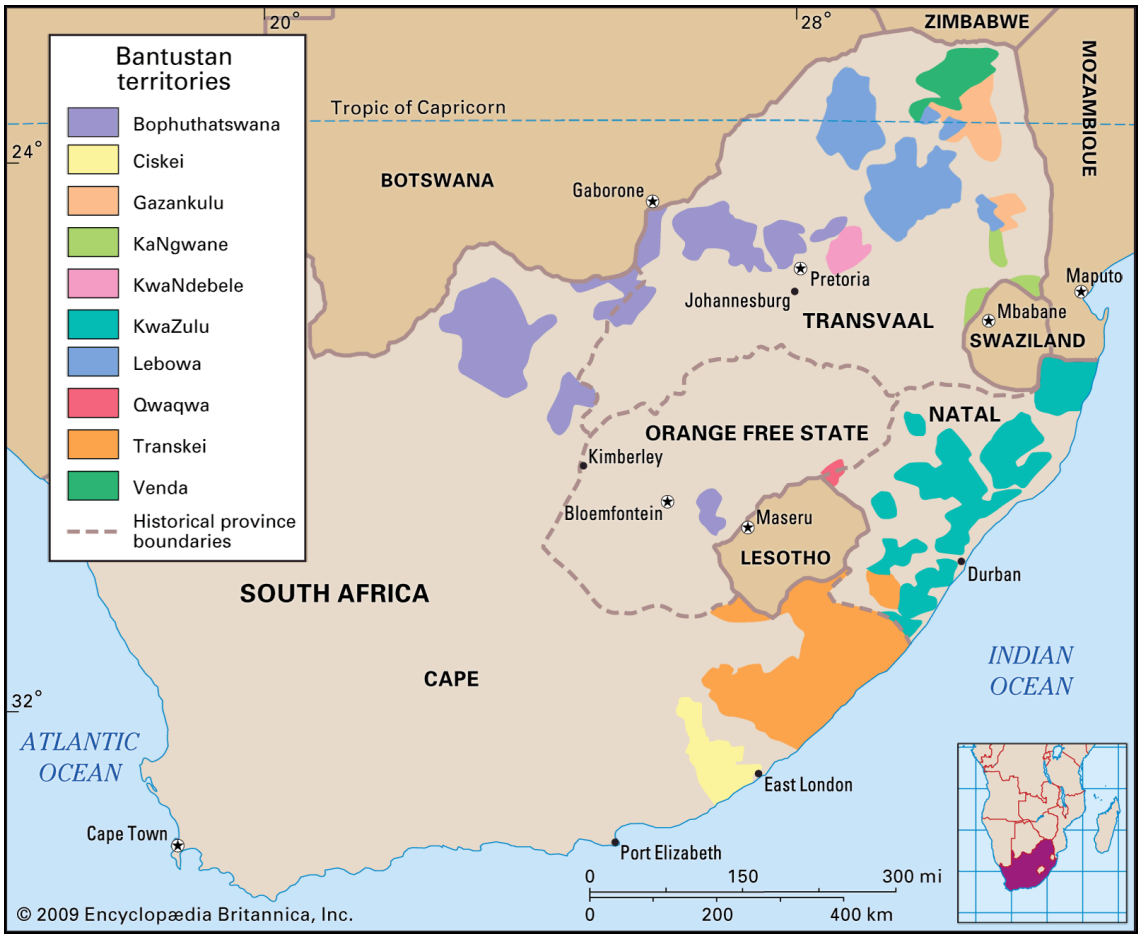


Figure 2.2 Map showing the apartheid Bantustan territories of South Africa taken from Encylopaedia Britannica (2009).

Apartheid laws heightened racial segregation, led to the relocation of 3.5 million people from 1960 to 1980 and increased the percentage of the total African population living in Bantustans from 39% to 53% (Ramphele, 1991). From the 1930s the government initiated the Betterment programmes in the former native reserve areas, which continued to operate into the 1980s (Ramphele, 1991). The Betterment programmes maximised agricultural production within the Bantustans by demarcating land into arable, residential and common grazing areas (Ramphele, 1991). Poverty, overpopulation and the small size of family holdings led to destructive land use practices, including deforestation and the removal of dung from the veld. Desperation and the

need to survive entrenched the non-sustainable use of the land (Wilson and Ramphele, 1989). The poor conditions in the Bantustans caused the men to migrate to the cities in search of wage labour and to seek alternative incomes on surrounding farms, leaving women alone to head the household (Beinart, 2008).

The impacts of the segregationist policies heightened negative perceptions among the African people towards conservation, with attitudes ranging from apathy to hostility (Khan, 1990). The poor socio-economic conditions of the African people and the differing priorities of the government worsened poverty levels:

"Kew Town and other associations throughout the Peninsula have been complaining to the Council to repair their houses and the response has always been 'We don't have money.' Yet the Council wants to spend R60 million on greening the city. This should be the last item on their list of priorities. We fail to see how the greening of the city can improve our living when the very houses in which we live are falling to pieces" (City Engineers Department, 1984, in Khan, 1990, p. 4).

2.7 The coming of democracy: A new South Africa

The late 1990s was marked by internal, economic and international pressure to abolish the land acts passed under the apartheid regime. The Bantustans were eventually dismantled and the territories reincorporated into the Republic of South Africa as part of the demise of the apartheid regime in 1994 (Fabricius and de Wet, 2002). The Restitution Act of 1994 shortly followed, allowing individuals or communities who had lost their property as a result of apartheid laws after 1913 to submit claims for the restitution of land (Fabricius and de Wet, 2002). The Land Restitution programme has been perceived as slow and ineffective, due to issues ranging from policy design to the practical consequences of implementation and post-restitution development (Weideman, 2004). Protected areas in South Africa have undergone similar changes to reflect the new political, economic and social realities underpinned by a democratic society (Anthony, 2007).

Derek Hanekom and Louis Liebenberg, of the African National Congress, highlighted the merits of livestock grazing in South African National Parks as a means of making protected areas more relevant to the subsistence activities of local Africans (Hanekom and Liebenberg, 1993). The conservation establishment responded by arguing that parks were of national interest and

sought to demonstrate their conservation benefits over livestock grazing (Grossman and Holden, 2002). However, the impetus to improve relations between parks and African communities in South Africa was underlined by the need to demonstrate that protected areas should contribute to developing democratic society, alongside growing international pressures to improve the involvement and participation of local people in protected areas (Grossman and Holden, 2002). In South Africa, these changes were represented in varying forms, such as the levying of park fees paid to neighbouring communities, the involvement of local peoples in management boards of conserved areas and facilitating land claims within protected areas (Grossman and Holden, 2002, Anthony, 2007). The establishment of the Social Ecology Department in 1994 by South African National Parks developed a new vision as described in its 1998 plan to convey:

"The philosophy and approach of South African National Parks to neighbouring communities…[is to] establish mutually beneficial beneficial dialogues and partnerships with these communities. The process ensures that the views of the community are taken into account to the largest possible extent and are acted upon, that the Parks' existence is a direct benefit to neighbouring communities and that, in turn, communities adjacent to Parks welcome the conservation efforts of the South African National Parks" (SANP 2000 in Anthony 2007, p. 20).

Currently the landscapes of South Africa's parks aim to promote integration, cooperation and a unification of the people. However, the impacts of South Africa's dramatic political history are still present in the psyches of its modern day inhabitants (Chapter 4). The segregatory policies of the past are visible in the landscape as observed through the division of separate areas of settlement between different cultural groups and their relative isolation from one another. History provides a foundation for understanding contemporary human-environmental interactions that gives cultural development its projection into present day reality. Strang (1997) argues that messages from the past offer its present-day people a stream of ideas about how their ostensibly separate cultures interact with the land itself, providing a socio-economic mode of interaction with the environment and a "set of roles to which its members can aspire" (ibid, p. 75). Strang (1997) suggests these ideas are self-perpetuating and continually expressed through a dynamic interaction with the land itself. It is against this broadly sketched historical and political background that perceptions of wildlife, protected areas and wildlife conservation of the present-day Northern-Sotho speaking Bahananwa and Afrikaner farmers in the Blouberg Mountain Range, South Africa, should be understood.

Chapter 3

Study site description

3.1 Introduction

The Blouberg Mountain Range falls under the Blouberg Municipality, forming part of the Capricorn District of the Limpopo Province (Blouberg Local Municipality, 2013-2016) (Fig. 3.1). The Blouberg Mountain Range is an inselberg situated 30km west of the Soutpansberg Mountains (Fig. 3.2). The highest peak of the mountain is 2051m above sea level and the altitude of the surrounding plains is 900m, giving the Blouberg a relief displacement of over 1000m (Scholes, 1978). The Brak River flows between the Soutpansberg and the Blouberg Mountains towards the Limpopo River in the north during periods of high rainfall and drains the southern slopes of the Blouberg Mountain. Protected areas cover an area of 18, 880 hectares and include the Maleboch Nature Reserve (MNR), Blouberg Nature Reserve (BNR) and the Lanjan Nature Reserve (LNR) (NCC-Group, 2012a, NCC-Group, 2012c, NCC-Group, 2012b) (Fig. 3.2). The reserves were proclaimed part of the United Nations Educational, Scientific and Cultural Organization (UNESCO), Vhembe World Network of Biosphere Reserves (WNBR) in 2009 (Tucker, 2013).

Figure 3.1: Map of the study site location in the Blouberg Municipality, Capricorn District, Limpopo, South Africa. Maps downloaded from Wikipedia (2014) and from the Limpopo Department of Agriculture (2014).

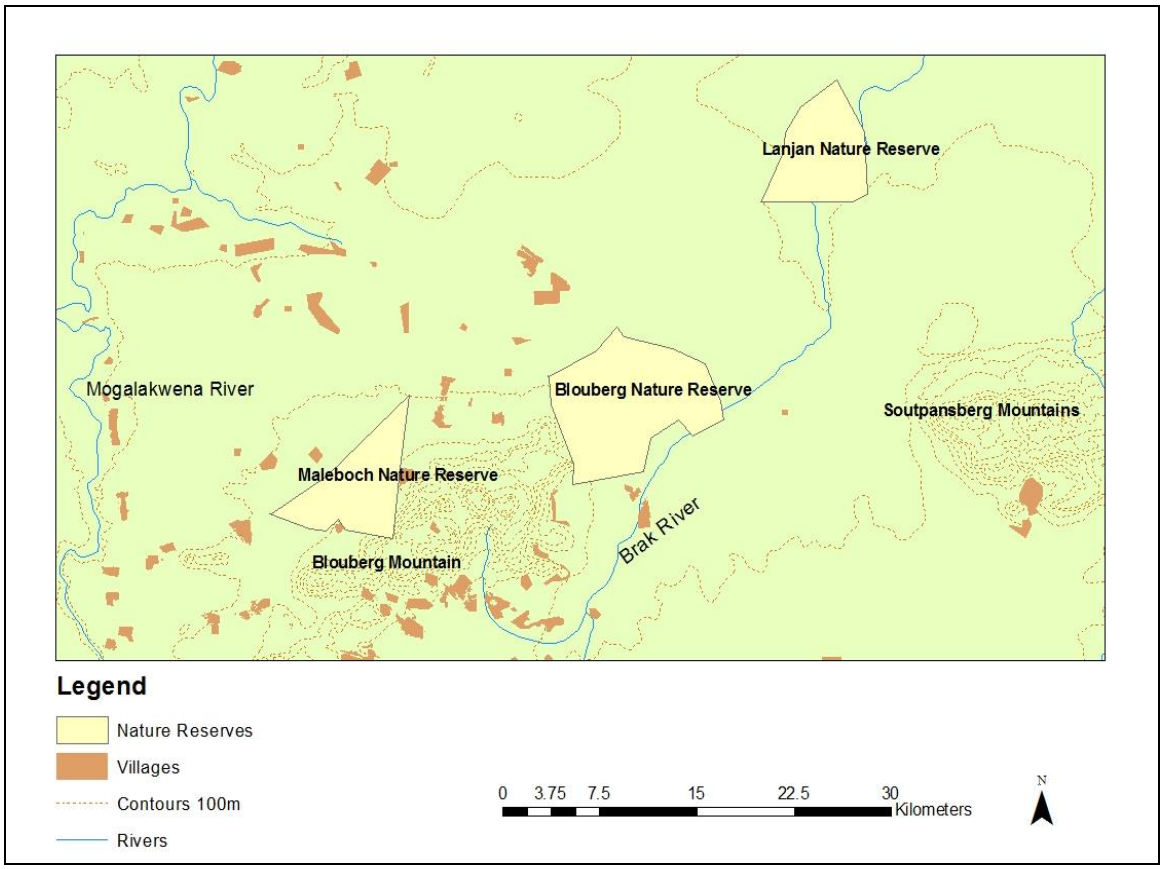


Figure 3.2: Map of the Blouberg Mountain Range.

3.2 People of Blouberg

3.2.1 History of the Bahananwa and European settlers in the Blouberg Mountain Range

The contemporary Northern-Sotho speakers that occupy the Blouberg are descendants of the Bahananwa, who originated from the Bahurutshe of Botswana[2]. The settlement of the Bahananwa in the Blouberg is widely debated, but assumed to be between 1722 and 1830 (Joubert and Schalkwyk, 1999, Joubert, 2004) when internal conflict amongst the Bahurutshe ensued between the two royal sons, Maliti and his younger brother Sebudi (Makhura, 1993). The younger brother Sebudi evaded his brother's assassination plot by crossing the Limpopo and Mogalakwena Rivers together with his loyalties and livestock and settling on the Blouberg Mountain (Joubert, 2004). The derogatory name of Banganani, meaning dissidents, resisters or rebels was hurled at the refugee group as they fled across the rivers and later co-opted into the name Bagananwa (Makhura, 1993). The second name Lebogo, meaning the "hand that would rule," was later adopted as the royal surname of the Bahananwa and evolved into the name Mmalebogo[3].

The Blouberg Mountain provided adequate defence against intruders and was sparsely populated by the San and the people of Madibana. The Madibana were from the northeast of the Transvaal, including Venda, Phalaborwa and Bolobedu (van der Merwe, 1978 in Makhura, 1993). The Madibana were renowned for their iron works and their abilities as traditional healers to heal, divine the future and act as mediums to connect with the ancestral spirits (Makhura, 1993). The relationship between the three groups was reciprocal and over time they became integrated and assimilated aspects of one another's lifestyles. The boundaries of

[2] Numerous names have been attributed to the tribe including Bakchananoa, Bakhananwa, Bahananoa, Gananwa, Bahananoa, Bagananwa, Bahananwa and Hananwa (Makhura, 1993, Joubert, 2004). I use the contemporary name Bahananwa in this thesis.

[3]The addition of Mma, the prefix for mother, was attributed to the historical role of female regents in the political structure of the Bahananwa (Makhura, 1993). Numerous variations on the name have persisted throughout the colonial era including Malaboch, Maleboch, and Mmaleboho (Makhura, 1993, Joubert, 2004). The contemporary surname for the royal family is Leboho (Joubert, 2004). I use the names Maleboch and Leboho throughout the course of this study.

territories were fluid and dynamic, dictated by seasonal changes in grazing and hunting grounds. The nineteenth century territory of the Bahananwa was:

*"*Bordered by the Limpopo River in the north and extended in the east as far as Salt Pan, that is, the western portion of the Soutpansberg, while in the west it shared the frontier with the Ba-ga-Seleka (the people of Seleka) in the environs of the present-day Elisrus. The southern frontier was shared with the Matabele of Mapela and Mokopane, and the Bapedi communities of Matlala and Moloto at Moletsi" (Makhura, 1993, p. 25).

Makhura (1993) goes into great depth to describe the economic and social modes of organisation within the Bahananwa. The dominating economic activities were based on agriculture and pastoralism. Supplementary activities included hunter-gathering, manufacturing and selling handicrafts and animal products. *Tswaing* (The Place of Salt), located to the north-east of the Bahananwa's range (currently named the Soutpansberg), provided the source of a thriving salt industry. The site was an important trading centre for the exchange of manufactured goods. The Bahananwa obtained iron works such as axes and hoes from the Phalaborwa smelters and other items such as ivory, animal hides and feathers from other Basotho groups.

The modern-day Afrikaners who occupy the Blouberg Mountain Range are descended from the Voortrekkers that colonised the Cape in 1652 (Worden, 2000, 2007). The settlement of the British in the Cape in 1772 introduced conflicts with the Voortrekkers due to land shortages, and the dissatisfaction of the Voortrekkers with British legislation (Keegan, 1996, Moodie, 2011). In 1835, the Voortrekkers set out from the Cape of Good Hope and began to trek east towards the Orange River and north into the Transvaal, to carve out a separate identity beyond the reach of the British (Keegan, 1996, Moodie, 2011).

The Voortrekkers entered the Soutpansberg in 1836 and by 1848 penetrated the southern parts of the Bahananwa territory close to Senwarbarwana (Makhura, 1993). The Voortrekkers briefly entered into hunting partnerships with the Bahananwa during the initial stage of their settlement. However, this cooperation eventually deteriorated as expanding numbers of European settlers filtered into the Bahananwa territory. From the 1860s missionaries, explorers, hunters and land speculation companies, heightened conflicts over access land and natural sources (Makhura, 1993, Kriel, 2004).

In the late 1860s, the Bahananwa allowed the Voortrekkers access to their territory on condition they paid annual tax to the Bahananwa in the form of rifles for hunting and

gunpowder (Sonntag, 1983, Makhura, 1993). However, some individuals took this permission as a passport to landownership and began to covertly manage tracts of fertile grazing land, water resources and cattle for their own use (Sonntag, 1983). The Voortrekkers evolved a system of labour coercion named *inboekstelsel* in which Bahananwa children were taken to work on the surrounding farms, increasing tensions and resistance between these cultural groups (Keane, 1900, Delius, 1983 in Joubert, 2004).

The Berlin missionaries entered the Blouberg in 1868 and set up the first mission station at the foot of the Blouberg Mountain (Makhura, 1993, Joubert, 2004). The missionaries were important agents of change and introduced new skills and technologies, including the first formal education system and the cultivation and irrigation of cash crops (Berlin Missonsberichte, 1880 in Makhura, 1993). These changes resulted in the erosion of existing ways of life among the Bahananwa by highlighting the importance of European goods and the development of a cash-based economy (Makhura, 1993). The discovery of diamonds in Kimberley in 1867 and gold at Tati in the Soutpansberg and Lydenberg from 1860-1870 paved the way for labour migration (Makhura, 1993). Migration from rural areas was further hastened by the introduction of a "work and pray system" by the missionaries, which emphasised the dignity of wage labour (Berlin Missonsberichte, 1872 in Makhura, 1993). Formal social institutions of the Bahananwa including witchcraft, ancestral worship, aesthetic ritual, polygamy, initiation programmes, rain-making and first fruit ceremonies were denounced by the missionaries as heathenism (Sonntag, 1983, Makhura, 1993). The missionaries encouraged young men and boys to partake in cultivation work and to attend formal religious and education programmes, bearing little relevance to the activities of hunting and herding (Makhura, 1993).

The introduction of Christianity caused social stratification among the Bahananwa into two groups: Christians and non-Christians. The conversion of Chief Matsiokwane's sons, Ramatho Kibi and Makgore to Christianity created a significant divide among the Bahananwa (Makhura, 1993). Furthermore, as neither son was eligible for the chieftaincy, they planned to murder their father and heir to the chieftaincy, Kgalushi Sekete. In 1879, Matsiokwane was killed and Kgalushi Sekete became the new leader. News of the plot to murder Kgalushi Sekete was revealed, leading to the murder of Makgore and some of his followers. Ramatho Kibi fled to build a second constituency to oppose Kgalushi's rule and later came to settle with his supporters on the south-eastern fringes of the Blouberg named Baga-kibi, becoming known as the people of Kibi (Joubert, 2004).

The annexation of the Transvaal began in 1877 through the creation of a state structure and society based on British imperial interests (Makhura, 1993). The British encroached on Bahananwa territory with a new system of taxation, informed the Bahananwa they would become British subjects and would be required to relocate to a restricted location away from the mountain (Berlin Missonsberichte, 1878 in Makhura, 1993; Sonntag, 1984). However, such plans never materialised due to the involvement of the British in military campaigns against the Bapedi in 1877 and the Anglo-Boer War from 1879 to 1881 (Makhura, 1993).

The conclusion of the Anglo-Boer War in 1881 saw the independence of the Transvaal republic from the British Empire and the inheritance of the British state structure by the Boers (Laband, 2005). The British and Boers represented highly polarised groups, however, they were united in their aims to subjugate African independent polities within their sovereign states. The Boer government began the process of demarcating reserves for the translocation of African communities through the Occupation Act, passed in 1886, in which land was made available free of charge to white settlers (Makhura, 1993). The Squatter Law followed in 1887, in which no more than five African households were allowed to live outside the reserves on each farm (Makhura, 1993). The reserves provided a reservoir of labour for the European farmers and facilitated the effective collection of taxes (Makhura, 1993).

In 1888, the Native Commissioner, Barend Voster, visited the Blouberg capital to inform the Bahananwa of new laws and plans to relocate the Bahananwa, to an area alongside the western portion of the Mogalakwena River (Sonntag, 1983). Many factors, including the Bahananwa's refusal to have their territory demarcated, to take part in a census for the delivery of hut taxes and to move to a new location, cumulated in the Bahananwa-Boer War of 1894. This led to the eventual surrender of Chief Kgalushi Sekete, who was arrested by General Piet Joubert and taken to Pretoria (Schalkwyk and Smith, 2004). Following the events of the war, both sides experienced the loss of human life and men, women and children were indentured on farms as labourers, for a period of five years (Boyens, 1994 in van Schalwyk and Smith, 2004, Makhura, 2003). The Bahananwa territory was divided up and distributed to European farmers.

Following the war, many people sought refuge in the missionary station at the base of the Blouberg and gradually began a process of reconstruction (Sonntag, 1983, Joubert, 2004). Over time many young men who had fled to outlying areas reappeared from the farms and goldfields in Pretoria and the Free State (Makhura, 1993). Chief Kgalushi Sekete was set free when the British took over Pretoria in 1900, returning to the Blouberg until his eventual death

in 1939 (Makhura, 1993). The events of the 1894 war are depicted in contemporary Northern Sotho rock art, present in the Makgabeng and Blouberg Mountain and continue to feature in Bahananwa culture today. Joubert and Van Schalwyk (1999) carried out a written translation of a prominent praise poem, recited during a 1989 political rally by Agnes Leboho over the future development of the Bahananwa homeland. In the oral performance, the century old story of Chief Leboho and his bravery during the war against the Boers and their allies was recounted and given new meaning.

After the conclusion of the second Anglo-Boer war in 1902, large tracts of land around the Blouberg were made available to overseas British investors and subsequently, sold to Afrikaans farmers during during the late 1930s. The introduction of the Bantustan systems enforced by the National Party under apartheid rule resulted in the nationalisation of the Bahananwa into the Lebowa Homeland through their generalised classification as Northern-Sotho speakers (Joubert, 2004). From the 1970s several privately owned farms close to the mountain were purchased by the government for the resettlement of Northern-Sotho speakers from areas of Venda and Pietersburg. The government saw the Bahananwa as rebellious on account of their refusal to cooperate with the registration of births and deaths, the introduction of passbooks, the Betterment programme and the new laws relating to courts for chiefs and headmen (Joubert, 2004). As punishment the Chief Bantu Commissioner decided to stop the payment of pensions and the maintenance of water supporting systems in the area (Joubert, 2004). The apartheid government starved the Bahananwa of basic infrastructure and developmental needs making it one of the least developed regions in the present-day Limpopo Province (Blouberg Local Municipality, 2007-2008). The turbulent history of the Bahananwa and early European settlers provides a context for understanding contemporary interactions between cultural groups, interactions between local people and government officials working for environmental institutions, conservation discourses and perceptions of wildlife conservation (Chapter 4).

3.2.2 Present-day demography and socio-economic conditions

The Integrated Development Plan for the Blouberg (2013-2016) provides a detailed account of the contemporary demographic and socio-economic situation in South Africa (Blouberg Local Municipality, 2013-2016). The Blouberg Municipality has 138 villages with an overall

population of 194, 119 inhabitants, constituting 16% of the total population in the Capricorn District. A significant proportion of the Blouberg population (99%) are categorised as black Africans. The western portion of the Blouberg Mountain and the surrounding plains are home to a large rural population descended from the Bahananwa (Scholes, 1978). Other cultural groups, including the Batlokwa, a sub-division of the Bahananwa, Vha-Venda, Shangaan, Indian and Afrikaners also reside in the area (Blouberg Local Municipality 2010-2011). Six percent of the population never attended school, 11% are educated to primary school level, 77% to secondary school level and 5% received a higher education. Poverty levels are high; a large number of households survive on an annual income of less than ZAR 1800 per annum, whilst many do not earn an income. The migrant labour system contributes to social disruption at the household level, as large numbers of men seek work in the cities, leaving women alone to head the households. The contemporary trend is for children to head the household, as women tend to follow their husbands. Only 18% of the Blouberg population are employed with 12% being unemployed, 6% discouraged work seekers and 64% not economically active. The Blouberg offers limited employment opportunities therefore, many people support themselves through subsistent agriculture and livestock farming, government pensions, child and disability grants or by family members working in the cities. Eighty percent of the Blouberg population have access to piped water, whilst 12% rely on natural water sources such as rivers, dams and natural springs. The Blouberg is in need of improved sanitation: 77% use pit latrines, 7% use a flush toilet and 11% have no access to any sanitation services. Eighty-eight percent of households have access to electricity, whilst a small percentage use other forms of power, including gas (0.1%), paraffin (0.6%), candles (10.8%) and solar energy (0.2%). The majority of people in rural areas do not have access to formal refuse removal systems and therefore, manage their own waste, which is often dumped in communal areas. Twenty-five percent of the road network is surfaced with the remainder being gravel roadways, which are in bad condition. The majority of people rely on taxis for transport as there is a shortage of bus services in the area. The Blouberg Municipality is one of the most marginalised municipalities in the Capricorn District which is further accentuated by high levels of poverty, a lack of infrastructural development and education and social stratification of families caused by the migrant labour system.

3.3 Ecology and conservation of the Blouberg Mountain Range

3.3.1 Climate

The Blouberg is semi-arid, with a warm and dry summer (October-March) and a dry winter season (April-September). Seasonal droughts occur between May and October and long-term droughts once every decade (Scholes, 1978, Limpopo Provincial Government, 2004). The daily maximum temperature on the lower-lying plains exceeds 31°C in October and 33°C in January, with a highest recorded temperature of 40°C (Limpopo Provincial Government, 2004). The daily minimum temperature falls between 12.3°C in May and 9°C in July, with a minimum of -3°C recorded (Scholes, 1978, Limpopo Provincial Government, 2004). Temperatures on the summit of the mountain are estimated to be 6°C lower than the lower-lying plains (Scholes, 1978). The average annual rainfall on the plains falls between 450mm and 500mm and exceeds 1000mm on the mountain summit (Scholes, 1978).

3.3.2 Vegetation

The Blouberg Mountain and its surrounds comprise eleven different vegetation types: Limpopo Ridge Bushveld; Limpopo Sweet Bushveld; Musina Mopane Bushveld; Subtropical Salt Pans; Makhado Sweet Bushveld; Mamabolo Mountain Bushveld; Northern Escarpment Afromontane Fynbos; Northern Mistbelt Forest; Roodeberg Bushveld; Soutpansberg Mountain Bushveld and Soutpansberg Summit Sourveld (Fig 3.3) and are defined by Mucina and Rutherford (2006) as follows:

- **Limpopo Ridge Bushveld**: Irregular plains, with ridges and hills, moderate open savannah, with a poorly developed ground layer. The presence of white seringa (*Kirkia acuminate*) on ridge skylines, boababs (*Adansonia digitata*) on calcareous gravel and the thrumphet thorn (*Catophracates alexandri*) on calc-silcate soils is characteristic of this vegetation type.

- **Limpopo Sweet Bushveld**: Plains, sometimes undulating or irregular, traversed by several tributaries and comprised of short open woodland in distributed thickets of blue thorn (*Acacia erubescens),* black thorn (*A. Mellifera)* and sicklebush (*Dichrostachys cinerea*).
- **Musina Mopane Bushveld**: Undulating to irregular plains with some hills. Depending on the geographical location, these types of habitats can include open woodland to moderate closed scrubland, moderate closed to open scrubland on basalt areas and moderate open savannah on deep sandy soils.
- **Subtropical Salt Pans**: Shallow depressions, often found in old alluvial terraces of rivers surrounded by zones of bank reeds or low herblands and in more perennial pans filled with macrophytic floating vegetation.
- **Makhado Sweet Bushveld**: Slight to moderate, undulating plains and shrubby bushveld with a poorly developed grass layer.
- **Mamabolo Mountain Bushveld:** Slopes are moderate to steep, very rocky and covered by small trees and scrubs.
- **Northern Escarpment Afromontane Fynbos**: Dominant structural form is scrubland comprised of *Schlerophyllous* scrubs and herbs and fragmented patches of high-line quartzite ridges.
- **Northern Mistbelt Forest**: Tall, evergreen Afrotemperate Mistbelt forests occurring in subridge scarps and moist sheltered kloofs where they form small, fragmented patches.
- **Roodeberg Bushveld**: Plains and slightly undulating plains, including some low hills, with short closed woodland to tall open woodland and a poorly developed grass layer.
- **Soutpansberg Mountain Bushveld**: Low to high mountains, with the highest in the west, splitting into increasing number of lower mountain ridges towards the east. Dense tree layer and poorly developed grassy layer. The main vegetation variations include subtropical moist thickets, mistbelt bush clumps, open savannah sandveld and arid mountain bushveld.
- **Soutpansberg Summit Sourveld**: Rugged summit crests and adjacent steep rocky slopes supporting a mosaic of low, wiry, closed grassland and scattered closed canopy bush clumps.

The forests of the Blouberg Mountain are conserved under the Government Gazette no. 34809 of 2011 of the National Environmental Management Act 10 of 2004 (Egan, 2013). However, despite this level of protection the forests have become degraded, due to deforestation, forest fires and periodic droughts (Egan, 2007). Trees are cleared for firewood to make way for agricultural fields and to harvest illegal cannabis and tobacco. Veld fires are a natural phenomenon occurring during the summer months of January and February and are also induced by rural villagers as a traditional method for calling the rain. Peatlands, grasslands and forests, including the important yellow wood trees (*Podocarpus latifolius*), a national emblem for South Africa, are also damaged from uncontrollable fires. The Blouberg area is reliant on subsistence livestock farming therefore, the over-grazing of livestock on the mountain plateau and communal areas contribute to the erosion of peatland and wetland areas, along with their water retention capabilities (Egan, 2007). This dries up important waterways, which supply lower-lying regions thereby, increasing flood risks during times of heavy rainfall (Egan, 2007). Soil erosion resulting from water run-off from the mountain environment in the lower-lying villages, results in a decline in productivity of the land and its water resources (Grwambi et al., 2006). The mountain environment forms an important resource for rural communities however its on-going degradation threatens important ecosystem services.

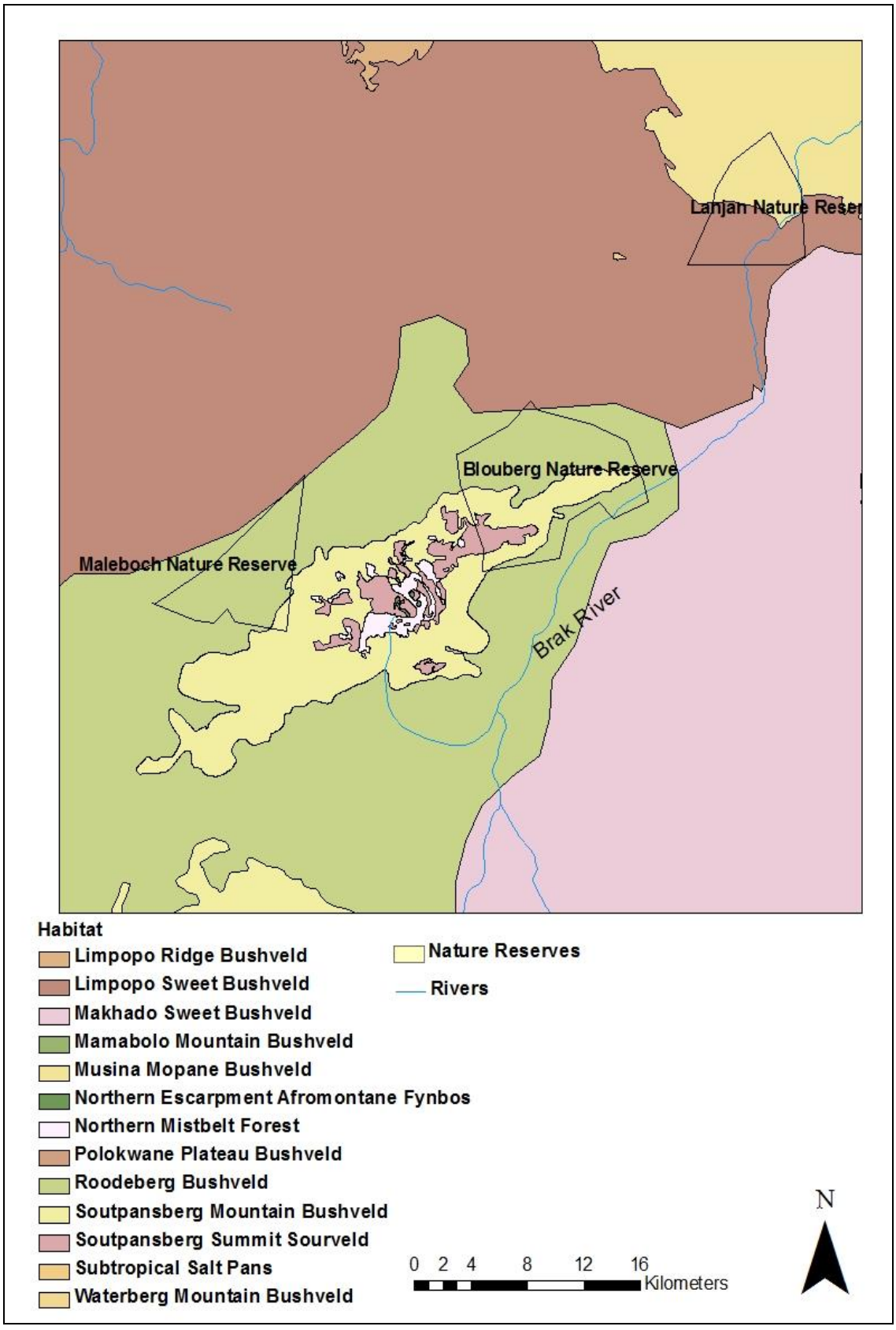


Figure 3.3: Map of vegetation types in the Blouberg Mountain Range (Mucina and Rutherford, 2006).

3.3.3 Blouberg Nature Reserve

The BNR consists of 9,348 hectares of protected land and was proclaimed in 1983 by the South African Development Trust, in terms of Section 18 of the Lebowa Nature Conservation Act (No. 10 of 1973). In 1992 the management of the reserve was transferred to the Transvaal Provincial Administration (van Wyk, 2002, NCC-Group, 2012a). Following the 1994 democratic elections the reserve was incorporated into the newly formed Northern Provincial Government (now the Limpopo Provincial Government) and managed under the Limpopo Environmental Management: Protected Areas Act (Act 57 of 2003) (van Wyk, 2002, NCC-Group, 2012a).

BNR is defined as a provincial nature reserve under the Limpopo Environment Management: Protected Areas Act (2003), in order to (1) protect an area because of its natural landscapes, indigenous fauna and flora and biotic communities; (2) to propagate scarce and endangered species of fauna and flora; and (3) sustainably use the area for scientific, educational and ecotourism purposes. The regulation, planning and management of protected areas in the Limpopo Province are administered by the Limpopo Department of Economic Development, Environment and Tourism (LEDET). The Limpopo Tourism Agency is responsible for the management of tourism activities and nature reserves in Limpopo (see Chapter 5 for further details).

The BNR boasts a rich diversity of plant life including 1600 plant species (van Wyk, 2002). Important habitat features include large baobabs (*Adansonia digitata*) at their most southerly distribution from the Limpopo River, tamboti woodland (*Spirostachys Africana*), a fig forest including sycamore fig (*Ficus sycomorus*), fever-berry trees (*Croton megalobotrys*) and to the north, nyala berry trees (*Xantocercus zambeziaca*) (van Wyk, 2002). The northeast of the reserve is characterised by large marula trees (*Sclerocarya birrea*) and the south is dominated by acacia woodland (van Wyk, 2002).

The BNR hosts 50 reptile species, 21 bat species and 128 bird species including a large breeding colony of Cape griffon vultures (*Gyps coprothere*) nesting on the southern side of the mountain cliffs (van Wyk, 2002, NCC-Group, 2012a). The reserve also supports a variety of plains game including impala (*Aepyceros melampus*), kudu (*Tragelaphus strepsicero*), blue wildebeest (*Connochaetes taurinus*), bushbuck (*Tragelaphus sylvaticus*), waterbuck (*Kobus ellipsiprymnus*), Burchell's zebra (*Equus quagga burchellii*), gemsbok (*Oryx gazella*), red

hartebeest (*Alcelaphus caama*), eland (*Taurotragus oryx*), giraffe (*Giraffa camelopardalis*), sable (*Martes zibellina*), Cape buffalo (*Syncerus caffer*), klipspringer (*Oreotragus oreotragus*), mountain reedbuck (*Redunca fulvorufula*), steenbuck (*Raphicerus campestri*), common duiker (*Sylvicapra grimmia*), warthog (*Phacochoerus africanus*) and bushpig (*Potamochoerus larvatu*). Additionally, chacma baboons (*Papio ursinus*) and vervet monkeys (*Chlorocebus pygerythrus*) and a number of carnivore species including, brown hyaena (*Hyaena brunnea*), spotted hyaena (*Crocuta crocuta*), caracal (*Caracal caracal*), black backed jackal (*Canis mesomelas*), cheetah and leopard have also been recorded. Illegal poaching is a significant issue on the BNR as well as the other nature reserves, private, game farms and communal land, where wild game are killed for bushmeat and traditional medicine (Blouberg Local Municipality, 2013-2016).

3.3.4 Maleboch Nature Reserve

The MNR covers an area of 4758 hectares and encompasses the northern slopes of the Blouberg Mountain (Fig. 3.2). The Lebowa government proclaimed it a nature reserve in terms of Notice No. R. 18 of Lebowa Regulation Gazette No. 14 (814) of 20 December 1985, under Section 18 of the Lebowa Nature Conservation Act (Act 10 of 1973) (NCC-Group, 2012c). Communal reserves were proclaimed communal nature reserves by the former Bantustan homeland government before the 1994 elections. The Lebowa Nature Conservation Act (Act 10 of 1973) refers to legislation on the proclamation of communal nature reserves for (1) the protection of game and fish; (2) the conservation of fauna and flora; and (3) the destruction of vermin. After 1994 communal reserves were taken over by the new provincial government and designated as provincial nature reserves under the Limpopo Environmental Management: Protected Areas Act (Act 57 of 2003). Communal nature reserves are proclaimed on land occupied by a tribal authority where the community donates a piece of land to the government for conservation (Sebola, 2004). Currently the land on which the reserve is located is owned by the Bahananwa Tribal Authority and managed on behalf of the Authority by LEDET (see Chapter 4 for further details). The MNR contains mountainous areas and bushveld plains, which support a variety of game species including giraffe, gemsbok, eland, blue wildebeest, red hartebeest, waterbuck, zebra, kudu and impala (Sebola, 2004). Leopard and brown hyaena have also been recorded (Sebola, 2004). Two hundred and thirty bird

species have been identified on the reserve including bateleurs (*Terathopius ecaudatus*), martial eagles (*Polemaetus bellicosus*) and the Cape griffon vulture (Sebola, 2004).

3.3.5 Lanjan Nature Reserve

The Lanjan Nature Reserve was first proclaimed as a game reserve and native flora reserve on the 8th September 1954, but later de-proclaimed from the 30th September 1983 and reinstated as a nature reserve under Section 3 of the Transvaal Nature Conservation Ordinance, 1967 (ordinance No. 17 of 1967) (NCC-Group, 2012b). Currently the reserve is defined as a provincial nature reserve in accordance with the Limpopo Environmental Management: Protected Areas Act (Act 57 of 2003). The management and tourism activities of the reserve are managed by LEDET. The reserve consists of undulating plains with no hills or valleys, whilst the south of the Brak River flows through the south-east section of the reserve (NCC-Group, 2012b). A game count conducted in 2010, recorded 17 mammal species including bushbuck, giraffe, kudu, blue wildebeest, zebra, ostrich, red hartebeest, warthog, waterbuck, common duiker, eland, gemsbok, impala, nyala, steenbok and black-backed jackal (NCC-Group, 2012b). A total of 35 reptile species, 5 amphibian and 108 bird species have also been recorded on the reserve (NCC-Group, 2012b).

3.4 Farming systems

The Blouberg has a large commercial agricultural sector based on crop, cattle and game farming, with private landowners incorporating a range of these activities. The dominant vegetation in the Blouberg consists of mixed bushveld types, rendering the area suitable for cattle and game farming (Capricorn District Municipality, 2007-2011).

3.4.1 Crop farming

In 2010, the agricultural sector contributed 2.7% of the total Capricorn District economy and 7.9% of employment in the district in 2010 (Capricorn District Municipality, 2013-2014). Irrigated systems provide access to ground water supplies for large-scale production of cut flowers, vegetables, tobacco and citrus fruits (Capricorn District Municipality, 2007-2011).The majority of commercial crop farms are mechanised and dependent on significant volumes of inputs such as chemical fertilisers and pesticides. Crop farming is supported by a well-developed infrastructure and marketing outlets in Johannesburg, the Free State and Durban. The majority of labourers are employed seasonally from local villages and there is a growing trend towards the employment of immigrant Zimbabweans. The farms produce a range of crops including potatoes, wheat, sunflowers, maize, sorghum, soya beans, cotton, groundnuts, lucerne, watermelon, sisal, butternut, pumpkin, spinach, tomatoes and citrus fruits. Potatoes are the most intensively produced and important crop in the Capricorn District, with production value exceeding ZAR 200 million in 2000 (Fig. 3.4).

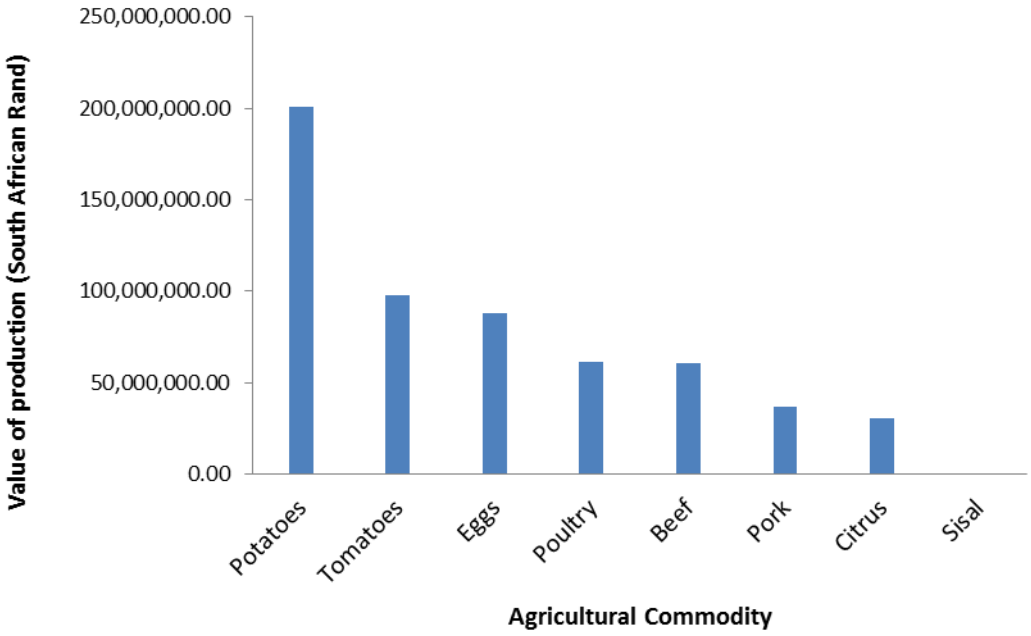


Figure 3.4: Economic value of agricultural commodities produced in the Capricorn District in 2000 with data extracted from the Capricorn District Municipality (2007-2011).

Crop farming within rural villages falls under two categories: subsistence and emerging commercial farmers (Republic of South Africa, 2009). Subsistence farming occurs on small, unfenced, fragmented plots of < 12 hectares close to village homesteads or communal arable lands. Crops are used for domestic consumption; any surplus is often sold at local markets in nearby villages or the large town of Senwarbarwana. Crops such as maize, sorghum and wheat are grown, as well as black beans, pumpkins, wild sugar cane, sorghum, watermelon, white beans and ground nuts. Agricultural activities are managed by household members with tasks being divided by gender: men are responsible for ploughing, whilst women weed and harvest the crops. In some villages, fields have been abandoned due to drought and extensive soil erosion caused by over-grazing and floods. The same fields are used throughout the year and the lack of irrigation due to cultivation being largely rain fed reduces the fertility of the soil. Other problems include crop damage caused by domestic and wild animals due to poor fencing.

Emerging commercial farmers usually farm on communal arable land and have the potential to develop into/or are already functioning as small-scale farming businesses. These farmers are supported by government programmes such as the South African Agricultural Broad Based Black Economic Empowerment; Land Redistribution for Agricultural Development; Comprehensive Agricultural Support Programme; and Micro-agricultural Financial Institutions

of South Africa (Republic of South Africa, 2009). These programmes provide funding and capacity building in the form of knowledge transfer and skills training to aid small-scale farming operations (Republic of South Africa, 2009). Most produce is sold at local markets in neighbouring villages, Vivo and Senwarbarwana.

3.4.2 Livestock farming

The Capricorn District has a thriving livestock farming industry of 242, 298 goats, 209, 027 cattle, 55, 238 pigs, 98, 685 poultry and 50,000 sheep recorded in 2001 (Urban-Econ Development Economists, 2010). However, projections of the percentage of cattle in the district from 2001-2020 indicate a slight decline within the cattle industry, as many farmers convert to game farming or other industries to diversify their income (Fig. 3.5).

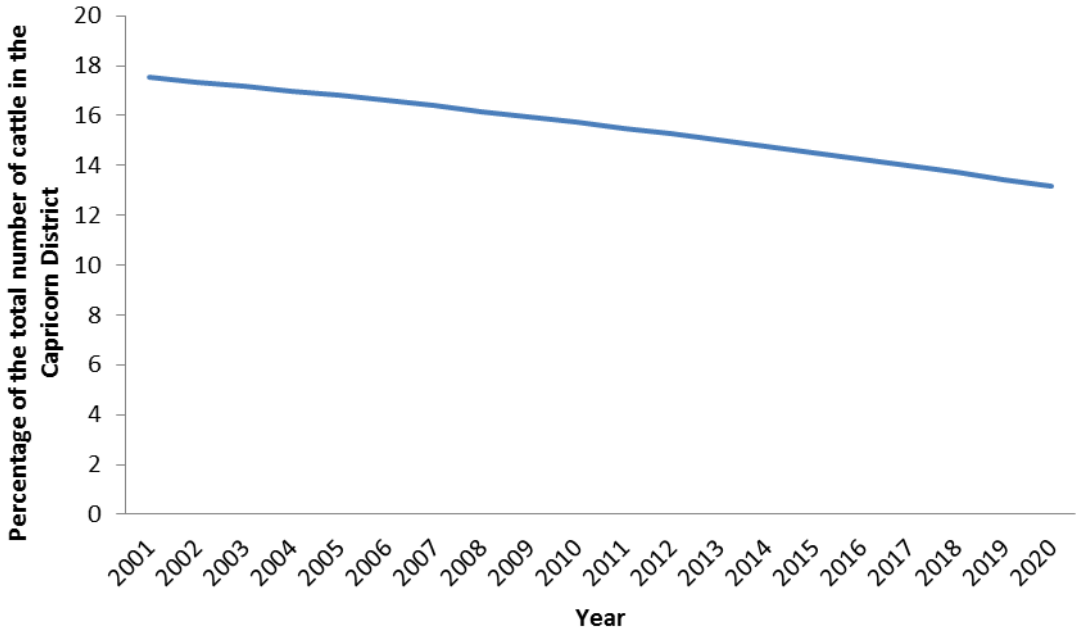


Figure 3.5: Projections of the percentage of the total number of cattle in the Capricorn District from 2001-2020 (Acheampong-Boateng et al., 2003).

Cattle are slaughtered when they reach a weight of 215kg to supply distant meat markets in Johannesburg; breeding and selling livestock at local auctions also form a significant part of the industry. Emerging commercial farmers differ from subsistence farmers because they own

larger numbers of livestock and are supported by government programmes and are encouraged to develop small-scale farming businesses on sponsored land. The infrastructure on farms contains rotational grazing systems, water systems, feeding lots and abattoirs

3.4.3 Game farming

The shift in land use from pastoralism to game farming has been identified as a growing trend in South Africa since the 1980s (Grossman et al., 1999). Game on land formerly dedicated to agriculture has increased from 340,000 animals in 1996 to 1.7 million in 2007 in South Africa (Van der Merwe et al., 2004, Du Toit, 2007). Game farms provide 80% of nature conservation activities on privately owned land, with the Limpopo Province having the most game farms in the country (Fox and Du Plessis, 2000, Eloff, 2001). Game farming offers several forms of income for commercial farmers in the Blouberg, including game capture (58%), hunting (74%) and eco-tourism (10%). The breeding and sale of rare game species, such as buffalo, black rhino (*Diceros bicornis*), sable antelope, and endangered roan antelope (*Hippotragus equinus*); form a profitable part of the game industry. Various types of hunting occur on properties including trophy hunting, bow hunting and biltong hunting. Over one million animals are hunted annually in South Africa, contributing ZAR 6 billion to the gross domestic product for the country (Saayman et al., 2011, D'Amato et al., 2013). Ecotourism ventures include guided walks, game drives, bird watching, photographic safaris, horse riding, conference facilities, golfing and promotion of local attractions such as bushman paintings. In some instances, game farms were managed solely by foremen and rarely visited by their owners. In these instances, game farms are used as a recreational retreat for leisure and seasonal hunting expeditions with family and friends.

Chapter 4

Governance and local perceptions of protected areas: Traumatic nature in the Blouberg Mountain Range

4.1 Introduction

Protected areas are defined by the International Union for Conservation of Nature (IUCN), as "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008, p. 8). The effectiveness of protected areas depends on their size as well as their location, structure and management systems (Cantú-Salazar and Gaston, 2010). The South African protected areas network covers 7.9 million hectares (6.5%) of land in South Africa with targets to increase the network by 8.8% in 2029 (Department of Environmental Affairs, 2009). However, protected areas often fail to achieve their objectives because management initiatives exclude local people and do not provide tangible benefits (Hoole and Berkes, 2010). Historically, top-down approaches characterised the establishment and management of protected areas, serving to exclude local people whose livelihood strategies depended on direct exploitation of natural resources (Ervin et al., 2010, Anthony and Szabo, 2011). From the 1980s protected areas worldwide gradually adopted a paradigm shift towards the involvement and inclusion of local people through participatory processes which share information at the local level to the complete devolution of power and responsibility (Mannigel, 2008). The success or failure of participatory approaches depends on the prevailing socio-economic, political and institutional conditions relevant to specific protected areas (Hirschnitz-Garbers, 2011). The perceptions of local people and managers are crucial for the provisioning of benefits and voluntary participation of local people. Understanding local perceptions of and relationships with protected areas is crucial because they cannot be sustainable in the long-term if communities are "hostile to them" (Anthony and Szabo, 2011, p. 256).

Van Assche et al (2012) develop a theory of traumatic nature to describe local people's constructions of nature and place concepts within the Danube Delta, Romania. The origin and distribution of nature concepts relates to local people's historical and recent experiences with

government regimes arising due to conflicts surrounding land and resource use, which promote legacies of disempowerment, marginalisation and stigmatisation. The impact of these cumulative processes creates a series of effects defined as traumatic nature. Common themes emerge such as the tendency of local people to create scapegoats of particular species of animals or different social actors "in attempts to reduce complex patterns of causality to a single culprit" (Van Assche et al., 2012, p. 175). Local people oscillate between different narratives of the delta and human actors, animals and landscapes feature as discursive elements within these narratives. Van Assche et al (2012) argue that local anxiety, resistance, resentment and disempowerment are manifest in people's nature concepts, articulated against a rationalisation of environmental discourse borrowed from conservationists to make sense of place.

Here, I investigate the impact of protected area establishment and governance (socio-economic conditions, communication structures and the provisioning of benefits)as contributing factors leading to the perceived marginalisation, disempowerment and stigmatisation of rural villagers and private landowners in the Blouberg. Secondly, I investigate the impacts of traumatic nature, as a result of these processes on rural villagers' and private landowners' discourses pertaining to their understanding of the role of nature reserves and conservation, as a causal factor for generating social conflict between different user groups and generating resistance towards the establishment and functioning of protected areas.

4.2 Methods

4.2.1 Sample selection

I conducted a pilot study from March-May, 2010 where I established contact with a government official working for the Blouberg Municipality, who served as a gatekeeper to access the Bahananwa community. My contact organised a meeting with the Blouberg Traditional Authority where I presented the aims and objectives of the study to the Chief and his advisers, followed by an introductory meeting with the headmen of all villages. The Blouberg Tribal Authority gave me written permission to proceed with the study. I used a purposive (targeted) sampling strategy, which selects "sampling units (e.g. individuals, groups of individuals and institutions) based on specific purposes associated with answering a

research study's questions" (Teddlie and Yu, 2007, p. 77). I interviewed 20 rural villagers (including village headmen) in Setloking, Ga-Kgatla, Burchrecht, My Darling, Glenferness and Indermark (Fig 4.1). These villages were targeted as they are defined as the main beneficiaries of the Blouberg Nature Reserve and Maleboch Nature Reserve in management plans. I then followed a snowball sampling strategy, where "individuals who have the desired characteristics, and uses that person's social networks to recruit similar subjects, in a multi-stage process" (Sadler et al, 2010, p. 3), using the headman of each village to identify individuals for interview based on the condition that they had previous interactions with the nature reserves and its staff. I then interviewed 19 commercial farmers, defined as individuals who engage in crop, livestock and game farming activities for material benefit, who I accessed through the head of the Bo Brak Farmers Association to act as a gatekeeper to the community based on the premise that all individuals had previous interactions with the nature reserves and its staff (Fig 4.1). Surveys were carried out with household heads (predominantly men). The sample size of the respondents was governed by time and travel constraints as many of the villages required travelling for more than one hour due to the poor conditions of the roads. In light of these constraints and my decision to live within a local village, I concentrated my efforts towards collecting detailed contextual information from semi-structured interviews and participant observation.

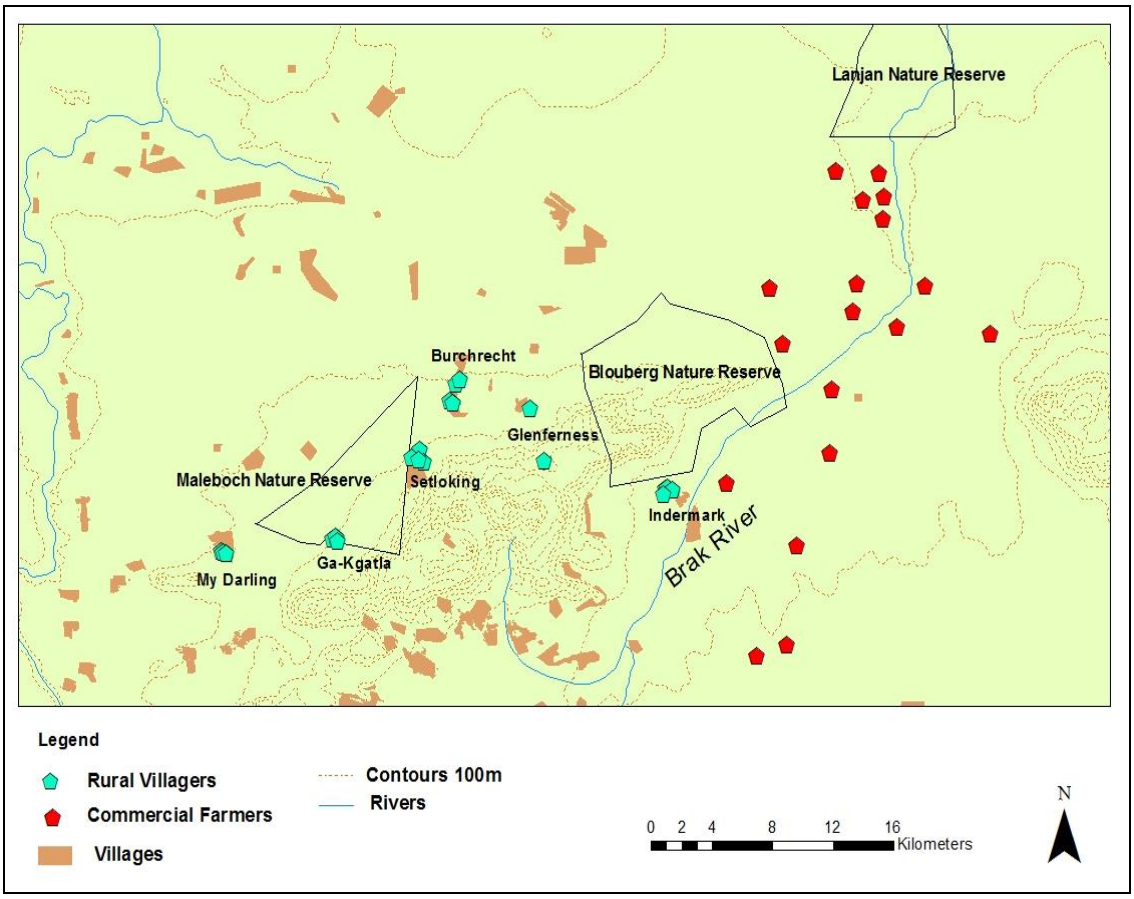


Figure 4.1: Locations of rural villagers and commercial farmers interviewed in the Blouberg

I also interviewed two previous landowners of the BNR, members from the Blouberg Tribal Authority (3), Blouberg Tourism Association (3), the Manoko community (2), Kune Moya (2) and LEDET government officials (6) (see Definitions of Organisations). These stakeholder groups were selected because they had direct knowledge and experience of the history of the land and establishment of nature reserves, governance and management of protected areas and relationships between wildlife authorities and local people.

4.2.2 Semi-structured interviews

I initially designed, planned and trialled semi-structured interview questions during the pilot study which were later, adapted for the main data collection period extending from October, 2010-October, 2011. Semi-structured interviews used a combination of formal and open-

ended questions. Questions were pre-defined and sets of topics of interest were listed as reference points: protected area establishment and consultation; governance and management of protected areas (socio-economic conditions, communication structures and the allocation and provisioning of benefits to local people); perceived costs of protected area establishment; perceptions of rural villagers and private landowners of the role of nature reserves and their understanding of conservation; perceptions of poaching incidents; and interactions between stakeholders. I analysed policy documents (management plans, strategic plans and co-management agreements) to understand how policies influence the quality of participation and opportunities for local people to engage in protected area management and benefit from the presence of the reserves.

4.2.3 Participant observation

Participant observation was carried out by participating in the everyday lives of the local people and observing their behaviour, conversations and details of their lives (Bernard, 2011). Participant observations provide rich insights into the root causes of attitudes, beliefs, value systems and the behaviour of the people under study (Bernard, 2011). The events, observations and conversations of each day are recorded in an ethnographic journal. I lived in the villages Indermark and Buffelshoek for the duration of my fieldwork. I obtained access to Indermark through a contact at the Lajuma Research Centre in the Soutpansberg, where I had previously conducted my research for my Master's degree. The manager of Lajuma Environmental Research Centre supports a crèche in Indermark, which is run by a headmistress who I stayed with. During my pilot study, I met and employed my translator through the recommendation of the Blouberg Tribal Authority and stayed with his family in Buffelshoek. Living within these villages enabled me to learn the Northern-Sotho language. The opportunity to live within a local village and learn the local language provided an insightful form of data collection. I was able to immerse myself in the daily lives of the local people, build trustful relationships and access a rich tapestry of information not easily accessed by outsiders. I found the qualitative methods to be reductive in comparison to the qualitative research methods, which enabled me to capture complex forms of self-expression and emotional responses. I was also invited to attend numerous social events including weddings, funerals, birthdays and cultural ceremonies. I regularly socialised and interacted with the local people and gave talks on my work in local schools regularly interacted with private landowners, wildlife authorities,

conservationists and Non-Governmental Organisations (NGOs) at social events in local bars, shopping trips and when conducting camera trapping surveys in the BNR and commercial farms. All these activities provided ample opportunities for participant observation. This form of data collection also provided opportunities to test the accuracy of data provided from the interviews to the behaviours observed using participant observation. All observations were recorded and written in an ethnographic diary during the course of the study. Overall this multi-method allowed for the collection of in-depth qualitative data. his method was preferred compared to other studies that have related quantitative socio-economic, demographic and resource drivers with local perceptions of protected areas (Tessema et al., 2010, Guerbois et al., 2013) because these studies require the collection of large sample sizes and often ignore important historical and cultural contexts, which are central for understanding local narratives and discourses of protected areas in the Blouberg.

4.2.4 Ethics

Anthropology ethics guidelines of the Association of Social Anthropologists of the UK and Commonwealth (Fairhead et al., 2011) were adhered to throughout the study. The objectives of the study, the nature of the interviews and the use of the data were presented orally to all informants or through a translator to avoid misinterpretation of the questions and responses. Individuals were asked if they wished to participate in the study before proceeding with interviews, individuals' oral agreement to partake in the study was viewed as consent. All data provided by informants were kept anonymous and confidentiality was ensured. The identity of informants is concealed throughout the thesis, unless prior permission was sought to allow the individual to be identified. Where relevant, the village, profession, age group and sex of respondents are indicated. Where I refer to people as young, it signifies that they are under 30 years of age and older refers to people of retirement age over 60 years. In some cases, short quotations are not assigned to individuals but are used to illustrate a point that was made by a wide range of informants.

4.2.5 Data analysis

I analysed the narratives and discourses of a wide range of stakeholders from semi-structured interviews and ethnographic research. Discourse is defined as "the unveiling of discursive construction and discursive production, by means of careful reading, listening, observing, and looking for repetitions, patterns and the network of assumptions behind these patterns" (Van Assche et al, 2012, p. 168). Discourses related to discussions of the environment provide insights into representations of the environment and of people's relationship with them, these factors are linked to wider social issues related to identity, sense making and general wellbeing (Sumares and Fidelis, 2011). Sumares and Fidelis (2011), suggest that human sense making takes place within narrative structures, which refer to the selection, ordering of events and their respective representations into meaningful patterns. Narrative structures are located "in a larger narrative context, of what happens before us and what comes after. Environments matter because they embody that larger context" (O'Neil et al, 2008, p. 163). Discourses in the Blouberg pertaining to protected areas, interactions with wildlife authorities and elements of nature (e.g animals, landscapes) all have their own respective histories and are interpreted through narrative terms to frame the stories of the people themselves (Sumares and Fidelis, 2011).

I apply context from South Africa's colonial and apartheid history and theory from Anthropology to examine the meanings behind local discourses. Narratives and discourses feature good and bad characters (government actors, private landowners and rural villagers as well as leopards). Different social actors relegate one another into collective stereotypes as a result of their historical and recent interactions with one another and their values, beliefs, behaviours and actions towards the environment. Narratives also represent structures that show how "others place us…that conditions the options open to us in identifying who we are, such that we as characters have a limited number of who we can be" (Sumares and Fidelis, 2011, p. 57). However, I observe that affected individuals represent counter discourses to challenge these notions. Concepts, narrative and discourse serve as tools of power and resistance to highlight conflicts between different social actors (Van Assche et al., 2012). Different social actors have their own use of language, definitions and interpretations of concepts, which are shaped by their associated positions and agendas in relation to wildlife conservation. In turn, the representation of animals, landscapes and different social actors in discourses imply different valuations and preferred uses of the environment (Van Assche et al.,

2012). I apply the study of discourses and narratives to investigate the impact of protected area establishment and governance on local people's conservation discourses, generating social conflict between different user groups and resistance towards the establishment and functioning of protected areas.

I coded transcriptions obtained from semi-structured interviews and participant observation using the software programme NVivo 9 (QSR International 2009) according to the specific research themes identified in section 3.2.2. In addition codes were searched and pulled together to identify reoccurring themes and ideas of particular interest. This form of analysis is defined as grounded theory, which places less emphasis on pre-defined theory; rather the data itself generates ideas and themes emerge, which allow the researcher to identify and apply relevant theoretical frameworks (Emerson et al., 2011). Grounded theory approaches towards data analysis attempt to make "frequent comparisons across the dataset, the researcher can develop, modify and extend theoretical predispositions so they fit the data" (Emerson et al., 1995, p. 143).

4.3 Results

4.3.1 Socio-economic characteristics of rural villagers and commercial farmers

Rural Villagers are all Northern-Sotho Speakers, whilst commercial farmers include Afrikaans (89%) and Northern-Sotho (11%) speakers, who engage in a wide range of farming activities based on crop, cattle and game farming. The majority of commercial farmers (97%) are managers of commercial farming operations, whilst 100% of rural villagers are unemployed and 65% are supported by government pensions. Rural villagers support on average five dependents per household (range 1-11) and commercial farmers support four individuals per household (range: 1-7). The age range of rural villagers varies between 28 and 93 years with a mean age of 67 years, this compares with commercial farmers who vary between 29 and 71 years, with a mean age of 49 years. Seventy five percent of rural villagers are male and 25% are female, whilst 94% and 6% of commercial farmers are male and female, respectively, as a consequence of the sampling strategy, which targeted household heads. Sixty five percent of rural villagers have no education, whilst 20% and 15% are educated to primary and secondary

school level, respectively. In contrast, 5% of commercial farmers are educated to primary school education, 45% to secondary school level and 50% to tertiary (university) level.

4.4 Contribution of traumatic nature to the governance of protected areas

4.4.1 Establishment of protected areas in the Blouberg

The present-day nature reserves include the pre-colonial range of the Bahananwa, which was previously used for human settlement, livestock grazing, hunting and gathering (Makhura, 1993). The colonising process, the 1884 Bahananwa-Boer War and apartheid policies led to the displacement of the Bahananwa into designated trust villages forming part of the Lebowa Bantustan. Afrikaner farmers used the land for cattle and game farming during the 1930s. The BNR was established in 1965 by a coalition of private landowners to assist the recovery of game populations from over-hunting and to seek alternative livelihood strategies resulting from the presence of the plant, poisoned leaf (*Dichapetalum cymosum*), which rendered the area unsuitable for livestock farming. The reserve was later de-proclaimed due to poor administrative planning and in 1972 the farms were purchased by the apartheid government for incorporation into the Lebowa Bantustan. The actions of the apartheid government were met with disdain. The following quote by a previous landowner aptly represents the attitudes of a wide range of private landowners:

“After they disowned us in 1972, my father wouldn’t sell the farm so they just forced us. They wanted to translocate some of the black people here. We had a big problem then they called my father a communist, he agreed with the people that they must remain South African citizens. They only put out 15 rand per hectare. The market price was 400 rand per hectare. They just disowned us, we got a letter that all of us didn’t want to sell the land to the government but they didn’t listen to us.”

Eight thousand hectares of land were left fallow for a decade, under the management of the South African Development Trust and used as recreational hunting grounds for government officials (van Wyk, 2002). The land was held in trust to develop the required infrastructure for later incorporation into the Lebowa Bantustan, however, this never materialised and the land was proclaimed as the provincial BNR in 1983 (Limpopo Provincial Government, 2004). In

1993, the boundaries of the reserve were extended to increase the size of the reserve from 9348 to 9630 hectares (NCC-Group, 2012a). Local people from the southern part of the Indermark village, describe how government representatives approached the elders of the village to negotiate the acquisition of land. Governmental representatives informed villagers they would receive compensation, acquiring an area of land for agriculture and additional benefits emanating from the reserve's presence. A woman from Indermark explains: "The land was situated far from the village…too far to travel to our cattle and had poor water facilities, compared to the land we previously had. Before it was fertile and lush, there was a river." Another woman states: "After the guy did the fence, we went there to claim those things, they promised us, but they didn't give us. They didn't want people to come in the reserve. After the fence was up we never saw them again." One woman states: "The leaders made their decisions on their own without the community we just heard this news like a rumour."

The MNR was traditionally used for communal grazing and agricultural land for four trust villages: My Darling, Burchrecht, Setloking and Ga-Kgatla. The MNR was established in 1981 by the Lebowa Bantustan Government under the Minister of Agriculture and Environment of Lebowa. Interviews with members of the Bahananwa Tribal Authority reveal that the Chief agreed to the establishment of the reserve in consultation with three headmen from the villages: My Darling, Burchrecht and Setloking. However, the headman of Ga-Kgatla describes how his village was excluded from the decision making process to establish the reserve: "When they established this nature reserve they never sat down with the people around and asked to establish a nature reserve, they just see something happening. People came from nowhere and started fencing."

The status of the people of Ga-Kgatla as a minority clan to the Bahananwa excluded them from participating in the tribal affairs of the Bahananwa (Sebola, 2004). Sebola (2004) reported mixed results regarding local villagers' perceptions of their level of consultation regarding the reserve's establishment. Thirty-seven percent of informants agreed and 25% disagreed that sufficient consultation took place. The latter group acknowledged that, whilst the headman informed them of the reserve's establishment, they were not consulted as a village. The headman of Ga-Kgatla complained to the Chief stating government officials had threatened the villagers with heavy fines and arrests, if they intervened with the reserve's establishment. The Chief halted the project, but the fencing of the reserve continued after the Chief's death in 1981:

"They [Lebowa Government] did realise that nobody would voice out after the Chief died….it would take a year or so to get a new Chief. So they just went ahead and started fencing us out the village. They told us they would shoot our cattle, if we didn't comply, that's what happened. They even burnt the Chief's kraal down. You can still see the remains in the nature reserve."

A woman from Ga-Kgatla explains how the establishment of the reserve resulted in villagers being displaced and distributed into outlying trust villages: "Before the nature reserve was established some of the villagers were living here, once they wanted to establish the nature reserve they vacated them, far and wide. Some to neighbouring villages others further away. We couldn't see each other, because of those apartheid laws that stopped us moving around."

During apartheid, landholding was based on a permit-to-occupy system, which did not provide tribal authorities with legally secure official land titles (Ntsebeza, 2004). Most land in rural areas was owned by the state and development trust and managed by government created tribal authorities. The fact that rural communities did not own the rights to the land meant they could easily be exploited (Ntsebeza, 2004). The Lebowa Bantustan government undermined the Bahananwa Tribal Authority by adopting an authoritarian approach to establish the reserve during a time when the Authority was most vulnerable.

4.4.2 Management of protected areas in the Blouberg

The regulation, planning and management of protected areas in the Limpopo Province was managed by the Provincial Government after apartheid in 1994 and then managed by LEDET in 2003 (van Wyk, 2002). The Limpopo Tourism Agency is responsible for the management of tourism activities and nature reserves in Limpopo. In 2010, the Limpopo Tourism Agency outsourced the development and management of tourism facilities in the BNR to a private company named Kune Moya. In 1997 the Manoko community, descendants of the Bahananwa submitted a land claim over a section of the BNR in terms of Section 10 of the Restitution of Land Rights Act (Act no. 22 of 1994) (NCC-Group, 2012a). The Manoko community claim that the reserve includes part of their pre-colonial settlement on the eastern fringes of the Blouberg Mountain, prior to their displacement during the colonial and apartheid era. The land claim to date is not finalised, but the Manoko community have entered into an informal partnership with Kune Moya to benefit from tourism activities. Kune Moya's primary focus is

to provide support and development services to the beneficiaries of land restitution. A Kune Moya representative explains their role:

"We feel that communities should be empowered and trained in the sustainable ownership and management of their land. We help to facilitate this. At the same time we don't want to see conservation areas overrun by cattle so we facilitate the handover of land to the community, we identify the business market, and how the people can benefit, and train them up accordingly."

Kune Moya has employed members of the Manoko community to upgrade tourism facilities and will enter into a formal partnership with the land claimants on finalisation of the land claim. The revenue generated from tourism will be shared: 40% Kune Moya, 40% claimants and 20% Limpopo Tourism Agency, with an aim of handing over 100% of the business in 5-7 years to the land claimants.

The Manoko community will also enter into a contractual park agreement with LEDET if the claim is successful. Contractual parks emerged as a way of sharing conservation responsibilities and benefits between conservation agencies and rural landowners. They became popular during the 1990s as a way of resolving land claims in protected areas (Fabricius et al., 2004). Contractual parks give claimants communal land rights to protected areas on the condition they do not reside in reserves and retain the conservation status of the area (Paterson, 2009). The land is held in a communal trust and leased back to LEDET in exchange for remuneration (Paterson, 2009). Contractual parks give legal authority and co-management agreements to local communities and constitute a participatory form of natural resource management (Fabricius et al., 2004). The process allows communities to benefit from natural resources within the park and for conservation agencies to expand their protected areas network (Fabricius et al., 2004). Contractual parks can never be wholly community based, because the nature of the co-management agreement means the existing management authority will continue to manage protected areas after restitution (Limpopo Provincial Government, 2011).

A co-management agreement was signed in 2007 to hand over the management of the MNR to a state "executing agency" to manage the reserve on behalf of the Bahananwa Tribal Authority for the purposes of "tourism, nature conservation and socio-economic development" (NCC-Groupb, 2012, p. 10). The Limpopo Tourism Agency was appointed as the "executing agency" (NCC-Group, 2012c). Tourism activities are inactive because of the limited capacity of staff availability, so, LEDET are responsible for fulfilling the conservation management function of the reserve. LEDET pays a conservation levy of ZAR 5 per hectare

annually into a community trust account and shares the proceeds of the reserve's activities with the Bahananwa on a 50% basis (NCC-Group, 2012c).

4.4.3 Socio-economic conditions

Stoll-Kleeman (2001) identifies insecure and insufficient funding as a major constraint for protected areas in Germany, because it reduces the ability of protected areas to meet basic statutory obligations and threatens the comprehensive and long-term protection of conservation areas. Similarly, the funding of protected areas in South Africa is politically marginalised because government funding is channelled towards the country's development, education, health and security needs (Paterson, 2009). A financial assessment of Limpopo's nature reserves in 2000 showed that nature reserves were running at an annual loss of ZAR 30 million, functioning without action plans and facilities were in poor condition (Smith, 2002 in Sebola, 2004). Provincial nature reserves in Limpopo share a centralised budget of ZAR 4.2 million per annum amongst 49 reserves. Management decisions and allocation of funds to reserves are exerted through a top-down approach where reserve managers have no or limited access to budgets to effectively manage and develop protected areas.

The BNR has limited housing available for staff and office blocks, workshops, storage facilities, an education centre and water points are all in a state of disrepair. The MNR infrastructure including the outer gates, staff accommodation, a day visitor centre and overnight camping facilities, ablution facilities, reserve fencing, roadways, and water points are all in poor condition. The MNR receives few tourists due to poor accommodation and the isolated nature of the reserve, which is poorly marketed and difficult to access. The lack of Limpopo Tourism Agency staff constrains the ability of the reserve to manage tourism operations effectively. On both reserves ageing staff, understaffing and a lack of employment opportunities for interns and local people in the surrounding villages are a cause of concern.

The Limpopo Tourism Agency embarked on a strategy in 2000 to commercialise 15 of its 53 nature reserves to overcome its financial burden including the BNR through the outsourcing of development and management of tourism facilities to private operators (Sebola, 2004). The MNR was not included in this strategy. Commercialisation potentially enables tourism activities on the reserve to become self-sufficient and less reliant on governmental funding improving socio-economic opportunities for neighbouring communities. Kune Moya has invested funds to

upgrade accommodation facilities for tourists, developed wilderness trails, guided nature and birding walks and game drives to bolster the reserve's tourism potential. Kune Moya has employed members of the Manoko community as gate guards, cleaning staff and construction workers, with further plans to train members as nature guides in the future.

4.4.4 Communication Structures

The land claim on the BNR creates tensions between wildlife authorities and Kune Moya because the legitimacy of the Manoko community's rights to access and benefit from the reserve cannot be ascertained until the claim is finalised. LEDET officials and the Manoko community no longer attend meetings together, but, the strategic plan for the reserve includes management actions to maintain discussions with the Manoko community in future (NCC-Group, 2012a). Currently there is no formal communication between wildlife authorities and surrounding villages, which is perceived by both parties as a constraint to their relationship. A woman from Indermark states: "It would be better if someone from the nature reserve came here, to be part of our community to understand the issues we are having, that's what would make it easier on both sides. There would be less confusion, than we would know what is actually going on within the reserves' right now."

Conversely, the majority of commercial farmers perceive communication with protected areas in the Blouberg to be strong because LEDET staff regularly attend meetings at the Bro Brak Farmers Association to keep farmers informed of the reserves' activities. The strategic plan includes actions to establish a reserve management advisory committee to guide the planning, development and management of the reserve. A diverse group of conservation agencies have been identified as potential stakeholders. However, it is not clear whether representatives of local villages and private landowners will be included on the committee. Top-down approaches exerted by state conservation agencies fail to include the ideals and voices of local people, leading to anger, resentment and feelings of alienation and misunderstanding. Several villagers express concerns that decisions regarding the management of reserves are made by distant government actors that have a poor understanding of local problems. A man from Indermark explains:

"When we speak to these people they then speak to the department in town. A man in an office has no idea what we need, rather the people living and working closely here. The

government and these people [in the reserves] all have a different story; they are not on the same page. That's what makes us angry, they just ignore us…we need to be able to speak to them regularly when we have problems…I am talking about all the issues we have with the reserves. They can't just exclude us, what they manage has an impact on us. We should be able to share that with them"

The MNR co-management committee was established as part of the reserve's co-management agreement in 2007 to represent the interests of a wide range of stakeholders. The Blouberg Tourism Association was established in 1999 to manage community based tourism initiatives on behalf of the Bahananwa Tribal Authority to ensure accountability on how the royalties generated from the MNR were distributed. Village trusts were also initiated to recruit representatives from four villages surrounding the MNR to promote the views of the local people and provide feedback to villagers. The funds generated from the reserve were filtered into a central account managed by the Blouberg Tourism Association, 50% of which was shared by LEDET (Fig. 4.2). Village trusts and the headmen of villages submitted requests on how the revenue was to be used for each village (Fig. 4.2). This form of decentralisation has positive implications for allowing information-sharing between stakeholders, coordinating conservation and development objectives and providing a democratic structure to facilitate communal decision making processes (Child, 2004).

However, numerous constraints have negatively influenced the success of this approach. A villager from Setloking revealed that there was a high turnover of representatives from village trusts due to accusations of poaching. Sebola (2004) argues that representatives also performed roles as "honorary rangers," in which they were used to identify poachers in surrounding villages and were appointed by LEDET officials rather than the villagers themselves. In 2010 conflict within the Bahananwa caused tension and division due to the inauguration of a new Chief and the appointment of new staff within the Blouberg Tribal Authority. Government officials working for the Blouberg Tourism Association and local representatives of the village trusts no longer attend meetings with LEDET. These meetings appear to have been out of operation for several years.

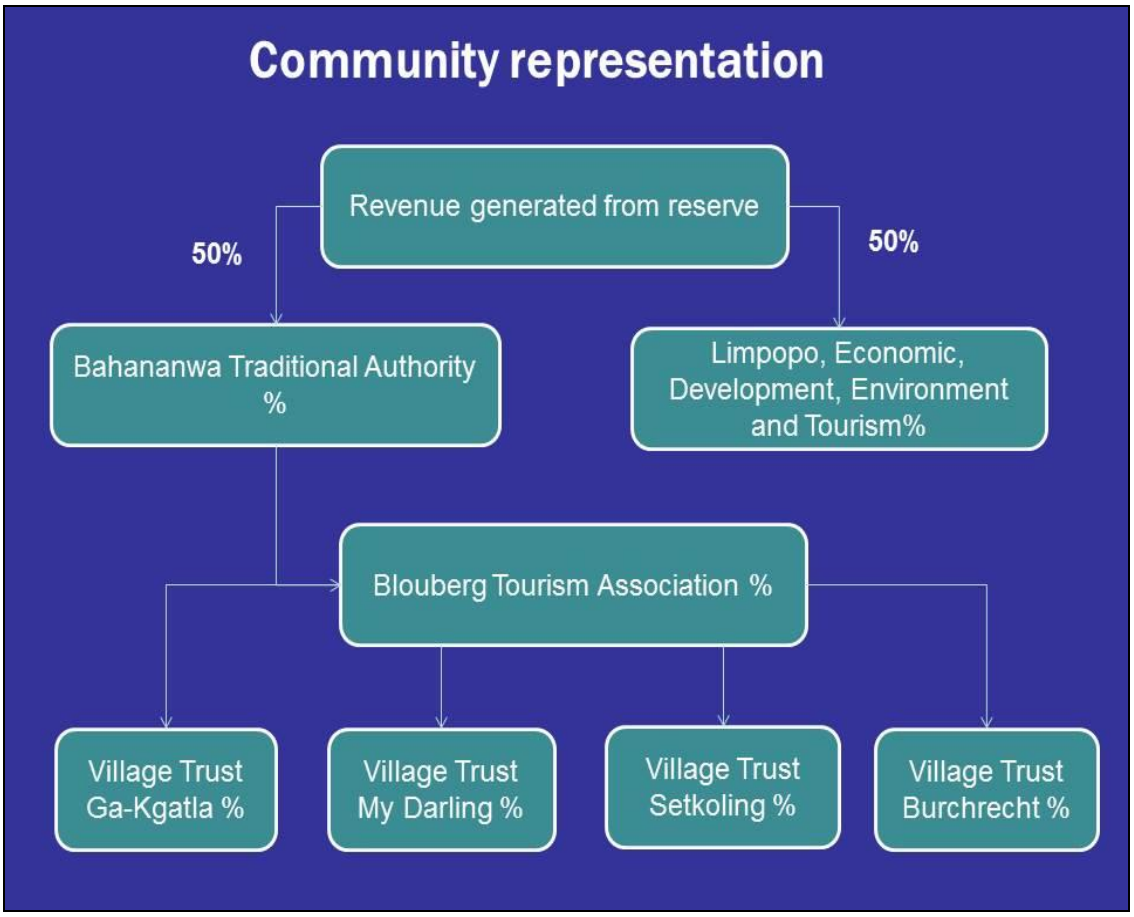


Figure 4.2: Flow chart showing how the the distribution of revenue generated from Maleboch Nature Reserve.

4.4.5 Who are the beneficiaries of the reserves?

The BNR was declared on state land for the purposes of fauna and flora conservation, therefore, any revenue generated from the reserve was directed to the government (Sebola, 2004). In post-apartheid South Africa, conservation ideology has evolved to become human-centred, this is reflected in the BNR's management plan to: "manage the Blouberg Nature Reserve through sustainable utilisation on a viable basis and to manage the biological diversity of the sourish mixed, arid sweet bushveld and mixed bushveld to the benefit of the community" (Limpopo Provincial Government, 2004, p. 21). The term "community" in the above statement is problematic because its definition is broad and includes neighbours, general public and the "scale of influence," as articulated in the management plan. The management plan doesn't state which neighbouring communities it will benefit, these may include commercial landowners, rural villages and land claimants. The general public is

inclusive of neighbouring farming communities and tourists and no definition is given for the scale of influence. The lack of clear definitions applied to the term "community" and absence of comprehensive action plans creates ambiguity and inadequate provisioning of benefits, driving hostile perceptions of rural villagers of the reserve.

Annual game counts ensure that sustainable quotas of animals are managed through game capture, culling and trophy hunting and generate an income for the reserves. Culled game animals are sold to neighbouring villages at a reduced tariff of ZAR 6 per kg from both reserves. The irregularity of culled meat provisioning to neighbouring villages creates distrust, because people are poorly informed about the reserves' management issues. Firewood and fodder were previously sold to neighbouring communities at a reduced tariff of ZAR 80 per bundle, but, this benefit was later withdrawn, as the rate of firewood and fodder use was deemed unsustainable for the area. Local villagers are unaware of this and expect to access firewood from the reserves. A woman from Indermark complains: "We are not receiving anything. It's been a long time since we received meat. We don't know when this will come because we don't talk [with the reserves]. We don't even get firewood these days."

In 2009, LEDET granted hunting concessions to the Manoko community, allowing them to benefit from trophy hunting and culled meat. Hunting rights were withdrawn in 2010 causing distrust towards the wildlife authorities. An elderly man from the Manoko community states: "We were given rights to the animals, then they were taken away, we don't trust these authorities, anymore, they just lie to us." The irregularity of culled meat, firewood and fodder provisioning, stems from a lack of communication between wildlife authorities and neighbouring villages. The premature actions of LEDET to devolve benefits from hunting and culling operations to the Manoko community before the settlement of the claim creates distrust due to the expectations of the Manoko community concerning their entitlements to reserve resources. LEDET inherited the management system of the MNR from the former Lebowa Bantustan, which did not benefit the rural communities, but instead consisted of a backlog of outstanding debts owed to the Blouberg Traditional Authority (Sebola, 2004). The current system of royalty sharing is modelled on the former Lebowa system, where 50% of the revenue generated from the reserve is designated to the Blouberg Tribal Authority. Overall there appears to be much controversy surrounding the devolution of funds to local villages. A farmer from Setloking recalls that, in 2007, the revenue was used to purchase computers and equipment for a school. Another communal farmer comments that the revenue had "been used to buy the chief a car, what about the people?" A woman from another village suggests that the revenue went "directly to the headman of the village, he was once given ZAR 500 we

didn't see any of that money." The majority of local fail to identify any benefits from the reserve when questioned; typical responses include: "No, it helps us with nothing" and "we are not benefiting, we are not benefiting at all." The lack of benefits tempts people towards negative assessments of conservation practices and militates against compliance with park regulations. Conversely, private landowners interact frequently with the BNR and enjoyed visiting the reserve for camping game drives at the weekends. Numerous commercial farmers also cited the importance of the reserve as a platform for environmental education. A commercial farmer states: "The Blouberg Nature Reserve is a beautiful place, we have often gone camping there during the holidays to view the game and have a braai. In the past, our children also went to the reserve to learn about the wild animals and conservation."

The Lebowa Environmental Awareness Programme was developed in 1993 as an outreach project to engage surrounding villages and private landowners on environmental issues, but ended in 2004 due to financial constraints (van Wyk, 2002). A reward system derived from the former education campaign is still in operation as an incentive to reduce the killing of Cape vultures in Indermark and Dunzicht and on private farms. Villagers receive cash awards totalling ZAR 120 and are awarded a certificate for returning injured vultures back to the reserve. A lack of educational outreach opportunities in both of the reserves was cited by wildlife authorities, villagers and private landowners as a major issue that needed improving. The strategic plan for the BNR includes management actions to assess the cost-effectiveness of developing an environmental education centre and establishing links with educational institutions to promote the reserve as an educational resource (NCC-Group, 2012a).

4.5 Community perceptions of protected areas and conservation

4.5.1 Perceived costs of protected areas

The social impacts of protected area establishment are widely acknowledged by a range of authors (Stoll-Kleemann et al., 2006, West et al., 2006, Igoe and Brockington, 2007, Coad et al., 2008). Displacement is used in this chapter to refer to the physical or involuntary removal of local people from their historical or existing home areas, as a result of action by government or other organisational actors. The terms "exclusion" or "loss of access" refer to the restriction of access to resources that may occur even without physical removal from an area. The Fifth

World Parks Congress conducted in Durban, South Africa, 2003 highlights the impacts of protected area establishment on local people, through an individual's closing statement:

"The declaration of protected areas on indigenous territories without our consent and engagement has resulted in our dispossession and resettlement, the violation of our rights, the displacement of our peoples, the loss of our sacred sites and slow but continuous loss of our cultures as well as impoverishment. It is difficult to talk about the benefits for indigenous people when protected areas are being declared on our territories unilaterally. First we were dispossessed in the name of kings and emperors, later in the name of state development and now in the name of conservation" (MacKay and Caruso, 2004, p. 14).

Rural villagers associate the nature reserves with restricted access to land for agriculture and grazing livestock, collecting firewood and gathering medicinal plants and wild fruits. The majority of rural inhabitants depend on agriculture and livestock for subsistence, therefore, so protected areas are perceived as having negative impacts on livelihoods. A woman from Setloking explains: "This nature reserve affects me badly, because my livestock should be grazing here. I have to go up the mountain to graze, because I don't have enough grass here. It affects me badly. When there is a drought I don't have enough water, the land is too little. It was better before [establishment of nature reserve] when we had access to those things. Now I have less cattle then before, I am worse off." Similarly, the eviction of local people from the Mkomazi Game Reserve in Tanzania resulted in a decline in livestock, inflicting impoverishment and economic hardship due to restricted access to grazing land (Brockington, 2002).

The nature reserves include the former graves of relatives, initiation sites and sacred areas used for prayer, healing and worship. A woman from Ga-Kgatla states: "There are places you can go in the reserve to connect with ancestors, but now you cannot. There are also graves there, but you cannot go to visit them. So they are not having a good relationship with the nature reserve because they are not allowed to go there." A man from Glenferness perceives the exclusion of villagers accessing family graves as a form of cultural decay: "You only find blue beads, those on top of old graves [in the reserve], they [wildlife authorities] destroyed our culture because they do not let us in…how can we teach our youth about these important sites? "

The village of Ga-Kgatla was reduced to a quarter of its size and isolated from neighbouring villages when the MNR was established (Sebola, 2004). A woman from Ga-Kgatla explains how the presence of the MNR disrupts important social networks: "The reserve affects us badly we

cannot visit our relatives so easily, it affects our relationships. People have to travel far. We only have two taxis that pass here per day, but it goes to town, we have to wave down lifts. It can take over three hours of waiting just to see a friend. We don't have the money and time for this; we are very isolated because of that reserve." The village of Ga-Kgatla was according to one individual, "pushed back onto land with no water, when the reserve was established. We are poor because of that, you can see, I'm sure, we are the poorest village in Blouberg." The village has 158 households with no access to underground water other than that which is pumped daily by a generator in a village 5km away (Republic of South Africa, 2011). The Integrated Development Plan for the Blouberg (2007-2008) states that Ga-Kgatla is a "fourth order village" with no or limited growth potential (Blouberg Local Municipality, 2007-2008, p. 30). Similarly, the land procured from the village Indermark to extend the BNR resulted in the loss of access to an important wetland and river. Both villages are impoverished a state, which is blamed on the reserves' establishment A woman from Ga-Kgatla comments: "Since this reserve took our land, it made us to be poorer, it made thing worse we have lost so much land, water, grass and cattle because of it."

Several individuals perceive the presence of the MNR as a causal factor for environmental degradation. An elderly man from Setloking states: "Because we don't have room for our cattle any more due to the reserve, people are competing for space, that's why we have little grass around the villages, there isn't enough space. We all got packed together. Before we had more land, before, it was full of grass, beautiful." The Integrated Development Plan (2013-2016) for the Blouberg identifies specific villages neighbouring the reserves as areas that require improved environmental awareness and protection due to deforestation, over-grazing and erosion (Blouberg Local Municipality, 2013-2016). The limited growth potential of Ga-Kgatla is perceived to be the cause of rural migration, as one woman states: "There's no place for the up and coming generation to build their houses, schools, and shops here. We have nothing and it took their space that's why this village doesn't increase it's always the same size. Young people are moving from here to far places to stay; to get away from the poverty." Resource drivers such as increased population growth and livestock numbers in rural areas may accentuate frustrations towards the perceived environmental degradation and migration of villagers from rural areas. For example, negative perceptions of protected areas near Hwange National Park, Zimbabwe were related to concerns of livestock losses due to wild animals, restrictions on access to natural resources within the park and concerns of overpopulation close to protected area borders (Guerbois et al., 2013). These factors may reflect a perceived lack of sustainability of their way of life, resulting from increased

competition with wildlife and other people for space and natural resources (Guerbois et al., 2013). The most recent statistics on the population growth of the Blouberg Municipality from 2001-2011 actually reflected a population decline (-0.5%) probably resulting from outward migration, death rates being higher than births due to the impact of HIV and AIDS and a lower fertility rate (Capricorn District Municipality, 2013-2014). However, the impact of these factors could not be accurately assessed due to a lack of reliable quantitative data on resource conditions in local villages. The migration of people from rural areas is commonplace in the Blouberg due to the lack of access to government facilities, employment opportunities and basic infrastructure (Blouberg Local Municipality, 2013-2016). The migrant labour systems have encouraged men and the youth to seek work in the cities leaving behind women and the elderly to head the households, creating social disruption for households (Blouberg Local Municipality, 2013-2016).

4.5.2 Human-wildlife conflict: A shared cost for rural villagers and private landowners

Human-wildlife conflict represents challenges for protected areas due to the close spatial proximity between people and wildlife and the perceived costs of living alongside wildlife (Knight, 2000, Naughton-Treves and Treves, 2005, Treves et al., 2009). In the Blouberg, predators, particularly leopards, are actively scapegoated to express people's frustrations with the establishment of protected areas and their relationships with wildlife authorities. A man from Ga-Kgatla states:

"The nature reserve provides a sanctuary for predators…they are having lots of predators in the nature reserve and those predators come out to attack our livestock, that's why we believe that all predators are coming from the nature reserve. They come to destroy our livestock, we hate them. It makes us angry because if our animals [livestock] go into the nature reserve they get shot, how is this fair? We suffer because of those animals being protected, they care more about their own animals and do nothing to help."

The establishment of game reserves and protected areas introduced new concepts of nature and culture as they became "the means by which many people see, understand, experience, and use the parts of the world that are often called nature and the environment" (West et al., 2006, p. 255). Protected areas serve as models for the separation of nature and human

societies heralded through the development of a preservation ideology that excludes people from the natural realm. The notion of separation from nature is exemplified by an elderly woman from Setloking as a causal factor underlying human-wildlife conflict in her area:

"Long before when we lived here, we were living alongside wild animals, they were like family, you could see a leopard walking in the bush but not attacking the cattle, they were more like friends. After the reserve was established, the conflict happened, the domestic and wild animals were separated so when they came together it was like war and they no longer knew each other."

A narrative emerges that draws on an idealised past, depicted as a time when people, domestic and wild animals lived in harmony before the reserve. Predation on domestic animals is likened to an act of war whereby the source of conflict is traced to the creation of the reserve that disrupts the harmonious relationships between the domesticated and wild. Another communal farmer comments: "It would be a joke to think domestic and wild animals could live together. The wild animals live in the reserve, they belong to the reserve. If they [leopards] cross over into our land I don't like it, that's our place and they aren't meant to be in it." Leopards transgress marked spatial boundaries by moving from the reserves (where they belong) into private/communal land (where they do not belong). The farmer excludes the leopard from the human realm, reminiscent of the rationale behind the fortress conservation approach that excludes human beings from the natural realm. Leopards are frequently cited as belonging "to the reserves" and understood to be the "government's animals."

Conflicts involving leopards are informed by wider conflicts occurring between local people and wildlife authorities. It is commonplace for farming communities to blame protected areas for leopard depredations on livestock, because of the perceived inability of wildlife authorities to assist. The headman of a village neighbouring the BNR states: "These animals they want them chucked out maybe to another reserve not here by our village, there's no way we can live together, considering all the problems we have with them, that's why we dislike the reserves, they do nothing to help." The same individual continues: "We would like to call them and sit down with them, but they refuse, our communication is very slow as a leader of the village they don't come and the promises they make never come true. If a wild animal gets caught in a trap we don't know who to speak with, or if it takes our cattle and goats, it's their animals, what about our own? We need help with this."

A generalised antipathy towards leopard conservation is rooted in wider issues related to the indifference of conservationists and the wider society to the damage suffered by farmers. A

private landowner states: “I don’t really support leopard conservation. Everyone else, like the conservation people and the city animal lovers, don’t see what we have to live with as farmers. They don’t care that we have mouths to feed. They care about the animal more and that doesn’t make people like me friendly towards conservation.” Similar conflicts have been documented amongst Saami herders in Sweden where predation on reindeer by wolves is indicative of their own marginality within contemporary Sweden: “Lapps and reindeer don’t count in your Swedish society. When wolves rip off the flesh of our reindeer, the friends of animals and the bureaucrats say nothing” (Knight, 2000, p. 23).

Leopards feature in narratives by commercial farmers as having “no respect for fences,” or “giving a damn about the fact he was on my farm” accompanied by the speakers’ recollections of their interactions with government agencies: “those people don’t respect us,” “they don’t listen” and “they don’t care.” For a communal farmer, leopards straying beyond reserve boundaries is like “trespassing…they take what they want, then leave.” The same farmer then recalled, “they told us that we would benefit from the reserves, they lied and took our land, just took it from us.” The oscillation of narratives in which different actors, animals and landscapes feature produces a set of highly polarised discourses that are expressed when people depict controversy. Similar relationships are identified in the Danube Delta, Romania where inhabitants draw parallels between those “damn cormorants” that are actively scapegoated as competitors by fisherman and those “damn ecologists” who are responsible for the birds’ protection (Van Assche et al, 2012., p. 176). Campbell (2000) suggests that the symbolic meanings of wild animals in folklore “play with the interpretative reversals between animals and human worlds” (ibid, p. 139-140). Rural villagers and private landowners interpret their interactions with leopards predating on livestock as mirroring their relationships with wildlife authorities that prevent access to land and important cultural and natural resources and fail to listen to local people’s frustrations.

4.5.3 Local people’s perceptions of conservation

Many rural villagers are unaware of the role of the reserves, whilst others claim: “The reserve is for nothing, it does nothing.” Others draw on scientific arguments to justify the reserves presence. A woman from Indermark states: “to save the animals that would go extinct” and a man from Ga-Kgatla to “secure animals, species and habitats, for future generations.” A

private landowner identifies the importance of the area for species diversity: “The reserves are here because this area was thought to be rich in plant species, we have many animals and habitats unique to the area.” Similarly, in Romania, older generations share a discourse about nature in the Danube Delta, where it is conceived as a “collection of species,” a meaning derived from engagement with both close and distant contact with “ecologists.” This view of nature is experienced by inhabitants of the delta as diminishing “the home in which they were born and bred to a mere background for over-valued plants and animals” (Van Assche et al., 2012, p. 173). In the Blouberg the concept of a nature reserve is embedded within historical memoirs of land dispossession at the hands of untrustworthy government officials that “lie” and fail to keep their promises. A woman from Indermark explains that the reserve was established:

“To keep the wild animals, so that our youth must know those animals and they must study them …we don’t want to lose them forever we want to keep them. But they [government officials] also said to our elders, ‘your people will come and join us to study the animals because people were killing them. We thought this was good…so the unborn people they must know the kudu, the leopard. Then we realised that all that talking was a strategy for them to take our land, knowing they would made promises to us to persuade us, without living up to it.”

A private landowner describes the function of the BNR, than draws on his perceived expropriation from the land during apartheid: “The nature reserve is here to protect wildlife and the mountain. That’s what we wanted in the beginning, to protect the nature of the area. The apartheid government stole this land from us. We received no money for it. Those government people just hunted on the reserve and killed off all the animals, they didn’t want it to be a reserve in the beginning.” In my field site a woman compares before and after the BNR was established in 1983 to portray a change in the aesthetics of the landscape: “Long before this place became a nature reserve they were practicing their culture, this place was beautiful, before they took the animals that’s when things got out of control, when the people came here to lie to them, now it doesn’t feel so beautiful.” The woman refers to an idealised past, before the reserve’s establishment where a change in the beauty of the physical landscape is tied to the lies of untrustworthy wildlife officials. The physical landscape symbolises a moral landscape, blighted by a lack of trust that is subsequently deemed, no longer beautiful.

Van Assche et al. (2012) attribute ambiguous and polarised conceptualisations of nature as being characterised by abrupt changes in discourse. Similarly, when informants in the Blouberg

are questioned about the role of nature reserves they respond using scientific explanations borrowed from conservationist rhetoric. Informants then abruptly change their narratives and discourses to revert to descriptions of their historical and contemporary interactions with governmental actors that impose restrictions on land and natural resources. In other contexts, the role of nature reserves is acknowledged, but then represented as a contradiction to warn conservationists of what could become if local people continue to be excluded from nature reserves. A woman from Ga-Kgatla states: "It is important to protect those animals so the next generation can see those animals live, but first the reserve must fix the relationship with the people, that are more important otherwise no one is going to want to protect animals." Similarly a private landowner describes: "Sure it's good to protect, but remember if it means getting nothing from it or being worse off because of it, no one will care, then you're going to have a whole lot of issues with poaching." The impacts of the displacement to make way for protected areas are far reaching. A LEDET member involved in publicising the Vhembe Biosphere Reserve states: "The first thing people ask [rural villages], will we be moved, where will the fence go? In a biosphere obviously there aren't any fences, but it just shows you how people's experiences of reserves are just that." The same LEDET official also comments: "I sent out letters to commercial farmers in the Blouberg inviting them to our talk. We had such a problem with all of them though, they didn't want to talk to us, thinking we would impose all sort of restrictions on using their land. One man even thought we wanted to buy a portion of land off him, to make up the reserve."

4.5.4 Poaching: A form of social conflict

Illegal poaching of wildlife by rural communities in protected areas and private farms is a contentious issue generating conflict between wildlife authorities, private landowners and rural villagers. The majority of village informants state that the main form of interaction with wildlife authorities is during a poaching event. A villager from Ga-Kgatla explains:

"There is no interaction between these people working there and us, no relationship at all. Although these days they are patrolling a lot, day and night, when you hear the motorbike coming, you know they are coming for somebody in the village. Once they find something killed they come straight to this village. These people, the authorities of the nature reserve, they are always suspecting these people of this village, because we are close to the nature

reserve. We resent that, because people come far away to poach as well. They are harsh and aggressive, when they speak to you, even if you are walking by the fence, on your own land, looking after your livestock, then you could be arrested."

The headmen of two villages in the Blouberg express dissatisfaction with the lack of consultation regarding poaching incidents reported inside protected areas. Both headmen ask that wildlife authorities approach them directly to resolve poaching incidents so that individuals can be made accountable and fined by the Blouberg Tribal Authority. Accusations of poaching have instilled suspicion amongst rural villagers and private landowners towards outsiders. Often private landowners were not comfortable with me bringing my assistant to help me set up camera traps on private land. Conversely, I was also viewed with suspicion by rural villagers, who believed I was working for the wildlife authorities or the police to find and locate poachers.

4.5.5 Stereotyping

Stoll-Kleeman (2001) applied theories from social psychology to explain the widespread opposition to conservation strategies in Germany. Stoll-Kleeman (2001) assesses how group membership affects a person's attitudes and behaviours towards protected areas through application of the social identity theory. Social identity theory states that "social categorisation results in social discrimination, because people make social comparisons between in-groups and out-groups," resulting in the "rejection of the out-group" (Stoll-Kleeman, 2001, p. 379). Social identity theory states that people need to provide themselves with a positive identity (Turner, 1982). For example, in the Blouberg, wildlife authorities emphasise their roles as brave defenders of wildlife, justified by moral and political reasons. A LEDET member states: "We have a big role to play for conservation, saving species, the habitat, everything as a collective, these days we have to fight politics as well that threaten the earth, for it doesn't have a voice. Take the coal mining for instance; we are all taking a stand against that! It's all a battle in the end and trying to get people on your side. Once they realise that we need to protect what we have, right here, right now, then we know we have done a good job."

Stoll-Kleeman (2001) emphasises that favouring the in-group over the out-group can result in the attribution of the out-group to "negative values and exaggerated stereotypes" (ibid, p. 379). Rural villagers represent themselves as victims of unfair poaching accusations from

malicious authority figures while wildlife authorities represent themselves as "saving wildlife" but relegate villagers as environmentally destructive and their illegal poaching activities as "barbaric, unlawful and cruel." Each group responds to the imposition of these stereotypes defensively. A private landowner states, "Communities pull out the 'I'm poor' card all the time. They say they have no other option but to hunt in order to survive; which we all know is a load of rubbish." A villager iterates how the village as a whole is relegated as the causal factor of poaching incidents: "They think that all we want to do, we as a village, is to kill animals and that all we want to do is eat them." The origin of these stereotypes is rooted in colonial history where Africans adapted to newly imposed rhetoric around poaching that defined the category and role of being a poacher through the imposition of game reserves and laws prohibiting traditional hunting techniques (Chapter 2). The persistence of these archaic stereotypes is difficult to overcome due to long-lasting social tensions and conflicts that have existed between these groups throughout South African history.

4.5.6 Resistance towards protected areas

Protected areas are targets for protest due to the dissatisfaction of rural villagers because nature reserves serve as "strong symbols of the state and state ideology of land use" (Holmes, 2007, p. 190). Wildlife authorities are subject to verbal threats and protected areas are targets for physical protests, which materialise in differential forms. Holmes (2007) distinguishes between explicit resistance as an act of protest motivated by a political nature (e.g. killing animals but leaving their bodies to rot) and implicit resistance where the politics is implicit in the protest act, but allows the individual or group to benefit through material gain (e.g. killing animals but obtaining benefits from the acts such as meats or skins). Many villagers spoke of setting the nature reserves on fire to express resistance to the reserves' presence. A rural villager states: "We want to show them that we don't want this reserve here anymore, and it does nothing for us. It makes us angry." Fire is a popular form of explicit resistance; for it evokes strong symbolism and is associated with traditional livelihood strategies and represents an anonymous form of protest (Holmes, 2007). Local people in Mexico responded to protection measures enforced by the Calakmul biosphere reserve by threatening conservationists and setting the forests on fire as a strategy to lessen the value of forests and state control (Haenn, 2005).

Land claimants threatened to cut down the fences of the BNR and drive their cattle onto the land. These actions stem from frustrations over the time taken to settle the land claim by the provincial government. A land claimant states: “We are tired of waiting, we want them to take us seriously, we want this claim finalised.” Former landowners from the Afrikaner community have responded to the Manoko land claim by submitting a counterclaim on the reserve a form of “explicit resistance”. The land restitution process was administered by the South African government to respond to the injustices of land dispossession in the past resulting in a reassertion of African rights and entitlements as heralded in the following land claimant’s statement: “Access to land is a fundamental right, we are meant to be here.” A commercial farmer states: “We have the same claim by the same apartheid government… so we have the same rights, whatever rights they had.” In the last example, the commercial farmer draws on his own perceived expropriation from the land during apartheid to also assert his own rights to land ownership and access.

The motivations of the Afrikaner community to submit a counterclaim are tied to fears that the land in the nature reserve will become degraded due to the presence of the land claimants and a lack of governmental support during the land restitution process: “My concern for the land is that they put people on it without any knowledge or skills, everything then gets hunted to extinction, because people get frustrated that nothing is happening, that’s because the government doesn’t have the capacity to assist.” Another commercial farmer reflects on his own experience with the land restitution process: “I had a farm which was claimed. I had worked on the land for 10 years, only four years later everything has been destroyed, the infrastructure, it looks derelict nothing is happening there.” Protected areas represent contested space enclosing important natural and cultural resources, which different groups seek to access or protect.

4.6 Conclusion

4.6.1 Marginalisation

Rural villagers' and private landowners' understanding of nature reserves and conservation in the Blouberg are strongly influenced by historical and contemporary experiences with governmental regimes due to conflicts surrounding land and resource use that promote legacies of disempowerment, marginalisation and stigmatisation; a traumatic nature (Fig. 4.3). Rural villagers in the Blouberg have been marginalised throughout the colonising process and apartheid era, as rights over land and natural resources were gradually eroded. The establishment of protected areas resulted in the further marginalisation of rural villagers. The Lebowa government adopted an authoritarian approach to the establishment of the MNR, which occurred during a time when the Bahananwa were most vulnerable. The Bahananwa Tribal Authority and the elders of Indermark village, failed to consult all headman and villagers about the establishment of both reserves. Rural villagers in both cases were poorly compensated for the land and excluded from receiving any benefits emanating from the reserves' presence. Similarly, private landowners perceive themselves to have been expropriated and poorly consulted by the apartheid government to procure land for the Lebowa Bantustan.

Nature conservation in South Africa is marginalised politically as a low priority compared to the country's development needs, resulting in the insufficient allocation of governmental funding to protected areas. Limited funding available for protected area management and the limited power of reserve managers to access and secure funds constrain the ability of protected areas to meet basic infrastructural development and employment opportunities and to provide tangible benefits. However, these constraints are being overcome through the commercialisation and outsourcing of tourism activities to private operators, improving tourism facilities and employment opportunities for surrounding rural communities.

The lack of formal communication between wildlife authorities, land claimants and neighbouring villages marginalises local people from participating in protected areas. These issues stem from ambiguity surrounding the legitimacy of the land claim, conflict within the Bahananwa Tribal Authority and a high turnover of village representatives. Top-down governing structures fail to accommodate the needs of local people, because decisions are

governed by distant governmental actors that have a poor understanding of local conditions and rural villagers are not given full capacity to engage in protected area management decisions. Although both reserves include management actions to improve communications with land claimants, neighbouring villages and private landowners by developing co-management committees and a management advisory team, it is not clear whether rural villagers and private landowners will have the power to contribute to management decisions and policies within the reserves.

The lack of clear definitions applied to the term “community” and absence of comprehensive action plans creates ambiguity and inadequate provisioning of benefits, driving hostile perceptions of rural villagers of the reserves. Poorly developed governance systems fail to clarify the agreed terms and conditions between user groups and to implement management objectives and actions plans for devolving benefits to local people. Corruption within the Bahananwa Tribal Authority, intra-tribal conflict and the breakdown in communication between rural villagers, the tribal authority and LEDET contribute to the poor distribution of benefits to the four villages surrounding the MNR.

4.6.2 Disempowerment

Rural villagers and private landowners have become disempowered, through the loss of access to land and important natural and cultural resources, eliciting strong emotional responses, because of their associated impacts on general wellbeing. Furthermore, a sense of rupture emerges because the joint impacts of the colonising process, 1884 war and protected area establishment were sudden, relentless and did not permit gradual accommodation. The consequences feature in the psyches of local people up to the present day. Villagers perceive the costs of establishing protected areas to include prohibition to livelihood strategies and sacred sites, impoverishment, disruption of social networks, environmental degradation and rural migration. Private landowners and villagers perceive human-wildlife conflict as a significant cost of local nature reserves. In other contexts, the failure to communicate and allow rural villagers to participate in the management decisions of the reserve, results in further disempowerment due to social and political exclusion.

4.6.3 Stigmatisation

Predators, particularly leopards, feature in discourses relating to villagers' and private landowners' frustrations with the establishment of protected areas and relationships with wildlife authorities. Leopards are perceived as being more highly valued by wildlife authorities' than the needs of local people. It is commonplace for farming communities to blame protected areas for leopard depredations on livestock, because of the perceived inability of wildlife authorities to assist. Leopards predating on livestock are likened to acts of war; metaphorical relations that are extend to the human world to represent conflicts between local people and government officials who "lie," fail to keep their promises, take away land and impose restrictions on natural and cultural resources. In other contexts, rural villagers continue to be stigmatised according to colonial stereotypes exerted by wildlife authorities and private landowners. They regard villagers as the cause of environmental degradation. The persistence of these colonial stereotypes creates barriers between different groups and emphasises the impact of historical and political events into the contemporary era.

4.6.4 The impacts of collective trauma

Traumatic nature is an outcome of local people's historical and contemporary experiences with government regimes concerning conflicts of natural resource use (Fig. 4.2). Collective trauma is manifested through local people's conservation discourses and manifested as social conflict between user groups, resulting from poaching accusations and resistance to protected area establishment. Both rural villagers and private landowners draw on scientific explanations borrowed from conservationists' rhetoric to justify the establishment of protected areas to "prevent extinction" and to "maintain resources for future generations." but are then represented as contradictions of what conservation means to local people; the past trauma of displacement and resource restriction. Discourses pertaining to nature reserves are used as a form of resistance to warn against of what could happen if people are not included in conservation initiatives in the future. This is implied by the continuation of poaching or when people undermine conservation initiatives by withdrawing support for the protection of wild animals. In other contexts, social conflict resulting from accusations of poaching and hostile interactions with wildlife authorities creates further suspicion and distrust amongst all user

groups. Resistance towards protected areas is manifested in different forms, including threats to wildlife authorities and physical acts of protest.

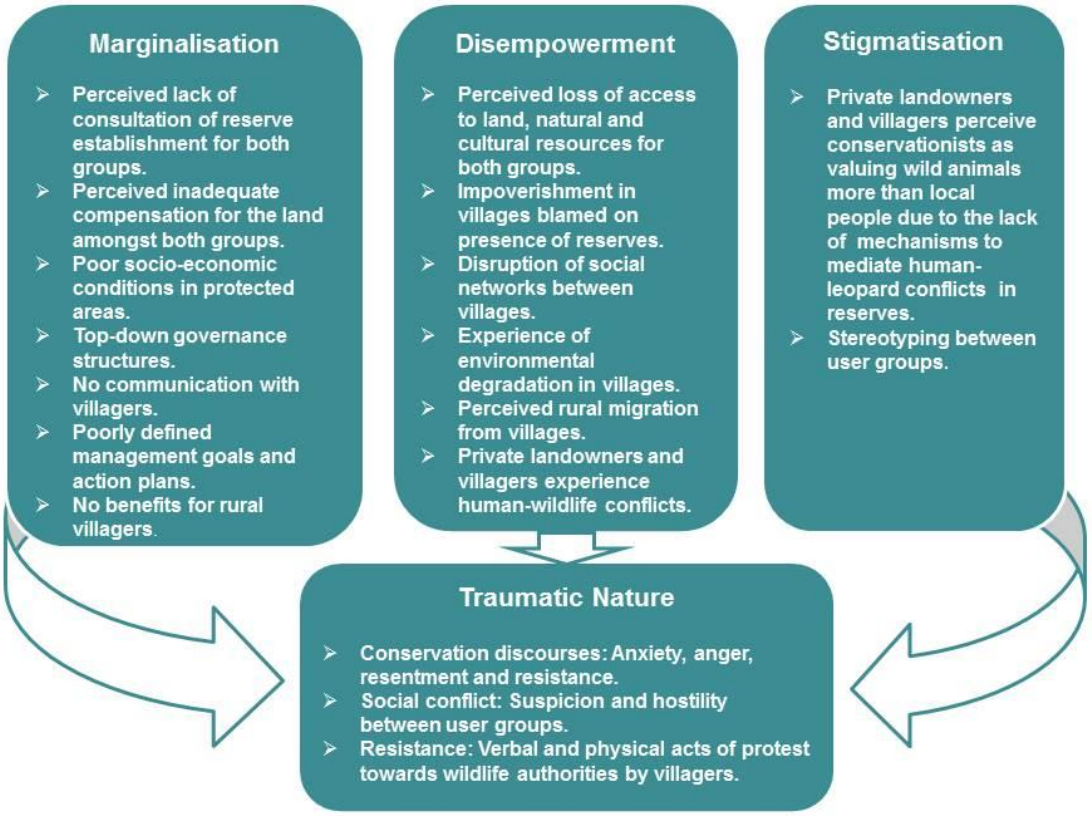


Figure 4.3: Key factors of protected area establishment and governance identified as influential in determining the perceived marginalisation, disempowerment and stigmatisation of local people and their associated impacts. Traumatic nature is defined as the outcome of these collective processes.

Chapter 5

Risk of leopard predation and the impacts of conflict on farming communities

5.1 Introduction

Research on livestock depredation by carnivores has focused on gathering baseline data on the extent and distribution of conflicts, the bio-physical and temporal characteristics of livestock attacks and the impacts of conflict on farming communities (Hill, 2004, Treves et al., 2006). The extent of wildlife damage is exaggerated by local people that fail to accurately identify problem carnivore species, or take into consideration the risk of other mortality factors compared to losses experienced by predation (Linkie et al., 2007a, Dar et al., 2009). Depredation events are linked to the characteristics of livestock such as age, type of livestock, total number owned and herd size (Michalski et al., 2006, Hemson et al., 2009, Thorn et al., 2012). The timing of calving periods, inadequate guarding strategies, poor construction of livestock holdings, relying on children to guard livestock and grazing livestock in high risk areas, also influence the risk of predation (Michalski et al., 2006, Holmern et al., 2007, Woodroffe et al., 2007b, Hemson et al., 2009, Thorn et al., 2012). Researchers have investigated the bio-physical factors driving observed differences between attack sites with and without predation, for example, proximity to deforested agro-pastoral areas (Michalski et al., 2006), distance to dense vegetation such as riparian corridors and forested areas (Stahl et al., 2002, Michalski et al., 2006, Thorn et al., 2012) and proximity to water (Michalski et al., 2006). Depredation by carnivores may also be influenced by anthropogenic factors for example, risk of predation has been shown to decrease with increasing proximity to human habitation, including urban centres (Michalski et al., 2006) and villages (Kolowski and Holekamp, 2006).

Ecological niche models have been adopted as a tool to integrate the effects of bio-physical, anthropogenic and spatial factors into modelling species richness (Nally and Fleishman, 2004, Barve et al., 2011), the invasive potential of exotic species (Goolsby, 2004, Kulhanek et al., 2011, Zengeya et al., 2013) and species distributions (Thuiller et al., 2005, Rodríguez-Soto et al., 2011). The software Maxent is an example of an ecological niche model that to date has mainly been used to determine species distributions (Mateo-Tomás et al., 2012). Recently Maxent has been applied to map landscapes of risk including the risk of illegal poisoning for a

range of species in North-West Spain (Mateo-Tomás et al., 2012) and to spatially predict predation risk of livestock attacks by pumas and jaguars in Mexico (Rosas-Rosas et al., 2010, Zarco-González et al., 2012). The distribution of livestock attacks within a landscape can be documented to produce risk maps, also defined as probability surfaces or predictive spatial models (Treves et al., 2011). Risk maps can be used to identify predation hotspots and to propose mitigation strategies, that limit depredations, such as avoiding grazing livestock in high risk areas (Treves et al., 2011).

People that depend on agriculture, crops, livestock and game animals for subsistence, economic and cultural reasons are at risk because wildlife damage and predation impose significant costs to affected households and farmers. The costs of human-wildlife conflicts can be defined as visible costs manifested as injuries, fatalities, damage to crops, livestock and game, and economic losses, as well as hidden costs, which induce negative social and cultural impacts (Barua et al., 2013). In the Indian Trans-Himalayas the economic costs of livestock depredation result in households losing half their annual per capita income (Mishra, 1997). Livestock may also act as a form of social insurance to finance funerals, bride prices and provide households with additional revenue (Hill, 2004). Quantifying the extent and impacts of livestock loss at the community level provides insights into the severity of the conflict problem for the general population, but, these impacts may not be uniform for individuals or households (Hill, 2004). People dependent on a single livelihood strategy are more antagonistic towards wildlife, because the social and economic impacts of wildlife damage are intensified (Dickman, 2010). Wealth, income diversification and social reciprocity within families and communities may provide adequate coping mechanisms for buffering the impacts of damage-causing animals (Naughton-Treves and Treves, 2005, Treves et al., 2006, Barua et al., 2013, Inskip et al., 2013). Thus, it is important to assess the impacts of livestock losses at extreme levels, because average figures may mask the severity of the problem (Hill, 2004). Livestock loss can also induce hidden costs amongst traditional pastoralist societies, because people attach emotional and cultural significance to livestock. For example, the Massai in East Africa, perceive cattle to facilitate a direct link to God (Dickman, 2009, Barua et al., 2013) and amongst pastoralist societies close to the Ruaha National Park, Tanzania, cattle are given to young men as rewards for killing dangerous animals such as lions (Dickman, 2013). In these instances, lion killing is motivated by a need to either protect or gain cattle (Dickman, 2013).

The visible and hidden costs of conflict are rarely explored by researchers. These insights are fundamental for understanding the key determinants of human-wildlife conflict, because they negatively impact human wellbeing and decrease support for species conservation (Barua et al., 2013). I investigate the: (1) different forms of livestock acquirement, (2) extent of livestock depredation in relation to other forms of livestock use and mortality and the extent of livestock depredation by leopards compared to other carnivore species, (3) livestock husbandry practices employed by farmers to protect livestock, (4) bio-physical factors influencing the risk of leopard predation on livestock and game and (5) visible and hidden impacts of leopard depredation. The results of the study are used to inform mitigation strategies for improving livestock and game husbandry practices in the Blouberg (Chapter 9).

5.2 Methods

5.2.1 Sample selection

The target sample population for topics related to human-leopard conflict were commercial and communal farmers bordering the Blouberg Mountain Range. I define subsistence and emerging commercial livestock farmers, who farm on communal arable land as communal farmers. I adopted a purposive (targeted) sampling strategy and snowball sampling strategy to identify villages where communal farmers were likely to graze their livestock in leopard habitat and informants that had experienced livestock losses to leopards, using the knowledge of local headmen from each village and other respondents (Fig. 5.1). I applied the same sampling strategies using the same criteria to identify respondents from the commercial farming community, using the head of the Bo Brak Farmers Association to act as a gatekeeper to the community and the knowledge of other respondents. I interviewed 23 communal and 19 commercial farmers.

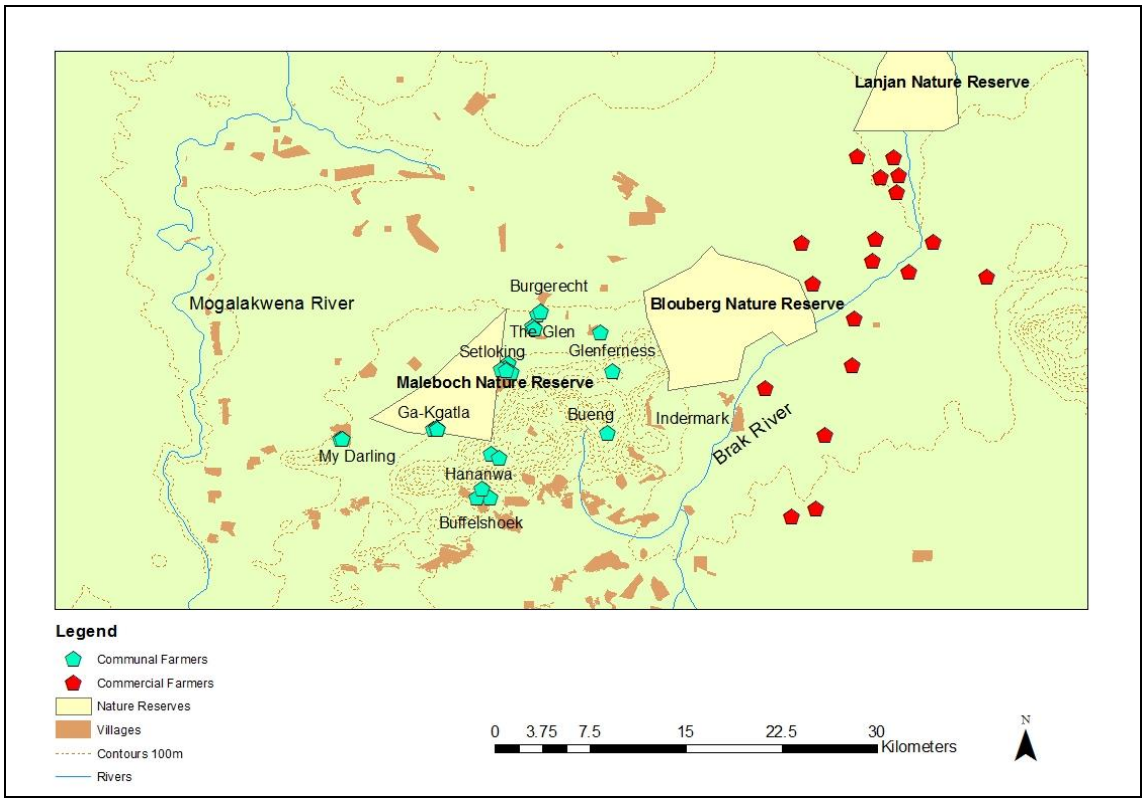


Figure 5.1: Locations of commercial and communal farmers interviewed in the study.

5.2.2 Cultural mapping, semi-structured interviews and participant observation

Cultural mapping as an ethnographic approach and serves as an as important elucidative tool for gaining access to people's historical and contemporary relationships with the local environment, by actively engaging with people in their environment and visiting the places they deem important (Strang, 2010). Strang (2010) uses this method to record and map the traditional story places of the Aboriginal people within the Mitchell River of Queensland, Australia. The mapping process involved physically mapping important cultural sites onto ordinance survey maps and obtaining additional forms of information from photographs and video interviews. Strang (2010) carried out a number of formal and informal interviews and participant observation techniques, the photographs were used for discussing the landscape and their story places. The research process was driven through a collaborative and participatory approach guided by the aspirations of the Aboriginal people to maintain a record of their own story places for future generations. Cultural mapping allows researchers to collect a variety of ethnographic data *in situ*. Places are literally mapped in collaboration with

informants using topographic and ecological information GIS technology, satellite imagery and related technologies. This holistic approach to the collection of data allows people to express information related to culture and history that is embedded within the landscapes.

I employed participatory cultural mapping techniques in this study by taking guided walks with commercial and communal farmers on farms/communal land to simultaneously collect GPS data and conduct semi-structured interviews and participant observation *in situ*. I drew on farmers' knowledge by going out into the environment to map the locations of livestock and game attacks and landscape features on communal land/farms. The cultural mapping technique provides an important interdisciplinary tool in combining both biological and anthropological methodologies to gather rich data in a more relaxed, informal setting than would be obtained from a sedentary interview. I collected detailed contextual information on livestock and game husbandry practices by exploring the farms/communal land with commercial and communal farmers and this process allowed opportunities for informants to discuss and identify topics they deemed important. The flexibility of the research process allowed me to explore research topics prioritised by the informants themselves, for example, The flexibility of the research process allowed me to explore research topics prioritised by the informants themselves and generated new topics for research, for example, during my walks with communal farmers on the Mountain we often passed sacred sites. From these encounters, I was able to collect information on spiritual beliefs and the management of natural resources (discussed in Chapter 7, Section 7.6). The collection of data can be viewed as a collaborative process to integrate and represent the perspectives of local people and the research topics they deem important.

I also conducted 42 (19 commercial and 23 communal farmers) semi-structured interviews from October, 2009-October, 2011. The aim of the semi-structured interviews was to determine: (1) the socio-economics of the farming communities, (2) the extent of livestock depredation by leopards, relative to other livestock gains, losses and depredation incidents caused by other predators, (3) information on livestock husbandry practices and (4) the economic, cultural and social impacts of livestock and game losses. Firstly, socio-economic data was collected from the respondents including their name, age, gender, ethnicity, religion, education level, occupation, land use, number of dependants, name of village/property, main type of income and the size of the property. Secondly, I collected information covering the period from October, 2009-October, 2011 on the number and type of livestock owned, the total number of livestock of each type gained (births, purchased or acquired as gifts), used (sold and slaughtered) and lost (stolen, predation, disease and accidental deaths).

I questioned respondents about the circumstances surrounding each livestock/game attack by five key predators including leopard, cheetah, brown hyaena, caracal and black-backed jackal. I recorded the type and number of livestock lost to each predator, including the age, sex and breed of livestock, the date of the attack and the number killed. I asked respondents how the predator was identified by either a (1) direct sighting of the predator, (2) indirect sighting around the kill e.g. spoor of the carnivore and kills stashed in trees and (3) signs on the carcass e.g. bite marks to the neck conditions. I showed informants photographs of the five carnivore species and their spoor and referred to my own knowledge of carnivore feeding ecology and predatory behaviour to assist in the correct identification of the predator. In cases where it was unclear which predator was responsible for the attack, these results were omitted from the final analysis. Long-term monitoring techniques for recording livestock losses over month long intervals are more favourable (e.g. Kolowski and Holekamp, 2006, Dickman, 2009) because individuals are probably better able to recall attack events compared to longer survey durations, with the latter approach leading to potential overestimates or underestimates of the true extent of predation (Kissui, 2008). In the Blouberg, the majority of commercial farms kept detailed reports of livestock gains and losses summarised over monthly and annual periods, allowing opportunities to cross check-information. However, numerous factors including a lack of funds to employ research assistants, low cell phone reception in rural villages and long travelling distances required to reach the mountain, limited the possibilities for regularly monitoring livestock attacks.

Livestock and game attacks were categorised as the number of attacks occurring during the dry season, which extends from April-September and the wet season from October-March. I collected information on calving seasons, seasonal grazing patterns and protective livestock guarding strategies (use of shepherds, guard dogs and night-time kraals). Finally I questioned informants about the reasons for owning livestock and game, the economic, social and cultural impacts of depredation events and coping strategies employed to minimise the impacts of losses. I also drew on ethnographic data derived from participant observation, recorded within an ethnographic diary to supplement the information provided from the interviews. This multi-method of data collection also provided opportunities to triangulate and cross-reference the accuracy of the data provided from different sources.

5.2.3 Environmental data for GIS mapping

The locations of known livestock and game attacks were visited in the field and their geographical location recorded using a handheld eTrex Vista Hcx Garmin Global Positioning System (GPS) using cultural mapping techniques (Fig. 5.2). The coordinates of all livestock and game attacks were imported into a Geographical Information System (GIS) (ArcGIS v. 9.3 [ESRI Inc. 2010]) for analysis.

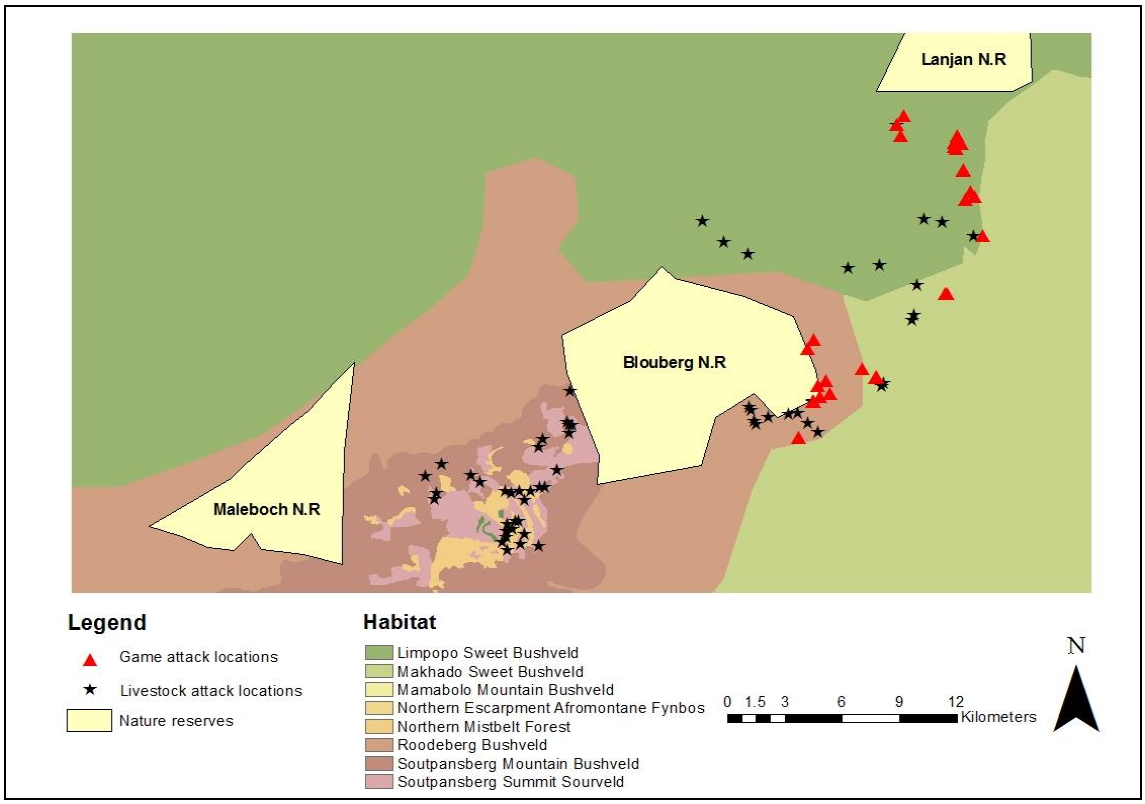


Figure 5.2: Map showing the distribution of reported livestock and game attacks in different habitat types from October, 2009-October, 2011 in the Blouberg Mountain Range

Following previous studies investigating bio-physical factors influencing predation risk by large carnivores, seven environmental variables including elevation, habitat type, grazing capacity, distance to villages, distance to roadways, distance to nature reserves and distance to water were used to analyse the risk of leopard predation on livestock and game (Stahl et al., 2002, Treves et al., 2004, Kolowski and Holekamp, 2006, Holmern et al., 2007, Basille et al., 2009, Kissling et al., 2009, Rosas-Rosas et al., 2010, Zarco-González et al., 2012). Within GIS, an orthorectified SPOT (Système Pour l'Observation de la Terre) satellite image obtained from the

Council of Geoscience (acquired October, 2010), served as a base map of the study area. Additional vector data on the locations of villages, roadways, water points, inland reservoirs, river channels, nature reserve boundaries, farm boundaries, habitat type and grazing capacity were acquired from the Department of Limpopo Economic Development, Environment and Tourism (LEDET) and imported into the base map. Elevation data (m) were extracted from a digital elevation model (DEM) of the study area downloaded via the ArcGIS online capabilities in ArcMap v.10 (ESRI, Inc., 2010) (accessed on the 22nd May, 2012) using a 30 arc-second DEM of Africa and the extract values to points tool in ArcGIS spatial analyst tools. Distance to villages, roadways, water and nature reserves (km) were determined by calculating Euclidean distances in ArcGIS, using spatial analyst tools to produce raster-based distance maps with a cell size of 20x20m^2. Distance to water was estimated as the Euclidean distance to artificial water points, river channels and inland reservoirs. Distance to roadways included Euclidean distances to primary and secondary roadways. Habitat type was classified by Mucina and Rutherford (2006) into Roodeberg Bushveld, Makhado Sweet Bushveld, Limpopo Sweet Bushveld, Northern Mistbelt Forest, Soutpansberg Summit Sourveld, Northern Escarpment Afromontane Fynbos and Soutpansberg Mountain Bushveld (Fig. 5.2). Grazing capacity is a measure of the available biomass for grazing animals estimated from vegetation biomass, incorporating Normalised Difference Vegetation Index (NDVI) and tree density (Morgental et al., 2005). NDVI is a measure of photosynthetically active biomass and reflects vegetation productivity and related bioclimatic variables (Swanepoel et al., 2012). The range values of all environmental variables inputted into the raster maps are summarised in Table 5.1.

Table 5.1: Table showing the data type and range of environmental values inputted into ArcGIS raster maps

Environmental variable	Data type	Range of data values in raster maps
Distance to water	Continuous	0-5km
Distance to nature reserves	Continuous	0-29km
Distance to villages	Continuous	0-13km
Distance to roadways	Continuous	0-18km
Elevation	Continuous	749-1972m
Habitat	Categorical	Limpopo Sweet Bushveld, Makhado Sweet Bushveld, Mamabolo Mountain Bushveld, Northern Escarpment Afromontane Fynbos, Northern Mistbelt Forest, Roodeberg Bushveld, Soutpansberg Mountain Bushveld, Soutpansberg Summit Sourveld
Grazing Capacity	Categorical	7, 10, 12 and 16 ha/LSU (hectare/large livestock unit)

To account for potential spatial bias arising from grid cells with varying sizes because of extended latitude range (Elith et al., 2011), the maps were projected onto an equal area projection (Africa Albers Equal Area Conic). All spatial data were converted to a cell size of 20x20m^2 using the resample tool in ArcGIS data management tools to correspond with the resolution of the GPS occurrence data. To reduce the potential for spatial correlation between GPS points, the data were filtered in ArcGIS to obtain one point per pixel.

5.2.4 Data analysis

5.2.4.1 Interview data and participant observation

All fixed response data from the semi-structured interviews were numerically coded and entered into the statistical package SPSS v. 19 (SPSS Inc., Chicago, USA). Livestock data were categorised into a table summarising the total number of livestock and the proportion of the total livestock herd, gained, used and lost from October, 2009-October, 2011, on commercial and communal land. The number of livestock owned on commercial and communal land was compared using a Chi-Squared Test. The proportion of the total livestock herd gained, used and lost on commercial farms and communal land was used as a measure of comparison to standardise results, rather than using other measures such as livestock breeding unit in order to allow results to be comparable with other human-wildlife conflict studies that have adopted similar approaches (Dickman, 2009, Zarco-González et al., 2012). The proportion of livestock gained, used and lost for each land use was compared using a Kruskal Wallis Test and the proportion of livestock gained, used and lost between commercial and communal land was compared using a Mann-Whitney U Test. The total number of each livestock and game species killed by each predator was categorised into a table. The number of livestock killed by leopards on commercial and communal land and the number of livestock and game killed by leopards on commercial farms was compared using a Chi-Squared Test. Sample sizes were too small to compare the extent of livestock and game species on different land uses by other carnivore species. Financial evaluations of livestock and game losses for each respondent were calculated based on average annual market prices in South African Rand based on the age, sex and condition of livestock (see Appendix 1 for market prices). Whilst average values may not always be accurate, I have adopted this method to make my results comparable with other studies that have used similar approaches (Dar et al., 2009, Thorn et al., 2012). The economic cost of leopard attacks on livestock and game was determined and summarised on commercial and communal land. Mean rainfall data (mm) provided from the BNR was summarised over monthly intervals to show changes in the extent of livestock depredation with rainfall. The total number of livestock and game attacks by leopard occurring between different months and seasons on commercial and communal land was compared using a Chi-Squared test. All statistical tests were deemed significant when $P < 0.05$.

Ethnographic data from participant observation techniques and semi-structured interviews were transcribed and uploaded into NVivo 9 (QSR International 2009). Data were coded against the relevant themes: the extent of livestock and game depredation, information on livestock and game husbandry practices and the economic, cultural and social impacts of livestock and game losses.

5.2.5 Maxent: Mapping risk of leopard predation

Maxent software was applied to identify biological and anthropogenic factors influencing the risk of predation on livestock and game attacks in the Blouberg. Maxent software uses a maximum entropy algorithm to determine the unknown distribution of a species over a geographical range, from a known sample of occurrence data and set of spatially explicit environmental conditions (Phillips et al., 2004, Phillips and Dudík, 2008). By adapting this methodology to the current study, the GPS locations of leopard attacks on livestock and game represent the series of presence data where predation is present. Maxent is used to predict a distribution of predation risk subject to a series of environmental and anthropogenic variables, represented as a grid of pixels into a GIS format to delineate the predicted area.

The distribution of maximum entropy (closest to uniform) is calculated subject to a set of constraints where the expected values of the environmental and anthropogenic conditions under the estimated situation match their empirically observed averages (Phillips et al., 2004, Phillips and Dudík, 2008). Maximum entropy modelling is similar to other statistical techniques that are commonly used to model species distributions, such as generalised linear models and generalised additive models. However, these approaches are dependent on the collection of presence and absence data (Phillips et al., 2006). In contrast to other studies that have investigated the impact of livestock holding characteristics on predation rates (e.g. Ogada et al., 2003, Kolowski and Holekamp, 2006), I assess the impact of landscape variables on the risk of leopard predation by analysing presence only data as my pilot study revealed that the majority of attacks on livestock and game occurred on free-ranging herds of livestock and rarely took place close to livestock holdings. Maxent was used for mapping the risk of predation because it offers many advantages compared to other statistical methods: (1) requires the collection of presence only data; (2) uses both continuous and categorical predictor variables; (3) assesses the importance of each predictor variable in modelling species

distribution; (4) frequently outperforms other presence only modelling methods; and (5) is effective for small samples of occurrence data and species with widespread distributions (Phillips et al., 2006, Hernandez et al., 2008, Elith et al., 2011, Zarco-González et al., 2012).

The default values for Maxent were used including a convergence threshold (10^{-5}), maximum iterations (500), regularisation multiplier (1) and all feature types, since these settings are found to achieve good performance in other studies (Phillips and Dudík, 2008). A subsample method was used, where 10 random partitions of the occurrence localities were made (Phillips et al., 2006). In each partition, 75% of the presence localities were used for training, 10,000 random background pixels were treated as negative training data and 25% of the occurrence points were set aside for testing the final model (Livestock: $n_{training} = 42$, $n_{test} = 14$; Game: $n_{training} = 24$, $n_{test} = 7$). Low sample sizes of 5 and 10 occurrence points perform at near maximal accuracy levels within Maxent, therefore, the sample sizes for the game are deemed sufficient for analysis (Hernandez et al., 2008). The model was trained using a background sample, which included only the surveyed farms where attacks were found in order to control for selection biases resulting from the collection of occurrence data. The background data, from which the negative training data were drawn, contain the same sample selection biases as the occurrence data. Protected areas were removed from the final prediction area to determine the distribution of predation risk outside of these areas on commercial and communal land.

Threshold-independent methods were used to assess the performance of models. The area under the receiver operating characteristic curve was used as a measure of how well model predictions discriminate between locations where observations are present and absent (Phillips and Dudík, 2008). The Area under the curve (AUC) statistic is often used in other studies to assess model accuracy (Phillips et al., 2006, Phillips and Dudík, 2008). AUC values ranging 0.5-0.7 were considered poor models, 0.7-0.9 were moderate and > 0.9 were high performing models (Manel et al., 2001). The performance of the AUC was assessed by testing whether the AUC value for the test data was significantly different to that of a random model (AUC = 0.5) using a Mann-Whitney test, based on 10 sensitivity values at each of the fractional 0.1 intervals of the predicated area from the Maxent omission output (Phillips et al., 2006). AUC values are usually high for models with many variables even if those variables have negligible influence (Warren and Seifert, 2011). The change in the training and Test AUC was therefore compared for different levels of model complexity.

Environmental variables were assessed for multicollinearity and only variables with pairwise correlation coefficients of < 0.5 were included in the analysis following Zarco-Gonzalez et al

(2013). The environmental variables grazing capacity and distance to village were correlated at 0.709. Grazing capacity was not included in the final analysis as prior analyses showed that this variable consistently produced the lowest decrease in the average training gain (had the most minimal effect for modelling predation risk). All other variables had pairwise coefficients less than 0.5 and were included in the analysis. The following variables were inputted into the final Maxent model: distance to water, distance to nature reserves, distance to villages, distance to roadways, elevation and habitat.

The objective was to build models with the best set of predictor variables following Yost et al (2008). The modelling process started with a full model containing all predictor variables, the variable with the lowest decrease in the average training gain was removed and the remaining variables were used to build the final model. Regularised model gain measures the likelihood of the sample points compared with the random background pixels (Phillips et al., 2006). Training and test gain were compared for different levels of model complexity. Following Yost et al (2008), the average training gain was used to decide which of the best performing models should be used for mapping predation risk. The model with the fewest predictor variables and an average training gain not significantly different to the model with the highest training gain was considered the most parsimonious. This method for selecting the most parsimonious model was preferred to the sample size-corrected Akaike information criterion (AICc: Akaike, 1974, Burnham and Anderson, 2002) because preliminary tests showed that the latter method selected models with reduced model complexity containing one-two predictor variables, with poor AUC values within the range of 0.5-0.7 indicative of poor model performance. Models with a similar number of variables as the full model tend to exhibit better performance on average, compared to models with too many or few predictor variables (Warren and Seifert, 2011).

Maxent's Jacknife and heuristic test was used to evaluate the importance of each predictor variable. Percent contribution of each predictor was determined as the proportional contribution of each predictor to the model training gain (Phillips et al., 2006). A high training gain for models containing only a single predictor variable indicates that these variables on their own are useful for explaining the risk of predation by leopards. A high training gain when one variable is omitted compared with the complete model suggests that this variable contains information that is already provided by other variables. Conversely, a high loss of training gain of models on individual variables suggests that no variable on its own was useful for estimating predation risk. Finally, visual inspection of the final probability maps of leopard predation risk was assessed to see if predicted high risk areas showed strong agreement with regions

containing the highest number of attacks (Yost et al., 2008). Threshold dependent methods were not used to assess model performance, because the final maps were not categorised into presence-absence maps, but instead represented as continuous probabilities indicating areas of high-low risk.

5.3 Results

5.3.1 Socio-economics of the farming community

Commercial farmers include Afrikaans (89%) and Northern-Sotho (11%) speakers who engage in a wide range of farming activities based on crop, cattle and game farming, whilst 100% of communal farmers are of Northern-Sotho origin (Fig 5.3). The majority of commercial farmers interviewed during the study (97%) are managers of commercial farming operations, whilst 87% of communal farmers are unemployed. Fifty three percent of commercial farmers state that crop farming earns the greatest income, with game (32%) and livestock (16%) accounting for the remaining responses. Commercial farms in the Blouberg vary in size between 320 to 10,000 hectares with an average size of 2694 hectares. Few communal farmers (8%) survive on an entirely subsistence lifestyle (agriculture and livestock) alone, the majority rely on pensions to enhance their income (61%), followed by the selling of consumptive goods (22%) and other employment opportunities (9%). Commercial farmers' support on average four dependents per household (range: 1-7) and communal farmers support five individuals per household (range: 1-11).

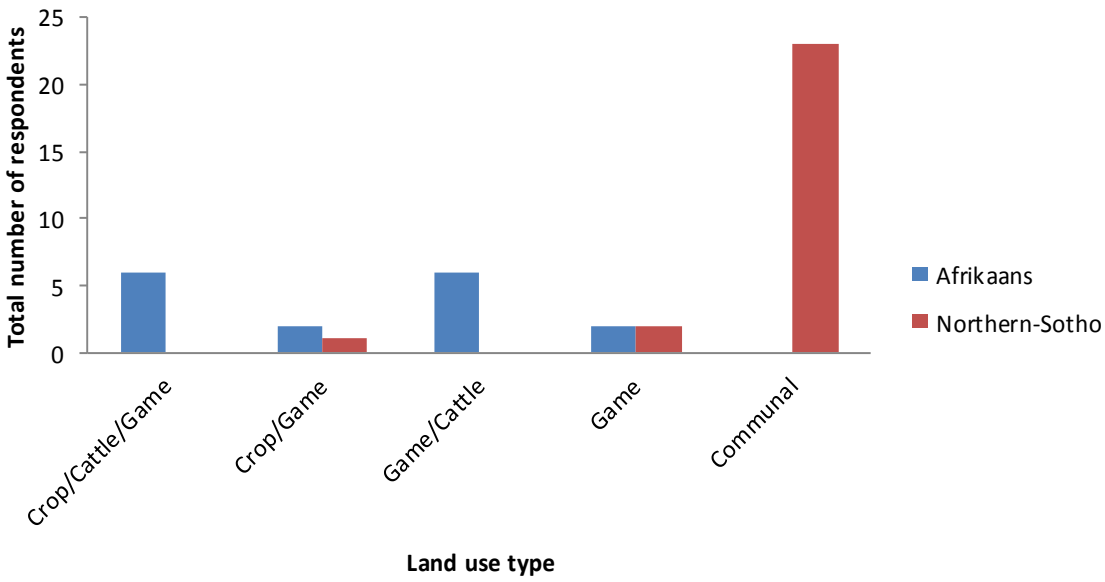


Figure 5.3: Number of Afrikaans and Northern-Sotho speakers interviewed in the study engaged in each land use type.

The age range of commercial farmers varies between 27 and 72 years with a mean age of 50 years, this compares with communal farmers who vary between 16 and 93 years, with a mean age of 55 years. Ninety five percent of all farmers are male and 5% are female. Ninety seven percent of farmers prescribe to a particular faith: 84% of commercial farmers are Christian and 87% of communal farmers adhere to a traditional belief system. General trends indicate that all commercial farmers have received a formal education with 39% of commercial farmers educated to university level (tertiary) (Fig. 5.4). In contrast, 35% of communal farmers do not have a formal education and only 25% of communal farmers are educated to secondary level (Fig. 5.4).

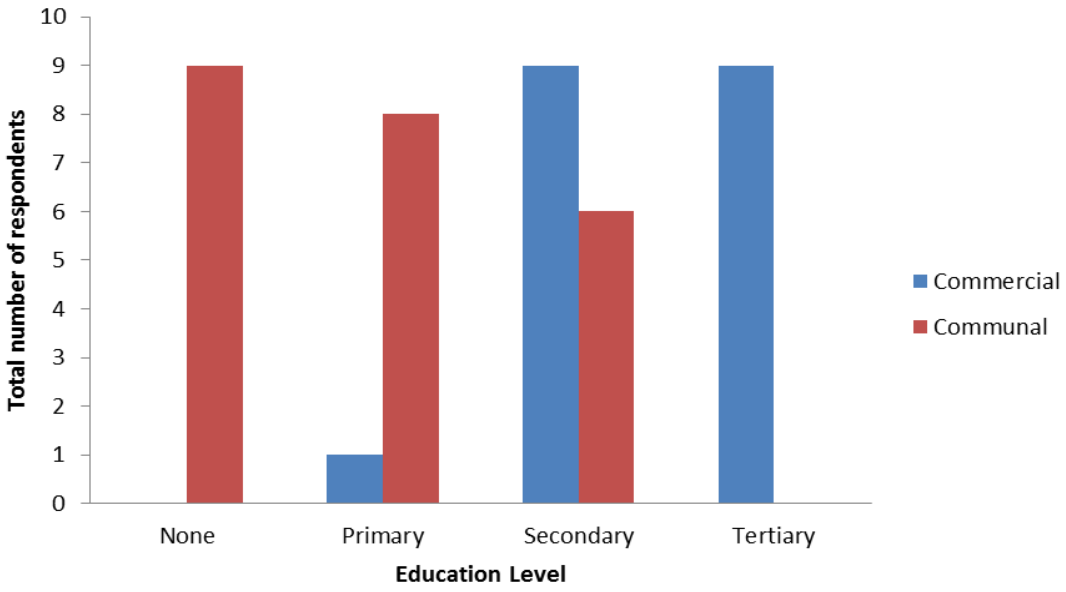


Figure 5.4: Education level of commercial and communal farmers interviewed

5.3.2 Livestock holdings

The number of livestock for the study site totalled 4087 head of stock, comprising 62% cattle, 20% sheep, 16% goats and 2% donkeys. The mean number of livestock kept per household was 149 (S.E.M. +/- 32) on commercial farms and 26 (S.E.M. +/- 6) on communal land. Commercial farmers owned a significantly higher number of cattle (Chi-squared Test (CST): $\chi^2 = 828.1$, df = 1, $P < 0.001$), sheep (CST: $\chi^2 = 87.8$, df = 1, $P < 0.001$) and goats (CST: $\chi^2 = 11.5$, df = 1, $P < 0.001$), while communal farmers owned a higher number of donkeys (CST: $\chi^2 = 56.5$, df = 1, $P < 0.001$) (Fig. 5.5). The total number of livestock gained was 1386 with 87% (n = 1210) gained from natural births, 12% (n = 159) were bought and 1% (n = 7) were acquired as gifts. Natural births were the most signficiant form of stock acquisition on commercial farms (Kruskal Wallis Test (KWT): $\chi^2 = 56.3$, df = 3, $P < 0.001$) and communal land (KWT: $\chi^2 = 118.2$, df = 3 $P < 0.001$) (Fg. 5.6). A significantly higher proportion of livestock were born (Mann-Whitney U Test (MWT): U = 34, Z = -5.9, $P < 0.001$) and brought (MWT: U = 227.5 , Z = -3.7, $P < 0.001$) on commercial farms compared to communal land, whilst livestock were only acquired as gifts on communal land (Fig. 5.6).

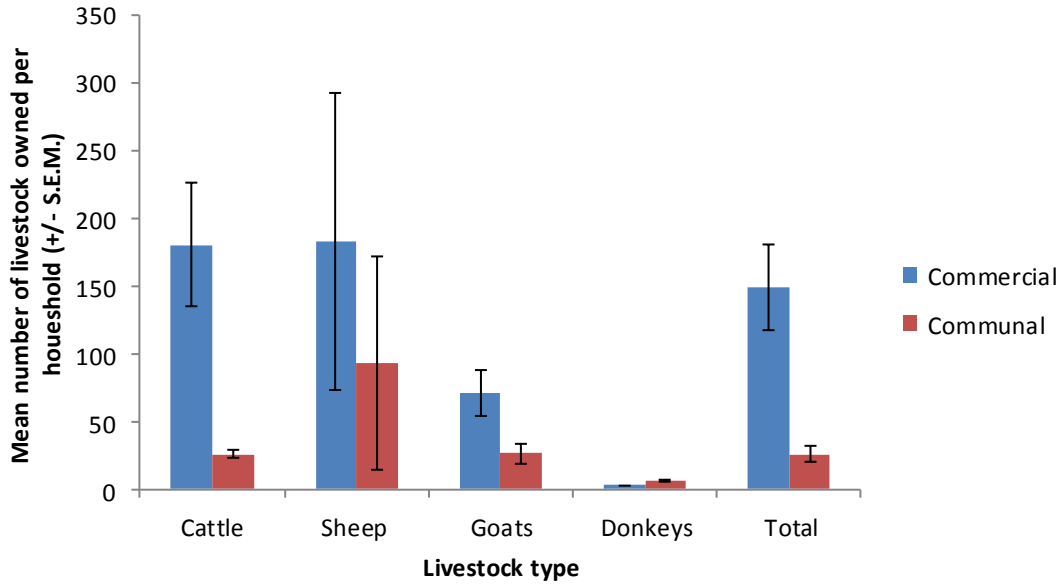


Figure 5.5: Mean +/- S.E.M. number of livestock owned per household on commercial and communal land from October, 2009-October, 2011.

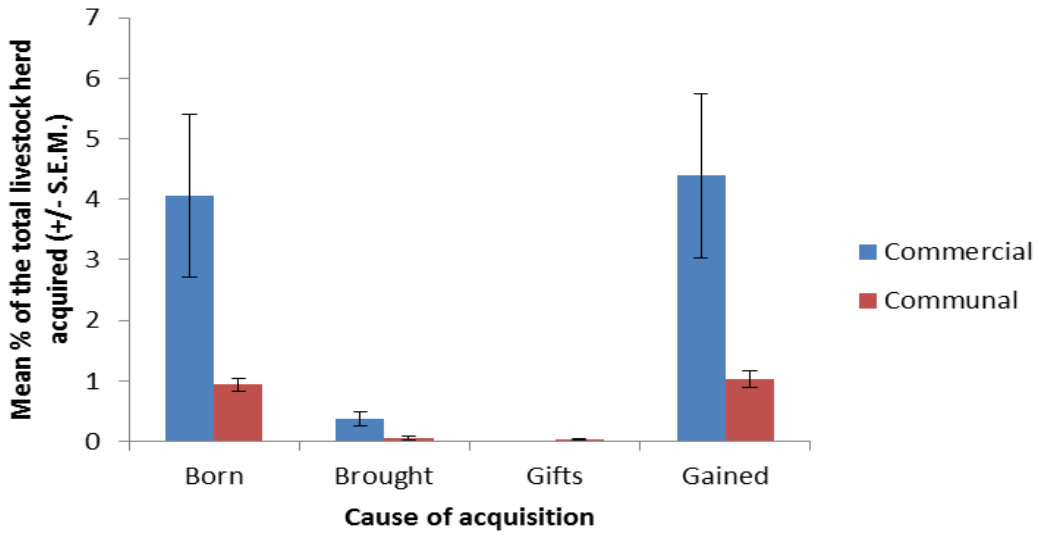


Figure 5.6: Mean % +/- S.E.M. of the total livestock herd on commercial and communal land acquired through natural births, purchases and gifts from October, 2009-October, 2011.

5.3.3 Extent of livestock use and loss

The total number of livestock used was 827 of which 29% were sold and 71% slaughtered. On average a significantly higher proportion of commercial farmers sold (MWT: U = 231, Z = -3.5, P < 0.001) and slaughtered livestock (MWT: U = 88, Z =-5.3 P < 0.001) compared to communal

farmers (Table 6.2). A total of 178 livestock were lost in the study site with livestock depredation representing the greatest form of loss (65%), followed by disease (18%), theft (13%) and accidental deaths (3%). On average a significantly higher proportion of livestock were lost to predators on commercial farms (KWT: $\chi^2 = 24.3$, df = 3, $P < 0.001$) and communal land (KWT: $\chi^2 = 19.4$ df = 3, $P < 0.001$) compared to other causes of mortality (Table 6.2). There was no significant difference between the proportion of livestock lost due to predators (MWT: U = 412.5, Z = -0.8, P = 0.604), disease (MWT: U = 380, Z = -1.2, P = 0.220), theft (MWT: U = 404, Z = -1.1, P = 0.288) and accidental deaths (MWT: U = 420, Z = -0.7, P = 0.451) on commercial farms compared to communal land (Table 6.2). On average there was a significantly higher proportion of livestock lost then used on communal land but not on commercial farms (MWT: U = 1313, Z = -1.5, P = 0.146) (Table 6.2).

Table 5.2: Summary of the mean number of livestock per household and the mean % of the total livestock herd, used and lost on commercial and communal land and all livestock combined on both land use types from October, 2009-October, 2011.

		Commercial		Communal		Total	
		Mean no	Mean % herd size	Mean no	Mean % herd size	Mean no	Mean % herd size
Used	Sold	10.58	0.37	0.83	0.06	3.64	0.15
	Slaughtered	28.84	0.99	0.83	0.06	8.89	0.33
All stock uses		39.42	1.36	1.36	0.12	12.53	0.48
Lost	Stolen	0.26	0.01	0.40	0.03	0.36	0.03
	Predators	2.58	1.40	1.43	0.63	1.76	0.48
	Disease	0.53	0.02	0.47	0.04	0.48	0.03
	Accidents	0.05	0.00	0.12	0.01	0.09	0.01
All stock losses		3.42	1.43	2.42	0.71	2.69	0.55

5.3.4 Extent of livestock losses due to predators

A total of 116 depredation events by predators were reported in the Blouberg from October, 2009-October, 2011. Sixty-eight percent (n = 79) of reported livestock attacks were based on indirect signs including bite marks on the carcass and the positioning of carcasses in the habitat (e.g. leopards frequently stashed kills in trees), 27% (n = 31) through indirect signs such as spoor and 5% (n = 6) based on visual confirmation of the predator. Overall livestock loss by predators represented a 2.8% loss of the total livestock holdings recorded in the Blouberg from October, 2009-October, 2011. Leopards were involved in 67 of 112 of the reported incidents (60%), followed by brown hyaenas (19%, n = 21), jackals (12%, n = 13), and caracals (10%, n = 11). Carnivores killed 67 cattle (60%), 27 goats (24%), 9 sheep (8%) and 9 donkeys (8%). Leopards accounted for 87% (n = 58) of all cattle and 100% (n = 9) of all donkeys killed but no reports of attacks goats or sheep were reported. Jackals accounted for 78% (n = 7) of all sheep and 20% (n = 6) of all goats killed. Brown hyaenas killed 13% (n = 9) of cattle and 44% (n = 12) of goats with no reports of attacks on sheep and donkeys. Caracal killed 13% (n = 2) of all sheep and were responsible for 33% (n = 9) of all goats killed. All reported predator attacks on cattle and donkeys were on young calves and foals (< three months of age). No livestock attacks were recorded for cheetahs.

The number of livestock killed by leopards on commercial and communal land was not significantly different (CST: $\chi^2 = 0.6$, df = 1, P = 0.808). Similarly, the number of livestock and game killed by leopards on commercial farms was not significantly different (CST: $\chi^2 = 0.9$, df = 1, P = 0.345). Leopards were the greatest cause of game loss for 89% (n = 33) of attacks, followed by cheetahs (10%, n = 3) and caracals (3% = 1) on commercial farms. Higher numbers of nyalas, impalas and warthogs were lost to leopards compared to other species (Fig. 5.7). Reports of game depredation by other carnivores were small, with cheetahs predating on impala and a warthog and caracals predating on common duiker in one incident.

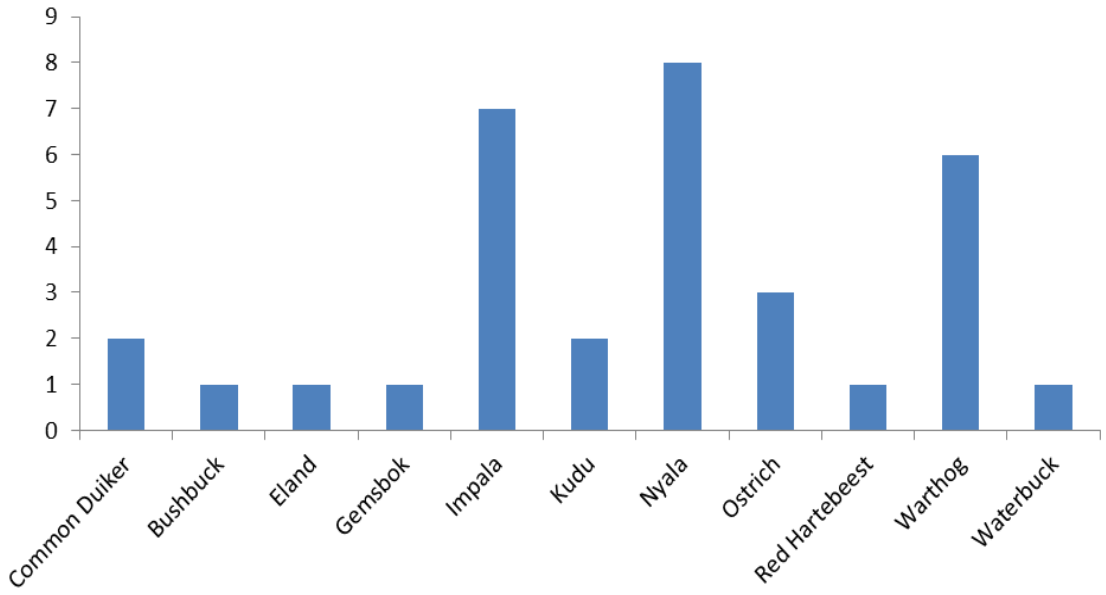


Figure 5.7: Total number of different game species reportedly lost to predators from October, 2009-October, 2011. All eland, kudu, gemsbok, nyala and waterbuck kills were on calves.

5.3.5 Economic impacts of livestock depredation

The total economic loss arising from livestock deaths during the study period was estimated at ZAR 563, 655. These financial losses were attributed to predation (65%), disease (18%), theft (13%) and accidental deaths (3%) (Fig. 5.8). Total cattle losses by predators represented a loss of 1.6% of the total livestock holdings in the Blouberg followed by 0.7% for goats, 0.2% for sheep and 0.2% for donkeys. Livestock owners suffered an average loss of 5.2% of their total stock for cattle (range 0.4-29.4%), 1.6% for sheep (range 2-7.4%), 1.4% for goats (range 6.3-33.3%) and 11.4% for donkeys (range 25-60%) by predators. Over a 24 month period, livestock depredation resulted in a total cost of ZAR 321, 455, of which leopards were perceived to be responsible for 60%, brown hyaenas 19%, jackals 12% and caracals 10% of this total. The total estimated livestock loss due to predators was ZAR 205, 955 on commercial farms and ZAR 126, 000 on communal land.

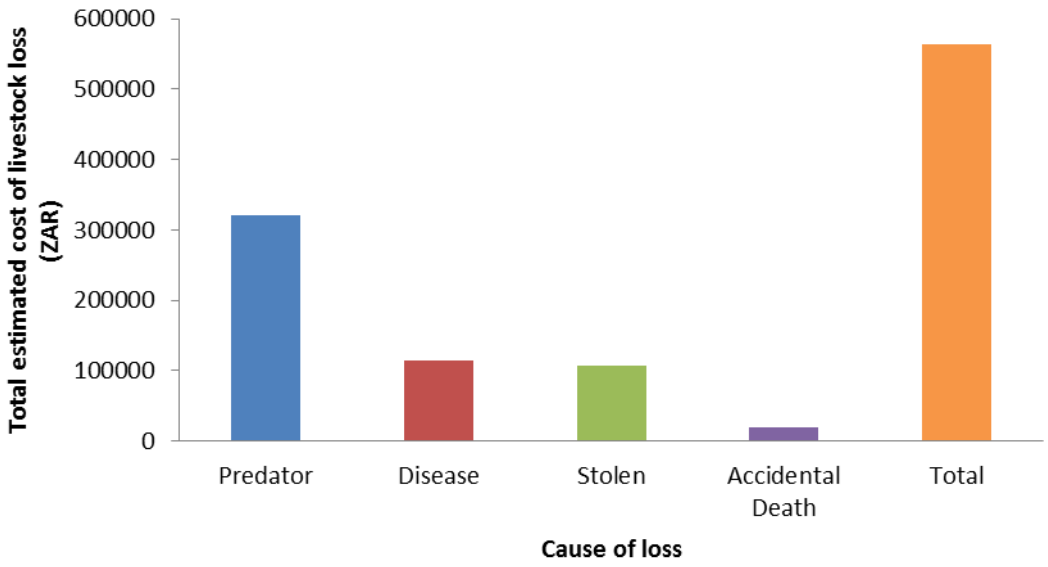


Figure 5.8: Total estimated cost of livestock losses in South African Rand losses by cause.

The total estimated livestock loss due to leopard predation on commercial farms was ZAR 111, 582 and ZAR 86, 600 on communal land. Cattle owners lost on average 3.0% (range: 1.-4.8 %) of their total cattle holdings per household due to leopard depredation on commercial farms and 12.4% (range: 4.3-18%) on communal land. Economic loss for cattle depredation by leopards resulted in an average loss of ZAR 12, 182 per household per annum on commercial farms and ZAR 10, 500 on communal land. Donkey owners lost on average 25% (range: 0-25%) of their total donkey holdings per household on commercial farms and 42.5% (range: 25-60%) on communal land respectively. Economic loss for donkey depredation by leopards resulted in an average loss of ZAR 700 per household per annum on commercial farms and ZAR 2625 on communal land. The total estimated financial loss of game predated on by leopards was ZAR 43, 111 on commercial land, with young nyala prey forming the greatest financial loss of all game species ZAR 5171 each (Fig. 5.9). Economic loss for game farmers due to leopard predation on game resulted in an average loss of ZAR 3354 per household per annum on commercial farms.

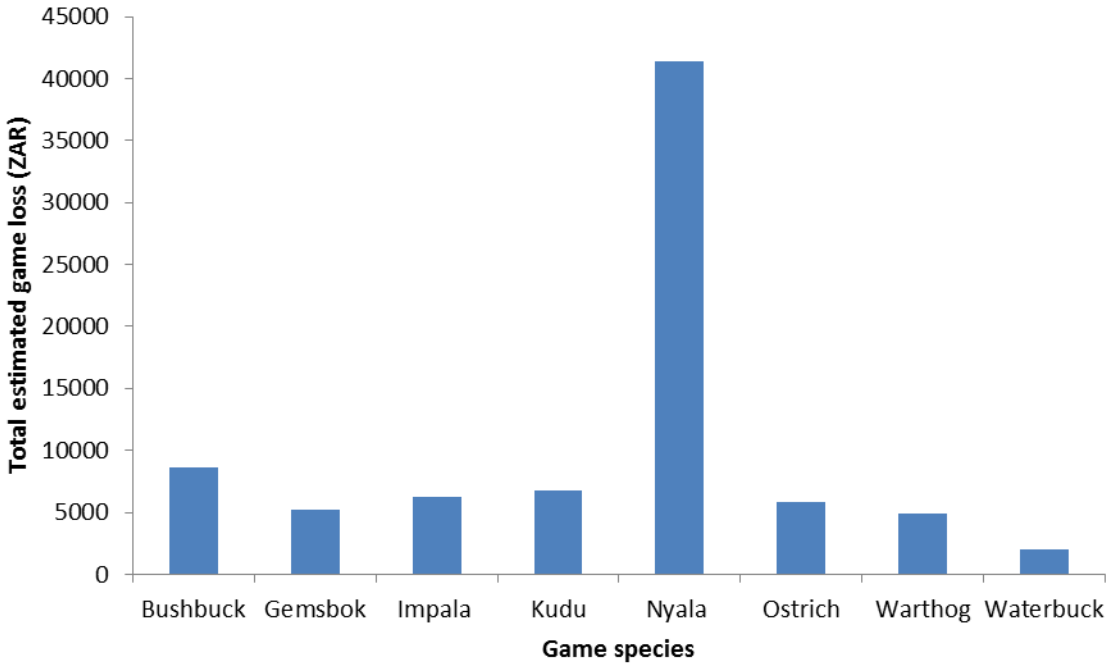


Figure 5.9: Total estimated cost of game losses in South African Rand for each game species by leopard predation. All kudu, gemsbok, nyala and waterbuck kills were made on young.

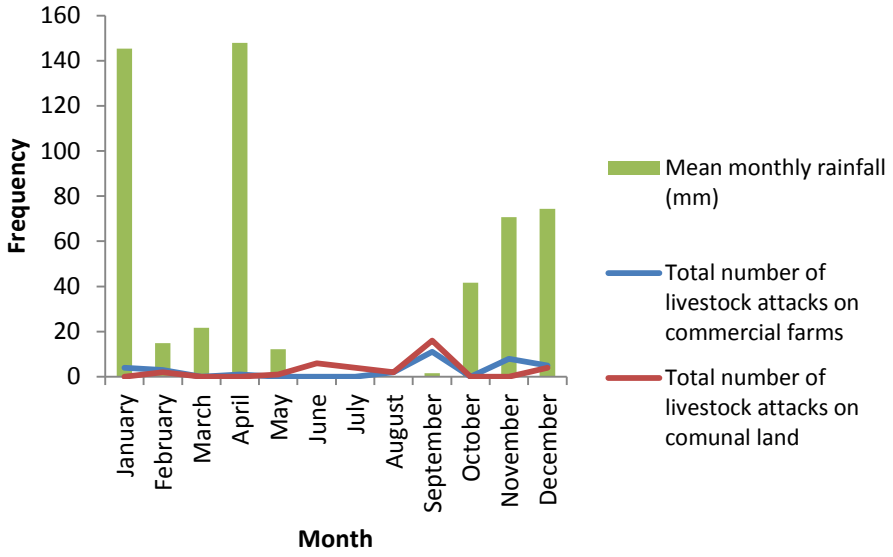
5.3.6 Livestock husbandry practices

Seventy percent of commercial cattle farmers (n = 7) and 81% (n = 17) of communal cattle farmers stated that the calving season occurs from September-January, whilst for all other informants, the calving period extends throughout the year. Sixty percent of commercial cattle farmers (n = 6) and 33% (n = 7) of communal cattle farmers kraal their calves (0-3 months of age) at night. In contrast, no adult cattle are kraaled at night, or guarded by shepherds or dogs on both land use types. All smallstock owners on commercial farms and 91% (n = 10) of communal farmers, kraaled their goats and sheep at night. Twenty percent of commercial smallstock farmers (n = 1) and 27% (n = 3) of communal smallstock farmers employed a shepherd to guard goats and sheep. Twenty percent of (n = 1) of commercial smallstock farmers and 45% (n = 5) of communal smallstock farmers employed a livestock-guarding dog to protect goats and sheep. No donkey owner's kraaled donkeys at night and employed shepherds or livestock-guarding dogs to protect donkeys on both land use types. Of all reported attacks on livestock by leopards, 97% (n = 67) took place on free-ranging grazing herds and 3% (n = 2) took place in kraals, in all cases, shepherds and guardian dogs were not present during the time of attack. Of the reported livestock attacks in kraals, these households

were located on the Blouberg Mountain close to the BNR and experienced the highest levels of predation by leopards amongst communal farmers. The first communal farmer lost 18% of his total cattle holdings and 60% of his total donkey holdings with the second farmer, losing 12.5% and 25% of his total cattle and donkey stock.

5.3.7 Seasonality and rainfall

The number of livestock killed by leopards was significantly higher in September on commercial farms (Fisher's Exact Test (FET): $P = 0.018$) and communal land (FET: $P < 0.001$) (Fig. 5.10a). The number of game species killed by leopards on commercial farms was also significantly higher in September (FET: $P < 0.001$) (Fig. 5.10b). Peak livestock and game attacks by leopards coincided with the start of the rainy season and the calving season.



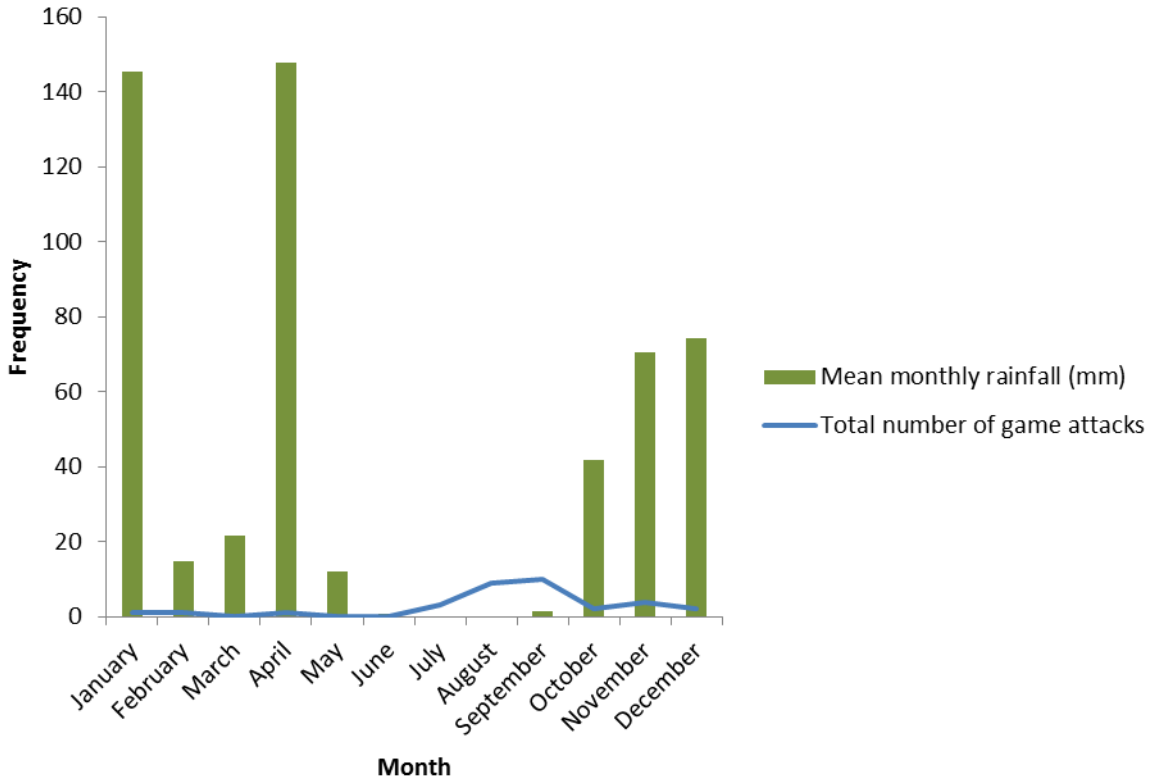


Figure 5.10 (a): The total number of livestock attacks per month by leopard on commercial and communal land and (b) the total number of game attacks per month by leopard on commercial farms and mean monthly rainfall (mm) patterns.

The number of livestock killed by leopards during the dry season was significantly higher on communal land compared to commercial land (CST: $\chi^2 = 7$, df = 1, P = 0.008), whilst the number of livestock killed during the wet season was not significantly different between land use types (CST: $\chi^2 = 2$, df = 1, P = 0.157) (Fig. 5.11a). A significantly higher number of game species were killed by leopards in the dry compared to the wet season (CST: $\chi^2 = 4.2$, df = 1, P = 0.040) (Fig. 5.11b). However, no significant differences were found between the number of livestock and game killed by leopards in the dry and wet season on commercial farms (CST: $\chi^2 = 3.4$, df = 1, P = 0.064) (Fig. 5.11b).

a) b)

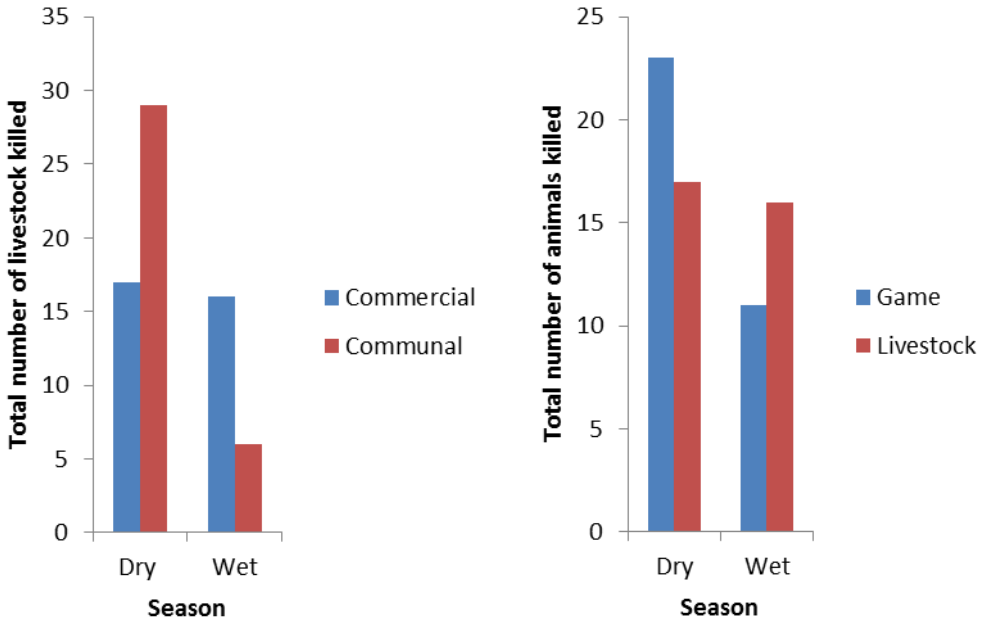
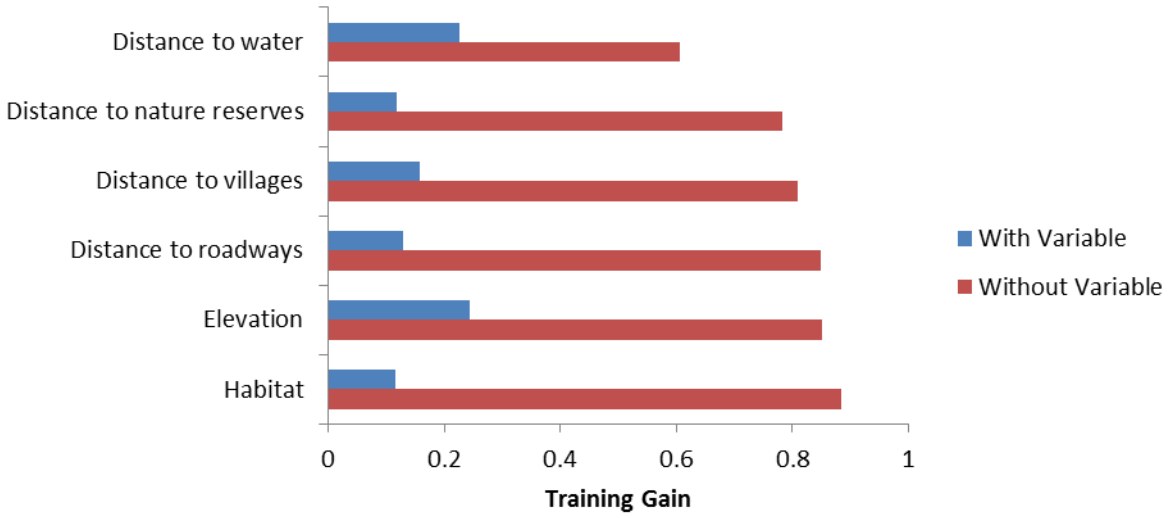


Figure 5.11 (a): The total number of livestock killed by leopards during the dry (April-September) and wet season (October-March) on commercial and communal land and (b) the total number of game and livestock species killed by leopards during the dry and wet season on commercial farms.

5.3.8 Risk of leopard predation on livestock and game

The Jacknife test of variable importance showed that elevation and distance to water produced the highest training gain for the livestock and game model respectively, indicating that these variables influence the risk of predation most greatly when modelled independently (Fig. 5.12a-b). Distance to water decreased the gain the most when omitted from the full model for both the livestock and game model, suggesting that distance to water contains the most information not present in other variables (Fig. 5.12a-b). Based on the lowest decrease in the average training gain, the order of variable removal from the livestock model was habitat, elevation, distance to nature reserves, distance to roadways, distance to water and distance to villages. For the game model, the order of variable removal was distance to roadways, habitat, distance to village, distance to nature reserves, elevation and distance to water.

a)



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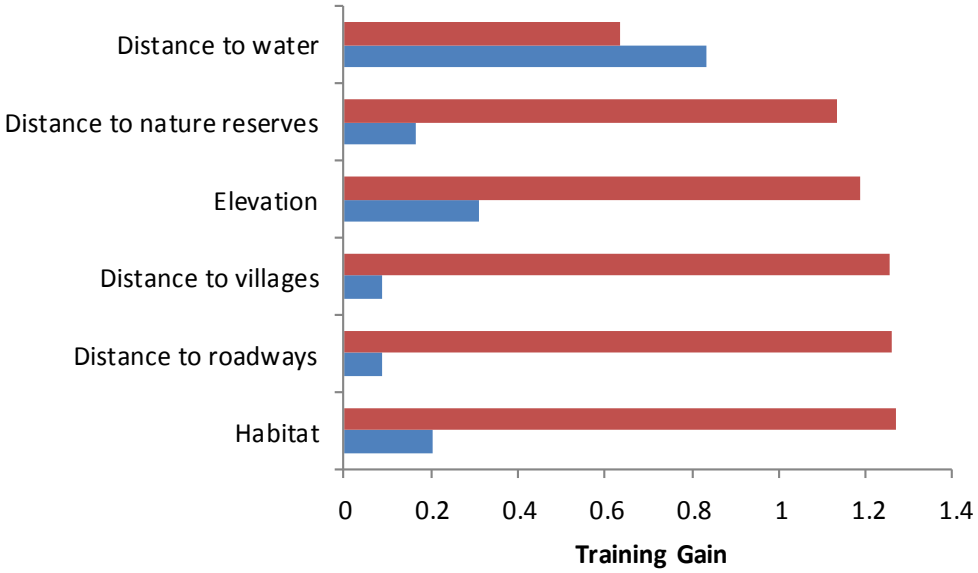
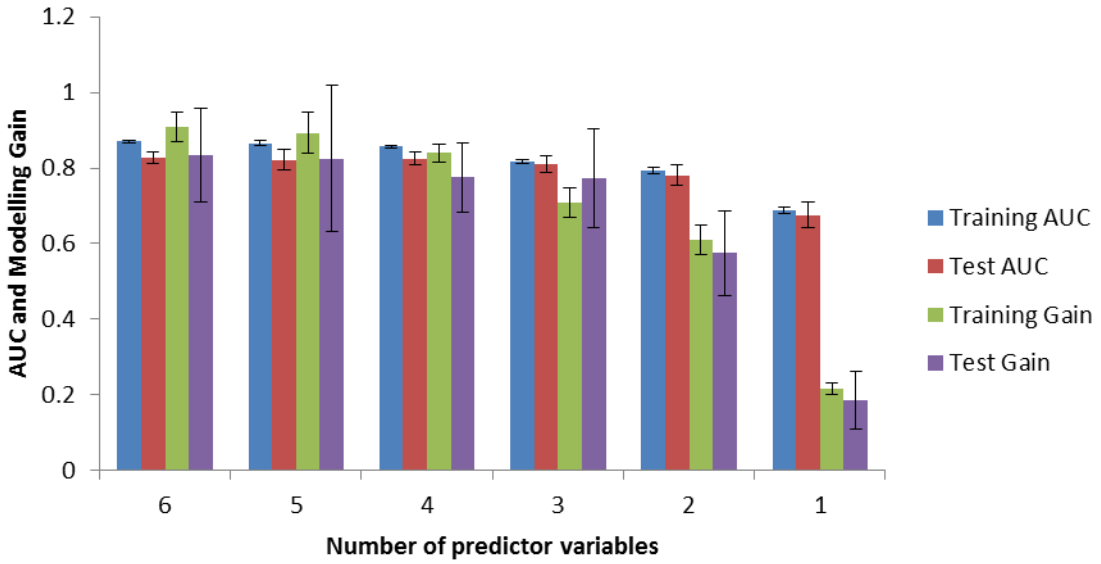


Figure 5.12: Jacknife results showing the training gain for each predictor variable alone (blue bars) and the drop in training gain when the variable is removed from the full model (red bars) for (a) livestock and (b) game attacks.

The average Test AUC values (n = 10) produced from all partitions was significant (Mann Whitney U Test: $P < 0.001$) for both the livestock and game models, indicating a better model then predicted by chance. The average training and Test AUC values were similar for the six-two variable models and decreased with the one variable model for both livestock and game. The average training gain values were similar for the six-four variable model and the six-five variable model, decreasing thereafter for livestock and game respectively (Fig. 5.13a-b). The test gain values were similar for the six-three variable models and decreased thereafter, for both livestock and game (Fig 5.13a-b). The standard deviations of the test gain values for each partition were more variable for both livestock (0.05-0.22) and game (0.37-0.60) compared to the training gain standard deviations of 0.01-0.07 and 0.09-0.18, respectively. Considering the high sensitivity of the average training gain relative to the average AUC values, the model with the fewest predictor variables and an average training gain not significantly different to the model with the highest training gain was considered the most parsimonious (Yost et al., 2008). The overlap between 95% confidence intervals for the training gain averages was used as the criterion for significance (Yost et al, 2008). The five variable model containing elevation, distances to village, water, roadways and nature reserves was selected for the livestock model and the three variable model containing elevation, distance to nature reserves and distance to water was the most parsimonious for the game model (Fig. 5.13a-b).

a)



b)

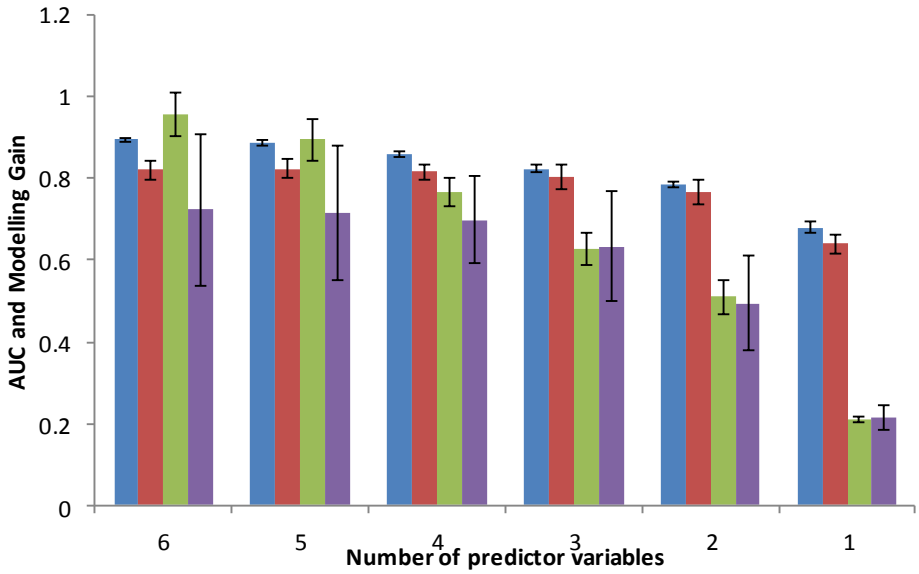
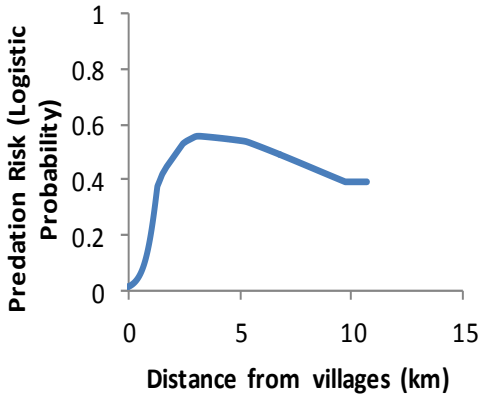


Figure 5.13: The Test AUC, Training Gain, and Test Gain averaged across 10 random partitions of the presence records with 95% confidence intervals. The x axis represents the number of predictor variables in each model for (a) livestock and (b) game attacks.

The risk of leopard predation on livestock was most significantly influenced by distance to villages (contribution = 30.9%), followed by distance to water (23.3%), distance to roadways (21.2%), distance to nature reserves (15.4%) and elevation (9.2%). The risk of leopard predation on livestock peaked at a distance of 3km from the nearest village and decreased

thereafter (Fig. 5.14a). The risk of leopard predation on livestock was highest close to water sources and declined with increasing distance (Fig. 5.14b). The risk of leopard predation on livestock increased at a distance of 8km from roadways and increased thereafter (Fig. 5.14c). The risk of a livestock attack by a leopard was highest close to the borders of nature reserves and decreased with increasing distance (Fig. 5.14d). Risk of leopard predation on livestock was highest at low altitudes between 670-780m and at high elevations of 1540-1760m (Fig. 5.14e).

a)



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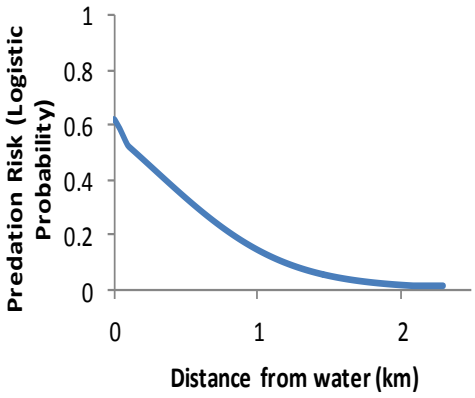

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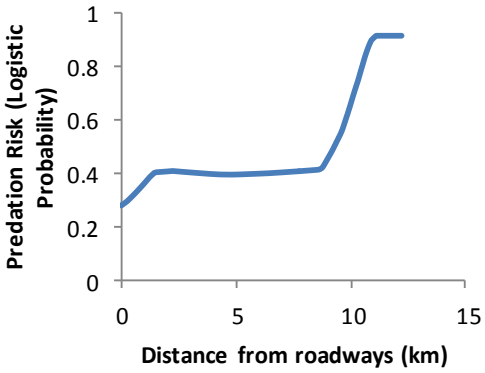
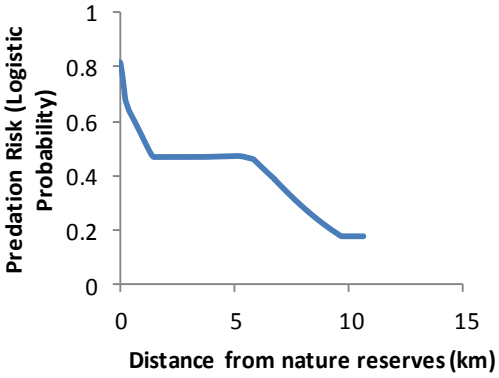


d)



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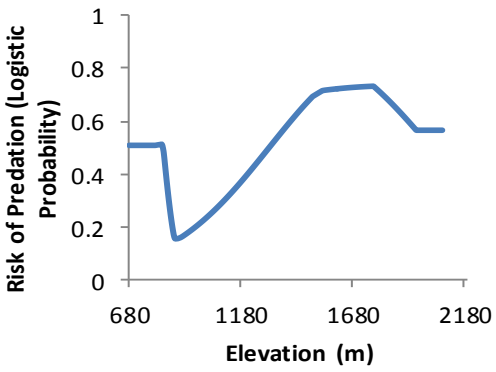
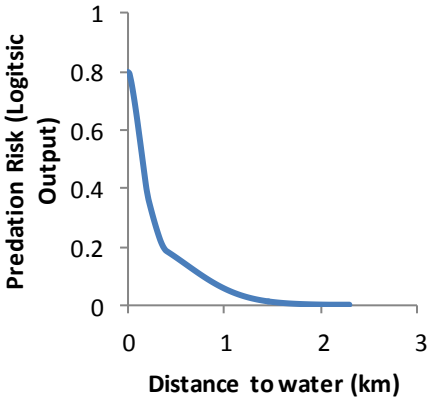


Figure 5.14: Risk of predation on livestock and (a) distance to village, (km), (b) distance to water (km), (c) distance to roadways (km), (d) distance to nature reserves (km), and (e) elevation (m).

The risk of leopard predation on game was most significantly influenced by distance to water (contribution = 70.6%), followed by elevation (16.8%) and distance to nature reserves (12.6%). The risk of leopard predation on game was highest close to water sources and declined with increasing distance (Fig. 5.15a). The risk of a game attack by a leopard was highest at low altitudes between 775-990m and high elevations between 900-920m (Fig. 5.15b). The risk of leopard predation on game initially declined sharply at distances of 1km from the borders of nature reserves and plateaued shortly thereafter as distance increased (Fig. 5.15c).

a)



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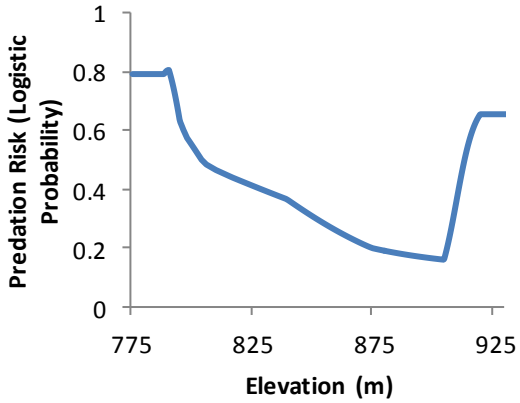


c)

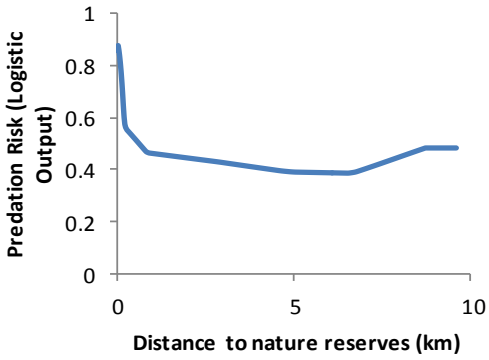
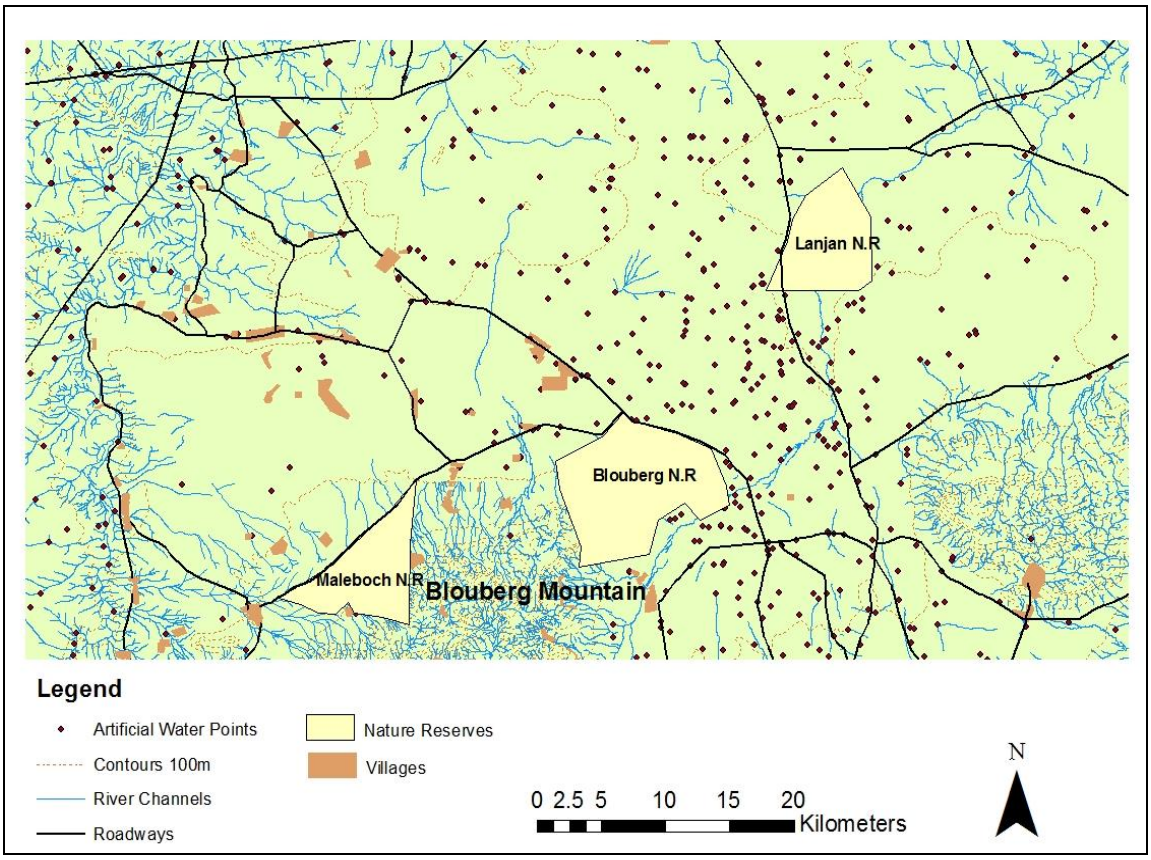


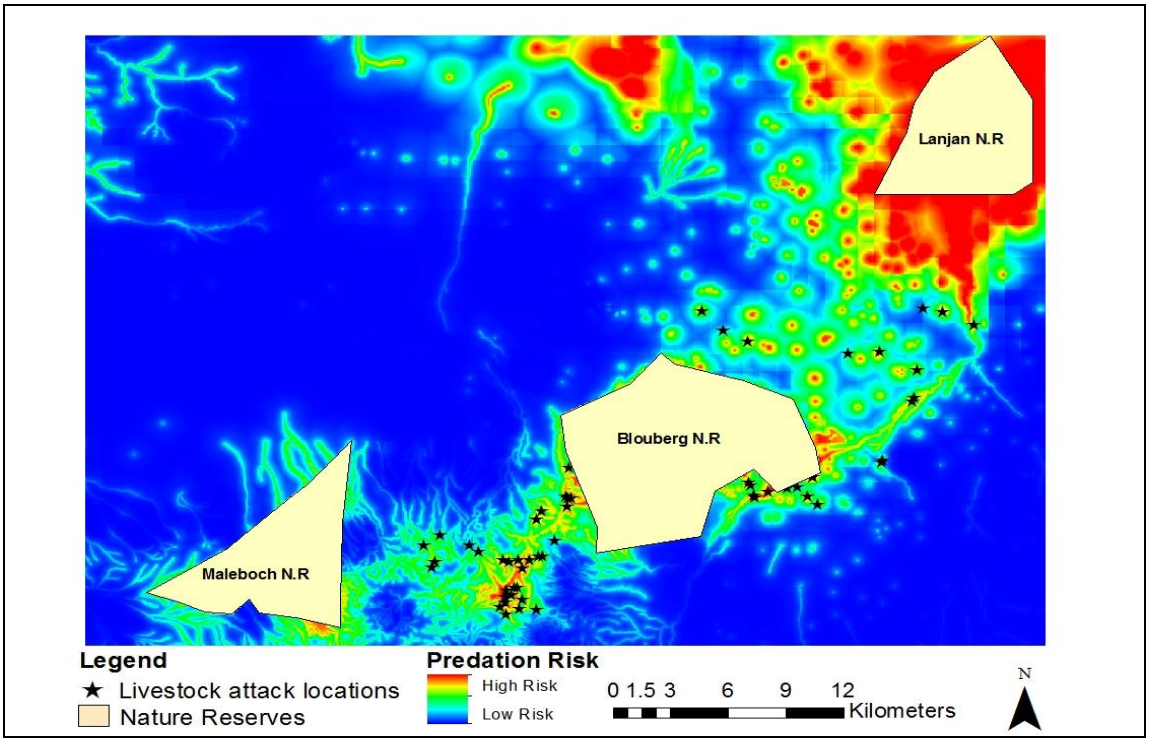
Figure 5.15: Relationships between predation risk on game and (a) distance to water (km), (b) elevation (m) and (c) distance to nature reserves (km).

The risk of predation on livestock was highest in areas bordering the Lanjan Nature Reserve (Fig. 5.16b) and in an area to the north-west of the reserve positioned at a high elevation and close to a river source, near the south-eastern corner of the Blouberg Nature Reserve where the Brak River runs through the reserve, at high elevations on the Blouberg Mountain and to the south-east corner of the Maleboch Nature Reserve (Fig. 5.16b). The probability of game attacks by leopards was high in areas bordering the Lanjan Nature Reserve where risk of predation increased close to the Brak River. The risk of leopard predation on game was highest close to the borders of the Maleboch Nature Reserve and along river channels on the Blouberg Mountain (Fig. 5.16c).

a)


Lanjan N.R
Blouberg N.R
Maleboch N.R
Blouberg Mountain
Legend
Artificial Water Points
Contours 100m
River Channels
Roadways
Nature Reserves
Villages
0 2.5 5 10 15 20
Kilometers
N

b)


Lanjan N.R
Blouberg N.R
Maleboch N.R
Legend
Livestock attack locations
Nature Reserves
Predation Risk
High Risk
Low Risk
0 1.5 3 6 9 12
Kilometers
N

c)

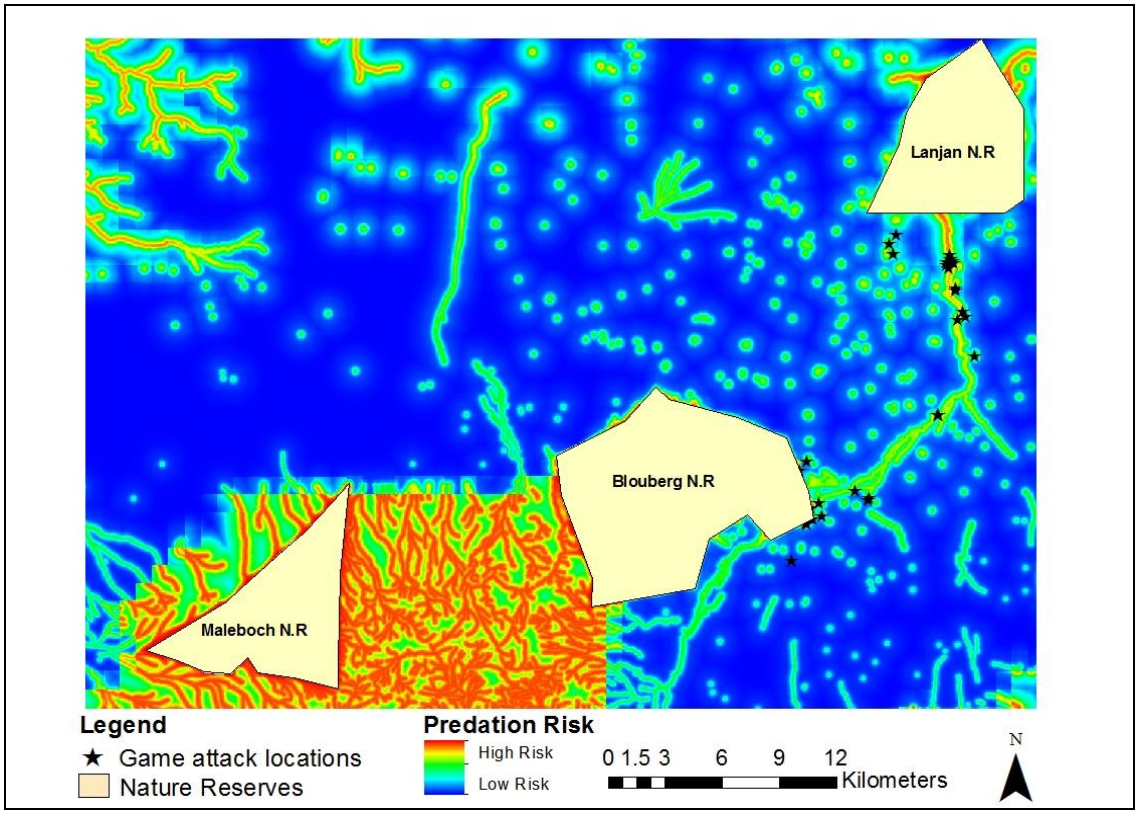


Figure 5.16: Maps showing (a) the topographical range of the Blouberg Mountain Range, (b) Predicted areas of high-low predation risk on livestock by leopards and (c) Predicted areas of high-low predation risk on game by leopards in the Blouberg Mountain Range.

5.4 Discussion

5.4.1 Livestock acquisition

Livestock on commercial farms and communal land were mainly acquired through natural births. Commercial farmers on average sold a higher number of livestock to other breeders at auctions and slaughtered a greater number of livestock to supply the meat and biltong industry, compared to communal farmers. Livestock are only acquired as gifts by communal farmers, through patrilineal modes of inheritance. A communal farmer explains:

"I acquired my cattle from my father this is how most of us got started with cattle. We then went to find jobs within the cities during the apartheid because we couldn't survive here easily during those times. Our sons would look after the cattle until we got back and so we will continue to pass on our cattle to them in the future."

Traditionally, in Bahananwa culture, livestock are acquired through natural increase and exchange using traditional livestock sharing systems, which allow for the acquirement of cattle through the custom of *mafisa. Mafisa* occurs when a man places some of his cattle under the care of another in exchange for milk or, if livestock numbers increase under the man's stewardship, he would be rewarded with a young calf. Traditional forms of cattle sharing such as these are defined by the rules of the "Bovine Mystique," in Lesotho a concept introduced by Ferguson (1990, 1992). In Lesotho, wealthy individuals named *barui* used livestock as a form of social capital to advance their prestige and status by making their animals available to their community. Ferguson suggests that male migration from rural areas in search of mining jobs in South Africa resulted in the absence of men from their communities for long periods of time. Therefore, in order to support their families and prepare for retirement, livestock sharing enhanced an individual's social standing in the community. Traditionally, livestock were also acquired through exchange of livestock as social capital in the form of marriage goods (Mönnig, 1967). A man claims livestock from his agnatic kin upon marrying and the family of the bride also acquire livestock as a bride wealth payment from the groom (Monnig, 1987). Currently bride wealth payments are largely paid in cash. Bride wealth payments are more commonly made for wealthier households and individuals with no income or livestock, often forego payments. The commodification of livestock in the Blouberg has resulted in the erosion of traditional sharing systems between communal farmers, because livestock are mainly used

for individual income enhancement. In the Blouberg, respondents did not report any forms of livestock acquirement through the *mafisa* and bride wealth customs during interviews.

5.4.2 Extent of leopard livestock depredation

Livestock depredation by carnivores constitutes the greatest form of livestock loss relative to other natural causes of mortality in the Blouberg. This finding contrasts with other studies on large carnivores, where natural causes of mortality predominate (Schiess-Meier et al., 2007, Kissui, 2008, Palmeira et al., 2008, Dar et al., 2009, Hemson et al., 2009). In contrast, livestock depredation due to carnivores represents 2.8% of the total livestock holdings for the Blouberg from October, 2009-October, 2011, similar numbers were reported in the North-West Province of South Africa, where farmers lost 2.8% of total stock holdings to large carnivores (Thorn et al., 2012), and 2.2% in Botswana (Schiess-Meier et al., 2007). Other African studies reported lower levels of depredation in Namibia and Ethiopia of 1.4% (Marker et al., 2003, Atickem et al., 2010), 1.8% in Kenya (Kolowski and Holekamp, 2006) and higher losses in Tanzania of 4.5% (Holmern et al., 2007). Leopards accounted for 60% of livestock attacks in the Blouberg compared to other carnivore species, coinciding with similar rates of 64% by leopards in Botswana (Schiess-Meier et al., 2007), whilst lower rates of predation of 15% by leopards were reported in the Waterberg Plateau, South Africa (Thorn et al., 2012) and 17% in Tanzania (Kissui, 2008). Higher levels of depredation by leopards have been recorded in Bhutan of 70% (Sangay and Vernes, 2008) and 91% in Pakistan (Dar et al., 2009).

Predators demonstrated preferential predation on small to medium sized animals, coinciding with the feeding ecology of different carnivore species. Leopards in the Blouberg predate on young calves and donkey foals, which fall within the optimal weight range of 10-40kg for leopard prey (Hayward et al., 2006). Similarly, 64% of reported depredation by leopards in the Soutpansberg Mountains occurred on young calves (Chase-Grey, 2011). Chase-Grey (2011) corroborated these findings by analysing the scats of leopards to determine the actual diet of the leopard population. Findings demonstrated that bushbuck, hyrax and common duiker comprised the majority of leopard diets in the Soutpansberg, with no reports of expensive game or livestock species (Chase-Grey, 2011). Scat analysis could not be carried out in the Blouberg owing to time constraints and the difficulty in locating leopard scats on roadways, game and cattle trails. Such a low incidence of detection may result from higher levels of

human presence, hunting and illegal persecution compared to the Soutpansberg. In the Blouberg, farmers did not report any attacks on goats and sheep by leopards, perhaps due to improved livestock guarding strategies for these species. Higher rates of kraaling smallstock at night and employing shepherds and livestock guardians to protect smallstock are reported by farmers compared to cattle and donkeys. Leopards predated on high numbers of nyala calves, warthogs and impalas. These species had the highest relative abundance index (RAI) on commercial farms defined as the number of independent photographs/ 100 trap nights, which is used as a proxy for measuring abundance in camera trap surveys, of 1.8, 1.6 and 1.4, compared to other prey species reportedly predated on by leopards (see Appendix 2 for a full summary of RAI values). Nyala are not indigenous to the Blouberg and were introduced on game farms during the 1980s for hunting. However, this expensive game species represents the highest economic cost for game farmers. In a review of 33 studies on leopard diets, nyala was proportionally the most common prey species and impala and warthog were the most frequently predated game species by leopards (Hayward et al., 2006).

Brown hyaenas predated on young calves and goats with no reports of attacks on sheep and donkeys. Mills (1973, 1976) described brown hyaenas as scavengers of bones from old and fresh kills made by other predators. In the Kalahari, Mills (1976) reported that a brown hyaena killed an animal itself in only 0.8% of cases and reported attacks were directed towards prey species that were smaller than a springbok lamb. Cattle carcasses were reported as an important component of brown hyaena diets in the Malgadikgadi National Park in Botswana (Maude, 2005). Maude (2005) reported that brown hyaenas did not hunt livestock but fed on carcasses killed by lions, spotted hyaenas and jackals and on cattle that had died during droughts. In the Blouberg, a brown hyaena was observed scavenging from the carcass of a leopard kill stashed in a tree as identified by a camera trap placed on a commercial farm (Fig. 5.16). A brown hyaena den was also found on the Blouberg Mountain that revealed a store of cattle bones (Fig. 5.17). Although, it is likely that cattle form part of this species diet, it is also possible that many claimed attacks were mistaken reports of brown hyaenas scavenging on the carcasses of livestock killed by other carnivores, or those that had died from natural causes of mortality.

Caracals and jackals reportedly killed goats and sheep in the study site, although at fairly low densities. In the majority of cases, caracals predominantly prey upon hyraxes, rodents, birds and small antelope (Grobler, 1981, Stuart and Wilson, 1988, Avenant, 1993). Caracals and jackals are considered problem animals in Namibia and South Africa where they predate on small stock (Nowell and Jackson, 1996, Avenant and Nel, 1998, Ray et al., 2005, Kent, 2011). A

single cheetah was captured during my camera trap pilot study on commercial farms, however, no livestock attacks and few game attacks were reported for this species, probably owing to their scarcity.

Figure 5.16: Brown hyaena scavenging on an impala kill made by a leopard.

Figure 5.17: Brown hyaena den on the Blouberg Mountain with the bones of cattle carcasses.

5.4.3 Livestock husbandry practices

Commercial and communal farmers rarely employ adequate livestock guarding strategies in the Blouberg, particularly for cattle and donkeys. Inadequate livestock guarding practices have been cited by numerous researchers as a significant contributor to livestock attacks by predators (Oli et al., 1994, Mishra, 1997, Ogada et al., 2003, Sangay and Vernes, 2008, Wang and Macdonald, 2009). Several commercial and communal farmers perceived the eradication of many large carnivores from the Blouberg as a causal factor for the declining employment of livestock guarding strategies. A commercial farmer explains:

"My grandfather, when he was farming in this area, had many problems with predators like lions, spotted hyaena and leopards. He used to kraal his cattle daily and he employed people to shepherd them in the bush. But nowadays the leopard is the top predator in the area, and there are fewer carnivores around. I think because of that, us farmers have become lax and don't feel the threat to be as great as it was in the past."

In other countries where large carnivores have been eradicated, similar patterns have emerged where livestock are free-ranging and left unguarded, exposing them to high rates of depredation when carnivores recolonise (Linnell et al., 1996, Breitenmoser, 1998, Brieitenmoser et al., 2005). Traditionally, shepherding livestock, employing livestock-guarding animals and kraaling livestock at night, formed part of traditional livestock management strategies for the Bahananwa. Livestock management roles were fulfilled by young males who progressed through several stages of herding, and took on greater responsibility for livestock as they grew older (Fig. 5.18).

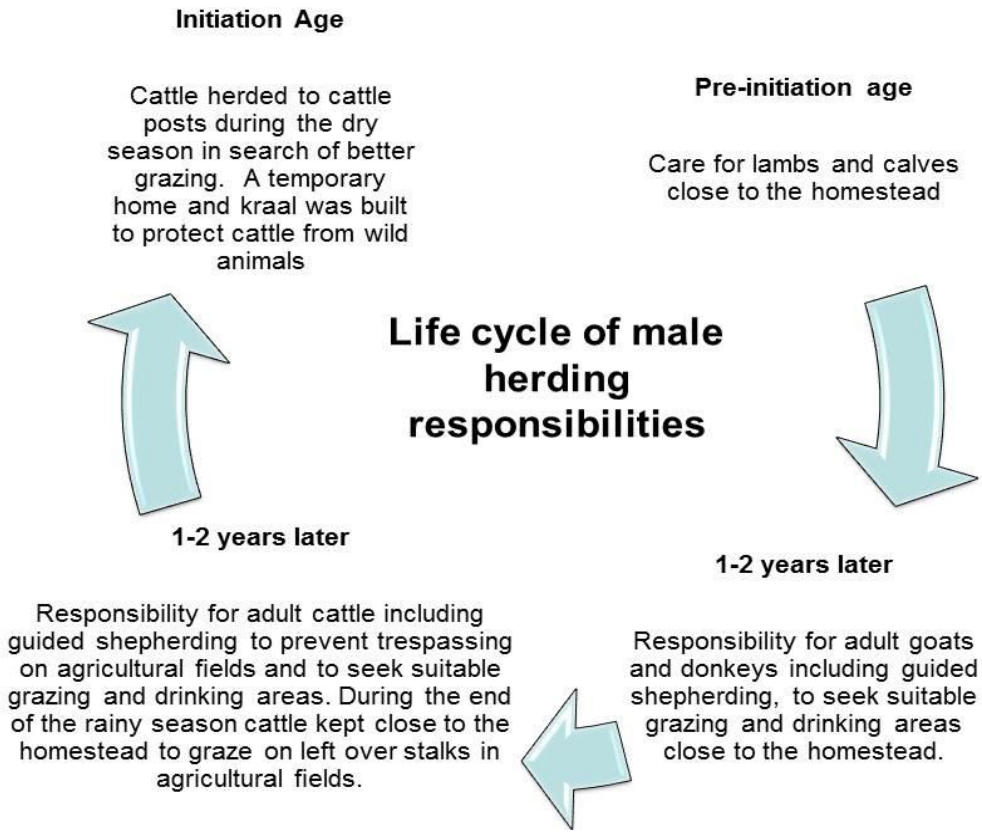


Figure 5.18: Life cycle of male herding responsibilities amongst the Bahananwa.

In the past, young boys would forego an education in order to look after herds of livestock, but many parents now recognise the importance of education and are reluctant to take their children out of school. The migrant labour system contributes to social disruption within the household as large numbers of men seek work in the cities, leaving women alone to head the households (Blouberg Local Municipality, 2013-2016). Furthermore, many younger people do not share ambitions to own livestock and instead seek further education and employment opportunities in the cities. These factors have contributed to the erosion of traditional

management practices and the declining labour force available to manage livestock, shifting the responsibility of herding onto elderly men. A communal farmer explains:

"The youth today are not interested in livestock, when they were very young we used to spend time with them in the bush, showing them how to care for the cattle. But now they don't care, they are at school every day and on the weekends they would rather be with friends or seeing girls, not in the bush. There's nobody to look after the cattle now, apart from us. We also don't have the resources to climb the mountain every day to check on them"

Currently many of the fences and water systems in the communal areas introduced by the apartheid government have been destroyed, rotational camps systems are no longer employed and communal grazing areas are extensively over-grazed (Grwambi et al., 2006). During the dry season (March-September), the condition of the grazing land close to villages is poor, because of a lack of rain, over grazing and high stocking rates of livestock. Cattle and donkeys are left free to graze on the mountain in communal areas, unguarded and not kraaled at night because of the significant distances required for elderly communal farmers to travel to the mountain. Economic considerations related to the labour costs of shepherding livestock, employing livestock guardians and kraaling livestock at night, prevent both farming communities from employing these methods, as discussed in Chapter 8.

In the Blouberg, leopard attacks on livestock and game peaked during September on commercial farms and communal land, coinciding with the start of the calving season and the beginning of the wet season. Palmeira et al (2008) reported high predation rates on cattle by jaguars which were linked to seasonal birth rates during the start of the rainy season. Similar processes may also be operating in the Blouberg where seasonal birth rates of livestock and game peak during the beginning of the rainy season. Rainfall seasons have often been recognised as periods of increased predation activity on livestock (Patterson et al., 2004, Woodroffe and Frank, 2005), while other studies have found the inverse relationship, with high rates of livestock predation during the dry season (Ikanda, 2005). In Africa, higher rates of depredation on livestock have been associated with rainfall patterns, seasonal movements and numbers of wild prey (Patterson et al., 2004, Ikanda, 2005, Woodroffe and Frank, 2005, Kolowski and Holekamp, 2006). Although the current study was unable to assess prey abundance with rainfall the number of livestock attacks occurring during the dry season was significantly higher on communal land compared to commercial farms. Livestock depredation in communal areas may be linked to seasonal changes in livestock grazing patterns. Communal farmers are forced to graze their cattle on the Blouberg Mountain during the dry season,

where leopards are present. An elderly communal farmer explains: “The only grass available during this time is on the mountain. Grazing is too scarce and the cattle are travelling a long distance to search for pasture, like now this loose hay is too dry. Every year when this time comes, the cattle’s fats are going down, then we have no milk. That is the time for the predators. Every time this year, we know we are risking, grazing up there. But we have no other choice.” On communal land, breeding seasons often take place throughout the year, as livestock are free-grazing and mix with other livestock herds. Many cattle give birth in the mountain environment during the dry season thereby, increasing the vulnerability of young calves to leopard attacks.

5.4.4 Bio-physical factors influencing the risk of leopard predation

To my knowledge this is the first time Maxent software has been used to model predation risk for leopards at finite scales although, other studies have used Maxent to model predation risk for the jaguar and puma in Mexico (Rosas-Rosas et al., 2010, Zarco-González et al., 2012, Zarco-González et al., 2013). The selection criteria for the most parsimonious model involved selecting a model with the fewest predictor variables that explained the data adequately. However, the principle of parsimony adds that models produce estimates of reality and that no single model is likely to perform well in all applications (Hilborn, 1997). Therefore, following Yost et al (2008) the effect of different levels of model complexity on the accuracy of the final models was determined. Training and Test AUC values remained consistently high as model complexity declined, with high AUC values indicating good-moderate model performance for both livestock and game. The average training gain showed greater variability and gradually declined with decreasing model complexity and was, therefore, used as the main criterion for model selection (e.g. the model with the fewest predictor variables and an average training gain not significantly different than the model with the highest training gain). The most parsimonious models for livestock and game produced high AUC and average training gain values, indicating good model performance. The distribution of livestock occurrence data for livestock and game attacks coincided with areas of high predation risk, indicating a high level of accuracy for both models. This approach for model criteria is favoured because it produces a level of model complexity that makes it useful to elucidate how specific environmental variables influence the predation risk of species across landscapes. Despite the lower sample size for occurrence points in the game model, Maxent produced high levels of model

performance and accuracy, as documented for other species with wide ranging distributions and few occurrence records (Hernandez et al., 2008).

A combination of anthropogenic and ecological factors were important in predicting the predation risk on livestock, whilst purely ecological factors significantly influenced the probability of attacks on game. The livestock models indicated that increased human activity was associated with a decreased probability of attack on livestock as has also been documented for other studies on leopards (Ogada et al., 2003, Kolowski and Holekamp, 2006). Distance to villages was the most influential predictor of a leopard attack on livestock, with a high risk of predation further away from villages. During the winter months the quality of grazing close to villages is poor so the communal farmers graze their livestock away from villages on the Blouberg Mountain, often leaving their livestock unattended, thereby increasing their vulnerability to leopard attacks. Similar relationships have been observed in the Azad Jamu and Kashmir Himalayas of Pakistan, where the risk of predation by leopards increases when livestock are grazed further away from villages during the summer months (Dar et al., 2009).

Distance to water represented the strongest predictor of game attacks and exerted a moderate effect on the risk of predation on livestock, with the probability of an attack increasing close to water for both prey species. Proximity to streams is an important criterion for leopard habitat selection, with leopard habitat use being greater close to streams in Thailand (Ngoprasert et al., 2007, Simcharoen et al., 2008). Landscape features such as these may provide adequate hunting grounds or attract a high abundance of prey species for leopards (Stephens and Krebs, 1986, Karanth and Sunquist, 2000). The Brak River and river channels flowing through the Blouberg Mountain are attractive for leopards and prey because they offer sources of drinking water and corridors for movement during the summer months when the rivers are dry. The Brak River and mountain river environments are interspersed by forest providing adequate cover for leopards to stalk livestock and game.

Distance to roadways was the third most important variable for predicting risk of predation on livestock, with risk increasing with decreasing distance from roadways as has also been observed for puma attacks on domestic livestock in central Mexico (Zarco-González et al., 2012). Leopards have also been documented for selecting habitats further away from roadways, further highlighting the importance of anthropogenic factors and their impact on leopard behavioural ecology (Hebblewhite et al., 2011).

Proximity to nature reserves was moderately important for predicting livestock and game depredation with the greatest risk close to the borders of reserves, these findings follow other studies on large carnivores (Holmern et al., 2007, Gusset et al., 2009).

Elevation constituted the weakest predictor of predation risk for livestock and produced a moderate effect on the probability of an attack on game species. Risk of predation was greatest at low altitudes (Livestock: 670-780m; Game: 775-790m) and at high altitudes (Livestock: 1540-1760m; Game: 900-920m) reflecting the differences in surface ruggedness across land use types. Surface ruggedness has been found to be an important predictor of the suitability of leopard habitats across South Africa (Swanepoel et al., 2012), and west and central Asia (Gavashelishvili and Lukarevskiy, 2008). The predation risk map for livestock and game indicates that high risk areas are concentrated at the higher elevations of the Blouberg Mountain. Leopard kills were associated with higher elevations in Welgevonden Private Game Reserve, South Africa, possibly to take refuge away from other predators or to avoid kleptoparasitism (Pitman et al., 2012). Mountainous areas are often preferred habitat for leopards because they offer refugia from human persecution compared to lower-lying regions (Norton et al., 1986, Gavashelishvili and Lukarevskiy, 2008).

5.4.5 Visible and hidden impacts of leopard depredation

The impact of livestock depredation on local livelihoods depends on the extent of livestock depredation at the household level and the range of livelihood options available to farmers. Carnivore depredation in the Blouberg represented 2.8% of the total livestock holdings for the Blouberg and does not appear excessive. The total economic loss for livestock due to leopard depredation was higher on commercial farms compared to communal land, despite similar levels of depredation between land use types. Commercial farmers own more expensive cattle breeds such as Bonsmara equating to higher economic losses. Total game losses were considerably lower than livestock losses on commercial farms, with nyala representing the greatest economic cost for game farmers. However, economic costs at the household level induce significant economic impacts for farmers. The average cattle loss of ZAR 12, 182 per household per annum is high compared to losses of game of ZAR 3354 on commercial farms. Overall, there is a lack of published data concerning game, livestock and crop farming profitability in South Africa (Bothma, 2005). However, average annual incomes for white

agricultural households were estimated at ZAR 460, 357 in 2000 for the Limpopo Province (Pauw, 2005). Cattle losses due to leopard depredation represent 2.7% of the estimated annual income for this demographic group. The majority of commercial farmers (79%, n = 15), engage in more than one land use type as a means of diversifying their income by participating in a range of activities including crop, livestock and game farming. Large livestock holdings owned by commercial farmers mitigate the impacts of livestock losses on local livelihoods. The costs of depredation by leopards can be overcome by selling between one to two pregnant Bonsmara cows of ZAR 8776[4] per annum.

In contrast, average economic cattle losses represent 12.4% of total livestock holdings for communal farmers compared to 3% for commercial farmers. Seventy percent of households in the Blouberg receive an estimated annual income of ZAR 18,000 per annum (Capricorn District Municipality, 2013-2014). The average economic loss of cattle on communal land of ZAR 10, 500, per household per annum, constitutes 58% of the estimated annual income in the Blouberg representing significant economic costs for individual households. In extreme cases, donkey losses for farmers represent losses of 25% of their total donkey stock on commercial farms and between 25-60% on communal land. However, donkeys are not considered an economically valuable resource and are mainly used as draught animals on commercial and communal farms. In the Blouberg, livestock are used as an insurance fund during times of economic hardship and sold to generate finances for immediate needs such as paying for food and household necessities. Wealthier families may sell livestock to meet education expenses or to finance business ventures and, in other cases, large livestock herds are maintained as an insurance fund for the future. Whilst some individuals still manipulate livestock as social capital for bride wealth payments, others employ strategies motivated by market considerations.

The following quote aptly summarises the changing economic status of livestock in communal areas. “Malleability of identity, social mobility, and latitude for action have helped to transform social capital of all forms into tactical assets that serve to separate and differentiate individuals rather than integrate them within a collectively” (Turkon, 2003, p. 55).

The changing economic status of livestock and the erosion of traditional livestock sharing systems in the Blouberg reduce the ability of poorer households to cope with livestock depredations and negatively impact livelihoods. Predation by leopards represents the greater

[4] Figure is based on the average cost of a female Bonsmara cow sold in October 2013 (Proveld Bonsmara, 2013)

cost for communal farmers, particularly those that rely on cattle and agricultural activities for subsistence (8%). In contrast, communal farmers earning an additional income from monthly pension grants (61%) and other entrepreneurial activities such as selling vegetables (22%) and employment (9%), provide additional reserves for coping with livestock loss.

Livestock provide many functional benefits to support local livelihoods which are lost when livestock are predated upon by carnivores. Cattle and goats are used by communal farmers for milk and to make butter and a salve for the skin. Livestock products such as skins are used to decorate households, and cattle dung is used as soil stabiliser to build houses and as a protective layer to support walls and floors. Donkeys are used to transport people and to collect firewood and water. Both donkeys and cattle are used as draught animals to plough agricultural fields at the start of the rainy season in September.

Cattle, goats and sheep are also sacrificed during celebrations such as marriages, birthdays, welcoming newborn children to a family and also for funerals to mourn the death of deceased family members. Cattle represent the highest form of sacrifice in Sotho culture to appease or ensure success with ancestral spirits and as a means of obtaining health, prosperity and happiness (Mönnig, 1967). The loss of livestock is perceived by one communal farmer as a loss of an important spiritual resource in order to maintain a harmonious relationship with his ancestors:

“When you lose one of your cattle, it’s not just about the money you could lose, but also those cultural things you lose alongside it. We slaughter cattle and goats, as gifts to our ancestors. When we are having hard times we slaughter a cow, to help that situation. Our livestock are gifts for the ancestors they help us to keep a good relationship together. Without those things, our relationship could get worse, and bad things might happen because we can’t make the ancestors happy.”

Cattle are valued more highly by communal farmers than other livestock species. Cattle are loved by their owners. In some instances communal farmers referred to cattle as their “children” and associated cattle losses with feelings of diminished wellbeing. A communal farmer said: “I love my cattle, you can say they are like my children, we love and care for them when they are young. When they are taken away from us, it hits us hard, as if you lost a close relative. It makes me sad and I no longer feel happy. It is worse when you do not know what happened to it and you can’t find the carcass. It causes more stress not knowing what happened.” Similarly, commercial farmers express feelings of diminished wellbeing when articulating their thoughts about livestock losses. A commercial farmer said: “It’s sad on our

farm to see an attack on one of our stock. We put a lot of hard work and time into rearing that animal and you just feel it's a bit of a waste."

In other contexts, the loss of cattle was perceived by several farmers as a cause of cultural decay. An elderly communal farmer explains: "Cattle are part of our culture, since we were born and before us we had lots of cattle, but those predators killing our cattle are also killing our culture." Similarly, another communal farmer states: "These days we farmers do not own as many cattle as we had before, the younger generation are no longer interested in staying in these rural areas and keeping livestock. Predators taking our livestock contribute to the decline in livestock, and it's a sad thing because it just reminds us that our culture is dying out as well." Overall, livestock loss represents both visible and hidden costs for both farming communities. Livestock loss induces significant economic costs for communal farmers as well as the loss of functional and material benefits and causes a sense of diminished wellbeing amongst both farming groups. For communal farmers hidden costs translate into a loss of social capital, a spiritual resource and perceived cultural decay.

5.5 Conclusion

The bio-physical and social factors influencing the risk of leopard predation on game and livestock and the visible and hidden impacts of depredation incidents on farming communities are summarised in Fig. 5.19. The risk of predation by leopards depend on the characteristics of livestock and game for example, preferred prey for leopards vary from 10-40kg and are predominantly young calves, donkey foals, young nyala, impala and warthog. Temporal and seasonal characteristics influence the probability of an attack by a leopard, which peaks during the dry season and the start of the calving and rainy season in September. The risk of predation increases with increasing distance from areas of human habitation, including villages and roadways and increases close to water sources, the borders of nature reserves, low elevations (Livestock: 670-780m; Game: 775-790m) and high altitudes (Livestock: 1540-1760m; Game: 900-920m). Traditional management livestock strategies include shepherding, livestock-guardian dogs and penning livestock in night-time kraals, have eroded with changing land use systems, the historical eradication of large carnivores from the area and the perceived high economic costs of implementing these strategies, increasing the risk of predation on livestock. A lack of social reciprocity amongst villagers and alternative livelihood strategies limits the ability of vulnerable groups such as communal farmers to overcome the costs of predation.

These collective processes induce a series of visible and hidden impacts that negatively impact the economic security and the wellbeing of affected farmers (Fig. 5.19).

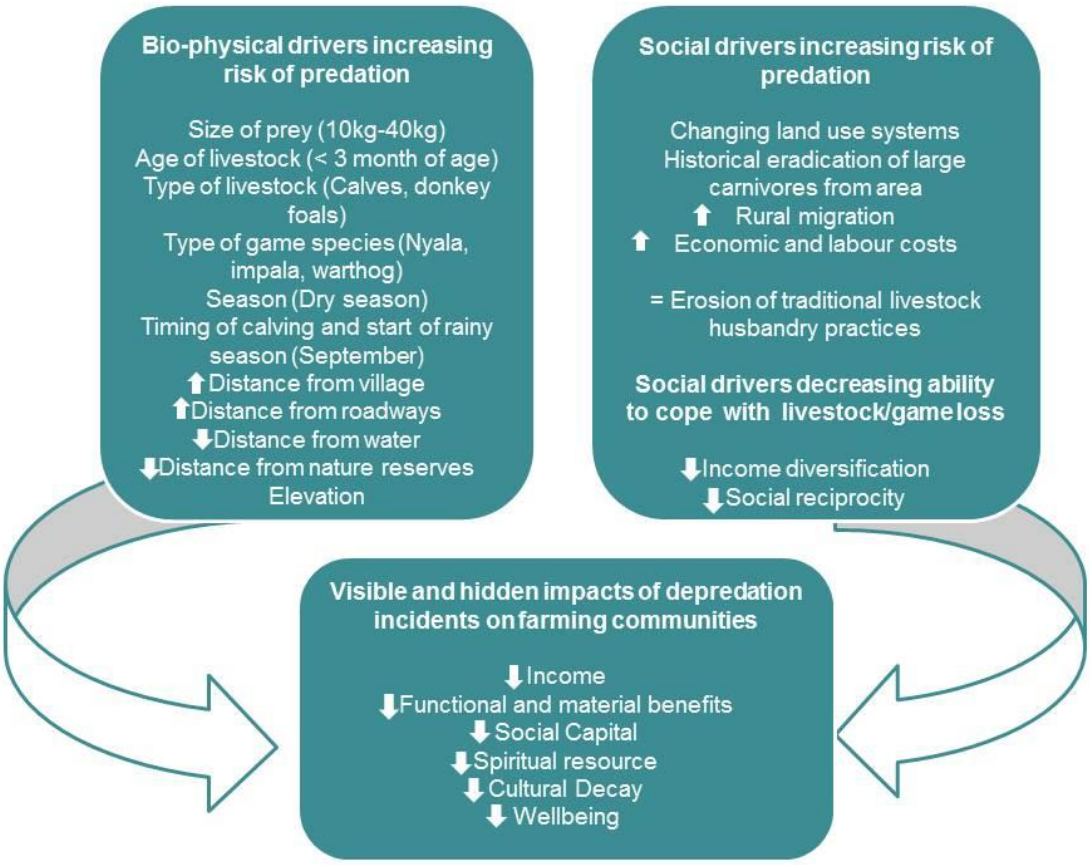


Figure 5.19: Bio-physical and social factors influencing the risk of predation and the visible and hidden impacts on farming communities. Small white arrows pointing upwards represent an increase and arrows pointing downwards represent a decrease.

Chapter 6

Estimates of leopard population density and occupancy at finite spatial scales within a multi-use land system

6.1 Introduction

The widespread distribution, ecological flexibility and resilience of leopards often results in this species being classified as a low conservation priority (Nowell and Jackson, 1996), but regional populations are increasingly threatened, because leopards occur at low densities, have extensive habitat requirements and regularly come into conflict with humans (Cardillo et al., 2004). Human-wildlife conflict often results in the persecution of carnivores influencing the population status and spatial distribution of species across landscapes (Novaro et al., 2005, Balme et al., 2010a). Leopard populations are divided into meta-populations with their core populations maintained in protected areas (Friedman and Daly, 2004). Meta-populations consist of a network of semi-isolated populations maintained through regular or intermittent migration sustaining gene flow between populations (Meffe and Carroll, Groom et al., 2006). Source-sink dynamics are maintained through immigration of individuals from source populations balancing the ecological system as a whole through regular dispersal of individuals (Delibes et al., 2001).

Protected areas provide refuges for large carnivores and serve as source populations for surrounding areas, but they are often not large enough to maintain viable populations (Woodroffe and Ginsberg, 1998). Large carnivores often range beyond reserve boundaries where they come into conflict with people, high rates of mortality can produce population sinks if mortality rates are not balanced by reproduction and immigration (Woodroffe and Ginsberg, 1998, Woodroffe, 2001, Balme et al., 2010a). Human-induced edge effects can induce localised population declines at the peripheries of protected areas (Woodroffe and Ginsberg, 1998, Balme et al., 2010a). Whilst a plethora of studies have focused on leopard ecology and behaviour within protected areas, their status outside protected areas has received less attention, 85% of leopard research in South Africa is conducted inside protected areas (Balme et al., 2014). Protected areas contribute only 32% of suitable leopard habitat in South Africa (Swanepoel et al., 2012). Thus identifying the population status of leopards on

private land is necessary to inform conservation efforts for the species (Swanepoel et al., 2012). Currently the majority of suitable habitat for leopards (72%) in the Limpopo Province resides outside protected areas (Swanepoel et al., 2012).

Anthropogenic pressures, including legal and illegal off-take due to hunting pressure and human persecution, as well as habitat conversion, are important factors influencing leopard density and distribution (Balme et al., 2010a, Balme et al., 2010b, Chapman and Balme, 2010, Swanepoel et al., 2012). The extent of livestock farming is a major factor influencing fragmentation of leopard populations in South Africa, because small ruminants and other livestock species are a preferred prey size for leopards. As a result leopards are often persecuted by farmers (Norton et al., 1986, Hayward et al., 2006, Swanepoel et al., 2012). The conversion of land for game farming in South Africa has also increased the availability of small and medium sized ungulate species leading to the recolonisation of leopards into areas outside of protected areas (Lindsey et al., 2009). The introduction of game farming introduces a new type of conflict as a result of predation on economically expensive game species, resulting in the persecution of leopard populations by game farmers. Game farms may function as "attractive sinks" or "ecological traps" because they represent areas with disproportionate mortality that otherwise provide suitable resources for leopards (Delibes et al., 2001, Sherman and Runge, 2002). High rates of mortality also impact population structure and demography of carnivores across small spatial scales (Logan and Sweanor, 2001, Balme et al., 2010a, Chapman and Balme, 2010). Research on lynx show that populations experiencing high levels of mortality are characterised by high numbers of dispersing sub-adults recolonising vacant territories due to the removal of adults from the population (Zimmermann et al., 2005). Many carnivores also display sex-biased dispersal rates of juvenile males (Chepko-Sade and Halpin, 1987, Zimmermann et al., 2005). The immigration of sub-adults into a population may mask the effects of population decline caused by high rates of persecution leading to the misidentification of potential source populations (Howe et al., 1991, Robinson et al., 2008). Therefore, taking into consideration the sex and age classes of individuals identified within a survey may provide more accurate insights into the population status of leopard populations in different land use types. Practical and accurate methods for estimating population numbers and monitoring demographic trends are key priorities in identifying areas of high conservation concern.

The suitability of habitats for leopards, as well as the population status of leopards (density and distribution) are dependent on a number of ecological constraints. The normalised difference vegetation index (NDVI,) measures photosynthetically active biomass and its

associated bioclimatic variables, which is important for predicting suitable leopard habitat (Swanepoel et al., 2012). NDVI indices are associated with other ecological factors known to shape leopard density and distribution, including the abundance of prey species, water and vegetation cover (Gould, 2000). The abundance of large carnivores is limited by the abundance of its prey species, thus carnivore density is party determined by differences in prey biomass and abundance across landscapes (Carbone et al., 2001, Karanth et al., 2004). Consideration of the underlying ecological and anthropogenic factors shaping leopard population density and occupancy is important for informing the key factors driving human-leopard conflict. Furthermore a comparative analysis of leopard population status within and outside of protected areas addresses a deficit in the research literature by contributing further to our knowledge of the population status outside of protected areas (Balme et al., 2014). Moreover, there is a demand for reliable estimations of leopard numbers, both provincially and nationally, in South Africa to inform trophy hunting quotas and the issuing of damage-causing animal permits (Balme et al. 2010a; Chapter 1).

In this chapter, I first apply data produced from camera trap surveys to estimate and compare leopard density in the Blouberg Nature Reserve (BNR) and commercial farms. Secondly, I assess the sex ratio and age of leopards present in the BNR and commercial farms to establish potential differences in population structure between surveys. Finally, I examine the impact of anthropogenic and ecological factors influencing leopard occupancy across land use types. I later apply the results of this chapter to provide recommendations on the management and conservation of leopard populations and the development of mitigation strategies to manage human-leopard conflicts in the Blouberg Mountain Range (Chapter 9). The results of this chapter also contribute further to providing data on leopard numbers in the area to inform trophy hunting quotas for the Province.

6.2 Methods

6.2.1 Camera trap surveys

Camera trapping provides a non-invasive method for monitoring rare and elusive species (Dinata et al., 2008) and has been useful in identifying the population status of species, estimates of density (Karanth, 1995, O'Brien et al., 2003), presence-absence relative abundance (Jackson et al., 2006) and species composition (Azlan and Sharma, 2006). Camera trap surveys used to estimate density are based on a capture-recapture statistical framework, in which cameras are used to photograph individuals of a specific species (Karanth, 1995). Animals are photographed by cameras triggered by infrared remote sensors as the animal walks through the beam. Capture-recapture frameworks have been adopted to estimate the density of large felids including tigers (Karanth and Nichols, 1998, Karanth et al., 2006), jaguars (Maffei et al., 2004, Soisalo and Cavalcanti, 2006), snow leopards (Jackson et al., 2006), cheetahs (Marnewick et al., 2008) and leopards throughout their range (Edgaonkar, 2008, Stein et al., 2008, Balme et al., 2009, Steyn and Funston, 2009, Wang and Macdonald, 2009, Balme et al., 2010a) based on their uniquely identifiable pelage markings. Identification of individuals of a specific species allows one to develop a history of recaptures for each individual photographed (Karanth, 1995).

Estimations of density using these methods require that abundance estimates are converted to density estimates by dividing abundance by the effective sampling area (Noss et al., 2012a). The sampling area within which individuals in a population exist is spatially organised because individuals have home ranges and territories within these areas (Royle et al., 2011). Calculation of the spatial area where individuals persist is problematic because the area cannot be precisely delineated and capture-recapture models assume that the survey is carried out on a closed population from which there are no births, deaths, immigration or emigration of individuals during the survey (Karanth, 1995). The movement of individuals into and outside of the camera trapping area can violate population closure assumptions introducing heterogeneity in capture probabilities (Royle et al., 2011). Historically an effective sampling area in camera trap surveys included an enlarged area surrounding the camera trap array calculated by applying a buffer determined by the mean maximum distance moved (MMDM) or half the mean maximum distance moved (HMMDM) for each individual captured at > two camera trap sites (Wilson and Anderson, 1985, Karanth and Nichols, 1998, O'Brien, 2011).

HMMDM and MMDM are often used as a surrogate for the home range radius or diameter of the species concerned but lack a theoretical approach to link abundance with the survey area in order to estimate density (Williams et al., 2002).

Several studies have reported that HMMDM buffers underestimate the effective sampled area, consequently overestimating population density estimates (Parmenter et al., 2003, Soisalo and Cavalcanti, 2006, Dillon and Kelly, 2008). Moreover, MMDM may underestimate at lower densities and overestimate at high densities, declining as capture probabilities increase (Parmenter et al., 2003). The use of either method requires additional considerations of the size of the trapping grid, the spacing of camera trap sites as well as the size of the study area (Maffei et al., 2011, Tobler and Powell, 2013). Movement patterns may vary between study areas due to seasonality and between species, thus such generalisations of the most effective method are difficult to determine (O'Brien, 2011). Radio telemetry can overcome some of these problems by providing more accurate estimations of movement patterns compared to camera trap surveys but this information is lacking in most studies (Soisalo and Cavalcanti, 2006).

Researchers have questioned the seemingly ad hoc process of estimating the effective sampling area (Efford et al., 2004, Gardner et al., 2009, Royle, 2009, Singh et al., 2010). Spatial capture-recapture models overcome the problems of estimating the effective sampling area and heterogeneity in capture probabilities by incorporating information on the spatial locations of capture histories and camera traps. Individual activity centres and the density of these activity centres are embedded within a larger area named the state-space, containing the trapping array (Royle, 2009, Singh et al., 2010, Sollmann et al., 2011). Two types of spatial capture-recapture models have been applied to estimate population density; a maximum likelihood (Efford et al., 2009) and Bayesian framework (Royle, 2009). The latter approach is important for estimating density using small sample sizes (Kery et al., 2011).

In cases where animals are not individually identifiable, camera trap data has been used to develop relative abundance indices that can be used as a proxy for the abundance of prey species (Carbone et al., 2002). However, there are considerable debates questioning whether the observed variation in count statistics is due to differences in animal abundance or detection probabilities between sites (Jennelle et al., 2002). Through adaptation of the traditional capture-recapture framework, estimations of the proportion of an area occupied (ψ) by a single species provide an alternative state variable to abundance, where species are detected or not at particular sites (MacKenzie et al., 2002). Occupancy models assume that not

all species will be detected over the course of a survey period, giving rise to false absences where species fail to be detected. This source of variation is important for cryptic carnivores that occur at low densities or are not widely distributed over an area resulting in imperfect detection probabilities (MacKenzie et al., 2002). Thus, the probability of detection in which at least one individual of the species is detected during a sampling occasion is accounted for in the modelling process (MacKenzie et al., 2002). Occupancy models can be used to estimate the occurrence of species across landscapes (Karanth and Nichols, 2002, MacKenzie, 2006), area specific variation on probabilities of occupancy (MacKenzie and Royle, 2005) and to assess the impact of different environmental and anthropogenic covariates on occupancy rates (MacKenzie, 2006, Linkie et al., 2007a). Camera trap surveys were conducted to estimate the impact of biological and anthropogenic factors influencing the density, occupancy and population structure of leopards in a range of land use types in the Blouberg.

A total of three camera trapping surveys were carried out using 30 Bushnell® Trail cameras (Trophy, model, 2010, Non Typical Inc., USA). The first survey was conducted within a 54.43km^2 protected area named the BNR, the second survey was carried out on 55.20km^2 of commercial farming land composed of cattle and game farms and the third survey was undertaken on 31.77km^2 communal land on the Blouberg Mountain (Fig. 6.1). Capture rates of leopards must be high enough to maximise the capture probability of all animals in the sampled area, therefore, cameras must be positioned in areas that frequent leopard activity (Karanth, 1995; Karanth and Nichols, 2002; Silver, 2004). Potential camera locations were identified and their positions recorded with a handheld eTrex Vista Hcx Garmin global positioning system (GPS) using the knowledge of local landowners to identify areas along roadways, close to waterways as well as game and cattle trails, indicative of previous leopard activity (through tracks, scats or physical sightings). The locations of camera sites were downloaded into a base map using ArcGIS v. 10 (ESRI Inc.).

Camera trap surveys assume that every animal inhabiting the study area has at least some probability of being photographed. This can be ensured by placing one camera trap within the range of a leopard during the survey (Karanth, 1995). Therefore, the maximum distance between cameras traps should include the smallest home range size for the target species (Silver, 2004). Female leopards with young tend to occupy smaller home ranges compared to males (Bailey, 1993). A literature search revealed that the smallest home range size of a female leopard ever recorded was 8.8km^2 (Grassman, 1999). Based on suggestions provided by Silver (2004), the diameter of this area represents the maximum distance between cameras. The diameter of a circle of 8.8km^2 is 3.35km, which represents the maximum distance between the

cameras in the study site. Currently there is no restriction on the minimum distance between cameras (Chase-Grey, 2011). Gaps between cameras were filled to ensure that no holes existed in the trapping grid, which were large enough to encompass the smallest home range of a female leopard with young by maintaining a distance < 3.35km between camera traps. Mean camera distances +/- S.E.M. for the BNR, commercial farms and communal land were 2.66 +/- 0.06, 2.63 +/- 0.07 and 2.62km +/- 0.09, respectively.

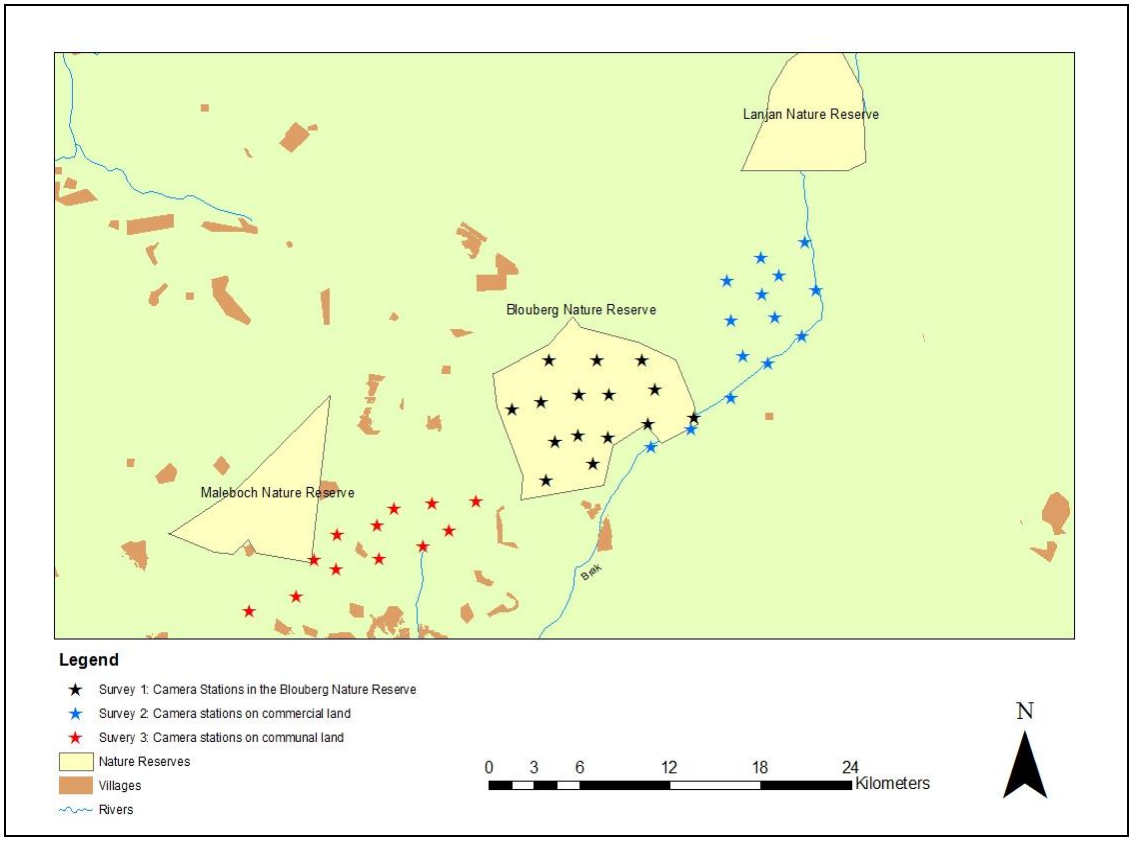


Figure 6.1: Map of study area showing the locations of camera surveys in the Blouberg Nature Reserve, commercial farms and communal land.

A pilot study of four weeks was conducted to test the effectiveness of the camera trap locations prior to each survey. Cameras were set up in pairs positioned opposite one another with a maximum of six metres between them to allow simultaneous identification of leopards from each flank. Cameras were attached to trees or wooden stakes, which were driven into the ground at a height of 40cm above the ground which was considered the shoulder height of an adult leopard (Henschel and Ray, 2003). Cameras were protected by metal cases and locked with padlocks in order to protect the cameras from animals and thieves. However, during the course of the study two cameras were stolen in the BNR as well as two from commercial farms

and four from communal land. The traps were set for 60 nights with 24 hours within a day constituting a single sampling occasion (BNR: 7th March-5th May 2011; Commercial Farms: 6th July-3rd September 2011; Communal land: 28th October-26th December 2011). The survey duration was deemed short enough to satisfy population closure assumptions of capture-recapture models, as camera trap surveys of eight to twelve weeks are recommended for leopards (Henschel and Ray, 2003). The delay between consecutive photographs was set for one minute and the sensitivity of cameras was set to medium. Cameras were checked every two weeks for the BNR and commercial farms but a longer period of three weeks was needed on communal land, due to the considerable hiking distances and terrain that needed to be traversed. Photographs were uploaded into the programme Camera Base v. 1.5.1 (Tobler, 2007). Ethical approval from the Durham University Life Sciences Ethical Review Panel was granted to allow the non-invasive camera trapping of leopards and other non-target species.

6.2.2 Data analysis

6.2.2.1 SPACECAP

The spatial capture-recapture model SPACECAP (Singh et al., 2010) was employed within the R statistical package (R Development Core Team 2012) to estimate leopard population density within the BNR and on commercial farms. Only two individuals were captured once each on communal land and so sample sizes were not large enough to reliably estimate density. SPACECAP uses information provided from capture histories of individuals and the spatial locations of captures and using a unified Bayesian modelling framework to estimate density (Royle et al., 2009). The core assumptions of spatial capture-recapture models are that individuals have independent activity centres within fixed locations, trap encounter probability decreases with increasing distance from individuals' activity centres and each capture is an independent event (Efford et al., 2004, Royle, 2009). Leopards were individually identified from photographs by comparing their distinct pelage patterns, sexed (observation of the genital area, body size or females with cubs) and aged (size of dewlap, facial and ear scarring, examination of the genital area) as cubs < one year of age, sub-adults < two years of age and adults > two years of age according to recommendations by Balme et al (2012) (Fig. 6.2). The

sex and age of leopards were corroborated with four other leopard researchers working in the region.

Figure 6.2: Camera trap photograph of a male leopard, the rosette markings on the flanks of the leopard are unique and used to identify individuals.

Individual capture histories were constructed in a standard X-matrix format with rows representing capture histories of each captured individual and columns representing captures per sampling occasion (Table 6.2-6.3). Cubs were excluded from the analysis because they have been found to have low capture probabilities (Karanth, 1995). Camera trap days were divided into 15 sampling occasions with each sampling occasion representing four consecutive camera trap nights as these number of sampling occasions satisfied population closure measures using the Programme CloseTest 3.0 (Otis et al., 1978). Trap deployment details included a binary matrix indicating the number of occasions when each camera trap was operational (= 1) and not operational (= 0) due to damage, theft or flat batteries. In two incidents where camera traps (constituting a camera trap pair) had been stolen, the number of

days that this camera was inactive was accounted for in the trap deployment details and the subsequent analysis.

The trapping array was embedded within a larger area named the state-space which is assumed to be large enough to ensure that no individual outside of the state-space had a probability of being captured in the camera trapping array (Gopalaswamy et al., 2012). The state-space was determined by employing a buffer around a rectangle polygon named the "minimum area rectangle" linking the outermost cameras of the trapping array using the statistical software ArcGIS (Gopalaswamy et al., 2012). The buffer size was determined by using the largest MMDM of 5.29km increasing with increments of 5.29km until the density estimates began to stabilise at 26.45km (Appendix 3). The same buffer width of 26.45km was also applied to estimate leopard density on commercial farms in order to ensure consistency between results. The state-space consisted of a mesh of equally spaced potential home range centres, set 1km apart (1km^2 pixel) covering the camera trap area and the extended area surrounding it. Home range centres were classified as being within suitable leopard habitat (= 1) and unsuitable habitat (= 0) (e.g. villages, roadways and water bodies) provided by the input matrix of potential home range centres (Fig. 6.3-6.4). X and Y coordinates for potential home range centres (Universal Transverse Mercator Coordinate System) and the suitability of habitats were incorporated as data files for analysis in SPACECAP.

The following model definitions were used: trap response present, spatial capture-recapture, half normal detection function and Bernoulli's encounter model. The trap response accounts for behavioural responses of individuals such that the probability of a repeated detection at a camera trap increases subject to initial captures at that same camera trap site (Gopalaswamy et al., 2012). The Bernoulli encounter model was used because individuals are assumed to only encounter a trap once per trapping occasion in which the probability of capture declines with distance between home range centres and camera traps (Efford et al., 2004, Royle, 2009). Bayesian analysis of the model in the BNR was conducted using one Markov chain Monte Carlo with 100,000 iterations, a burn in of 10,000, thinning rate of one and a data augmentation value of 304 (38 times the total number of individuals identified in the survey). Data from the commercial farms were analysed using 200,000 iterations, a burn in of 60,000, a thinning rate of one and a data augmentation value of 304 to ensure convergence of the model. The value for data augmentation was assessed by the distribution of "Nsuper" by ensuring that data augmentation value was larger than the NSuper 95% upper HPD level produced from the model output (Noss et al., 2012b). Convergence of the model was assessed by visual

examination of the chains and the Geweke statistic, such that Z scores > 1.6 indicate that the chains have not converged (Gopalaswamy et al., 2012).

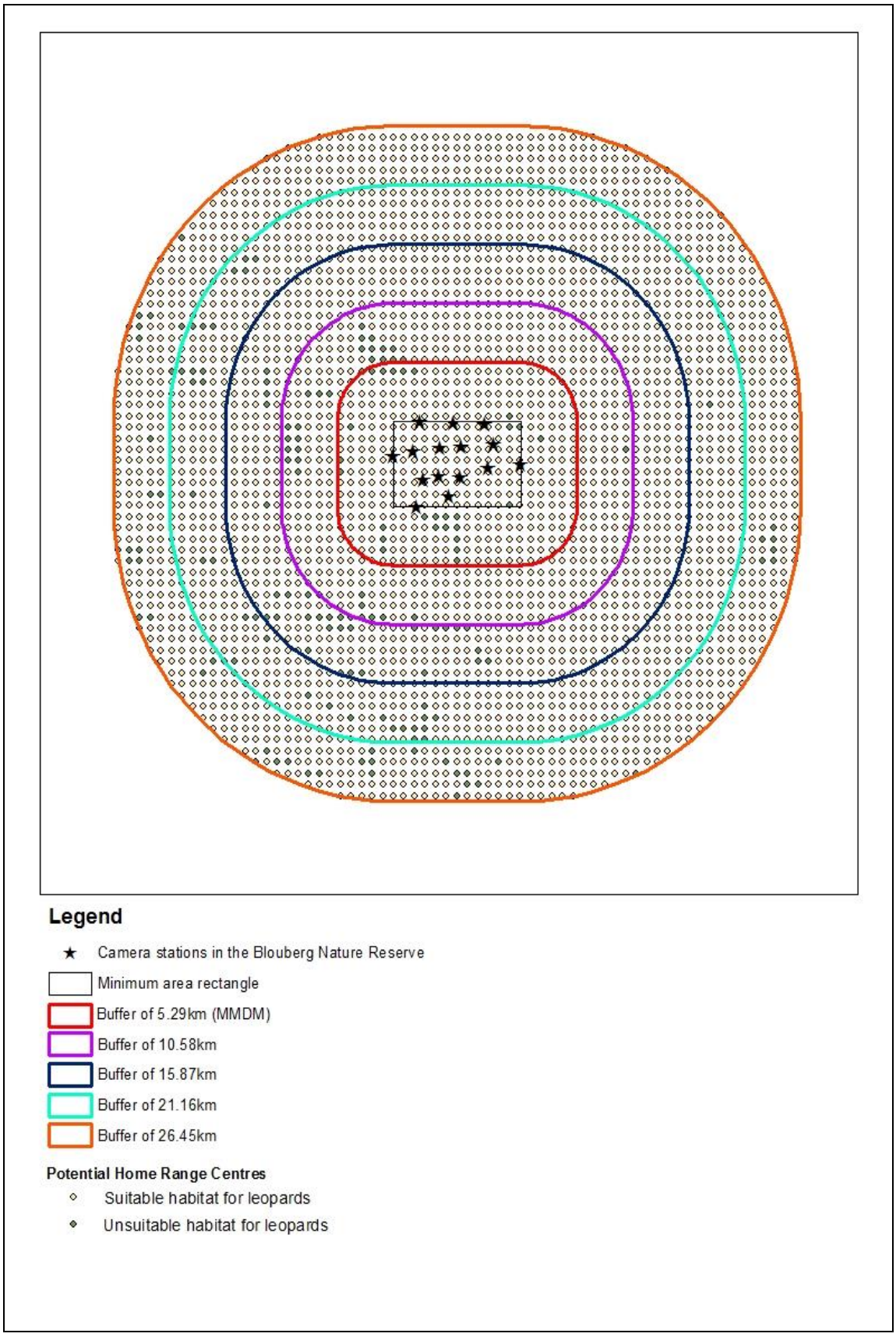


Figure 6.3: Map showing different buffer widths forming the state-space around the camera trapping array and potential home range centres for leopard in the BNR.

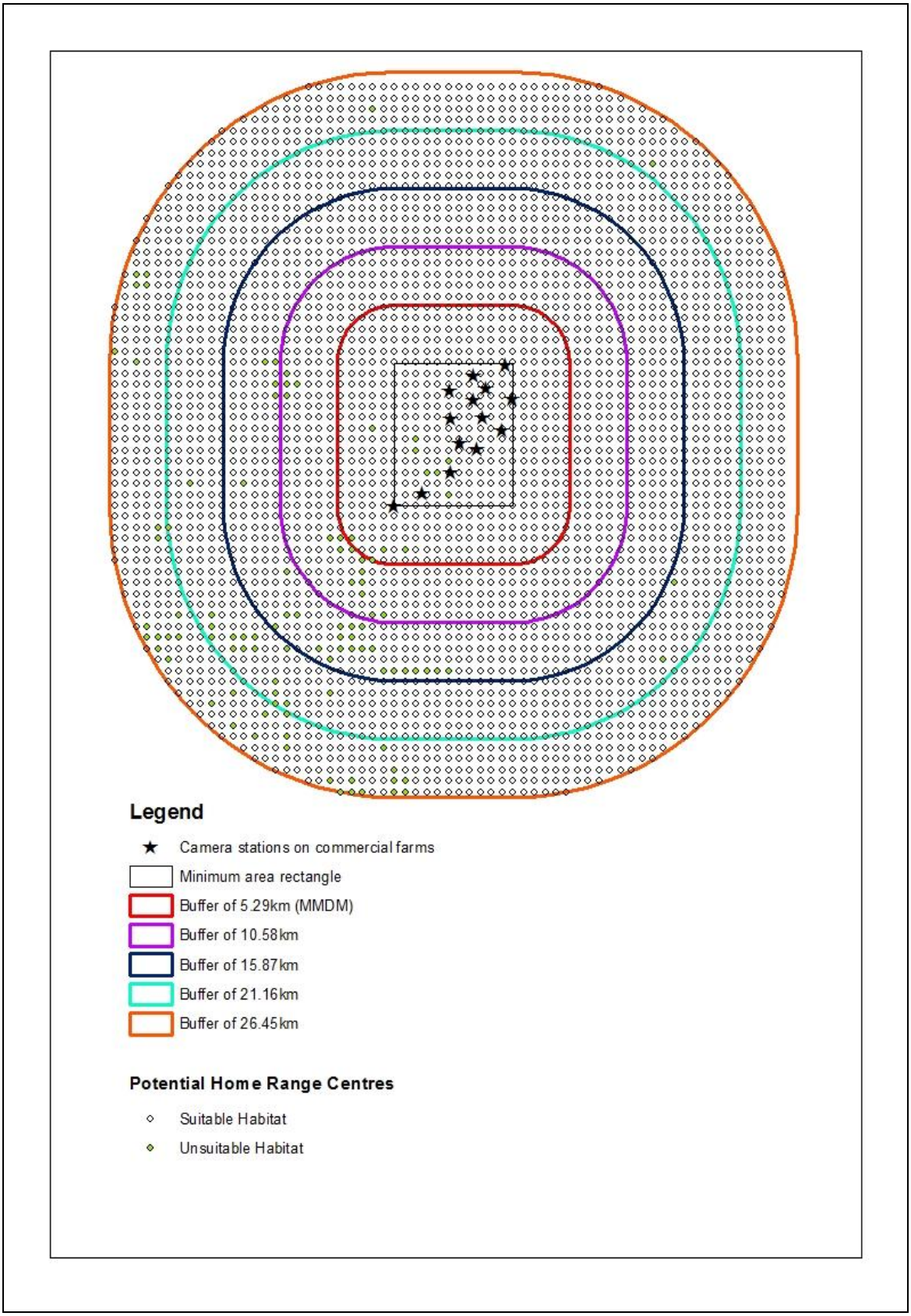


Figure 6.4: Map showing different buffer widths forming the state-space around the camera trapping array and potential home range centres for leopard on commercial farms.

6.2.2.2 Occupancy Analysis

Occupancy in this study is defined as the proportion of the study site which is occupied by a leopard. Occupancy models are based on several assumptions first leopard occupancy should not have changed over the study for example, population closure must be ensured (MacKenzie et al., 2002, MacKenzie, 2006). Similar to the density analysis a standard X-matrix format was constructed with rows representing the capture histories of leopards at each camera trap site and fifteen sampling occasions consisting of four consecutive nights were pooled from each 60 day survey in order to satisfy population closure following Kent et al. 2011. Where camera stations were inactive for more than one day during a sampling period because of theft from the camera trap survey, the data point for that period was entered as a missing observation and accounted for in the statistical analysis. Detection histories were produced for each of the three camera surveys and pooled together as one data set obtaining a total sample size of $n = 40$ and analysed using the programme PRESENCE v5.8 (Hines, 2006). One camera in the BNR was positioned < 1km from a camera location on a commercial farm and was removed from the analysis to ensure consistency between camera trap distances. Secondly, leopards should be correctly identifiable during the surveys this measure was satisfied as all leopards were able to be uniquely identified from their distinct pelage markings (MacKenzie et al., 2002, MacKenzie, 2006). Thirdly, survey sites should be independent otherwise a form of detection heterogeneity is introduced into the modelling process (MacKenzie et al., 2002, MacKenzie, 2006). Camera traps are considered to be a non-intrusive form of population monitoring therefore, camera traps should not affect leopard behaviour however, the spacing between camera traps was < 3.35km and considering the mobility of the study species, occupancy rates are spatially autocorrelated because the state of occupancy at a given site is likely to be influenced by the occupancy states of other sites located nearby. To account for spatial autocorrelation an auto-covariate value was populated for each camera station per sampling occasion and modelled as a function of occupancy such that the occupancy of a site is conditional of the value of all sites in the neighbourhood (Besag et al., 1991). The auto-covariate value was calculated where $y_i =$ 1 or 0 for occupied sites in a set, J_i is defined as the neighbours of site i and $w_{ij} = 1/h_i$ where h_{ij} is the distance between site i and j (Moore and Swihart, 2005).

$$auto\,\mathrm{cov}_i = \frac{\sum_{j=1}^{Ji} w_{ij} y_j}{\sum_{j=1}^{Ji} w_{ij}},$$

The neighbourhood of each camera station is expressed as all camera traps within the radius of a leopard home range. Spatial capture-recapture models produce an estimate of the shape of the half-normal detection function σ that can be converted into an estimate of home range radius (Noss et al., 2012b). SPACECAP produces a value for σ that can be converted into the half normal shape parameter of σ using the equation √ ((σ/2) x 5) (Noss et al., 2012b). Subsequently, this value is used to estimate the radius of a leopard home range radius (km).

Finally, the probability of occupancy is assumed to be constant across all sites or is a function of a site covariate (MacKenzie et al., 2002, MacKenzie, 2006). The probability of occupancy and the probability of detection were modelled as a function of covariates to determine the variables that best explain overall leopard occupancy within the survey area. Covariates can be incorporated into the model to estimate occupancy or detection probability and can be either site (per camera trap) or survey specific. At each camera station variables were measured and incorporated as covariates in the modelling process. Elevation data (m) were extracted from a digital elevation model (DEM) of the study area downloaded via the ArcGIS online capabilities in ArcMap v.10 (ESRI, Inc., 2010) (accessed on the 22nd May 2012) using a 30 arc-second DEM of Africa and the extract values to points tool in ArcGIS spatial analyst tools. Distance to villages, roadways, water and nature reserves were determined by calculating Euclidean distances (km) in ArcGIS using spatial analyst tools to produce raster-based distance maps with a cell size of 20x20m^2. Distance to water was estimated as the Euclidean distance to artificial water points, river channels and inland reservoirs, whilst distance to roadways included Euclidean distances to primary and secondary roadways.

Capture rates were expressed as RAI values calculated for people (visitors, rangers, poachers, villagers, hunters, farmers), small and large naturally occurring prey species and livestock (goats, sheep, donkeys, and cattle), which were obtained for each camera station and defined as the number of independent photographs/100 trap days (O'Brien et al., 2003). Data were filtered to exclude photographs of the same species/people at the same station within a 60 minute period to ensure photographic rates were independent (Tobler et al., 2009). Only naturally occurring prey species known to be predated on by leopards as identified by Hayward et al (2006) were included in the analysis. The body mass of all prey species predated

on by leopards as identified by Hayward et al. (2006) was used as a guideline in this study to classify prey into small (< 40kg) and large (> 40kg) prey categories (Appendix 2). Prey species < 5kg were not included in the analysis due to their low sample sizes. All independent photographs for each prey species, livestock type and person were added together to obtain a single RAI value for each camera station. All RAI values for all species captured during the camera trap surveys are summarised in Appendix 2. The South African National Land-cover data (1994) obtained from Department of Limpopo Economic Development, Environment and Tourism was used to categorise each camera trap station as occupying either Forest/Woodland (= 1) or Thicket/Bushland (= 0). Camera trap surveys in the BNR extended from the end of the wet season into the dry season, whilst surveys on commercial farms and communal land were undertaken during the dry and wet season, respectively. Time constraints and the long survey period meant that repeat surveys could not be conducted between sites, representing a limitation of the study. Carrying out the camera trap surveys in different seasons on different land use types may introduce a form of detection heterogeneity, which in turn may over or underestimate occupancy estimates. This effect was controlled for in the analysis by modelling season as a covariate to assess the effect of season on occupancy rates. Camera traps within each sampling occasion were categorised as being active during either the wet (= 1) season from October-March or the dry (= 0) season from April-September.

Covariates for sites were assessed for multicollinearity using Spearman's rank correlation (SRC) and only pairwise correlation coefficients of less than 0.75 were included in the analysis. Elevation and distance to roadways were correlated (SRC: $r_s = 0.849$, N = 40, $P < 0.001$) and the RAI of people and distance to village (SRC: $r_s = 0.862$, N = 40, $P < 0.001$). Therefore, elevation and the RAI of people were removed from the analysis as preliminary tests showed that these variables had minimal effect on occupancy rates. All other variables had pairwise coefficients less than 0.75 and were included in the analysis (distance to roadways, distance to water, distance to villages, habitat type and RAI values for small and large prey species and livestock). To avoid potential problems during the numerical optimisation of the likelihood result, the continuous predictor variables were standardised where x_i = an observed covariate value, a = the average of the covariate values and $b =$ 100 (if units in m) or one (if units in km) so that a one unit change of the standardised covariate shows a measureable change in scale with changes in parameters (MacKenzie, 2012).

$$x_i = \frac{x_i - a}{b}$$

RAI values for people, small and large prey and livestock were not transformed because their values were close to zero. Categorical variables were dummy coded as indicator variables. Occupancy and detection probability were modelled first as constant across all sites represented as ψ (.) p (.) and as a function of covariates (ψ (covariate) p (covariate). A naïve occupancy and actual occupancy were calculated. The naïve occupancy assumes that non-detections at sites represent true absences where $p = 1$ (Linkie et al., 2007b, Ghoddousi et al., 2010). In contrast, actual occupancy measures non-detections at sites as either true absences, or non-detection when present at sites (false absences) (Ghoddousi et al., 2010). Candidate set of models were then produced where the probability of occupancy was modelled singly as a function of distance to roadways, distance to water, distance to villages, habitat type and capture rates for small and large prey species and livestock with all environmental and anthropogenic covariates inclusive of the auto-covariate. The probability of detecting leopards at camera stations (p) was modelled as a function of habitat type, distance to water, season or as constant p (.). Models were constructed with < five parameters to ensure that the ratio of sample size (n) to parameters (k) was > eight to avoid over parameterisation of the model. Finally, camera trap survey was modelled as a function of occupancy as ψ (survey) p (.) to estimate occupancy rates between survey areas. Model selection was based on ΔAIC values for occupancy models < two and in situations where more than one model persisted then model-averaging was performed for each of the parameter estimates (Burnham and Anderson, 2002). Weighted means of ψ and p were calculated following (MacKenzie, 2006, Linkie et al., 2007b) where n = the number of best models outputs:

$$\psi = \sum_{n=1}^{N} AICweight_n \times \psi_n$$

$$p = \sum_{n=1}^{N} AICweight_n \times p_n$$

6.3 Results

6.3.1 Camera trap surveys

Camera trap surveys in the BNR and commercial farms had a similar number of mammal and bird species, whilst lower numbers were recorded on the communal farms (Table 6.1). Overall all camera trap surveys documented a low number of reptile species, possibly due to the positioning of the cameras which were targeted to capture large mammals such as the leopard.

Table 6.1: Camera trapping effort and species richness for three camera trap surveys conducted in the Blouberg in 2011.

Survey	No of camera trap pairs	Camera trapping days	Total no of useable photographs	Mean trapping days/station	No mammal species	No bird species	No reptile species
BNR	15 (30)	900	1663	58	37	10	1
Commercial farms	14 (18)	840	2618	59	36	13	1
Communal Farms	12 (24)	720	914	55	20	2	0
Total	41 (82)	2460	5195	172	45	15	1

6.3.2 Density estimates from SPACECAP

In the BNR, nine individually identified leopards including six males (two adults and four sub-adults), two females (two adults) and a young cub (< one year old) were captured during the survey producing a sex ratio of 3:1 (males: females). On the commercial farms four individually identified leopards including two males (one adult and one sub-adult), and one female (adult)

and a young cub (< one year old) were captured during the survey producing a sex ratio of 2:1 (males: females). Capture frequencies ranged 1-7 for males and 3-18 captures for females in the BNR (Table 6.2) and 7-15 for males and two for females on commercial farms (Table 6.3). The programme CloseTEST supported the assumption of population closure during the 15 sampling occasions for the BNR (z = -0.1, P = 0.469) and commercial farms (z = -0.6, P = 0.269).

Table 6.2: Capture histories of individually identified leopards photographed in the BNR on 15 sampling occasions with each occasion representing 4 days of a 60 day survey conducted from the 7th March-5th May 2011.

	No of sampling occasions														
No of individuals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A1 Adult Male	2	1	0	0	0	0	0	1	0	0	0	0	0	3	0
A2 Sub-Adult Male	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
A3 Sub-Adult Male	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
A4 Sub-Adult Male	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
A5 Adult Female	0	0	4	0	0	1	1	0	3	0	0	1	1	2	5
A6 Sub-Adult Male	0	2	3	0	0	0	0	0	0	1	0	2	0	0	0
A7 Adult Female	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0
A8 Adult Male	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

Table 6.3: Capture histories of individually identified leopards photographed on commercial farms on 15 sampling occasions with each occasion representing 4 days of a 60 day survey conducted from the 6th July-3rd September 2011.

	No of sampling occasions														
No of individuals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A1 Adult Male	0	0	0	0	1	0	1	1	0	0	1	2	0	0	1
A9 Sub-Adult Male	0	1	3	1	2	1	0	3	0	0	0	2	0	1	1
A10 Adult Female	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0

For the BNR a density of 5.36 leopards per 100km^2 was produced giving a density estimate of 2.91 leopards within the 54.43km^2 BNR. The initial encounter probability (p1) increased from 0.08 to 0.51 (p2) for the recapture probability, indicating a trap behavioural response in which the probability of encounters in a trap increases subsequent to initial captures at that trap. The initial encounter probability (p1) increased from 0.14 to 0.79 (p2) for the recapture probability. Total number of individuals (Nsuper) was estimated at 25 leopards. Convergence was reached for the chains of all parameters in both surveys (Table 6.4).

Table 6.4: SPACECAP results from the BNR and commercial farms.

	Posterior Mean	Posterior SD	95% Lower HPD Level	95% Upper HPD Level	Geweke Z Statistic
BNR					
Sigma (range parameter)	2.13	0.55	1.37	3.10	-5.26
lam0 (expected encounter frequency)	0.08	0.03	0.03	0.15	0.65
Beta (regression coefficient of behavioural response)	0.82	0.47	-0.08	1.77	-1.80
Psi (ratio of individuals present within the state-space of the maximum number stated in the model).	0.54	0.19	0.21	0.92	1.36
Nsuper (total number of individuals)	169.21	57.58	62	282	1.33
Density (number of individuals/100km^2),	5.37	1.82	2.03	9	-
p1 (encounter probability of an individual before initial encounter)	0.08	0.03	0.03	0.14	-
p2 (encounter probability of individual after initial encounter).	0.51	0.23	0.08	0.88	-
Commercial Farms					
Sigma (range parameter)	5.43	20.13	2.39	7.97	-1.49
lam0 (expected encounter frequency)	0.15	0.11	0.03	0.37	-0.62
Beta (regression coefficient of behavioural response)	1.70	0.54	0.64	2.74	-0.37
Psi (ratio of individuals present within the state-space of the maximum number stated in the model).	0.09	0.06	0.01	0.20	1.19
Nsuper (total number of individuals)	25.66	17.23	3	59	1.19
Density (number of individuals/100km^2),	0.74	0.50	0.09	1.70	-
p1 (encounter probability of an individual before initial encounter)	0.14	0.09	0.03	0.31	-
p2 (encounter probability of individual after initial encounter).	0.79	0.12	0.55	0.96	-

6.3.3 Occupancy analysis

From all surveys pooled together, 77 leopard photographs (BNR: 43 photos, Commercial Farms: 32 photos and Communal land: 2 photos) were recorded from 2460 camera trap nights producing a naïve occupancy estimate of 0.50 over 15 sampling occasions, indicating that leopards occupied half of the camera traps in the study area. A sigma of 2.14 produced from the BNR was used to determine the home range radius of a leopard of 5.16km. This radius was used to determine the proximity of neighbouring cameras to calculate the auto-covariate for each camera station, per sampling occasion. Investigation of potential differences among the candidate models where occupancy and probability of detection were allowed to vary with environmental and anthropogenic covariates produced four models with ΔAIC < two and similar model weights indicating that all models were equally plausible (Table 6.5). Model averaging techniques were applied to produce an overall occupancy estimate and probability of detection. Model average results (+/- S.E.M.) from all models produced an actual occupancy estimation of 0.61 (+/- 0.06) and a detection probability of 0.16 (+/- 0.03) suggesting that the naïve occupancy (0.50) underestimated occupancy by 10.9%.

Table 6.5: Summary of occupancy results produced from models with the auto-covariate where the probability a site is occupied by a leopard is ψ and p is the detection probability p (.) assumes that leopard detection probability are constant across sites. k is the number of parameters in the model, ΔAIC is the difference in AIC values between each model and w_i is the AIC model weight.

Model Ranking	Models	AIC	*K*	ΔAIC	w_i	ψ (+/- S.E.M.)	p (+/- S.E.M)
1.1	ψ (RAI large prey + auto-covariate), p (.)	331.46	4	0.00	0.42	0.61 (0.06)	0.16 (0.02)
1.2	ψ (RAI large prey + auto-covariate), p (habitat)	332.75	5	1.29	0.22	0.61 (0.06)	0.16 (0.03)
1.3	ψ (RAI large prey + auto-covariate), p (distance water)	333.15	5	1.69	0.18	0.61 (0.06)	0.16 (0.03)
1.4	ψ (RAI large prey + auto-covariate), p (season)	333.25	5	1.79	0.17	0.61 (0.06)	0.15 (0.03)
					Model averages	0.61 (0.06)	0.16 (0.03)

Table 6.6: Model averaged estimates of covariates, intercepts of each model +/- S.E.M, Beta coefficients +/- S.E.M, odds ratios measure the effect size of each covariate, and the summed Akaike weights w_i for each predictor, indicating its relative importance from the candidate set of leopard occupancy models. Occupancy is also modelled in order to determine leopard occupancy rates between surveys as ψ (survey) p (.). The BNR is not included in the table summary because it was the indicator variable for the analysis. The effect size of covariates on occupancy estimates and the probability of detection are determined by calculating odds ratios for discrete covariates and modelled average beta coefficient values for both continuous and discrete covariates. Positive beta values indicate a positive effect and negative values represent a negative effect on the dependent variables.

	Intercept	S.E of intercept	Beta Coefficient	S.E.M. of Beta	Odds ratio	Summed Model Weights
Occupancy						
RAI of large prey	-2.87	1.15	73.45	32.14	1.33	0.99
Auto-covariate	-2.87	1.15	-3.77	9.72	0.68	0.99
Probability of detection						
p (.)	-2.88	1.15	-1.69	0.15	-	
Habitat type (Forest/Woodland or Thicket/Bushland)	-2.87	1.14	0.28	0.34	1.33	0.22
Distance to water (km)	-2.87	1.15	-0.39	0.71	0.68	0.18
Season (Wet/Dry)	-2.86	1.15	-0.15	0.34	0.86	0.17
Occupancy						
Commercial Farms	1.27	0.77	-0.81	1.10	0.45	-
Communal Land	1.27	0.77	-2.76	0.16	0.06	-
Probability of detection						-
p (.)	1.27	0.77	-1.56	0.16	-	-

The summed model weights for the RAI of large prey and the auto-covariate collectively explained 98.7% of the variation in occupancy for leopard in the Blouberg (Table 6.6). The constant model produced the highest support for probability of detection (41.8%), followed by habitat type (21.9%), distance to water (18%) and season (17.1%). The odds ratio for the auto-covariate had a negative effect on leopard occupancy indicating that leopards are 0.68 times less likely to occupy camera station, when neighbouring sites are occupied by leopards, demonstrating a trap shy response. RAI values of large prey species had a positive effect on occupancy indicating that leopard occupancy at sites is 1.33 times more likely when the frequency of large prey species captured at camera trap sites increases per 100 trap nights. Habitat type had a positive effect on the probability of detection where leopards are 1.33 times more likely to be detected in forest/woodland compared to thicket/bushland, whilst season had a negative effect on the probability of detection. Leopards are 0.86 times less likely to be detected during the wet season compared to the dry season. Distance to water had a negative effect on the probability of detection where leopards are 0.68 times less likely to be detected at camera trap sites with increasing distance (per km) from water.

Modelling survey type as a function of occupancy produced occupancy estimates (+/- S.E.M.) of 0.78 +/- 0.13, for the BNR, 0.62 +/- 0.14 for commercial farms and 0.18 +/- 0.12 on communal land, with a constant probability of detection of 0.17 +/- 0.02 for all land use types (Fig. 6.5). The negative beta coefficients and odds ratios for commercial farms and communal land suggest that leopards are 0.45 times as likely to occur on commercial farms compared to the BNR and 0.06 times less likely to occur on communal land compared to the BNR. Occupancy rates were significantly different between land uses (Kruskal Wallis Test (KWT): χ^2 = 39, df = 2, $P < 0.001$) reflecting significant differences in the RAI of large prey species between land use (KWT: χ^2= 22.7, df = 2, $P < 0.001$) where mean RAI values were higher in the BNR and commercial farms compared to communal land (Fig. 6.6).

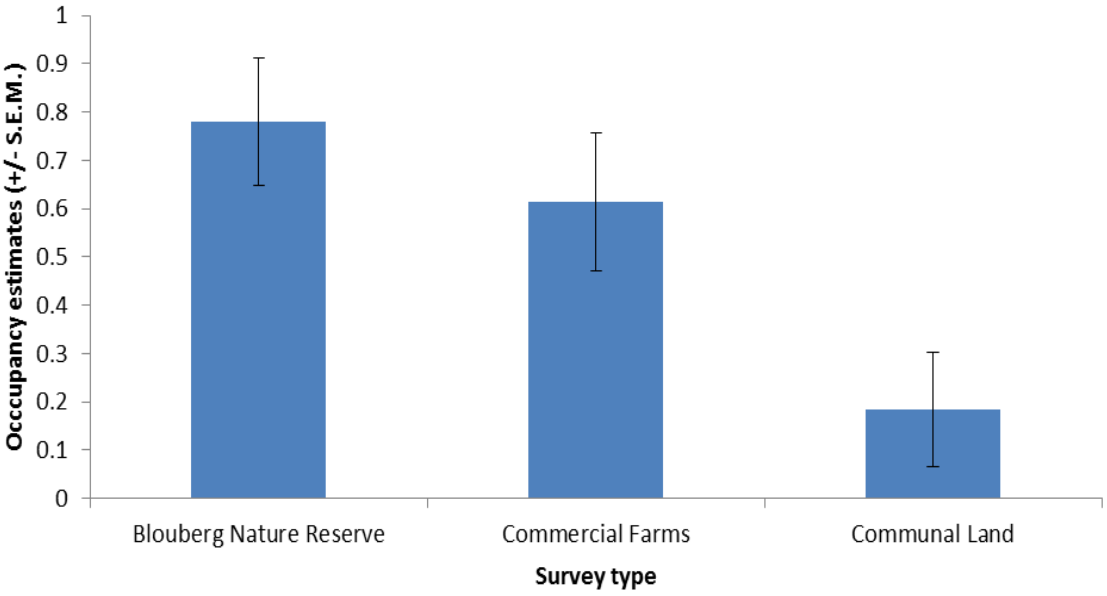


Figure 6.5: Occupancy estimates of leopards +/- S.E.M. on different land uses in the Blouberg in 2011.

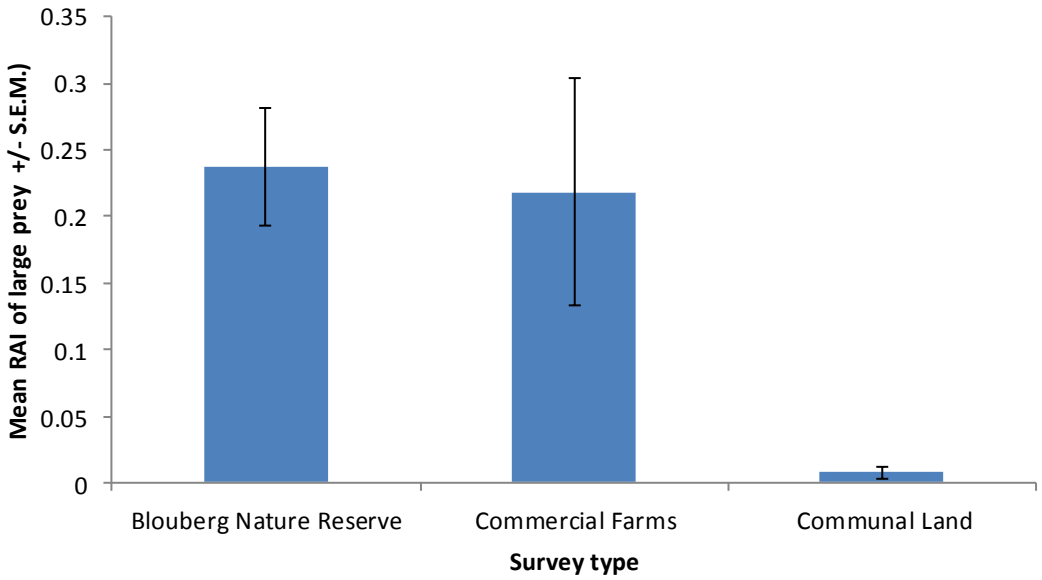


Figure 6.6: Mean RAI values of large prey +/- S.E.M. for large prey species on different land uses in the Blouberg in 2011.

6.4 Discussion

6.4.1 Leopard density and population structure

The results of the study produce the first density estimate for leopards within a protected area in the BNR of 5.4 leopards per 100km^2. Density estimates in the Blouberg fall within a similar range to densities predicted within the protected areas of the Phinda Private Game Reserve and Zulu Rhino Reserve in Kwa-Zulu Natal of 3.3-11.1 leopards per 100km^2 and 2.5-7 leopards per 100km^2, respectively (Balme et al., 2009, Chapman and Balme, 2010). Density estimates for leopards close to the Kruger National Park in the Limpopo Province were reportedly higher at 30.3 leopards per for the Sabie riverine area and 12.7 leopards per 100km^2 in the N'wanetsi concession (Maputla et al., 2013). Density in the BNR is higher than in other protected areas in South Africa including the savannah environments of the Kalahari Gemsbok National Park of 0.6 leopards per 100km^2 and the mountainous environments of 0.6-2 leopards per 100km^2 in the Cederberg Wilderness Area (Bothma and Le Riche, 1984, Martins, 2010). The final estimates of leopard density inside the BNR and commercial farms are not independent from one another for two reasons: the model sampling regions overlap and one leopard (A1) was present in both surveys, therefore, I would expect population densities to be similar between surveys. However, the population structure and density estimates for both surveys are different at finite spatial scales warranting further investigation. Density estimates on commercial farms are lower than the BNR at 0.7 leopards per 100km^2. Density estimates produced from a camera trap survey conducted in 2008 from a non-protected area in the nearby mountainous area of the Soutpansberg yielded double the density in the Blouberg at 10.7 leopards per 100km^2 (Chase-Grey et al., 2013). Chase-Grey et al. (2013) suggest the mountainous environment may provide suitable habitat for leopard due to a high density of prey species and low density of livestock farms

Most mortality occurs outside of the BNR boundaries where leopards come into conflict with people and are killed legally, illegally and accidently by people. Interviews conducted from October, 2009-October, 2011, revealed that seven leopards using lethal control measures over a 400km^2 area. Four of the deaths were illegal through snaring, poisoning and shooting leopards. Two leopards were legally shot through the issuing of a damage-causing animal permit, while one was killed as a result of a trophy hunting permit (Chapter 8). Chase-Grey (2011) reported that 28 leopards were killed due to lethal control measures (24 illegal deaths

and four from trophy hunting permits) in the Soutpansberg over a ten year period and a 600km^2 area. Scaling results reported from the Blouberg over a 10 year period and applying the results from a 400km^2 to a 600km^2 area, produces an estimate of 53 leopard deaths. Considering the potentially high levels of illegal and legal off-take reported for the Blouberg and taking into account that most leopard deaths are unlikely to be reported, these actual numbers are likely to be considerably higher. Complex social factors are responsible for motivating farmers to adopt lethal control measures; these issues are discussed in Chapter 8, Section 8.4.2 and need to be overcome in order to mitigate the effects of human-induced mortality rates.

As I will discuss in greater depth in Section 6.4.2, occupancy rates for leopards are high on commercial farms ($\psi = 0.61$) due to a high availability of large prey species. The differences in leopard density between the Blouberg and Soutpansberg area may reflect higher anthropogenic pressure and rates of mortality in the Blouberg due to a greater number of livestock and game farms and communal farming land, increasing the potential for human-leopard conflict. Considering the high leopard density recorded in the Soutpansberg and the lower density estimates of 5.4 leopards per 100km^2 in the BNR and 0.7 leopards per 100km^2 on commercial farms, the farms may function as population sinks due to high levels of leopard mortality rates driving population declines. The BNR may also suffer from edge effects driving leopard numbers below their carrying capacity, as documented in Kwa-Zulu Natal (Balme et al, 2010a; Chapman and Balme, 2010).

The population structure of leopards in the BNR and commercial farms produces a male-biased sex ratio of 3:1 and 2:1, respectively. This compares with a female-biased sex ratio of leopards of 5:9 in the Soutpansberg (Chase-Grey et al., 2013). The male-biased sex ratio in the Blouberg may result from (1) the higher capture probabilities of males compared to females because of their larger home range size and greater dispersal abilities (Chapman and Balme, 2010), (2) potential sources of error when differentiating between the sexes because sexual dimorphism in leopards is not always distinct between males and females of two years old (Balme et al., 2012), and (3) high levels of mortality resulting in the entry of migrant males into the population. A male-biased sex ratio can to an underestimation of density (Tobler and Powell, 2013). This bias can be controlled for by modelling sex as a covariate using a Bayesian framework, but, this function is not available for SPACECAP analysis and requires sample sizes of n = 10 (Sollmann et al., 2011, Tobler and Powell, 2013). Male leopards also have greater dispersal abilities then females and are more likely to recolonise vacant territories (Bailey, 1993). Sink populations are characterised by a high number of dispersing sub-adult that enter

territories made vacant due to high mortality rates and are indicative of a high turnover of individuals in a population (Novaro et al., 2005). Other studies on leopards have excluded sub-adults from SPACECAP analysis to obtain reliable density estimates for leopards (Chase-Grey et al., 2013). Large numbers of dispersing sub-adults can inflate population numbers because they may represent transients that are not part of the resident population (Robinson et al., 2008). A high number of sub-adult males (n = 4) relative to adult males (n = 2) were identified in the BNR but due to the difficulty in aging leopards from photographic camera trap surveys, sub-adults (two years of age) and adult males (< seven years of age) could not be classified into distinct age classes, leading to the potential misidentification of age groups (Balme et al., 2012). Identifying the status of transients and resident leopards is problematic without long-term data on the population dynamics of leopards. As such distinctions could not be attempted here; the age status of the data remains a potential source of bias in the analysis.

Another potential limitation of the study design may result from the small size of the camera trapping array (Foster and Harmsen, 2012, Tobler et al., 2013, Tobler and Powell, 2013). Tobler and Powell (2013) suggest that the area of camera trapping polygons, defined as the area calculated by forming a polygon from the outermost camera traps in the survey, should constitute the largest home range size of a male to prevent a positive bias in density estimations from small survey sizes. However, data was not available locally on the home range size of an adult male for the current study. Chase-Grey (2013) extrapolated data from an adult female home range size of 16km^2 in the Soutpansberg to suggest that a male home range could extend to 65km^2 if no overlap occurred between females and an adult male home range overlapped with four females. However, spatial capture-recapture models have also produced unbiased density results when camera trap polygons equate to half the size of a male jaguar (Sollmann et al., 2011, Tobler et al., 2013) The camera polygon for the BNR was 54.43km^2 and the commercial farm was 55.20km^2 thus, only marginally smaller than the estimated home range size of a male.

Figure 6.7: Camera trap photographs of a large adult male leopard (A1) taken on the 2nd August 2011 on commercial farming land.

Trophy hunting in South Africa is often biased towards adult males because these individuals produce larger trophies for hunters (Bailey, 1993, Balme et al., 2010b). Camera trap surveys produced images of an abnormally obese adult male (A1) identified within both the BNR and commercial farms, suggesting that illegal baiting was taking place on adjacent farms to draw in individuals for trophy hunting or illegal hunting (Fig. 6.7). Full-time baiting can have negative impacts on leopard mortality rates by drawing leopards out of their original territories and creating population sinks where levels of persecution are high (Chase-Grey, 2011). Trophy hunting in the Blouberg is relatively small scale because of lengthy burecratic systems and the high economic costs of paying for trophy hunting permits and licence fees and a lack of accessible information of how to participate in the industry (see Chapter 8, Section 8.4.3). Nonetheless, trophy hunting can also place an additive source of mortality on populations that are already endangered by illegal hunting, particularly for populations that are less resilient to anthropogenic perturbations (Chase-Grey, 2011)

High rates of persecution and the removal of adult resident males from a population may increase intra-specific conflict because an influx of migrant males into vacant territories can potentially increase the risk of infanticide, threatening the survival of cubs (Wielgus and Bunnell, 2000, Logan and Sweanor, 2001, Balme et al., 2010a). Leopards maintain complex social relationships by defending their home ranges against same-sex intruders and whilst males do not invest in parental care, their presence in local territories limits incursions from migrant males (Balme et al., 2010a). The migration of new males into territories causes social disruption and threatens the reproductive success of females, driving population declines (Balme et al., 2010a). The male-biased sex ratio in the BNR may reflect differences in population structure resulting from high levels of mortality compared to the Soutpansberg. However, further information on the behaviour, home range size and movements of male leopards are required to test this hypothesis. Future camera trapping studies in the area should endeavour to monitor leopard population trends over longer time frames to assess changes in demography and population structure. GPS collaring would also assist in improving knowledge of leopard home range sizes, sex-specific ecology and behaviour and mortality rates to inform camera trap design and to assist in the identification of localised sink populations. In future, spatial capture-recapture models should attempt to incorporate age and sex specific covariates to calculate density, providing adequate sample sizes and the age of individuals can be determined.

6.4.2 Occupancy rates of leopards

Results of the study show that the naïve occupancy estimation of 0.50 underestimated leopard occupancy by 10.9% if detection probabilities were assumed to equal one (MacKenzie and Royle, 2005). Modelling occupancy and detection probability as a function of environmental covariates produced a more reliable estimation of 0.61 (+/- 0.06) for leopards, as the constant model of ψ (.) p (.) was not ranked highly (ΔAIC > 2). Leopards in the Blouberg occupied 60.9% of the camera trap sites (n = 40) in the study, indicating that leopards are widely distributed throughout the Blouberg. Incorporation of the auto-covariate marginally decreased occupancy with increasing presence of leopards captured at nearby sites indicating a trap shy response, this contrasts with results from the selection of the "trap response" for modelling leopard densities using SPACECAP to ensure convergence of each model. SPACECAP results showed that the encounter probability of individuals (p1) increased from 0.08 to a p2 of 0.51 on the

BNR and from 0.14 to a p2 of 0.79 on commercial farms. Leopards show a trap behavioural response where the probability of encounters in a trap increases with the number of initial captures within that trap. As no lures or baits were used during the surveys, the results may indicate individuals showing preferences for particular roadways and trails within their territories (Royle, 2009). In the BNR, four males identified during the survey were captured only once, perhaps indicating a behavioural response to avoid territorial disputes with other males or transients that were not resident in the area. Territorial status amongst coyotes has also been shown to affect vulnerability to photo-capture, with alpha coyotes being under-represented in photographs and never being captured outside of their territories (Séquin et al., 2003). Beta wolves were photographed inside and outside territories and non-territorial transients were found along the boundaries of territories, avoiding territory cores (Séquin et al., 2003). Male and female leopards defend their home ranges against same sex intruders (Balme et al., 2010a), so therefore, a decline in occupancy with a higher presence of leopards captured at nearby sites may indicate avoidance of intraspecific competition. Further research on leopard behaviour, home range size and movements would be necessary to investigate this hypothesis. Furthermore, identifying individuals as transients requires long-term data on leopard population dynamics which were not available for this study.

Occupancy for leopards was higher in the BNR and commercial farms compared to communal land, reflecting differences in large prey biomass between land use types (Fig. 6.5). Similar results have been documented for clouded leopards in Thailand, where site occupancy is dependent on the presence of preferred prey species (Ngoprasert et al., 2007, Steinmetz et al., 2013). Game on land formerly dedicated to agriculture in South Africa has increased from 340,000 animals in 1996 to 1.7 million in 2007 (Van der Merwe et al., 2004, Du Toit, 2007). Game farms provide 80% of nature conservation activities in South Africa on privately owned land, with Limpopo Province having the most game farms in the country (Fox and Du Plessis, 2000, Eloff, 2001). Game farms are important conservation areas for leopards outside protected areas because they support a high abundance of naturally occurring game species. However, they function as “ecological traps” because they can represent areas with disproportionate mortality that otherwise provide suitable resources for leopards as reflected in the lower leopards numbers on commercial farms. Lethal control measures on game farms are often used as strategies to reduce the perceived numbers of leopards on game farms when in reality their numbers are relatively low and negatively impacted by their interactions with people (Chapter 7, Section 7.3; Chapter 8, Section 8.3.3).

Communal land is shaped extensively by anthropogenic pressures: the mountain is heavily deforested and eroded by human induced veld fires, land has been cleared for firewood, agricultural fields and harvesting of illegal cannabis and tobacco, accentuating problems with soil erosion and flooding in lower lying regions (Egan, 2007). Illegal killing of wild animals for bushmeat and traditional medicine and other cultural uses is common in the Blouberg and motivated by the spiritual values associated with wild animals (Chapter 7, Section 7.6). However, these practices may also negatively impact wild prey numbers on communal land. Large prey biomass was significantly lower on communal land compared to other land use types, reflecting the potential impacts of overhunting and habitat conversion due to human activity. Despite the low occupancy rates for leopards on communal land, these areas are of conservation concern because they represent high predation hotspots for livestock losses (Chapter 5). In Asia, leopards are a significant problem species due to issues relating to livestock depredation and human associated deaths (Edgaonkar and Chellam, 1998, Athreya et al., 2004). One of the main factors driving human-leopard conflict relates to a loss of natural prey, causing a dietary shift to include domestic livestock (Marker and Dickman, 2005). Similarly, the abundance of tigers and their prey were negatively correlated as a function of increasing human density (O'Brien et al., 2003).

Detection probability was higher in woodland/forested environments compared to bushland/scrubland. Leopards prefer to occupy habitats with denser cover, providing reduced visibility for hunting prey compared to more open environments (Bailey, 1993, Sunquist and Sunquist, 2002). Some cameras were placed close to rivers and water channels and distance to water was an important factor influencing the probability of detection. Similar results have been documented for leopards in the Sariska Tiger Reserve, Western India and in Thailand, where leopards make use of habitats close to streams (Ngoprasert et al., 2007, Simcharoen et al., 2008, Mondal et al., 2013). Probability of detection was higher during the dry season compared to the wet season, reflecting differences in survey effort in each season between land use types. Habitat selection by leopards may depend on seasonal variation in resource availability, such as changes in prey availability and vegetation structure (Simcharoen et al., 2008) but this cannot be determined without repeat surveys in different seasons. Future studies should consider investigation of temporal and seasonal differences in assessing occupancy and detection probability between sites. Whilst it is beneficial to investigate the impact of both ecological and anthropogenic factors within surveys, a high number of stolen cameras and limited resources produced small sample sizes, such that data had to be pooled from all surveys to conduct the occupancy analysis.

6.5 Conclusion

The Blouberg leopard population is of conservation concern considering the low density estimates for the species, the male-biased population structure and low occupancy rates of leopards on communal land. These factors are indicative of the presence of population sinks, high rates of mortality and reduced female reproductive success. A combination of ecological and anthropogenic factors negatively impact leopard population status across the Blouberg landscape (Fig. 6.8). Habitat conversion of the mountainous habitat for agriculture and livestock grazing and the hunting of prey species for bushmeat and traditional medicine reduce the availability of large prey available for leopards on communal land. Game farming on commercial farms increases conflicts between humans and leopards due to increased predation on expensive game species, often resulting in the adoption of lethal control measures. The lower density estimates in the Blouberg compared to the Soutpansberg may result from a high human population density and mortality rates induced by lethal control measures in the Blouberg and different land use patterns and ecological conditions between sites.

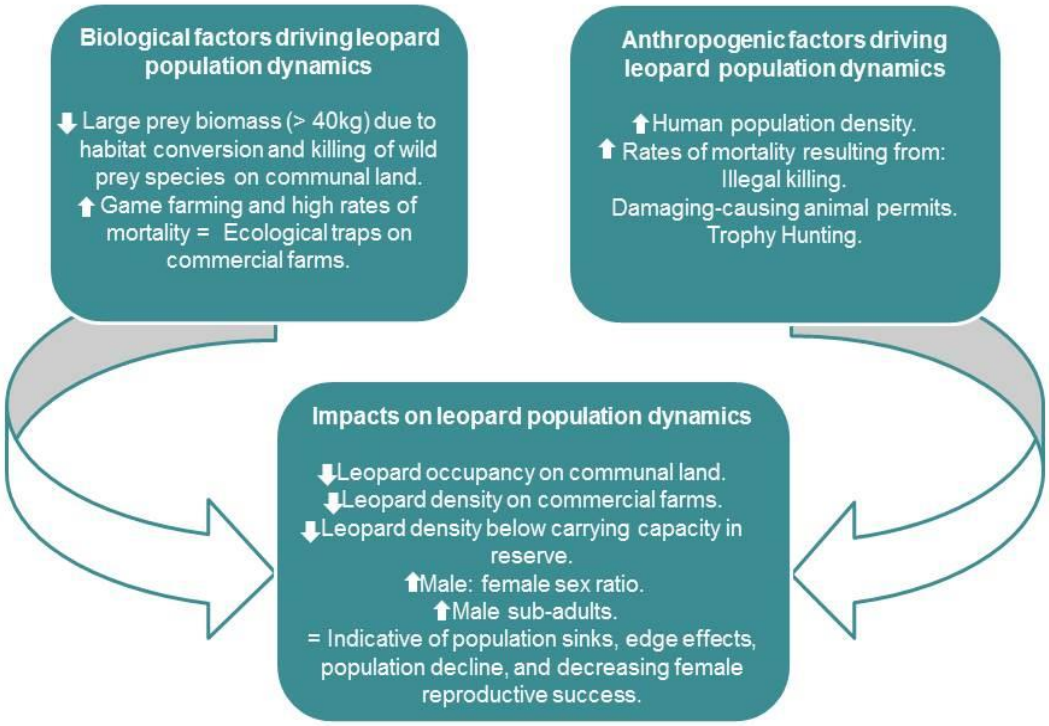


Figure 6.8: Biological and anthropogenic factors influencing leopard population status and structure in the Blouberg. Small white arrows pointing upwards represent an increase and arrows pointing downwards represent a decrease.

Chapter 7

Valuing the leopard: Identifying barriers and common ground for leopard conservation

7.1 Introduction

Human dimensions research contributes to our understanding of human-wildlife conflicts through knowledge of peoples' thoughts, behaviours and actions towards wildlife (Vaske and Manfredo, 2012, p. 8). Researchers focus on understanding values, attitudes and norms concerning wildlife by building on theory and concepts from social psychology (Manfredo, 2008). A cognitive hierarchical approach suggests that people's values influence attitudes and norms towards wildlife and attitudes-norms influence behaviours in particular wildlife related scenarios (Manfredo, 2008). Value is defined as "desirable individual end states, modes of conduct, or qualities of life that we individually or collectively hold dear" (Vaske and Manfredo, 2012, p. 43). Values are formed early in one's life, culturally constructed, tied to an individual's identity and resistant to change (Vaske and Manfredo, 2012). The study of values has conservation implications for example, it identifies topics for improved education and outreach programmes and conservation managers are better able to represent stakeholders in decision making processes and identify the mechanisms driving conflict between stakeholders (Manfredo, 2008, Vaske and Manfredo, 2012, Herrmann et al., 2013). The study of values identifies areas for common ground between stakeholders to seek solutions for conflict management (Manfredo, 2008).

S.R Kellert pioneered research on understanding the human dimensions of wildlife problems, by developing a typology of nine different domains of thought about wildlife (Kellert, 1976). The publication of the Biophilia Hypothesis contributed to the popularisation of Kellert's work (Kellert and Wilson, 1993). Wilson (1984) proposed the existence of a propensity for human beings to affiliate with other living things, and lifelike processes, resulting from millennia of human evolution and repeated dependence on the environment. Biophilic tendencies are adaptive because the organism exhibited evolutionary benefits when it was hardwired to respond emotionally to its environment (Kellert, 1993a). This notion suggests human-environmental relations depend not only on resource exploitation, but are also influenced by effects of the natural world on human physical, emotional, spiritual and intellectual wellbeing (Kellert, 1993a). An affiliation with the natural world is intrinsically tied to human identity and

personal fulfilment, thus it is in our own interest to preserve it (Kellert, 1993a). Conversely, degradation of the human dependence on the natural world is associated with the increased likelihood of a deprived and diminished existence (Kellert, 1993a).

Kellert's typology has been applied to research human perceptions of wolves, marine mammals, endangered species, invertebrates and bears (Kellert, 1985c, Kellert, 1986, Kellert, 1987b, Kellert, 1987a, Kellert, 1991b, Kellert, 1994). Diverse human groups have comprised these studies including hunters, birders, farmers and the American public, as well as different socio-economic groups defined by age, gender and place of residence (Kellert, 1976, Kellert, 1978, Kellert, 1983, Kellert, 1985b, Kellert, 1985a, Kellert and Berry, 1987). Kellert's typology has been applied cross-culturally in Japan, Germany and Botswana (Kellert, 1985c, Schultz, 1987, Kellert, 1991a, Mordi, 1991, Kellert, 1993a, Kellert, 1993b). The expression of these values varies in content and intensity and suggests that their widespread applicability and occurrence is indicative of a universal tendency for human-beings to affiliate with nature (Kellert, 2005).

Kellert's work has continued to be of use to researchers to understand the diverse array of public perspectives on wildlife. Herrmann et al. (2013) extended Kellert's typology to include three additional typologies, spiritual, cultural and existence dimensions and broadened Kellert's definition of utilitarian values to emphasise the direct use value of biodiversity for material, household or tradable use and the indirect use of biodiversity (Table 7.1). I adopt Herrmann et al's (2013), typology as a heuristic tool to identify potential differences and overlap in the expression of values towards leopards between commercial and communal farmers in the Blouberg. The analysis focuses on identifying discourses, narratives and representations of the leopard. I discuss the potential implications of these values for providing barriers and common ground for leopard conservation between farming communities and the conservation community.

Table 7.1: Typology for measuring values associated with leopards. The descriptions in red are defined by Kellert and Wilson (1993) and in black are defined by Herrmann et al (2013).

Values	Definitions of values
Naturalistic	1. Satisfaction from direct experience/contact with nature. 2. Deep experience with nature. 3. Awareness and attentiveness. 4. willingness to examine and discover 5. Enhanced creativity and imagination.
Ecologistic-scientific	1. Systematic study of structure. Function and relationship in nature 2. Systematic study of nature. 3. Pursuit of knowledge to understand nature. 4. Cycles and systems comprehension.
Humanistic	1. Strong affection, emotional attachment, "love" for nature. 2. Deep feelings of attachment to nature's components.
Utilitarian	1. Practical and material exploitation of nature. 2. Resource view (materialistic value). 3. Subsistence (of household use). Productive (of tradable use).
Aesthetic	1. Physical appeal and beauty of appeal. 2. Capacities for curiosity, imagination and creativity. 3. Recognition of order, harmony, symmetry, grace and balance. 4. Aesthetic search, real beauty, ideal and perfect.
Negativistic	1. Fear, aversion, alienation from nature. 2. Aversive reactions to nature. 3. Destructive practices. 4. Environmental problems like pollution.
Dominionistic	1. Mastery, physical control, dominance of nature. 2. Sense of control and domination of nature. 3. Nature as a place for exercising mastery.
Moralistic	1. Strong affinity, spiritual reverence, ethical concern of nature. 2. Nature as a philosophical resource. 3. Willingness to treat nature with respect and kindness Ethical responsibility.
Symbolic	1. Use of nature for metaphorical expression, language, expressive thought. 2. Use the sights, sounds of nature in

	language and other symbolic ways. 3. Religion, spirituality, anthropomorphism.
Spiritual	1. Attachment to nature through its affinity with ancestors, religion or its role in traditional ceremonies. 2. Related to cosmovision.
Cultural	1. Objects of nature that express the values of the culture superimposed on, thus linked to belongingness and identity.
Existence	1. Nature existence regardless of utility to humans. 2. Bequest to future generations.

7.2 Methods

I applied semi-structured interviews and ethnographic research to understand how farming communities attribute values with leopards. I interviewed 42 farmers (19 commercial and 23 communal) and three traditional healers who were identified through the assistance of village headmen, on their knowledge and experiences with leopards. Information was gathered on the following topics: knowledge and different values associated with the leopard, perceptions of leopard conservation, perceptions and experiences of human-leopard conflict and the use of leopards in traditional medicine and other cultural practices. I also drew on ethnographic data derived from participant observation recorded in an ethnographic diary.

7.2.1 Data Analysis

The analysis focuses on identifying discourses, narratives, representations and values associated with the leopard in the Blouberg (see Chapter 4, Section 4.2.5 for definitions). In unravelling the construction of environmental values, I adopted Hermann et al's (2013) framework to acknowledge that environments matter to people, "not only because we live from them, but also in and with them" (Sumares and Fiedlis, 2011, p. 54). I attempt to reflect these relationships and their diverse manifestations (O'Neill et al., 2008). The symbolic dimensions of nature, as acknowledged in the typology, dominate discourses and narratives

featuring leopards throughout and occur with the expression of other values. I do not refer to symbolism as a separate category value but an inherent attribute of all value expressions.

Hermann et al's framework is useful as it is includes negative values attributed to wildlife, often manifested as aversion, fear and dislike with species involved in human-wildlife conflicts. The typology allows for different types of knowledge about the environment. Scientific knowledge of biodiversity is incorporated under ecologistic-scientific values while other categories result from historical engagement and the subjective and personal meanings biodiversity represents (Sumares and Fidelis, 2011). The acknowledgment of a wide array of environmental values removes the tendency for the interview process to attribute the value used (e.g. a materialistic value) to inscribe forms of discourse into the elicitation process itself (Lockwood, 1999). The semi-structured interviews were designed to ask open-ended questions that allowed flexibility and scope for informants to respond and concepts and topics to emerge through the informants' descriptions. I apply the study of discourses and narratives to identify potential barriers and common ground between the values expressed by different social actors and to discuss their implications for leopard conservation. I coded interview transcriptions and ethnographic data according to the specific research themes identified in this Chapter, Section 7.2 and the value categories defined by Herrmann et al (2013) using the software programme NVivo 9 (QSR International 2009).

7.3 Negativistic and dominionistic values: Leopard boundary crossing and predatory behaviour

Structural anthropology examines the disjuncture between expected orders of space and the definable limitations of space as culturally constructed by humans (Lévi-Strauss, 1966). Wild animals transgress spatial boundaries between culturally constructed domestic and wild spheres, often becoming "animals out of place," following Mary Douglas's notion that dirt only becomes "matter out of place" depending on one's perception of spatial organisation (Knight, 2000, p. 15). Douglas views spatial organisation as a structuring principle of general order therefore an animal that transcends marked spatial boundaries by leaving its habitat to another of primary value may become a subject of strong attitudes. This phenomenon often manifests through the depiction of an animal as sacred, a bad omen, an inauspicious sign or the association of the animal with a taboo. Douglas' work on the Lele of Zaire revealed that the pangolin is revered as a powerful natural spirit, as well as as a giver of fertility and good hunting (Douglas, 1975). The pangolin is deemed anomalous by the Lele because its scaly, shelled appearance and tree climbing behaviour link the animal with both water and land dwelling animals. Anthropologists have applied these perspectives to other species assigned as wildlife pests. For example, Edmund Leach interpreted the concept of "vermin" as an intermediate categorisation for animals transgressing marked spatial boundaries:

"Consider, for example, the separate and often bizarre, rules that govern the behaviour of Englishmen towards the creatures which they classify as (i) wild animals, (ii) foxes, (iii) game, (iv) farm animals, (v) pets and (vi) vermin. Notice further that if we take the sequence of words: (ia) strangers, (iia) enemies, (iiia) friends, (iva) neighbours, (va) companions, (via) criminals, the two sets of terms are in some degree homologous" (Leach, 1964, p. 40).

In the Blouberg, the older generation cattle and game farmers are prone to perceive leopards as "vermin" and "pests," these connotations stem from the leopard's boundary crossing behaviour: "Leopards just didn't belong on the farms, they belonged in the mountains or the reserve, we didn't like them on our land." The depiction of large carnivores as "vermin" emerged during the late nineteenth century with the establishment of the first game reserves and a preservation ideology creating new spatial boundaries between wild animals and people (Carruthers, 1989, Chapter 2). This distinction conjured up images of spatially divided environments, subject to human control. Wild game became private property and predators that predated on economically valuable livestock and game species were exterminated. A

commercial farmer recalls carrying out lethal control measures in response to sightings of leopards: “Of course, if I saw one of those leopards on my farm I would reach for my gun. You were carrying out damage control on your farm. You didn’t want them eating all of your cattle and game. Leopards were pests. We called them vermin.” The leopard’s violation of imagined spatial boundaries determines lethal action against offenders: “I have imaginary line, if it comes below that line away from the mountain then it’s the leopard’s mistake, if I put livestock near the mountain it’s my fault. So if an attack happens away from the mountain, I’ll put poison out, if not I leave it alone.”

Similarly, the creation of new spatial boundaries was responsible for the eradication of wolves in North America during the late seventeenth century: “wolves were incapable of distinguishing an owned animal from a wild one, the drawing of new property boundaries on the New England landscape inevitably meant their death” (Cronon, 1983 in Emel, 1998, p. 96). An elderly commercial farmer describes how he “battled” with leopards, by employing lethal methods to prevent leopards from encroaching onto his land in the 1930s:

“It was like a game between us, they would sneak inside the kraals at night to take calves, and often it felt like there were hundreds of them. We would counteract by putting out poison, traps and waiting by the side of carcasses to kill them. We, like the leopard were hunters. Often it felt like a battle, it was adrenaline pumping, you were trying to control that situation just to stop them invading and taking everything.”

The colonial era and the early twentieth century were characterised by conflicts between the British, Boers, and African tribes over access to land and natural resources (Chapter 2). The notion of protecting one’s land and property from outside forces was characteristic of the time and metaphorically extends into the animal world where leopards threaten livelihoods. A dominionistic view of nature is articulated as a war against leopards and a need to control and kill the animal. These perceptions are rooted in earlier European environmental perceptions of nature, predicated on the mastery and control of animals through hunting (Chapter 2, Section 2.3). The description of an initiation lesson provides insights into the construction of the dichotomies between the village and bush environments and the risks leopards pose to humans in Venda culture. Nettleton (2002) discusses the utilisation of wooden and clay animal figurines named *matano* shown to youngsters undergoing initiation, as an educational tool to demonstrate different life lessons. The leopard *matano* is shown entering the village to attack livestock, and presented to initiates as being present in the bush, where people venture to collect firewood. Initiates are taught that leopards penetrate the boundaries of the bush and

village environment representing a danger to human livelihoods and life. The leopard matano is also shown to young females, to symbolise the sexual threats men pose to women when they venture outside the safety of the village. Similarly, Bahananwa women and communal farmers do not always feel safe to enter the bush alone because they fear the leopard. Common statements include: "The leopard is dangerous, it can come into our village to attack livestock if you're in the bush you are also in danger. We don't like that thing, it makes us scared to go in the bush alone" and "that thing is bloody horrible, you don't want to be alone in the bush when it attacks, I won't go out there in the dark alone." Fear is associated with historical interactions with the leopard. An elderly communal farmer from Indermark describes a leopard that attacked humans during the 1970s:

"Back then when we came to settle in the area [Indermark] there wasn't a village like you see today, it was a bush. There was a leopard close to our village that had been injured by a snare and lost its paw. It couldn't hunt properly and it attacked people, especially women, when they were out collecting firewood in the bush. That's where the stories started about leopards. They have attacked people in the past so they still could today. That story scares people about leopards, they don't like that animal. In the end the government had to get someone in to shoot it."

People often fear animals because of an exaggerated perception of the dangers wild animals pose to human life. Actual accounts of leopards attacking humans are rare in South Africa compared to other countries such as India and Uganda (Inskip and Zimmermann, 2009). In 2011, during the course of the study, two reported incidents involving leopard attacks on humans in South Africa were related to events where leopards had been injured. A husband and wife were attacked after shooting a leopard during a trophy hunt on a game farm (SAPA, 2011) and a cyclist in the North-West Province was attacked after an injured leopard released itself from a snare (Telegraph, 2011). A fear of the risks leopards pose to livestock and human life is linked to the expression of dominionistic values and serves as motivating factor driving the use of lethal control measures among communal farmers. A communal farmer states: "Because I fear what the leopard could do to my stock and even people. I set out traps to kill it, I do this by looking for the tracks [of the leopard], we must control them, keep the numbers down."

Among both farming communities, peoples' perceptions of the leopard's predatory behaviour predispose them towards negative associations with the leopard. The leopard is condemned for its "insatiable appetite," while another retired commercial farmer states: "I had been a

witness to the ferocious attacks of these animals [leopards] entering our pig sites where they apparently killed for the pure hell of it." Another communal farmer states: "Over time I had loved and cared for that animal, and then in the night, the leopard would come and take that innocent animal away. It will strangle it around the neck, tearing off flesh, then rips off large chunks from the body, it's not always a quick kill, and the poor animal would be done for." Reports of excessive killing of livestock by leopards are not unfounded, leopards killed 36 goats in one night in Botswana and 51 sheep and lambs in one incident in South Africa (Stuart, 1986, Winterbach et al., 2012). However, these cases are rare and demonstrate that a lack of knowledge of leopard ecology and behaviour generates conflicts with leopards, because these factors are used to justify the application of lethal control measures (Winterbach et al., 2012). Research demonstrates that improved scientific knowledge of wildlife decreases fear and improves tolerance for wildlife (Ericsson and Heberlein, 2003, Marker and Dickman, 2005, Prokop et al., 2009). Educational initiatives should focus on improving knowledge of leopard hunting behaviour e.g. identification of predation hotspots and circumstances that prevent excessive killing behaviour. Education initiative should also focus on familiarisation with the socio-ecological factors driving livestock and game predation and encouraged towards strategies that reduce the likelihood of attacks and calm people's fears of leopards.

7.4 Ecologistic-scientific values: knowledge of the leopard and livestock and game management systems

The Game Reserves Commission report, issued in the Transvaal (now the Limpopo Province) 1918, suggested that wildlife should be protected in its entirety, as opposed to select game species (Beinart and Coates, 1995). In the late 1920s, scavengers such as the jackal were attributed a new role as "nature's sanitary corps" (Fitzsimons, 1919 in Beinart and Coates, 1995, p. 83). When Kruger National Park was opened to the public, lions were favoured as the greatest animal attraction and in 1933, the relegation of predators as "vermin," was challenged by the Convention of the Protection of African Flora and Fauna (Carruthers, 1989, Beinart and Coates, 1995). The transition of the leopard from "vermin" to a "regulator of nature" is a common perception among younger generation farmers in the Blouberg, and linked to their understanding of leopard ecology. A young commercial farmer states: "I began to like the leopard. It kept the numbers of other carnivores such as jackal and caracal down, and ate the baboons for us crop farmers." Another young commercial farmer explains: "I like

having the leopard around, it means there is less work for us farmers. They kill off the other carnivores, without them we would have more problems with livestock losses." Young commercial farmers "co-exist with leopards" and consider themselves to live in "balance with nature," by adopting holistic livestock and game management systems. A young cattle farmer describes how he increased the numbers of wild prey on his farm, to limit livestock depredations: "I stopped shooting the impala for trophy hunting and we let their numbers grow…interestingly we actually experienced fewer livestock losses by leopards at the time. I think that new awareness changed my attitude towards them once we understood how nature worked we stopped killing them"

The farmer's improved knowledge of leopard and prey population dynamics encourages him to change his game management strategies to reduce livestock attacks, and raises his tolerance for the leopard. Four young commercial farmers manage livestock depredations by grazing cattle away from dry river beds and forested environments, and kraaling calves close to the homestead (Chapter 8). For all these farmers, their scientific knowledge of predatory behaviour informed their management strategies. In contrast, several communal farmers cited a lack of knowledge of leopard ecology and sustainable farming practices as a potential barrier, limiting their ability to initiate such practices (Chapter 8, Section 8.3.3). Education and outreach programmes should focus on improving knowledge of leopard ecology and behaviour. Measures that lead to holistic livestock and game management strategies may improve tolerance for leopard conservation. The expression of ecological-scientific values towards the leopard among young commercial farmers contrasts with the negativistic and dominionistic values of older generation farmers. Other studies have found an inter-generational trend away from dominionistic views of nature among older people, to a mutualistic (animals deserving rights for care and protection) view towards wildlife among younger generations (Vaske and Manfredo, 2012, Herrmann et al., 2013). Vaske and Manfredo (2012), suggest that the observed inter-generational trend is representative of a shift from a utilitarian to a protectionist worldview. Older generation commercial and communal farmers are key target groups for education initiatives and may benefit from the knowledge of younger farmers.

7.5 Utilitarian values: Trophy hunting, eco-tourism and traditional medicine

People attribute utilitarian values to the productive use of leopards. A commercial farmer emphasises the desirability of leopard skins and the economic benefits derived from trophy hunting: “All hunters want a leopard skin in their house, they are beautiful. You can fetch a good price for hunting a leopard sometimes for ZAR 30,000-40,000 that is income for me. ” Trophy hunting was frequently mentioned as a strategy for improving tolerance for leopards, by offsetting the costs of livestock and game depredations. However, both farming communities refrain from participating in the industry due to the political nature and high economic costs of paying trophy hunting fees to support Black Economic Empowerment initiatives; lengthy and bureaucratic application processes; and a lack of knowledge of the operational systems governing the industry (Chapter 8, Section 8.4.3). The above factors need to be overcome to improve the efficacy of the system and to assist in mitigating human-leopard conflicts.

The economic value of leopards for ecotourism on private game farms is exemplified by a game farmer: “I like having the leopards here because foreigners want to see that animal. We’ve had a couple of visitors that have seen leopards and were so very excited about their experiences. For us that can generate an income.” Another game farmer emphasises the importance of the leopard for ecotourism by drawing on the naturalistic values tourists associate with leopard encounters: “Tourists want to come here and see the leopard, a mystical animal that they won’t see in their own countries. I remember a woman crying when she saw her first leopard on our farm. She kept saying how magical it all was and what a truly unique experience it was to see such a beautiful animal.” The game farmers support leopard conservation, however, the ecotourism industry is deemed small-scale due to the isolated position of the Blouberg locality: “We fully support conservation initiatives for leopards and we try where possible to sell the leopard as an attraction for people to see when they come to visit. But to be honest tourism is not very big in this area as people tend to want to travel to the big parks like Kruger. We don’t always get that much press, normally we just get some tourists stopping off on their way to Kruger.”

The tradable use of leopard body parts for traditional medicine was described by a communal farmer: “Some people sell the body parts of leopards for their healing properties to make money. For example, if you killed a leopard you could sell the parts to traditional healers.

Traditional healers also make money from that thing…like buying and selling things in the supermarket but with animals." Definitions and explanations of illegal poaching depend on the positions and agendas of people in relation to nature conservation. Conservationists perceive illegal poaching as detrimental to the environment, in contrast, the narratives of traditional healers give evidence for a local conservation ethic, regulating the use of natural resources. A local conservation ethic is defined as an: "awareness that individuals can deplete or otherwise damage their natural resources, coupled with the commitment to reduce or eliminate the problem" (Johannes, 1994, p. 85). For the Bahananwa a local conservation ethic is tied to the spiritual beliefs of the people in addition, social factors, control and regulate the utilisation of natural resources through taboo systems (this Chapter, Section 7.6). A traditional healer states:

"I often take the roots from plants to make up some of my medicines, but I don't take too much so the plants can recover. If I take too many the ancestors wouldn't be happy. If you were to ask them from the reserve what I was doing with my stuff, it would be said that what I am doing is illegal. Yes, we use the parts and the herbs from the environment like we have always done that for years. Some of us try to only take a little. It is different from what you might witness with other people. Some people take too much or just do it for money. I don't agree with the large rhino poaching or the way they use dogs for hunting on the farms, it gives us all a bad name and it does decrease the numbers of wild animals. We are not supporting that thing, but we manage it ourselves differently. We are in fact helping with conservation because we are aware of how much we use, we maintain things for the future. If it were up to me I would punish those others that don't do as we do."

In the Blouberg, traditional healers perceive poaching as a traditional resource right that has been practiced for generations. Many researchers have associated poaching motivations with the perception that individuals believe they possess traditional rights of land tenure and resource use available to them in the past (Muth, 1998, Muth and Bowe Jr, 1998, Hampshire et al., 2004, Bell et al., 2007). Hampshire et al. (2004) demonstrate that local people view poaching activities in the Nemunas Delta, Lithuania, as a "way of life" and as part of normal behaviour and tradition. In the Blouberg, traditional healers differentiate between forms of poaching. The extractive use of herbs from the environment is deemed sustainable, but individuals also express antagonism towards commercial operations that make use of hunting dogs, because these practices are perceived as environmentally harmful. Similar findings have also been documented at Lake Kerkini, north-west Greece (Bell et al., 2007). Electro-fishing and harpoon fishing are despised by "regular" fishermen, who judge these methods to be the

main cause of decline in the lake's carp population (Bell et al., 2007). "Regular" fishermen catch small amounts of fish for subsistence and their behaviour is rarely considered unethical (Bell et al., 2007).

Discourse and narrative serve as tools for power and resistance and, once articulated, generate new forms of knowledge which challenge conservationists to reconsider the impact of their assumptions (Van Assche et al, 2012). The examples above have wider implications for wildlife conservation by suggesting that the definitions of poaching require a reassessment. In my study site the impacts of poaching on biological populations need to be assessed and the ability of traditional healers to stand up against what they perceive to be detrimental forms of poaching serves as a platform for both conservationists and local people to take collective action in favour of conservation.

The use of wild animals for traditional medicine and trade is commonplace in the Blouberg, as throughout southern Africa. Few baseline data exist across South Africa to assess the impact of poaching on wildlife populations (Whiting et al., 2013). A review of the Faraday traditional medicine market in Johannesburg, South Africa by Whiting et al. (2010) found that a higher than expected proportion of traders (62.5%) sold species that were of conservation concern, according to the International Union for Conservation of Nature, Red List Categories and Criteria Leopard animal parts were sold by 25% of traders compared to other popular mammal species, including the chacma baboon (69%), cape porcupine (69%), vervet monkey (50%) and warthog (50%). Estimating the impact of traditional medicine on wildlife is problematic because traders are reluctant to reveal their sources. Traditional healers in the Blouberg collectively suggest that leopard animal parts are rarely used compared to other species: "We use leopard medicine very rarely and I would say that there isn't really a high demand or need for it. Other species like the vulture are in higher demand, because people believe that that animal will make you become lucky with money, you may win the lottery." Leopard body parts are acquired by traditional healers from animals that are recovered when dead (e.g. accidently caught in snares intended for other animals and sold to healers through word of mouth) or purchased from traders in Polokwane or Botswana. The impact of the traditional medicine trade on local leopard populations is hard to ascertain, but, conservationists should consider the environmental impacts of other forms of wildlife use before denouncing them as environmentally destructive.

7.6 Spiritual values associated with leopards

Rural villagers in the Blouberg often perceive their lived experience with nature through an animated world, where they coexist with other humans, animals and ancestral spirits and where interactions with these beings affect happenings in the human world. The connection of wild animals to the world of spirit beings conjures up feelings of fear and reverence resulting in "a macro-religious conversation…where the power of magic or supernatural forces allow for humans to constantly, negotiate, communicate and interpret events" (Dillon, 2011, p. 70) outside the human domain. Leopard attacks on livestock are causally linked to the immoral conduct of a particular person. An elderly communal farmer from Indermark explains: "If you have a leopard attack your livestock, you would expect that there is something wrong between you and it. Maybe you didn't respect that animal very well in the past, perhaps you killed it, so it wanted to get you back." Leopard attacks on livestock may be perceived as acts of judgement and the leopard viewed as an instrument of retribution. As an elderly man from Hananwa explains: "You upset your ancestors, perhaps you didn't do something right and this is their way of showing you that you did something wrong."

For other southern African Bantu groups, for example, the Bemba of Northern Zimbabwe, the killing of bushpig, bushbuck, rhino, eland and aardvark results in the release of vengeful spirits (*ifibanda*) (Richards, 1939), whilst for the Gwembe Tonga, malevolent spirits (*mizimu*) have to be placated by medicine in order to prevent harm coming to the hunter and his associated kin (Scudder, 1962). In the Blouberg, communal farmers seek the advice of traditional healers to prevent leopard depredation on cattle. Numerous prohibitions exist to manage the effectiveness of the medicine, depending on the intentions of the individual towards the leopard: "These secrets are guarded by our elders and only a few of us remember these traditions. Often if a healer had access to leopard fat, these would be mixed with rare herbs only found in Kwa-Zulu Natal and rubbed on the underside of the calves' forearms. If a leopard was passing through the area, it would smell that muti [medicine] and mistake it for another leopard. We know leopards don't interact that much, so they avoid others like them. The medicine will only work though if you show good intent towards the leopard. You must not wish to harm it."

An essential feature in people's narratives of the leopard is the animal's role as a totem animal. Animal totems amongst Native American Indian societies represent structural forms that define the ordering of clans and act as metaphors for human behaviour (Levi-Strauss,

1963). Totemism amongst the aboriginal people in Australia is defined as: (1) *identity*, meaning, the totem is a non-human species or phenomenon that stands for, or represents, the group, (2) a *relationship*, meaning the totem and the person or group share physical substance, and kin relatedness, and (3) a *worldview*, meaning that totemic relationships are embedded in an understanding of the world in which connectivity is the foundation of all life (Rose, 2002, p .3). Totem groups amongst the Sotho are inclusive of all members of a clan united by kinship and descent (Van Schalwyk et al, 2002). A totemic animal is of great social significance because it represents a person's affiliation to a set of historical and ancestral bonds. A traditional healer states: "Your totem animal shows you the beginning of us, it shows you, where you come from, you must respect it."

In Sotho culture, the word for totem is *moano* or *seano* derived from the verb *go ana,* to honour, venerate or respect and to swear an oath (Mönnig, 1967). Traditionally, it is taboo to kill or eat a totem animal, an act that may result in ancestral spirits inflicting vengeful punishments (Mönnig, 1967). Adherence to established customs and taboos has the effect of promoting the protection of certain totemic species such as the leopard (Khan, 1990). These examples reveal a moral economy involving relations between people, wild animals and spirits that reveal how rural villagers perceive leopards as possessing powers of perception and moral reasoning. The belief in supernatural sanctions being imposed on people as a result of misconduct towards animals and other people generates respect for leopards and constructs affective relations between humans and leopards.

Figure 7.1: Leopard skins acquired by a traditional healer in the Blouberg.

A prominent war praise poem honouring the former Chief Ratšhatašha, who reigned over the Bahananwa during the Bahananwa-Boer War of 1894, was recited by Agnes Leboho in 1989 during a political rally concerning the future development of the Lebowa Bantustan. One sentence of the poem states "We are the people of Leboho, the one with the leopard in the village" (Joubert and Schalkwyk, 1999, p. 35) (*Re batho ba bo Leboho nkwe motseng*). Joubert and Van Schawlyk (1999) suggest that the "leopard in the village" refers to the Chief Ratšhatašha who is likened to a "fearsome and dangerous leopard," a force to be reckoned with in a time of war. The leopard skin forms part of the regalia of the Bahananwa chief and serves as a symbol of power and status as one informant explained: "The Chief will wear the skin of the leopard. He shows everyone that he is not somebody to be messed with. He is strong and powerful."

In Sotho culture, human life consists of a person (*motho*), body (*mmele*), soul (*moya*) and spirit (*seriti*) with the latter representing an important factor underlying people's spiritual relationship with wildlife (Mönnig, 1967). Cultural practices (e.g. prayers, rituals and traditional medicine) are predicated on the belief that latent powers named *maatla* (analogous to the *seriti* of a person) reside inside natural objects and can be drawn upon for healing illness, seeking protection from witchcraft and to achieve personal success (Eastwood and Eastwood,

2006). Similar processes underlie people's relationships with leopards, for example, the qualities symbolised by leopards (e.g. power, status, strength) are drawn upon and transposed onto human beings when taking traditional medicine and the perceived attributes of leopards acting as totemic animals are linked to the traits of an individual's ancestors and can be drawn upon for invocation in people's lives. The attainment of power requires the maintenance of a harmonious relationship with ancestral spirits that is predicated on a perpetual cycle of prayer, rituals and sacrifice. A traditional healer said: "The leopard is strong and powerful, so are your ancestors, if you need to be strong, make sure you please your ancestors through regular prayer and gifts, then it will work out for you." Similarly, a communal farmer states the "qualities of the leopard can be used to represent those qualities in man. If you visit a traditional healer and you are looking to overpower someone in a fight, you will find that she will often give you the muti [medicine] of the leopard, once you take that muti you will be given power and strength to defeat your opponent." The leopard's success as a hunter is often interpreted as evidence of its uncanny abilities. For example, the leopard is renowned by several communal farmers as "getting whatever it wanted from life" and "the leopard stalks under the sky at night. It's dark yet it always manages to catch its prey." These qualities are imbued in muti and confer similar skills upon the person to whom it is administered via the services of a specialist, as a young male villager states: "I can travel five hours under the cover of night without a single person seeing me on the road, if I take the leopard medicine. We can speed on the road and even the police won't notice you."

Leopard medicine is used to treat numerous afflictions (grinding teeth at night, common colds and balding in men). Leopard bone joints, named *ditaola*, are used by traditional healers for divination (Fig. 7.2). I met a healer who wore the claw of a leopard, the thang of a puff adder, the tooth of a baboon and the thorn from a buffalo thorn acacia tree as a necklace (Fig. 7.2). She explained their meaning: "My grandfather came to me in a dream and told me to gather these items. He used to be a hunter, my grandfather hunted these animals, and he told me I would be able to connect with him by wearing this necklace. The claw of the leopard gives me strength. Together they give me protection and the power to heal people." Rural villagers revere the leopard, as demonstrated in the complex spiritual values associated with the animal, their ties with the spirit world of ancestors and their magical command over humans underpinning its use in cultural practices. These values are embedded in normative and moral codes of conduct and should not be aligned purely with commoditised practices of illegal poaching as depicted by conservationists.

Figure 7.2: Traditional healer's necklace and ditaola, crafted out of animal bones and wood, used for divination and stored in the skin of a genet.

Colding and Folke (2001) define six categories of resource and habitat taboos, one of which is defined as a species–specific taboo that gives protection to a particular species. Totemic animals are an example of a species-specific taboo, where to eat or kill the animal results in ancestral spirits afflicting vengeful punishments. Habitat taboos apply when a cultural group regulates both access to and use of resources from particular habitats in space and time. Species-specific and habitat-specific taboos function as informal institutions, defined as "norms, of behaviour, conventions, self-imposed codes of conduct, and their enforcement characteristics" (Colding and Folke, 2001, p. 585), and are central to indigenous forms of resource management. Such institutions are decentralised and self-enforced by a community, where no external authority is available to guarantee that social actors will abide by rules and procedures (Colding and Folke, 2001).

Rural villagers ascribe supernatural powers to wild animals, ancestral spirits and mythical creatures that reside in sacred rivers, water springs and forests. The mythical water snake *Mmamogaswe* resides in sacred water pools and rivers in the Blouberg Mountain. Before entering these sacred sites to use natural resources (e.g. collecting water and extracting plants or herbs for traditional use) people must consult a prophet or healer to obtain guidance from the ancestors regarding a set of protocols that must be followed to ensure safe passage. As a

deterrent against unwarranted use of these sites (e.g. cutting down trees, swimming in the water, trampling on herbs) people recite stories of the water snake *Mmamogaswe* killing people, eating and drowning children and conjuring up vast winds and rains. Some villagers imply that the drying up of old streams and rivers on the mountain is inflicted by ancestral spirits as retribution against improper use of sacred water sources. Sacred forests inhabited by the spirits of deceased Chiefs, or areas on the mountain that are avoided by people, represent the dwellings of ancestral spirits. If people attempt to access these sites without the prior permission of a Chief or prophet they will never return home. The spiritual values attributed to totemic animals and sacred sites contribute to the maintenance of a longstanding and culturally specific conservation ethic, limiting the extraction of natural resources. These values align with values conditional to wildlife conservation to suggest areas for common ground, where local values can be incorporated into existing conservation policies. However, there is also a noticeable diminishment of these values amongst younger generations, which according to an elderly communal farmer results in a lack of familiarity with the leopard: "These days, the young people won't be able to tell you about these cultural things, some don't even know that there is a leopard around here on the mountain, they are clueless. They can't tell you what rules to follow, about not eating it. They wouldn't even know. That's a general pattern here. Younger people don't respect our culture."

7.7 Aesthetic and cultural values: Linking leopard conservation with the Blouberg landscape

Aesthetic values attributed to animals have been associated with public support for species conservation. Environmental groups use charismatic species such as large carnivores or aesthetically pleasing animals including seals pups, eagles, spotted owls, kingfishers and different tree species in their campaigns (Knight, 2008, Takahashi et al., 2012). In the Blouberg, both farming groups associate aesthetic values with the leopard, which is admired for its "beauty," "agility" and "grace." Aesthetical appreciations of wildlife evoke emotional responses in people, represented through their spiritual experiences of nature (Kellert, 1995, Cooper, 1998). King (1996) suggests that the expression of spirituality is inclusive of creativity, imagination, change, and intense feelings of harmony, serenity and wellbeing, which extends Herrmann et al's (2013) definition of spiritual value, beyond the depiction of religious practices.

A woman from Indermark recalls tending her agricultural fields and seeing a leopard through the fence of the nature reserve, prompting her to rhapsodise a sensory experience embedded in the totality of sounds and visual beauty of the mountain landscape: “How graceful she stood in the morning against the mountain mists, it was quiet, just me and the leopard. It stood and stared at me, beautiful.” Similarly, a commercial farmer states: “The leopard is a very beautiful animal, just like all of the nature we have here in the Blouberg. It’s truly a beautiful sight to wake up to every morning, and see the mountain view…you feel peaceful. I wouldn’t want to lose any of that…for it to be damaged in any way. We must look after all of nature including the leopard.” The beauty of the leopard is intrinsically linked to the beauty of all of nature, and a sense of peace is evoked by an appreciation of the wider Blouberg landscape. The farmer perceives the degradation of the environment as a justification for the protection of the leopard, because it forms part of nature in all its’ entirety. The pleasure the farmer gains from his experience with nature can also be depicted as an expression of naturalistic values. Aesthetic values evoke religious connotations, a commercial and communal farmer state: “All animals like leopards are beautiful, they are God’s animals, they deserve to live as well” and “these animals are stunning, very nice animals, they aren’t ours to kill. They belong to God.” The same individuals condemn the killing of leopards as being morally unjustified. In the Blouberg, informants from both farming groups attribute existential values towards the leopard that confer an inherent right to life. A communal farmer states: “We must protect the leopard for our youngsters so they will know what it is to see one in the future.”

Cultural values associated with the leopard by communal farmers represent the leopard as being part of an individual’s cultural heritage, through its association with the spiritual worlds of the ancestors and its historical ties to the land prior to human settlement. A communal farmer articulates existence values that justify the leopard’s conservation through its sense of belonging to place: “The leopard is part of our heritage, they are connected to our ancestors. They were here before us, before we were born. They deserve to be here as much as we do. They are part of the entire Blouberg area, part of everything.” Similarly, a commercial farmer states: “I support the protection of the leopard. They belong to us, they are part of our home like the entire environment here.” The association of the leopard as belonging to the Blouberg is articulated as an ontological state due to its historical ties to land and people. The leopard is represented as belonging through its connections with home and the ways in which, “rootedness…evokes conditions of existence which tend to stress the emotional gravity of place” (Lovell, 1998, p. 8). A communal farmer associates humanistic values with the leopard’s rights to life; the leopard matters because it has its own history that ties it to the Blouberg.

This sense of belonging evokes a strong emotional response to the leopard's potential extirpation: "The leopard deserves to live here with all of us. The mountain is where it is from, where it lives. They love this place, their home. I think it would be unimaginable to live on this mountain without the leopard around knowing that it was once here but we destroyed it. It wouldn't be the same."

The preservation of leopards and their mountain habitat symbolises the continuation of life as well as human life and identity, a communal farmer states: "If you preserve the leopard, you are protecting life, we are both from here, therefore, we should still both be here in the future. This is his place and mine and that makes me happy knowing that we are here together." Sumares and Fidelis (2011) suggest that the representations of the environment and our relationship with the environment are strongly tied to identity relations and dynamics and "it is the fear of identity-loss…that underlies management discourses on sustainability" (Porter, 2005, p. 1). A sense of continuity underlies support for leopard conservation which is intrinsically tied to identity maintenance as well as general wellbeing. Another communal farmer perceives the preservation of the leopard as being tied to the wider conservation of other species, suggesting that species diversity is fundamentally important because individual species form part of a whole system that constitutes nature: "If we save the leopard, you have to save all the other animals because they are all part of nature, we must look after them all." A commercial farmer states: "Leopards are part of the Blouberg. I want to look after this place not just the leopards, if you can show me how me protecting the leopard does that – then I am in." Similarly, a commercial farmer said: "people are more likely to conserve leopards if you conservationists highlight the perks that come with the protection of the leopard for other aspects of nature."

The expression of aesthetic and cultural values represents the leopard as a species embedded within a wider ecological system that constitutes nature and its conservation as tied to the preservation of the wider Blouberg landscape. This perception of the environment overlaps with ecological-scientific values, emphasising an interconnectedness and interdependence between biotic and abiotic elements within a system. The expression of aesthetic and cultural values in campaigns and marketing strategies may encourage support leopard conservation. For example, representing wide-ranging, large carnivores as umbrella species follows the logic that if large carnivores are protected this may ensure that sufficient habitat is protected for other species (Balme, 2009). Representing the leopard as a flagship species for the preservation of the wider Blouberg landscape, a poignant symbol of cultural history and an important resource for future generations, may promote support for leopard conservation.

7.8 Conclusion

Commercial and communal farmers exhibit a full array of environmental values for the leopard. The expression of these values among commercial and communal farmers show similarities and differences, which are summarised in Table 7.2. In the Blouberg, negativistic and dominionistic values relate to the perceived spatial boundary crossing and predatory behaviour of leopards. The representation of leopards by commercial farmers as "vermin" and "pests" is rooted in colonial history and linked to the development of a fortress preservation ideology, the changing economic status of game, notions of taming and controlling wilderness and protecting one's property from outside forces. For communal farmers, a fear of being alone in the bush and historical experiences with the leopard are related to the depiction of the leopard as "dangerous" and "bloody horrible." Negativistic values associated with the leopard stem from a fear of livestock and game depredations for both farming groups. However, communal farmers perceive the risks leopards pose to human life as fundamental. Dominionistic values associated with the leopard are articulated through a need to prevent livestock and game depredations, to control the perceived high numbers of leopards in the area and to protect livelihoods/properties. The latter factor is manifested in the actions of both commercial and communal farmers to violently defend their properties/villages from leopards by adopting lethal control measures, which are described as "battles" and likened to acts of "war" and leopards "as taking what they want."

Scientific knowledge of leopard population and behaviour is tied to the participation of younger generation commercial farmers in sustainable livestock and game management systems, designed to prevent depredation events. Conversely, a lack of scientific knowledge of leopard predatory behaviour and ecology intensifies conflict with leopards and prevents communal farmers from adopting sustainable farming strategies. The definition of ecologistic-scientific values is not purely mediated by scientific knowledge of leopard ecology but also an awareness of the leopard as a species embedded within a wider ecological system that constitutes nature. These viewpoints are common amongst both farming communities and demonstrate an awareness of the inter-connectedness and interdependence of abiotic and biotic factors within an ecological system. The affiliation of the beauty of the leopard with the wider beauty of the Blouberg landscape and a local understanding of the linkages between leopard conservation and the preservation of other species, habitats and environments, accentuate this point.

Few farmers' associate utilitarian values with the leopard, those that do are commercial farmers who recognise the material benefits derived from trophy hunting and eco-tourism, which contribute to local livelihoods. The economic benefits generated from the tradable use of selling leopard body parts for traditional medicine are cited by several communal farmers, but, the spiritual values associated with the leopard serve as a motivating factor for the leopards use in traditional medicine. Rural villagers fear, respect, and revere the leopard because of its connection with ancestral spirits and as possessing powers of perception and moral reasoning. The belief in supernatural sanctions being imposed on people as a result of misconduct towards leopards generates respect and constructs affective relations between humans and leopards.

Both farming groups draw on feelings of harmony, serenity and wellbeing evoked in their representations of leopards, against the wider backdrop of the Blouberg Mountain, to demonstrate their own spiritual connections to place. I extend Herrmann et al. (2013) definition of spiritual values beyond the documentation of religious and cultural practices to incorporate these factors. Spiritual, naturalistic, moralistic, existence and aesthetical values are interwoven to elicit a wide range of human responses that encourage support for leopard conservation (Table 7.2). The beauty of the leopard is tied to the aesthetics of the Blouberg landscape, people's emotional, sensory and religious experiences with nature and the representation of humans as stewards with a responsibility to ensure the protection of the leopard for future generations. Cultural values are rooted in an attachment to the Blouberg, made apparent in the association of the leopard with historical ties to the land and the representation of the leopard as belonging to the Blouberg. For commercial farmers, cultural values are linked to humanistic values that highlight a love of leopards through their connection to home. In contrast, the spiritual beliefs of communal farmers link leopards to cultural history. For communal farmers, the conservation of the leopard symbolises the preservation of ongoing human life and the continuity of human identity and wellbeing.

Values associated with leopards can be broadly divided into values that provide barriers for leopard conservation and those that promote tolerance and support for leopard conservation. Indiscriminate lethal control measures, underlined by negativistic, dominionistic and spiritual values, have the potential to negatively impact the viability of local leopard populations and non-target wildlife and represent the most contested form of conflict management amongst a range of stakeholders. Negativistic, dominionistic and ecologistic-scientific values demonstrate that a lack of knowledge of leopard behaviour and ecology highlight the importance of education to prevent the adoption of indiscriminate lethal control measures and to encourage

the implementation of sustainable farming practices (Chapter 9). Utilitarian values associated with the material benefits generated from trophy hunting and ecotourism serve as tools for conservation, but few farmers engage in these industries, highlighting a need to improve farmer participation. An awareness of the interconnectedness between leopards and the wider conservation of other species, habitats and environments has positive implications for leopard conservation by representing the leopard as a flagship species for the conservation of the wider Blouberg landscape.

Contrasting values introduce conflict between stakeholders, whilst, overlapping values identify areas for common ground between conservationists and farming communities to take collective action for leopard conservation. The use of leopards for traditional medicine seems at odds with conservation because it is defined as a form of illegal poaching. However, traditional healers challenge their representation as poachers, suggesting that the definition of poaching requires reassessment. Traditional healers' ability to denounce what they perceive to be more detrimental forms of poaching, serves as a platform for conservationists and local people to take collective action. Species-specific and habitat-specific taboos are a form of spiritual belief that are relegated as superstitious by conservationists. Anthropology elucidates the spiritual role of wild animals in human societies and alerts conservationists to the role of symbolism and ritual in managing natural resources. The spiritual values associated with totemic animals and sacred sites align with values conditional to wildlife conservation to suggest areas for common ground, where local values can be incorporated into existing conservation policies. The above examples demonstrate the need for meaningful opportunities for dialogue and deliberation between conservationists and local people surrounding the expression of value in relation to the conservation of leopards. Conservationists should attempt to recognise that human beings operate with a full array of motivations, that extends beyond the pure utilitarian view of nature, and that these values should be recognised and incorporated into existing policies and legislation governing wildlife management.

Table 7.2: Typology of values associated with the leopard amongst commercial and communal farmers. Points highlighted in red indicate overlapping values.

Value	Commercial Farmers	Communal Farmers
Negativistic	1. Fear of the leopard due to the threats it poses to livestock/game and livelihoods. 2. Depiction of leopards as vermin and pests. 3. Perceived spatial boundary crossing behaviour used to justify lethal control measures. 4. Leopard predatory behaviour perceived as ferocious and the leopard as having an insatiable appetite to justify lethal control measures.	1. Fear of the leopard due to the threats it poses to livestock, livelihoods and human life. 2. Depiction of leopard as dangerous and bloody horrible. 3. Perceived spatial boundary crossing behaviour used to justify lethal control measures. 4. Leopard predatory behaviour viewed as violent attacks on livestock and used to justify lethal control measures.
Dominionistic	1. Violent measures used to kill and control leopards from invading properties. Farmers depict themselves as battling to kill leopards and defending their properties.	1. Indiscriminate lethal control measures to kill and control leopard numbers.
Ecological-Scientific	1. Acknowledges the functional role of the leopard to limit the abundance of other prey and carnivore species, which younger generation farmers perceive as pests 2. Beauty of leopard intrinsically linked to wider beauty of all of nature. 3. Awareness of leopard as embedded within a wider system that constitutes nature. 4. Leopard conservation tied to the conservation of the wider Blouberg landscape.	1. Acknowledges the functional role of the leopard to limit the abundance of other prey and carnivore species, which younger generation farmers perceive as pests. 2. Beauty of leopard intrinsically linked to wider beauty of all of nature. 3. Awareness of leopard as embedded within a wider system that constitutes nature. 4. Leopard conservation tied to the conservation of the wider Blouberg landscape.
Utilitarian	1. Functional productive use of leopards for trophy hunting and ecotourism.	1. Tradable use of leopard body parts for traditional medicine.
Spiritual	1. Beauty of leopard related to a sense of harmony, peace, serenity and wellbeing and people's sensory experiences of the Blouberg Mountain. 2. Association of the leopard as God's animal.	1. The Bahananwa fear, revere and respect the leopard because of the perceived connection of leopards with ancestral spirits and as possessing a magical command over human behaviour. 2. The human qualities leopards symbolise (power, strength and

		status) are drawn upon and transposed onto humans when taken as traditional medicine and when leopard body parts are used in other cultural practices e.g. leopard's skins are used for the inauguration of the Bahananwa Chief to represent power and status. 3. Leopard as a totem species ensures its protection through the application of species-specific taboos that prevent it from being killed and eaten. 4. Beauty of leopard related to a sense of harmony, serenity and wellbeing and people's sensory experiences of the Blouberg Mountain. 5. Association of leopards as belonging to God.
Aesthetic	1. Appreciation of the leopard for its beauty, grace and agility. 2. Beauty of leopard related to a sense of harmony, peace, serenity and wellbeing and people's sensory. experiences of the Blouberg Mountain 3. Beauty of leopard intrinsically linked to wider beauty of all of nature.	1. Appreciation of the leopard for its beauty, grace and agility. 2. Beauty of leopard related to in a sense of harmony, serenity and wellbeing and people's sensory experiences of the Blouberg Mountain. 3. Beauty of leopard intrinsically linked to wider beauty of all of nature.
Naturalistic	1. Beauty of leopard related to a sense of harmony, peace, serenity and wellbeing and people's sensory experiences of the Blouberg Mountain.	1. Beauty of leopard related to a sense of harmony, peace, serenity and wellbeing and people's sensory experiences of the Blouberg Mountain.
Existence	1. Leopards as having inherent rights to life and belonging to the Blouberg. 2. Leopards require protection for future generations.	1. Leopards as having inherent rights to life and belonging to the Blouberg, because they were here prior to human settlement. 2. Leopards require protection for future generations.
Cultural	1. Leopards as belonging to the Blouberg linked to connections with home and a shared history with people. 2. Loving leopards through their	1. Leopards linked to cultural heritage through its ties with the spiritual worlds of the ancestors and historical ties to land prior to human settlement.

	connection to home. 3. Leopard conservation tied to the conservation of the wider Blouberg landscape.	2. Conservation of leopard tied to concepts of ongoing life and the maintenance of human identity. 3. Leopard conservation tied to the conservation of other species and the wider Blouberg landscape.
Humanistic	1. Loving leopards through their connection to home.	-
Moralistic	1. Leopards as having inherent rights to life and belonging to the Blouberg. 2. Leopards require protection for future generations.	1. Leopards as having inherent rights to life and belonging to the Blouberg. 2. Leopards require protection for future generations. 3. Willingness to treat leopards with respect, often out of fear of supernatural sanctions being imposed for immoral misconduct.

Chapter 8

Assessing strategies to mitigate conflict: a threefold framework for appraising multiple measures

8.1 Introduction

Traditional human responses to human-wildlife conflicts often involve retaliation through lethal control measures that undermine conservation goals in areas where carnivores are high profile and legally protected (Gittleman et al., 2001, Woodroffe, 2001, Treves and Karanth, 2003, Hazzah et al., 2009). Research on human-wildlife conflicts worldwide has focused on providing alternative solutions to managing problem animals that do not rely on retaliation alone (Treves et al., 2009). These include assessing the feasibility of lethal and non-lethal mitigation practices as well as other actions that seek to "reduce the severity or frequency of encounters between wildlife and property," and "aim to raise people's tolerance for such encounters" (Treves et al, 2009, p. 2). Several studies have focused on the economic feasibility of different mitigation strategies, their capacity to manage wildlife threats and protect human safety and property without compromising the population viability of wildlife populations (Treves et al., 2009, Barlow et al., 2010). Treves et al. (2006) encourage conservation practitioners to combine technical expertise with local knowledge to assess the socio-political acceptability of different strategies amongst a range of stakeholders, to guide the design of conflict resolution strategies.

Modern approaches to improved livestock husbandry include electric fencing and radio-activated guards. However, these strategies are costly to implement and are not feasible for marginalised communities in less developed countries (Brieitenmoser et al., 2005). Wildlife authorities often favour capture and relocation operations for managing problematic carnivores. These methods are popular with the public, but carry substantial economic costs for wildlife authorities to implement (Linnell et al., 1997, Naughton-Treves et al., 2003, Manfredo and Dayer, 2004). The success of environmental institutions at mediating conflicts arising between human populations and wildlife depends on socio-economic and political conditions as well as the "institutional architecture designed to manage these conflicts" (Anthony et al., 2011, p. 225). Misunderstandings, disagreements and disappointments experienced by people affected by wildlife can arise because people have unrealistic

expectations surrounding the degree of wildlife damage that can be controlled by governments (Hill, 2004). Institutions that fail to effectively manage damage-causing animals can have detrimental effects on human security and undermine the effectiveness and legitimacy of state institutions in the eyes of local people (McGregor, 2005).

The effects of strategies on target and non-target wildlife may reduce the feasibility of the strategies (Burns et al., 1991). Lethal control of large carnivores can create population sinks outside protected areas, leading to the decline or extinction of localised species when immigration and reproduction rates are unable to balance mortality (Woodroffe and Ginsberg, 1998). The removal of predators from ecosystems can have cascading effects on small predator species leading to "mesopredator release," resulting in the decline of other prey populations (Estes et al., 1998, Terborgh et al., 2001, Ritchie and Johnson, 2009).

Many studies emphasise the need to include a range of stakeholders, including researchers, policymakers and local people into the appraisal of mitigation strategies (Treves et al., 2006, Messmer, 2009, Treves et al., 2009). Researchers stress a need for management teams to develop capacities for transparent and democratic participatory approaches to address planning responses to conflicts caused by wildlife (Treves et al., 2006, Messmer, 2009, Treves et al., 2009). Participatory planning procedures generate ideas that one party alone may not have envisaged and define the expectations and responsibilities of different stakeholders. Reaching a unified consensus on the feasibility of different strategies may be difficult to achieve because stakeholders introduce opposing values, attitudes and belief systems (Messmer, 2009).

Wildlife management planning procedures then become a process of understanding "wicked problems," that must first be identified and understood in the initial design process. Wicked problems do not lead to a single correct outcome but depend on the individual "experiencing it and how the person chooses to explain the problem determines the scope of resolution" (Leong et al, 2012, p. 30). Leong et al (2012) suggest that each problem is understood and articulated differently depending on the individual or group, creating social conflict over desired outcomes and how to achieve them. I apply a three sphere framework to assess the feasibility of different mitigation strategies according to their cost-effectiveness, wildlife specificity and the social-political acceptability (Fig. 8.1).

- Cost-effectiveness is evaluated according to the resources, time, and experience required to implement and maintain the strategy, with the assistance of environmental institutions and local farmers.

- Wildlife specificity is appraised according to the ability of each strategy to reduce attacks by leopards on livestock and game, and the anticipated ecological effects of each strategy on the viability of leopard populations and non-target wildlife.

- Socio-political acceptability is defined as tolerance for the implementation, maintenance and consequences of each practice among environmental institutions and local farmers.

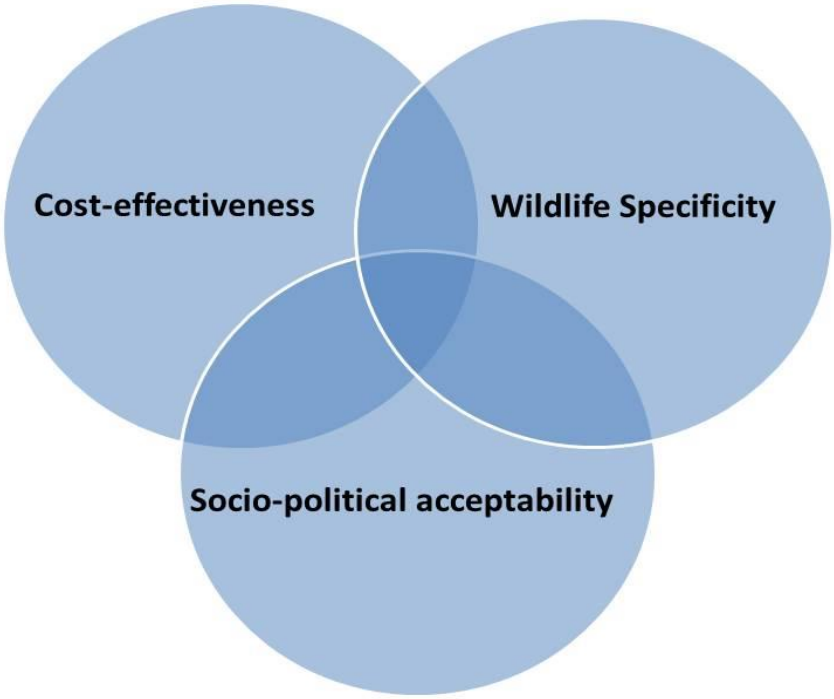


Figure 8.1: The overlapping impact of cost-effectiveness, wildlife specificity and socio-political acceptability to evaluate the feasibility of different mitigation strategies.

I collect baseline data on the perceptions and experiences of local farmers and environmental institutions to evaluate the feasibility of different mitigation strategies to guide future planning strategies in the Blouberg. I envisage that decisions regarding the socio-political acceptability of each strategy will depend on how each individual and group assesses cost-effectiveness and wildlife specificity based on a set of factors they identify as important. The degree of overlap

between each sphere will contribute to understanding value differences and commonalities between different stakeholders and highlight factors that require further research.

8.2 Methods

During the pilot study conducted from from March-May, 2010, I interviewed two governmental officials from the Department of Environmental Affairs (DEA) a branch of the Department of Economic Development, Environment and Tourism (LEDET) of the Limpopo Provincial Government. I interviewed six farmers (three communal and three commercial) during a pilot study to identify a list of mitigation strategies employed by farmers and environmental institutions. Individual mitigation strategies employed by all farmers include improved livestock and game husbandry and lethal control measures including shooting and wildlife trapping (snares and gin traps). The DEA manage problem animals using relocation operations and lethal control measures (shooting problem animals through the issuing of a damage-causing animal permit and trophy hunting). Currently many damage-causing animal operations are outsourced to local Non-Governmental Organisations (NGOs), namely, DeWildt and the Endangered Wildlife Trust to investigate reports of problem animals and to assist the DEA in translocations of problem animals.

I assessed the feasibility of implementing different mitigation strategies by interviewing 42 farmers (19 commercial and 23 communal) and four government officials from the DEA. I asked informants about their perceptions of the cost-effectiveness of each strategy, their personal experiences of the success of each strategy to limit leopard predation and the anticipated ecological effects on the viability of leopard populations and non-target wildlife, as well as their attitudes towards the socio-political acceptability of each practice. I draw on ethnographic data derived from participant observation, reviews of the human-wildlife conflict literature and ecological data presented in Chapters 5 and 6 to discuss the potential impacts of each strategy on the ecology of leopard populations and non-target wildlife. The research process had to reflect the sensitive nature of the data to be collected because some strategies adopted by farmers such as wildlife trapping are illegal. Therefore, confidential semi-structured interviews and participant observation were carried out on a one-to-one basis as opposed to research methods that allowed for open group discussions.

8.3 Individual strategies to mitigate human-leopard conflict: livestock and game husbandry

8.3.1 Livestock Guardians

Traditional societies have employed shepherds to care for free-ranging herds since the dawn of domestication (Linnell et al., 1996). Guided grazing improves livestock management systems by avoiding areas where predation risks are high, herding livestock into kraals at night and improving rates of disease detection (Brieitenmoser et al., 2005). Shepherding is more effective when guardians are assisted by trained dogs or other creatures (Rigg, 2001). Livestock-guarding animals, include a variety of animals such as dogs, zebras, horse stallions, horned oxen, mules, baboons, donkeys and llamas (Brieitenmoser et al., 2005). Livestock-guarding animals are socialised with livestock herds at an early stage of development, live with the herd continuously and are able to intercept an attack by providing an alarm or chasing and attacking the predator (Smith et al., 2000). Some livestock-guarding animals represent potential prey species for large predators so, their ability to effectively protect livestock is controversial (Linnell et al., 1996, Meadows and Knowlton, 2000, Brieitenmoser et al., 2005).

In the Blouberg, traditional livestock management systems have eroded with changing land use systems and the historical eradication of large carnivores from the area (Chapter 5). As a result, farmers adopt husbandry systems where livestock graze freely on mountain pastures and forests, are left unguarded and not kraaled at night; exposing young calves and donkey foals to high rates of predation by leopards (Chapter 5).

Nearly half of communal farmers (48%, n =11) do not perceive shepherding and the employment of livestock guardian dogs as cost-effective. Opportunity costs arise from this form of conflict management because these methods are deemed labour intensive. Traditional shepherding roles for the Bahananwa were fufilled by young boys, who took on greater responsibilities for the care of livestock as they reached pre-initiation age (Chapter 5, Fig. 5.20). Currently full-time education and the migration of young and adult men out of rural areas in search of greater employment opportunities shift the responsbility of shepherding onto elderly men (Chapter 5). Shepherding livestock poses increased health risks for the elderly, due to the long distances travelled to reach the mountain during the dry season. A communal farmer explains: “One day, I had to travel far to the mountain to check on my

cattle. It took me such a long time to find them. I am far too old for this kind of work but nobody can help me. We don't have money to pay anyone to help. That day I fell on some rocks on the way home and injured my ankle."

The average estimated cost of employing a single full-time shepherd totals ZAR 604 per month. Currently 75% of households in the Capricorn District have a total income of ZAR 1500 per month (Capricorn District Municipality, 2013-2014). The costs of employing a full-time shepherd represent 40% of the estimated monthly income for households. Most communal farmers (61%, n = 14) rely on pension money (ZAR 1500 per month) to enhance their subsistence lifestyles, cover school fees for younger members of the household, purchase food and for local transport. Employing full-time shepherds constrains the economic security of local livelihoods, compared to other farmers that have diversified their income by selling vegetables or by being in full-time employment. One communal farmer suggests that the economic costs of employment can be overcome by joining forces with other farmers to secure funds to finance shepherds: "If we had a village fund that would really help us. Each interested farmer could donate a certain amount of money per month. The fund could be then used to provide a wage to employ herders. We can all elect someone that we find reliable."

Treves et al. (2006) suggest that communal coping mechanisms buffer the impacts of human-wildlife conflict for societies that depend on traditional forms of sharing and joint land management to provide additional resources and forms of labour. In the Blouberg, cooperative insurance schemes serve as communal coping mechanisms to generate revenue to fund the costs of funerals for individuals who cannot afford it. Villagers form committees and elect representatives to collect and bank money secured from all members at the end of each month. Similar strategies may prove successful for funding revenue to employ full-time herders in rural villages.

The majority of commercial farmers (74%, n = 14), perceive livestock guarding to be cost-effective. However, several commercial farmers highlight that the costs of employing livestock guardian dogs are high due to their increased exposure to predation, disease and injury. Training livestock guardian dogs was also identified as time-consuming. The Endangered Wildlife Trust initiated a Livestock Guardian Dog Project in the Limpopo and Mpumalanga Provinces by placing indigenous shepherd dogs on commercial farms over a 12 month trial period. Initially, the NGO covers the costs of food and veterinary care. To date the NGO has not explored the feasability of the project for communal farmers. A member of the Trust

expresses concerns that communal farmers do not have the finances to adequately care for dogs in the long-term.

Farmers stress that shepherding is effective in limiting livestock depredations, when used in combination with livestock guardian dogs. However, farmers also stress that guardian dogs are less successful over large areas and in mountainous environments. A member of the Endangered Wildlife Trust raised concerns that the feasibility of employing dogs in communal areas is constrained by their use for hunting. I often observed dogs hunting wild animals that would undermine their role as livestock protectors against predators. The programme trains dogs as deterrents and guardians rather then attack dogs. The livestock-guarding project is cost-effective and sources its funds from private donors, is free of charge and supports farmers by providing training sessions and regular visits to monitor their progress. Over a six year period, the project has placed 110 dogs within the Limpopo and Mpumalanga Provinces, leading to a reduction in economic losses of livestock ranging from ZAR 140,000 to R4.2 million (Cilliers, 2011).

Fifty eight percent (n = 11) of commercial farmers and 35% (n = 9) of communal farmers, tolerate the use of shepherds and dogs as guardians. Commercial farmers who support this strategy can afford to employ full-time shepherds and perceive the dual use of shepherds and guardian dogs as effective for reducing livestock depredations. In contrast, most communal farmers deem livestock guardians to be economically expensive and labour intensive. Sixty eight percent of commercial farmers (n = 13) express a willingness to participate in the project, which offers cost-effective solutions for farmers, builds long-term working relationships to foster trust and provides a support network for farmers. The project simultaneously incorporates solutions to reduce livestock depredation and raise tolerance for leopards by introducing agreed policies to ensure that farmers do not engage in lethal control measures. In future the Trust could provide education and training workshops in communal areas to advise farmers how to better care for and train their dogs to serve as effective livestock guardians and to raise awareness of the ecological impacts of hunting wildlife.

8.3.2 Night-time kraals

Fences made of natural materials to pen in livestock at night have been used by African societies to protect livestock from predators for centuries (Beitenmoser et al, 2005). The majority of communal farmers (65%, n = 15) in the Blouberg perceive kraaling to be cost-effective because local materials (wood, logs and acacia thorn bush), are sourced from the mountain without economic cost and are easy to maintain (Fig. 8.2). In contrast, night-time kraals on commercial farms are constructed from expensive materials using wire-netted fences, supported by wooden and metal stakes (Fig. 8.3). The majority of commercial farmers (74%, n = 14), perceive night-time kraaling as an expensive strategy to implement. Cattle are free-ranging throughout the day and night, and it is costly for commercial farmers to kraal cattle on a daily basis because it interrupts their natural grazing behaviour of cattle that prefer to graze during the cooler nights. A commercial farmer states:

"We run a tight ship on these farms, if we kraaled them all at night we would lose productivity. They would lose weight, we can't afford that. There's also the problem with time. It takes a long time to find the cattle and get them drawn into the kraals at night..I can't afford to do that everyday."

Similar findings have been reported amongst commercial cattle farmers in the Ghanzi District, Botswana (Kent, 2011). Some communal farmers also express concerns that kraaling is labour intensive because elderly farmers are unable to travel long distances to the mountain to shepherd livestock into night-time kraals during the dry season. This intrdouces opportunity costs for the elderly due to greater exposure to health risks (Section 8.3.1).

Figure 8.2: Traditional cattle kraal on the Blouberg Mountain.

I asked farmers to comment on their experiences of using night-time kraals and its effectiveness to evaluate wildlife specificity. In the Blouberg, only two livestock attacks occurred inside a kraal from a total of 67 reported attacks (Chapter 5). These attacks were reported by two households living on the mountain that experienced the highest levels of predation among all farmers (Chapter 5). The first communal farmer lost 18% of his total cattle holdings and 60% of his total donkey holdings, whilst the second farmer lost 13% and 25% respectvely. Both farmers comment that night-time kraals are only effective when farmers and dogs sleep close to kraals. Smilarly, Ogada et al. (2003) reported that the likelihood of livestock attacks occuring in kraals was reduced when people were present in the Laikipia District of northern Kenya. In contrast, Kolowksi and Holekamp (2006) showed that the presence of domestic dogs alone was ineffective in protecting livestock from predators along the northeastern border of the Massai Mara National Reserve, suggesting that a dual combination may be more effective.

Figure 8.3: Wire-netted fences on commercial land.

Some commercial farmers state that kraaling livestock during the calving and lambing seasons close to households reduces livestock depredation. Other commercial farmers suggest that the success of kraaling depends on the number of livestock placed in kraals and the positoning and structure of kraals. One commercial farmer explains: "I've always kept the calves close to the homestead, where there is a lot of noise and people around, this tends to ward off the leopard. You also have to be careful though, because if you have a high number of livestock in one kraal at a time, there's a greater risk that some leopards will wipe them all out in one go. I also know other farmers that have gaps in their fences, you can be sure a leopard will get through them if determined."

Research supports peoples' experiences of livestock depredation in the Blouberg; confining large numbers of livestock in kraals can promote surplus killing of livestock that cannot escape. In South Africa, one leopard was recorded to have killed 51 sheep and lambs in a kraal in a single night (Stuart, 1986). Research conducted adjacent to Masai Mara National Park, Kenya, showed that the likelihood of leopard attacks on night-time kraals was higher when kraals were isolated from areas of human settlement and constructed from poles with foot holds (Kolowski and Holekamp, 2006). However, in the Blouberg, farmers observed leopards penetrating netted fences and low fencelines. In South Africa, additional strands of electric

wire atop netted fences prevented jackal, carcal and leopards from penetrating fences, but are costly for communal farmers to power and maintain in isolated areas (Bowland et al., 1993). A communal farmer suggests adopting a collabarative approach to construct communal kraals on the Blouberg mountain for use during the dry season: "We could perhaps build kraals on the mountain during the dry season and share them between villages. If we could all come together and share these kraals...things would be much easier for us to build." Overall, few commercial farmers (32%, n = 6) tolerate kraaling as a feasible strategy to mitigate conflict. This finding reflects concerns surrounding the economic impacts of kraaling on the condition of livestock and productivity on commercial farms. In contrast, a high number of communal farmers (70%, n = 16), support kraaling because it is a familiar strategy and perceived as cost-effective.

8.3.3 Avoidance of predation areas and habitat improvement for leopards and their prey

At a landscape level, identifying areas of high predation risk and habitats occupied by carnivores is useful because these areas can be avoided by farmers grazing livestock. Many studies have shown that depredation incidents on grazing livestock herds and farms, are located close to areas with a high carnivore density and protected area boundaries (Oakleaf et al., 2003, Gula, 2008a, Gula, 2008b, Kaartinen et al., 2009). Leopard attacks on livestock are higher in dense bush environments that provide better cover to ambush prey, and are less likely to occur close to dense aggregations of people (Kolowski and Holekamp, 2006, Woodroffe et al., 2007a). In the Blouberg, the risk of leopard depredation by leopards decreased with increasing proximity to human habitation including rural villages and roadways, but, increased close to water sources, the borders of nature reserves and at peak elevations of 670-780m and 1540-1760m (Chapter 5). High risk predation areas can be avoided by shepherding livestock away from the borders of nature reserves, high elevations, monitoring livestock close to water sources and selecting areas with high densities of human habitation.

Manipulating habitats and resources required by problematic wildlife may discourage large carnivores from using human areas where livestock are kept. Conservationists in the Spiti Valley, western Tran-Himalayas, India have focused on improving habitat areas to help

increase numbers of wild prey available for snow leopards by setting aside areas of land that are free from livestock grazing (Mishra et al., 2003).

Higher rates of depredation on livestock have been found in areas where wild prey is less abundant (Sidorovich et al., 2003, Patterson et al., 2004, Bagchi and Mishra, 2006). High stocking densities of livestock on open rangelands compete with wild prey for common resources and lead to a decline in the abundance of wild prey species (Mishra et al., 2003). Maintaining wild prey populations outside protected areas may divert carnivore pressure away from domestic livestock (Mizutani, 1999, De Azevedo and Murray, 2007). In the Blouberg, camera trap results show that leopard occupancy rates on communal land are small and influenced by low wild prey biomass (prey species > 40kg) from over-hunting and habitat conversion (Chapter 6). High rates of livestock depredation occur on communal land therefore, a lack of wild prey may cause a dietary shift for leopards to include domestic livestock (Chapter 6). Further information on the feeding ecology of leopards is needed to confirm this hypothesis.

Four commercial farmers graze cattle away from dry river beds and forested environments, where leopards occur and kraal calves close to the homestead. Three of these four farmers improve the number of wild prey species available for leopards by reducing annual hunts on specific game species. A commercial farmer adopts several of the above methods on his farm:

"I decided to change my management strategy after I lost seven calves in several months, a few years ago. I started to create specific areas for the leopard to occupy, that had water and plenty of game. I stopped shooting so many impala to ensure the leopard had enough prey. I kept the cattle away from the bushy areas, kept the calves close to my home at night and expanded the farm to include grazing for cattle amongst the crop areas, which were too open for the leopard." No communal farmers identify strategies to manage habitats and resources to limit leopard depredation on livestock. However, I noticed that some villagers have re-established rotational grazing systems to improve the condition of grazing land throughout the year. Rotational grazing systems have implications for limiting livestock depredations by eliminating the requirement for communal farmers to graze livestock in the mountain during the dry season.

Few commercial farmers (32%, n = 6) perceive avoidance of predation areas and improvements of leopard habitat as cost-effective, because of the high economic costs of changing farming practices. Commercial farmers suggest that land use type, current infrastructure and management layout are important in evaluating cost-effectiveness. Some

commercial farmers will not kraal livestock close to the homestead because households are located far from available grazing land. On communal land, fences and water systems introduced by the apartheid government have been destroyed. Rotational grazing systems are no longer employed and communal grazing areas are extensively over-grazed (Grwambi et al., 2006). Such factors pose major constraints, as current infrastuctural conditions will need to be improved before rotational grazing camps can be reintroduced (Grwambi et al., 2006). Communal farmers also express a need for educational workshops on rotational grazing systems. Both farming communities suggest that the assistance of outside agencies (DEA and the Department of Agriculture) will be necesssary to provide expertise (e.g types of game species to increase, how to implement rotational grazing systems, where to avoid grazing livestock) and resources to formulate strategies to assist farmers. However, farmers commonly identify a lack of management capacity and are distrustful of government-led conservation initiatives; constraining partnerships between these stakeholders.

All commercial farmers (n = 6) that have changed livestock and game management systems on farms, have experienced reduced livestock losses by leopards, suggesting that these approaches may limit livestock depredations. A cattle and game farmer states: "Since moving livestock away from the river and bushy areas, I've had maybe one-two losses a year but mostly with game, which I just don't mind. It really works." Another commercial farmer states: "Since we've improved some of the habitat areas and moved the cattle away from the rivers, we have seen an all-round reduction in the number of livestock attacks. I think because the leopard now prefers to take the game, there isn't an opportunity for them with the livestock any more." Many commercial game farmers engaged in the hunting industry express concerns that increases in wild prey and the cultivation of habitats for leopards will increase leopard numbers in the area, leading to higher rates of predation on expensive game. Such strategies are unlikely to be supported by game farmers who do not tolerate attacks on game species and readily resort to lethal control measures. Research on the Eurasian lynx has shown that even when wild prey are abundant, depredation on livestock species is high, because carnivores spend more time in prey rich environments where high encounter rates with livestock are anticipated (Stahl et al., 2002, Moa et al., 2006). In areas where livestock are perceived as alternative prey, they may also be killed when wild prey are not abundant (Sidorovich et al., 2003, Kolowski and Holekamp, 2006, Woodroffe et al., 2007a). Further research on the population ecology of leopards and their prey species, as well as the composition of leopard diets through scat analysis, before and after the introduction of each strategy, will be necessary to determine their effects on wildlife specificity.

A higher number of communal farmers (52%, n = 12) support strategies that involve avoidance of grazing livestock in areas where leopards frequent compared to commercial farmers (37%, n = 7). Few commercial (37%, n = 7) and communal (44%, n = 10) farmers tolerate strategies to improve habitats and wild prey for leopards. Commercial farmers highlight the economic costs of changing farming behaviours and the negative impacts on game species. Communal farmers are unfamiliar with strategies that involve improving habitats for leopards. However, both farming groups state that the expertise of outside agencies is required to implement these approaches.

8.4 Institutional support for managing problem leopards

The management and control of problem wildlife are the responsibility of the Limpopo Provincial Government, headed by LEDET. Problem animal control in the Limpopo Province is mediated by the DEA located in Polokwane. The DEA is sub-divided into different municipality districts, which provide conservation extension services, regulate and monitor natural resource use and manage damage-causing animals in the Province. Both farming communities' perceptions of the DEA have been shaped by past and current experiences of protected areas that promote legacies of disempowerment, marginalisation and stigmatisation (Chapter 4). A commercial farmer's description of the DEA provides a context for understanding farmers' perceptions of the department: "The problem with government is corruption, racial issues and incompetence. If you took those three problems out you would have a foolproof system, always take the fool out of the system. The moment you work with them, you know you are going to have issues. Whites have no say in this country anymore. We get no financial support on the farms or anything. In the past, the last government would assist you in shooting those problem animals. Nowadays, I can't trust anyone I speak to. They won't get the job done."

Decisions regarding the management of problem animals are authorised by the head of the LEDET such that each complaint must first be documented and investigated before any management strategy is implemented. Permits are issued by the DEA to capture, control (by killing), or relocate the animal, actions that can only be undertaken by trained personnel. In reality, few reported cases are investigated by local environmental officers. A member of the DEA states: "Unfortunately, local district environmental officers do not always have the time, funds or even the transport to go and visit each reported case. We try our level best, but we

are very under resourced and working at full capacity that we cannot always meet everyone's needs. That's the problem with the system we literally cannot investigate every situation."

The DEA is politically marginalised because government funds are channelled towards economic growth and development initiatives (Chapter 4, Section 4.4.3). The DEA does not have the funding to attend all reported incidents because of understaffing and poor transport facilities. A commercial farmer explains: "They want us to go through the right channels, so I did that in the past, just as they wanted. The thing is nobody got back to me. I kept on having problems with the leopards nobody came or cared as my livelihood was eroded. It makes me angry that they don't even respond."

My research reveals a difference between farming communities regarding who is thought to be the appropriate contact in the event of a livestock depredation by predators. Forty eight percent (n = 11) of communal farmers did not know who to contact; whilst 79% (n = 18) of commercial farmers correctly identified the DEA as the institution responsible for managing problem animals (Fig. 8.4a-b). Commercial farmers engage with the DEA more frequently, due to the nature of their work, through the issuing of permits to manage game on private land. However, interactions between rural subsistence farmers and environmental institutions, including protected areas because information is not adequately shared and communicated (Chapter 4, Section 4.4.4).

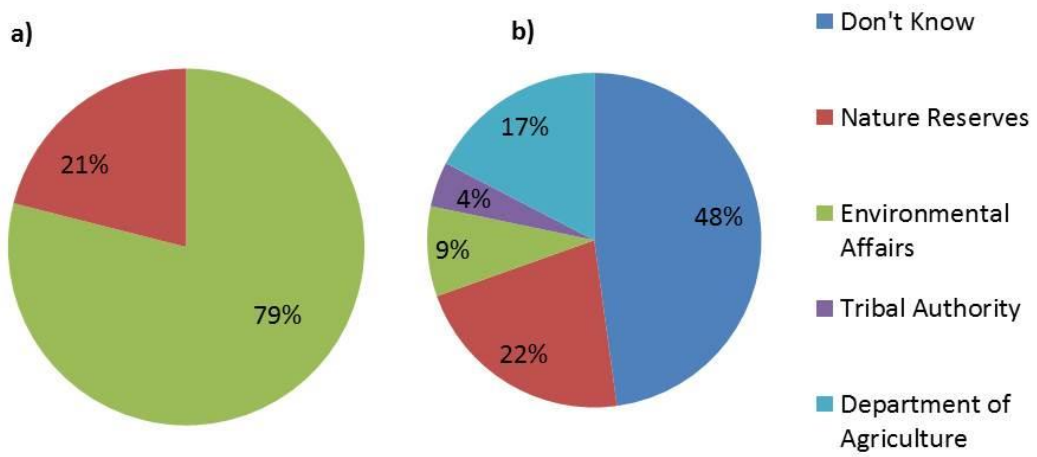


Figure 8.4: Perceptions of (a) commercial and (b) communal farmers on the responsibility of different institutions to manage problem animals.

Some commercial (21%, n = 5) and communal farmers (22%, n = 4) identify local nature reserves as responsible for controlling problem animals (Fig. 9.4a-b). Farmers' experiences with wildlife authorities in local nature reserves, in response to problem animal control, are mixed. Many commercial farmers spoke positively of their interactions with local wildlife authorities from the Blouberg Nature Reserve (BNR): "We have a good working relationship with the reserve they have put us in contact with the right people to contact if we have issues with leopards. In some cases they have come to investigate the situation themselves." A communal farmer from Indermark states: "The wildlife authorities have come to help us with the leopards taking livestock on our side of the fence one time. They helped us to put out a cage to trap that animal, then I believe they took it away somewhere."

In contrast, a commercial farmer spoke negatively of an interaction with reserve staff from the Lanjan Nature Reserve: "I go to the reserve to complain, they don't come along to have a look for themselves. They just look at you dumbfounded. I don't think they even know what to do

or they just fob you off with excuses." Several communal farmers complain that it took concerted efforts to travel to local nature reserves, in an area with limited transportation, to report attacks by leopards. A communal farmer describes an interaction with a ranger from the BNR: "I went to the reserve to tell them about the problems I was experiencing with the leopard. I spoke to a ranger for two minutes. He made it sound like I was making up the whole thing, that it was a mistake, that I was just an annoyance. He didn't even tell me where I should go. He wasn't sure himself. The whole journey was a waste." The inability of wildlife authorities to assist in mediating human-wildlife conflicts creates mutual antagonisms as a DEA officer describes: "The communities come here to complain. We tell them they have to contact the department in Polokwane. Most people don't understand the procedures, it's annoying for us because on the one hand we keep repeating the issue to them and we also want to help but can't."

As previously mentioned, decisions regarding problem animal control have to be administered through the DEA in Polokwane before local wildlife authorities can take action to assist. The inability of local nature reserves to communicate this information to local farmers creates distrust because the DEA are perceived as not wanting to assist. Nature reserves represent the closest representatives of the DEA and should know the procedures for managing problem wildlife to provide advice to the public. Negative interactions between farmers and government officials instil hostility towards protected areas and conservation. Consequently, the majority of commercial (95%, n = 18) and communal (96%, n = 22) farmers do not report damage-causing animals to a relevant institution because they have experienced ineffective action or inaction in the past.

8.4.1 Translocation

Translocation operations involve identifying, capturing, and releasing individual carnivores into areas with reduced conflict potential. Translocation operations are economically expensive for environmental institutions because complex methods to capture and handle animals require trained personnel and specialised equipment (Linnell et al., 1997). Success in identifying problem individuals is constrained by the efficiency of environmental departments to respond to reported incidents. A DEA officer explains some of the constraints of translocation programmes: "Relocating a predator is a huge task for us. It can take time to identify the

individual, we have to organise for a vet to be present to dart the animal. We have to find a post-release site. The latter is actually the hardest part because we need to speak with the landowners and 100% of the time they are not happy about having a problem animal in their area."

The effectiveness of translocation programmes to reduce human-wildlife conflicts involving leopards in the long-term are controversial. Translocations are selective and involve discovering and relocating the actual offender. Translocation operations assume that when individuals are displaced into areas of reduced conflict potential they will no longer represent problems for farmers and will not return to original conflict sites. Several DEA officers are against translocation programmes because of the limited success rates after leopards are released. A DEA officer said: "The success rate of translocations as shown from many studies worldwide also shows that it is ineffective, either the animal returns to the site, is outcompeted by other predators or continues predating on livestock. I don't think it can offer a strong solution. Another leopard will soon come and fill that lost territory after we take it out. More often than not these are young males that also like to turn to stock-killing. We rarely do it any more." Relocation of carnivores can lead to high mortality rates when animals are released because of stress, injury and extensive post release movements (Linnell et al., 1997, Miller et al., 1999, Letty et al., 2007). Assessment of translocations of stock-raiding leopards in Botswana showed that many of the leopards left the release site, returned to the capture site or showed extensive roaming behaviour after release, due to competition with other leopards that reside in the area (Weilenmann et al., 2011).

Research studies suggest that many carnivores continue their conflict behaviour on release. Three of four translocated leopards in Botswana resumed stock-raiding activities after release and were killed by farmers (Weilenmann et al., 2011). Translocation of leopards in Maharashtra, India, resulted in an increase in the number of attacks on humans (Athreya et al., 2011). The rate of attacks increased when leopards were relocated into forested regions where larger numbers of leopards had previously been relocated and dispersed into human-dominated landscapes (Athreya et al., 2011). The release sites contained resident leopards, thus newly relocated leopards were outcompeted and forced to move out of these areas. Athreya et al. (2011) suggest that increases in leopard attacks on humans are due to high stress levels induced through the translocation process, movement through unfamiliar territories and loss of fear of humans due to exposure during periods of captivity.

Overall translocation programmes are rarely adopted by environmental institutions because of high economic costs, limited success rates after release and the conviction that such methods only offer short-term solutions, because transient leopards soon fill vacant territories and may engage in further livestock killing. Few farmers in the Blouberg (5%, n = 2) support translocation methods because of perceptions that leopards will continue to kill livestock on release and present additional problems for other farmers. Several commercial farmers state: "Once a problem, always a problem," "I don't trust that thing because it can pose another problem for another farmer in the future, it's not fair," and "If I knew a leopard was to be released in the area without them asking us I would kill it straight away, simple as that." DEA officials frequently state that it is difficult to find suitable release sites for leopards, because many farmers are not willing to tolerate released leopards into their areas. Gaining the support of local farmers is necessary to ensure the success of many conservation programmes. A lack of consultation can undermine the success of translocation operations when farmers respond by killing post-released leopards.

8.4.2 Lethal control measures

The DEA administers and manages selective lethal control operations to kill problem animals by issuing permits to landowners that have proven experience and licences to shoot animals to trained personnel within the department. Such measures are intended to promote proper conduct and adherence to ethical procedures. In the past, the issuing of damage-causing animal permits entitled private landowners the rights to kill problem animals, but was considered open to misuse because landowners could benefit financially by selling the rights to shoot the animal to local hunters. A commercial farmer said: "In the good old days, if you were lucky enough to get a permit, you would be able to earn about ZAR 3000 for a local hunter wanting to come and shoot that animal for you."

Currently permits are issued in the name of the landowner or an environmental officer to prevent commercial hunts being sold to local hunters. However, the system is not infallible and remains open to corruption. Governmental policy dictates that damage-causing animals can be killed without a permit if done in self-defence when an animal threatens human life. Such incidents must be reported to the nearest relevant permit issuing authority within 24 hours. Some farmers admit exploiting this policy by shooting an animal on the grounds that it

threatens their safety, when actually it represents a livelihood threat. Others criticised the lengthy bureaucratic procedures and strict guidelines required to apply for a permit as justification for managing the problem themselves and keeping quiet. A commercial farmer said: "The whole thing is flawed, it can take weeks or months to get anywhere, to get any kind of go-ahead. First, they take ages to get back you second the permits come too late when that leopard has wandered off the property. We need faster reactions. I think in most cases, people just deal with the issues themselves. You can't rely on government."

Balme et al. (2009) reported similar problems with the issuing of damage-causing animal permits for leopards in Kwa-Zulu Natal. Prior to 2005, permits were issued to landowners without adequate evidence and landowners could benefit financially from permits, as in the Limpopo Province. Moreover, permits were also issued for leopards that killed expensive game species. Anthony et al. (2010) critiqued the procedures for managing damage-causing animals outside Kruger National Park and identified similar issues to those reported in this study as well as other factors: not all damage-causing animals being detected and destroyed, ambiguity surrounding the roles and responsibilities of different institutions within and outside the park in managing problem wildlife and poor communication between different stakeholders. These issues stem from a lack of management capacity. In the Blouberg, a high percentage of farmers (62%, n = 26) and DEA officials state that lethal control operations administered by the DEA are not cost-effective. The inability of institutions to effectively manage problem wildlife often results in affected farmers engaging in illegal control measures.

Twenty one percent (n = 4) of commercial and 17% (n = 4) of communal farmers report carrying out lethal control measures in response to attacks on livestock and game. Communal farmers kill leopards by setting out gin traps and wire snares, placed around the carcasses of attacked livestock (Fig. 8.5-8.6). Wildlife trapping is commonly used to capture wild animals for bushmeat and traditional medicine injury and killing leopards. Commercial farmers kill leopards by placing strychnine poison the carcasses of attacked livestock and game species or shooting the animal. From October, 2009 to October, 2011, seven leopards were killed by farmers over a 400km^2 area. Seventy-one percent (n = 4) of reported deaths are illegal through snaring, poisoning and shooting leopards. Similar levels of mortality induced by illegal activities were reported in Phinda Private Game Reserve and Mkhuze Game Reserve in Kwa-Zulu Natal, South Africa (Balme et al., 2010a). Over a two year period, people killed four leopards in Phinda and one leopard in the Mkhuze Game Reserve, constituting 80% of reported deaths (Balme et al., 2010a). Collectively, over a four year period, the number of leopards killed by

people was equal to the number of leopards that died from natural causes (Balme et al., 2010a).

In the Blouberg, two leopards were shot legally through the issuing of a damage-causing animal permit, while one was killed as a result of a trophy hunting permit. It is illegal to kill or hunt a leopard without a permit issued by the DEA. Chase-Grey (2011) reported that 28 leopards were killed due to lethal control measures (24 illegal deaths and four from trophy hunting permits) in the Soutpansberg over a ten year period and a 600km^2 area. Scaling results reported from the Blouberg over a 10 year period and applying the results from a 400km^2 to a 600km^2 area produces a higher estimate of 53 leopard deaths. Farmers in the Blouberg are open about their illegal activities, but actual levels of mortality are likely to be higher than reported, as some farmers may avoid telling the truth through fears surrounding the illegality of their behaviour. In one incident a communal farmer reports illegally killing a total of 11 leopards over a 13 year period, with a maximum of three leopards in some years, while a commercial farmer boasts of killing 10 leopards within a single year.

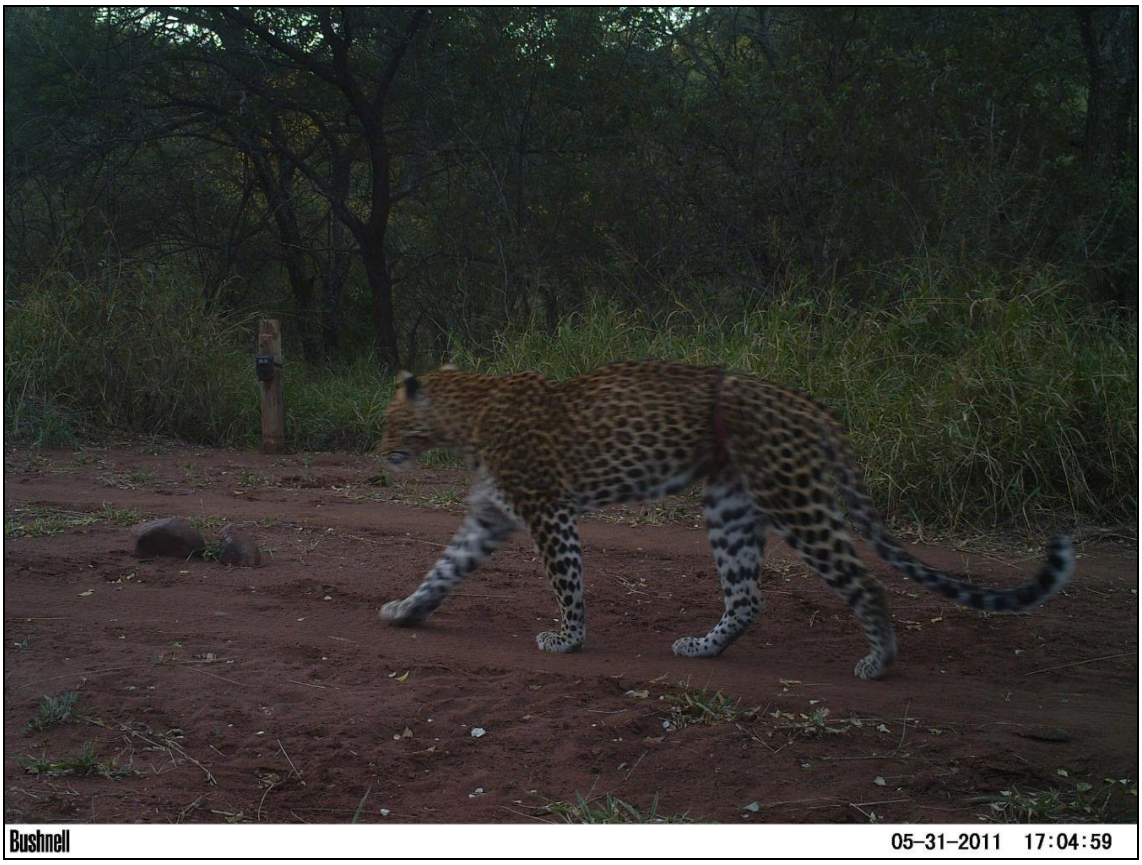


Figure 8.5: Female leopard injured by a wire snare on the 31st May 2011.

In part, killing leopards constitutes a symbolic gesture that asserts a farmer's rights over wildlife ownership, expresses dissatisfaction with governmental support and defiance of conservation initiatives that fail to involve local people. A communal farmer responded to a livestock attack by a leopard on communal land by setting out wire snares on the carcass of a young calf but was caught by wildlife authorities. The man responded by justifying his actions based on the lack of governmental support and his ancestral rights to control problem leopards: "I told them…..Perhaps you should number the animals from the nature reserves, then I will know which ones are theirs and the rest are God's animals which, were for all. Can you arrest me for something that belongs to all, when they come onto our land, whose are they then? They go and cause us problems but they are on our land now and you do nothing to help. We are just doing what our ancestors did, managing the wildlife in a way that kept things in balance. I don't see the government doing anything about these kinds of problems. " A commercial farmer killed a leopard in response to the inability of local wildlife authorities to assist with managing problem leopards: "I don't trust those people in the reserves, you go there tell them you have a problem with the leopard and they just shrug at you. I told them if they don't help me I'm going to shoot that animal. I did just that and took them a picture of it to show them." Another cattle farmer describes an event that resulted in the release of wild dogs (*Lycaon pictus*) by DeWildt, into a farming area, without the consultation of local people: "I was bloody pissed off, those bastards [DeWildt] just released them [wild dogs] without talking to us. Conservationists don't understand that these animals are pests to us. If they don't talk to us I'm going to sort it myself. So I shot at them and hung them out to show them [DeWildt] what happens when you think you can do what you want. We even asked a newspaper to come and we put the photos in the press."

I asked farmers to comment on their experiences and the success of individual and DEA initiated lethal control to assess wildlife specificity. As discussed in Section 8.4, the failure of the DEA to investigate problem animal complaints, as well as lengthy procedures to apply for permits, means many incidents remain unresolved and problem individuals cannot be identified. Two commercial farmers identify and kill problem individuals by setting out camera traps to identify continual stock-raiders. In two other cases, farmers adopted lethal control measures to limit the perceived numbers of leopards in the area, as opposed to targeting problem individuals. A high percentage of commercial farmers (68%, n = 13) and communal farmers (61%, n = 14) perceive the numbers of leopards to have increased over time in the Blouberg. These perceptions stem from an increase in game farming providing greater numbers of wild prey for leopards, the establishment of protected areas and a reduction in

hunting compared to the past. One commercial and one communal farmer set out poison and wildlife traps to limit leopard numbers despite experiencing attacks on livestock or game species in these instances: “I am eliminating that particular problem as it helps to control them. If you control their numbers you control the leopards to an extent,” and “If I see the tracks of a leopard on my property, I will kill it straight. You are doing damage control on your property, keeping the numbers down.”

Poisoning and wildlife trapping are indiscriminate control methods because they pose risks to non-target wildlife. Leopards in the Blouberg have been killed by people setting out snares targeting ungulates for bushmeat. Some communal farmers state that these methods often injure livestock, people and dogs. Moreover, removing leopards from a population is unlikely to reduce the density of leopards living in the area overall, because transients soon move into vacant territories (Loveridge et al., 2007, Cooley et al., 2009a, Cooley et al., 2009b). DEA officials express concerns that indiscriminate control measures will have negative impacts on the viability of leopard populations: “We know that some farmers kill leopards even if they aren’t a real threat. This is a real problem for leopards and can affect other wildlife. If farmers keep killing for the sake of it, we can expect to see a decline in leopard populations particularly outside of the nature reserves. Even in the long-term we prompt farmers to try other methods such as improving husbandry practices before resorting to these types of methods. If you kill a leopard, you can expect another one to replace it in future. ”

Figure 8.6: Gin traps used by some communal farmers to control leopards attacking livestock.

In the Blouberg, a reduced leopard density from the BNR (5.4 leopards per 100km^2), compared to the commercial farms (0.7 leopards per 100km^2) suggests that commercial farms may function as population sinks due to high levels of leopard mortality rates driving population declines. Similarly, the BNR may suffer from edge effects driving leopard numbers below their carrying capacity in the reserve as documented in Kwa-Zulu Natal (Balme et al, 2010a; Chapman and Balme, 2010). The removal of leopards from selected areas creates vacant territories, attracting dispersing sub-adult male leopards into new areas and may introduce new conflicts, as has been found for other carnivore species (Bailey, 1993, Balme et al., 2010a). These factors suggest that lethal control measures are not feasible for the Blouberg because they exert negative effects on leopard populations and leopard offtake needs to be managed to ensure population recovery. Overall few farmers (19% , n = 8) support lethal control measures. Those engaging in illegal killing do so to take ownership and control of wildlife on their own properties due to a general dissatisfaction with the DEA to manage damage-causing animals. Many farmers are against lethal control measures (81%, n = 34) because these strategies pose high risks to non-target wildlife. Others deem these practices “barbaric,” “producing a slow death” and “uncivilised” and agree with DEA officials that lethal control measures offer only short-term solutions because problem animals are likely to return.

8.4.3 Trophy hunting

Trophy hunting can provide greater tolerance for leopards that attack livestock and game species because the revenue it generates may offset the costs of predation (Leader-Williams and Hutton, 2005). Trophy hunting in Limpopo Province is regulated and controlled by the DEA. Equal numbers of communal (35%, n = 8) and commercial farmers (42%, n = 8) perceive trophy hunting as a cost-effective strategy. Commercial farmers identify the political nature and economic costs surrounding the payment of trophy hunting fees as constraints to their participation in the industry. High prices allocated to trophy hunting fees mean that many local hunters are unable to afford leopard hunts. Moreover, ZAR 5000 of the fee is paid to fund the training of disadvantaged individuals as professional hunters. This scheme was implemented to contribute to Black Economic Empowerment. Commercial farmers in the Blouberg argue against the payment of the fee. As a commercial farmer describes: “It’s very bureaucratic you need a black partner but why must I get somebody that has nothing to do with this farm? How must I give him money to give me authority to hunt on my own farm, sorry, come on? Everything is political in this country especially hunting. It is a waste of time. I don’t even know where the money goes.”

Both farming communities state the process of applying for trophy hunts is lengthy and bureaucratic, leading to additional transaction costs. Chase-Grey (2011) found that farmers in the Soutpansberg do not apply for permits because of what they consider to be an overtly bureaucratic application process entailing: a lot of paperwork, strict guidelines, a lack of information, unacceptable lengths of time before receiving a permit, and high levels of corruption among officials. Communal farmers state that a lack of knowledge of the industry prevents them from applying for hunts on communal land, because they do not know who to contact to apply and do not understand how the system operates. A member of the Blouberg Tribal Authority explains: “There have been discussions in the past, through our tribal authority on getting foreigners in to shoot leopards for trophies on the condition that we would get money from it. I doubt that thing to work well here. Firstly, I’m not sure we would ever see that money. We’ve had problems with leopards in the past, so the government doesn’t respond…The whole thing is also very complicated and there isn’t a whole lot of information about it. We don’t really think that thing would work well for us because often the government has come to speak to us about so called benefits we can get from the reserves.

But it doesn't ever work out well in our favour. I don't see the money coming to the right people, those most affected by those animals"

Communal farmers express concerns that the distribution of revenue generated from trophy hunting will not go to the individuals most affected by leopards. A communal farmer said: "I doubt the person that had lost his livestock would see that money. If you look at Maleboch Nature Reserve, we don't see any money from that. I would fear the Blouberg Tribal Authority would just pocket the money." The Blouberg Tribal Authority manage the revenue generated from Maleboch Nature Reserve and fail to distribute equitable benefits effectively to the local villagers affected by the reserves, because of intra-tribal conflict, corruption and a breakdown in communication between relevant stakeholders (Chapter 4). Anthony et al. (2010) report that traditional authorities living close to Kruger National Park do not receive meat or compensation from destroyed damage-causing animals because of confusion over who should be paid, as well as concerns over the legitimacy of community institutions and their ability to devolve money to the people most affected by wildlife. Chase-Grey's (2011) research in the Soutpansberg concluded that currently trophy hunting quotas are sustainable in the Soutpansberg and do not exert a detrimental impact on the viability of future leopard populations. However, Chase-Grey (2011) reported that when illegal rates of killing are high (n = 12 per year, combined with trophy hunting quotas of 26), the chance of extinction increases by 50%, and when the ratio of females: males killed is increased (60% females: 40% males), the chance of extinction is 100% over a 100 year period.

A lack of government capacity to investigate trophy hunts means that some farmers engage in undetected hunting leading to negative impacts on leopard populations .Trophy hunts are completed over two weeks and baits to attract leopards are only allowed to be used within this time. Over the course of the current study, an obese male leopard was photographed on the BNR and commercial farms, suggesting that illegal baiting may have occurred over an extended time period, perhaps for the selection of large males for trophies (Chapter 6). Full-time baiting can have negative impacts on leopard mortality rates by drawing leopards out of their original territories and creates population sinks where levels of persecution are high (Chase-Grey, 2011). Chase-Grey (2011) suggests that sustainability of hunting can be improved by using camera trap surveys to improve estimates of leopard population numbers to inform hunting quotas, regularly monitoring population trends of leopards by developing a regulatory framework for harvesting leopards, allocating male-only harvests, lowering harvests in source populations and reducing illegal hunting.

Overall few farmers (5%, n = 2) tolerate trophy hunting in the Blouberg as a feasible strategy to mitigate human-leopard conflict, echoing similar findings in the Soutpansberg where only game farmers participate in the industry. Commercial farmers commonly criticise the officious systems governing trophy hunting along with the high economic costs of fees preventing them from participating in the industry. Communal farmers state that lack of knowledge and information sharing marginalise them from participating in the trophy hunting industry and express concerns surrounding the equitable distribution of revenue generated from the industry to affected farmers. These findings support similar results found in the Soutpansberg, where few farmers engage in the trophy hunting industry (Chase-Grey, 2011).

8.5 Conclusion

The feasibility of different mitigation strategies depends on an evaluation of cost-effectiveness, wildlife specificity and the socio-political acceptability of a strategy as defined by criteria identified by farmers and environmental institutions as important (Fig. 8.7). The DEA consider a wide range of factors as constraining the cost-effectiveness of a strategy. Firstly, the DEA are politically marginalised as an institution because government funds are channelled towards funding the country's development needs, constraining the financial resources of the department. The poor socio-economic conditions and management capacity of the DEA, constrain the ability of the DEA to to support nature conservation activities including managing reports and responses to damage-causing animal reports, which generates distrust among both farming communities. A lack of communication and information sharing between the DEA and communal farmers creates ambiguity regarding the institutions to contact in response to attacks on livestock and the different mitigation strategies available to manage damage-causing animals. This is further exacerbated by lengthy and bureaucratic systems of applying for damage-causing animal and trophy hunting permits, encouraging both farming communities to engage in illegal control measures. These factors constrain the socio-political acceptability of centrally managed mitigation strategies including translocation operations, application of damage-causing animal permits and trophy hunting. Furthermore, strategies that are economic costly for the DEA to implement such as translocation operations are not tolerated and usually outsourced to local NGOs.

Wildlife specificity is assessed by the environmental institutions according to the risk of leopard mortality and to non-target wildlife for example, indiscriminate lethal control

measures such as wildlife trapping and poisoning are not tolerated by the DEA and are considered illegal. Other strategies that offer only short-term solutions to mitigating conflict are not tolerated for example, translocated leopards may continue their livestock killing behaviour on release and indiscriminate lethal control measures provide vacant territories for the recolonisation of sub-adult male leopards that may disrupt the population structure of leopard populations and accentuate conflicts with people.

Farmers consider a range of factors as important in evaluating the cost-effectiveness of a strategy. For communal farmers, access to labour and income generation constrain their ability to employ full-time shepherds and to afford materials for improvement of livestock husbandry practices. For commercial farmers, mitigation strategies that compromise the productivity of farms, negatively impact livelihoods and are time-consuming to implement are least likely to be tolerated. Commercial farmers are also unlikely to tolerate strategies that involve significant changes to current farming practices and entail high economic costs. Communal farmers are disinclined to support initiatives that are unfamiliar, compared to those that build on traditional knowledge systems. Both farming communities identify a lack of knowledge as constraining their ability to implement different types of mitigation strategies and are distrustful of government-led conservation initiatives to assist.

Wildlife specificity is evaluated by farming communities according to the mortality risk these strategies pose to non-target wildlife example, lethal control measures such as wildlife trapping and poisoning are not favoured because they also injury livestock and game. Translocation operations are often not tolerated by commercial farmers due to the risk of leopards continuing their livestock killing behaviour on release, whilst strategies that improve habitats for leopards and wild prey are not tolerated by game farmers because these methods are perceived as increasing the number of leopards in the area and may increase attacks on expensive game. Indiscriminate lethal control measures are tolerated by some farmers due to perceptions that leopard numbers have increased in the area, a lack of government capacity to effectively manage problem leopards and farmers not being consulted about release sites for translocation operations. However, in the majority of cases the socio-political acceptability of lethal control measures was reduced to the threats these strategies pose to animal welfare. Overall improvements to livestock and game husbandry may serve as the most feasible strategies to mitigate leopard depredation because they are cost-effective, do not exert negative impacts on the viability of leopard populations and are tolerated by all stakeholders.

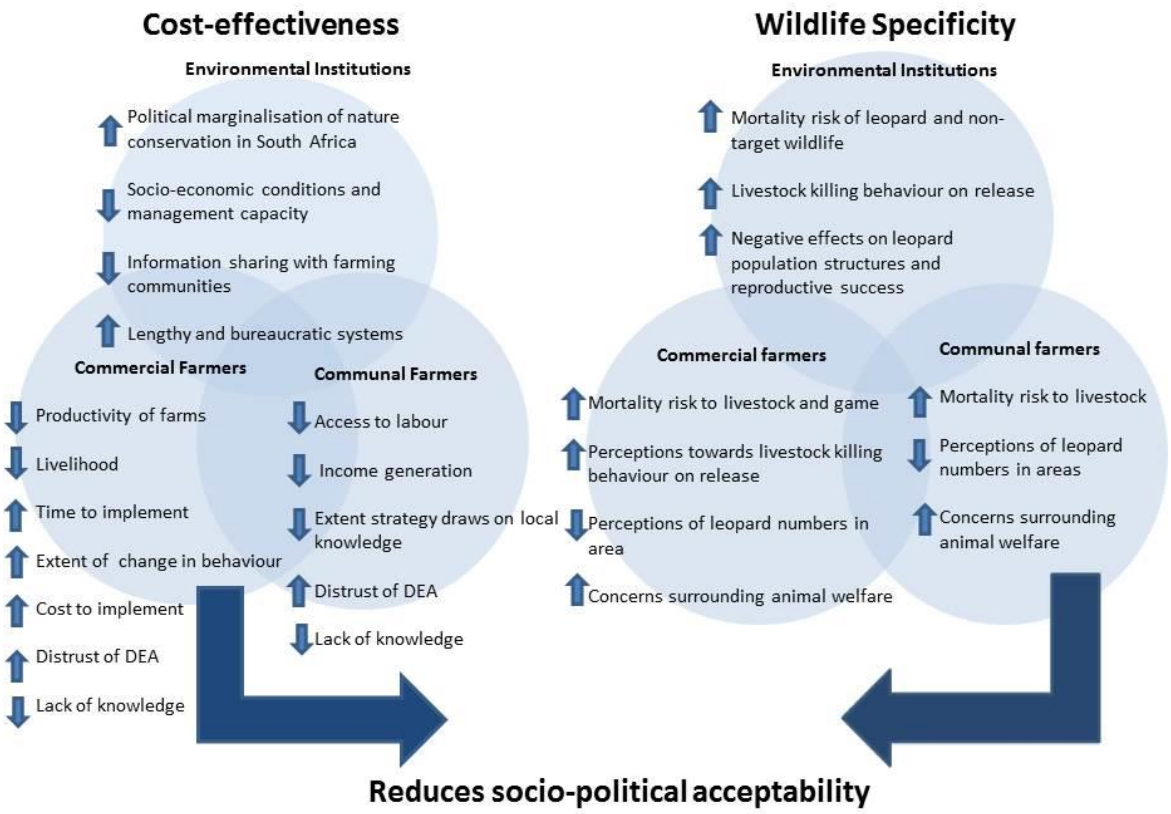


Figure 8.7: Factors identified by farmers and environmental institutions as important in evaluating the cost-effectiveness, wildlife specificity and socio-political acceptability of a mitigation strategy. Large blue arrows indicate an aggravating effect. Small blue arrows pointing upwards represent an increase and arrows pointing downwards represent a decrease.

Chapter 9

Final Discussion

9.1 Introduction

The thesis began with an overarching aim to identify the key socio-ecological factors driving human-leopard conflict in the Blouberg Mountain Range in order to formulate management strategies to assist in resolving the "fundamental dilemma posed by global and national concerns for biodiversity conservation on the one hand and individual and economic motivations to safeguard human life and livelihood on the other hand" (Treves et al. 2009, p. 215). An impact based assessment of human-leopard conflict adopts a socio-ecological approach, which treats social and ecological factors as an integrated and dynamic system, with effects and consequences for leopard conservation, human livelihoods and wellbeing. Here, the findings from the study are summarised and the accumulated data used to develop recommendations and areas for future research. The chapter concludes with reflections on the interdisciplinary research approach.

9.2 Research findings

In Chapter 2, the socio-political histories of the indigenous people and European settlers of South Africa, the evolution of conservation ideology and perceptions of the land, wildlife and conservation are contextualised. The perception of the indigenous people of the environment was born out of spiritual and cultural engagement with the land (Khan, 1990, Eastwood and Eastwood, 2006). The first European settlers developed an intimate knowledge of their new environment and its natural resources for survival by drawing on the local knowledge of the indigenous people, with whom they engaged in collaborative hunting partnerships (Beinart, 2008). This brief period of cooperation was interrupted by growing colonial expansion into the interior of the country, the introduction of sports hunting and European perceptions of taming wilderness and its local inhabitants, leading to the widespread decimation of wild game and the dispossession of indigenous people from their land (Khan, 1990, Carruthers, 1994). The first game reserves were established due to economic concerns of the dwindling game

populations and led to restricted access to wildlife of poorer Afrikaner and African people, through the imposition of harsh penalties for hunting on state land (Carruthers, 1989, Khan, 1990, Khan, 1994).

Protected areas united and advocated white rule and interests under the guise of wildlife conservation and served as divisive strategies, which politically alienated selected cultural groups and prevented them from obtaining access to natural resources (Carruthers, 1989). White privilege and power formed the foundation for the fortress conservation approach and entrenched the view of African people as environmentally destructive (Khan, 1990). The apartheid policies contributed to the further displacement of the African people from their land and the poor socio-economic conditions in the Bantustans, promoting unsustainable use of the land and its natural resources (Khan, 1990). From the late 1990s, the demise of the apartheid regime resulted in the implementation of the land restitution act and a paradigm shift in nature conservation ideology, which now recognises the need to improve relationships between protected areas and local people.

In Chapter 4, the establishment of protected areas and conflicts occurring between rural villagers, private landowners and local wildlife authorities due to issues relating to the access and control of land and natural resources, contributed to the perceived disempowerment, marginalisation and stigmatisation of local people. The marginalisation of rural villagers and private landowners, results from a perceived lack of consultation concerning the reserves' establishment and inadequate compensation for the procurement of land. Currently poor socio-economic conditions constrain infrastructure development, employment opportunities and the provisioning of benefits to rural villagers. Top down governance, a break-down in formal communication and an absence of clear action plans marginalise rural villagers from protected area management decisions and benefiting from the reserves' presence. Rural villagers and private landowners are disempowered by loss of access to land and important natural and cultural resources. The perceived costs of protected area establishment amongst villagers include prohibition to livelihood strategies and sacred sites, impoverishment, disruption of social networks, environmental degradation and rural migration, whilst both groups perceive human-wildlife conflict as a significant cost.

Leopards are scapegoated and killed by rural villagers and private landowners because they are perceived as being more highly valued by conservationists than the needs of local people, due to the lack of mechanisms for protected areas to mediate human-leopard conflicts. Villagers stigmatise wildlife officials as malicious authority figures, whilst villagers are

stereotyped as generic poachers and the cause of environmental degradation. These processes culminate in a series of impacts defined as traumatic nature (Van Assche et al., 2012). Traumatic nature is manifested in local people's discourses representing strong emotional responses ranging from apathy to anger and resentment towards wildlife authorities, protected areas and conservation. Social conflict emerges between different groups due to accusations of poaching and the inability of wildlife authorities to collaborate with local headmen regarding poaching incidents. This generates hostility, suspicion and distrust between groups. Resistance to protected areas is manifested through verbal threats to wildlife authorities and physical acts of protest by rural villagers. Overcoming trauma requires government actors to become aware of the social impacts of management decisions and strategies at the local level.

In Chapter 5, the bio-physical and temporal characteristics influencing the risk of leopard predation are explored, as well as the impacts of depredation incidents on farming livelihoods and wellbeing. Livestock depredation by predators constitutes the greatest form of livestock loss (65%) compared to other natural causes of livestock mortality. Perceived livestock depredation by carnivores' accounts for 2.8% of the total livestock holdings in the study site. Leopards accounted for the highest number of livestock attacks (60%) compared to other carnivore species. Calves and donkey foals (< three months of age), nyala calves (24%), impala (21%) and warthog (7%) are most highly predated on and fall within the optimal prey size category for leopards (10-40kg) (Hayward et al., 2006). Leopards killed more livestock during the dry season (April-September) on communal land, due to seasonal changes in grazing patterns and poor livestock husbandry practices, which increase the vulnerability of livestock to attack. Leopard attacks on livestock peaked in September on both land use types, coinciding with the start of the calving season. Traditional livestock management practices designed to protect livestock from predators (shepherding, livestock-guardian dogs and penning livestock in night-time kraals) have eroded with changing land use systems, the historical eradication of large carnivores from the area and the perceived high economic and labour costs of implementing these strategies. Distance to village is the most influential factor, influencing the likelihood of a leopard attack on livestock, with risk of predation increasing with greater distances from villages. Distance to water represents the strongest predictor of attacks on game and exerts a moderate effect on the risk of predation on livestock, with the probability of an attack increasing close to water for both livestock and game attacks.

Human-leopard conflict generates visible impacts for farmers, manifested as economic costs. The average annual loss of cattle per household due to leopard on commercial land (ZAR 12, 182), represents 2.7% of the estimated annual income for this group however, the economic costs of livestock depredation can be buffered by households that engage in more than one land use type and own large herd stock herds. Nyala represents the most expensive game species lost to leopards (ZAR 5171 each). The average economic loss of cattle on communal land of ZAR 10, 500 per household per annum, constitutes 58% of the estimated annual income in the Blouberg. A lack of social reciprocity amongst villagers due to the erosion of traditional cattle sharing systems and a lack of alternative livelihood strategies prevents farmers from buffering the impacts of predation. Livestock depredation for communal farmers represents a loss of functional and material benefits and causes a sense of diminished wellbeing amongst both farming communities. For communal farmers, hidden costs translate into a loss of social capital, a spiritual resource and perceived cultural decay.

In Chapter 6, leopard density, population structure and occupancy are determined by conducting camera trap surveys across a range of land use types. The resilience of the leopard population to recover from ecological and anthropogenic perturbations is of conservation concern considering a lower leopard density of 0.7 leopards per 100km^2 on commercial farms compared to 5.4 leopards per 100km^{2}in the protected Blouberg Nature Reserve (BNR) and the male biased population structure. Commercial farms are important for leopard conservation outside protected areas, but also represent "ecological traps" where rates of persecution are high (Delibes et al., 2001, Sherman and Runge, 2002). These areas may function as population sinks, indicated by lower leopard numbers on commercial farms, with the effects potentially extending into the BNR, driving leopard numbers below their carrying capacity. The leopard population is in a constant state of flux, indicated by low population density estimates, a male biased sex ratio and high numbers of sub-adult males, suggesting a high turnover of individuals in the population (Novaro et al., 2005). High rates of persecution in a population may increase inter-specific conflict, increase the risk of infanticide and threaten the reproductive success of females (Wielgus and Bunnell, 2000, Logan and Sweanor, 2001, Balme et al., 2010a).

The occupancy and number of leopard captures on communal land is small, reflecting a lower large prey biomass due to overhunting and habitat conversion. The lower density estimates in the Blouberg compared to the Soutpansberg (10.7 leopards per 100km^2, Chase-Grey et al., 2013) may result from several factors. Firstly, increased anthropogenic pressure due to a higher human population density in the Blouberg increases the potential for human-leopard conflicts to arise, as well as rates of human persecution. Secondly, population sinks resulting

from high mortality rates on commercial farms alter the population structure and breeding success of females. Finally, differences in land use patterns and environmental conditions influence the suitability of the Blouberg to sustain high leopard numbers.

In Chapter 7, commercial and communal farmers attribute a wide diversity of environmental values with the leopard. Both farming communities associate the same values with the leopard (except humanistic values) but, there are differences in the ways values are expressed and articulated. A high degree of overlap adds to the credence that values may be consistent across cultures (Robinson and Sasu, 2013). The observed differences in the expression of values, demonstrate historical and cultural differences between people and their relationships with leopards. Several attributes associated with the expression of negativistic and dominionistic values evoke a fear, lack of familiarity and aversion towards the leopard, the tendency to engage in lethal control measures and unsustainable livestock and game husbandry practices. For both farming groups these concepts stem from: (1) the leopard's perceived boundary crossing and predatory behaviour; (2) the perceived risks leopards pose to livestock and game, human life and livelihoods; (3) a lack of knowledge of leopard ecology and behaviour amongst older generations; and (4) controlling the high number of perceived leopards in the area. Other factors include the erosion of spiritual values associated with the leopard and the tradable use of leopard body parts for traditional medicine among rural villagers and the economic benefits derived from trophy hunting, amongst commercial farmers.

Numerous attributes associated with the leopard promote tolerance for livestock and game attacks, respect for, and affective relationships with the leopard, protection and preservation of the leopard, and the tendency to engage in sustainable livestock and game husbandry practices. Factors which promote support for leopard conservation and are characteristic of both farming groups include knowledge of leopard ecology, an appreciation of the beauty of the leopard, support for the protection of the leopard for future generations, the perception of the leopard as belonging to the Blouberg and the association of leopard conservation with the wider perseveration of other species, habitats and environments. In addition, rural villagers' fear, respect, and revere the leopard and perceive the leopard as being part of their cultural history, promoting, affective relationships with this animal. For commercial farmers, the economic benefits derived from trophy hunting and ecotourism also provide incentives for leopard conservation. The similar and different forms of value expression have implications for environmental governance, because conservation issues involve mediating diverse and often opposing values. In situations where values do not overlap, avenues for dialogue and

negotiation need to explore the root causes and cultural context of value systems, to open up opportunities for resolving and pre-empting conflicts. Current governance systems within protected areas do not allow opportunities for local people to express their values or to see these values reflected in conservation policies.

In Chapter 8, the feasibility of different mitigation strategies to manage human-leopard conflicts is assessed according to the cost-effectiveness, wildlife specificity and socio-political acceptability of each strategy. The management capacity of the Department of Environmental Affairs (DEA) to investigate and control problem animals is constrained by economic constraints, understaffing, time constraints and poor access to transport, driving hostile perceptions of the department amongst farming communities. Communal farmers perceive a wide range of institutions as responsible for the management of damage-causing animals. Problem animal control procedures are administered by distant government actors before local wildlife authorities can take action to assist. This information is not adequately communicated to farmers, creating distrust when reports of human-wildlife incidents are not investigated. The majority of members of both farming communities do not report damage-causing animals to a relevant institution, because they have experienced ineffective action or inaction in the past. Strategies not tolerated by the DEA are economic costly for the DEA to implement (e.g. translocation operations), increase the mortality risk of leopards and non-target wildlife (e.g. indiscriminate lethal control measures) and offer only short-term solutions to mitigating conflict (e.g. lethal control measures).

The majority of farmers do not adopt mitigation strategies employed by the DEA to control damage-causing animals, because of lengthy and bureaucratic application procedures. Strategies that reduce the productivity of farms, negatively impact livelihoods, take time to implement, involve significant changes in behaviour and are economically expensive to implement reduce the socio-political acceptability of a strategy among commercial farmers. Limited access to labour, a lack of income and strategies that do not draw on local knowledge lower the socio-political acceptability of a strategy, among communal farmers. For both groups, a lack of knowledge of how to implement a strategy reduces its socio-political acceptability. Conservation practitioners should focus on directing their resources towards designing strategies that effectively address these constraints to improve farmer participation in government led-mitigation strategies. Improvement of livestock husbandry practices represents the most feasible mitigation strategy for the Blouberg, because they are not costly to implement, do not exert negative impacts on leopard populations and are widely accepted by all stakeholders.

9.3 Management implications

9.3.1 Improving the economic status of protected areas and benefit sharing systems for local people

Adequate political and economic support for nature conservation is required so funds can be made available to improve tourism, reserve infrastructure, employment opportunities and tangible benefit sharing systems. Strategic plans for both reserves identify the minimum staffing and funding levels required for effective management of the reserves over a five year period (NCC-Group, 2012a, NCC-Group, 2012c). This provides a step forward for defining financial and operational requirements and comprehensive management actions for the reserves. South African National Parks have entered into concession agreements with private operators to operate lodges, camps, restaurants, shops and car rental services generating over 252 million rand for the parks and improving annual tourism occupancy rates in protected area accommodation (Paterson, 2009). Forging partnerships between protected areas and private operators, such as Kune Moya, improves the financial sustainability of protected areas by developing tourism infrastructure, attractions and employment opportunities for local people and similar strategies should be explored for the Maleboch Nature Reserve (MNR). The strategic plans for the reserves include management actions to work on collaboration with the Blouberg Municipality to improve the provisioning of infrastructure and services to the reserves and improve the marketing of tourism and recreational products for the region (NCC-Group, 2012a, NCC-Group, 2012c). The Friends of the Blouberg was also established in 2012 as a society and to date has provided logistical, administrative, technical and financial support for the BNR management team and participates on the reserve management advisory committee. The society provides a step forward to alleviate some of the infrastructural and management issues constrained by the BNR's poor socio-economic conditions and may enable the reserve to become financially self-sufficient in the future through volunteer action.

The design of management plans and policies guide the quality and effectiveness of benefit sharing systems. However, management plans for the reserves provide ambiguous definitions of the terms "community" and an absence of action plans limits the distribution of benefits. Co-management agreements between wildlife authorities and local resource users may provide clarity in defining legitimate user groups, meaning they are "less likely to suffer from the immigration of "outsiders" as the honey pot effect of economic stimulation unfolds"

(Grossman and Holden, 2002, p. 15). Many researchers have warned against seeing co-management as a remediable solution for legitimacy because co-management and decentralisation can lead to the reinforcement of a local elite power such that marginalised groups do not benefit from the system (Berkes, 2009). Strategic plans for the reserves include initiatives to review and amend co-management agreements with rural communities (NCC-Group, 2012a, NCC-Group, 2012c). Possible amendments may include: (1) clarify targeted villages for receiving culled meat, (2) implement management actions to identify how benefits will be provisioned, implemented and managed and (3) develop feedback processes to monitor the distribution of financial funds to villages surrounding the MNR to prevent the misuse of funds. I propose several approaches to improve relationships between neighbouring rural communities to offset the perceived costs of protected area establishment:

- Allow extractive use of resources such as fodder, grass and sickle bush and the collection of medicinal plants. Grass could be supplied to villagers during times of drought to reduce the requirement to graze livestock on the mountain.
- Allow villagers controlled access to sacred and religious sites.
- Allow villagers in the MNR to travel through the reserve from Ga-Kgatla to Setloking to improve access to neighbouring villages.
- Develop an educational campaign to improve awareness of deforestation, over-grazing and erosion problems and workshops in villages bordering reserves in collaboration with a larger environmental scheme for the Blouberg (this chapter, Section 9.3.10).
- Wildlife authorities should assist rural villagers where possible e.g. supplying firewood for funerals and water to Ga-Kgatla during times of drought.
- Wildlife authorities and Kune Moya should work in collaboration with the Blouberg Municipality's Integrated Development Plan to identify opportunities for the employment of local people and business development through tourism and nature conservation activities. In turn these actions could also be developed in coordination with other programmes such as the Rural Development Framework for the region, which aims to reduce rural poverty by diversifying employment opportunities and sustainable development (Blouberg Local Municipality, 2013-2016).

9.3.2 Improve communication between nature reserves and local people

Participatory and deliberative processes often help disparate groups to engage with one another and to manage conflict (Redpath et al., 2012). A first step process towards participation is to improve communication between stakeholders, as stated in strategic plans for the reserves. Strategic plans for the BNR include actions to develop a reserve management advisory committee, while strategic plans for the MNR include actions to amend the structure and management of the co-management committee (NCC-Group, 2012a, NCC-Group, 2012c). Co-management agreements involve the sharing of power and responsibility between government and local people (Berkes, 2009). Co-management agreements improve justice, equity and empowerment of local people, who have a stake in how conservation decisions are made (Berkes, 2009). Power sharing is made more equitable through state legitimisation and formal arrangements between government and resource users (Berkes, 2009).

The legitimacy of the Manoko community to access and receive benefits from the BNR cannot be finalised until the land reclamation process is settled. However, ongoing communication must ensue between the Manoko community and LEDET to ensure individuals are kept up to date on the land reclamation process and to enable the Manoko community to keep updated on the management issues of the reserve. Public participation ensures that local values and cultural norms are represented in decision making processes and local people are empowered to access and influence management decisions. However, participation is not a panacea to resolving conflicts and needs to be handled with care to avoid being an empty process dominated by policy interests.

I propose that management committees allow the participation of parties most affected by protected area policies, including representatives from the Blouberg Tribal Authority, headmen or representatives of rural villages, land claimants and the Bro Brak Farmers Association. In the absence of a village headman or counsellor, villagers should be responsible for electing representatives. Management committees should not be created purely to act as governing bodies but also to promote forums such as round tables and multi-stakeholder dialogues. The committee should review and recommend changes in practices on a regular and ongoing basis to ensure that management processes are adaptive and responsive to local contexts. For example, local representatives of farming communities should identify factors preventing them from applying for trophy hunting and damage-causing animal permits. These

constraints can be communicated back to government agencies at head office to improve policy design.

A process of social learning will need to take place between stakeholders to ensure the viewpoints of others are taken into consideration and for committee members to take responsibility for meeting the interests of their partners. These processes become a form of adaptive management where social learning equates to "learning by doing" (Berkes, 2009, p. 1692). The impacts of traumatic nature may give rise to intense discussions amongst stakeholders to air their grievances about past and contemporary conflicts, therefore, stakeholders must be prepared to listen to one another even if individuals are in disagreement with them. Cooperation emerges out of extensive deliberation and negotiation that evolves over time (Pinkerton, 1992). A neutral third party may need to be appointed to improve stakeholder engagement (Redpath et al., 2012).

A role for a community engagement officer should be made available to act as a contact for outside enquiries, and to facilitate educational and awareness programmes on behalf of the reserves. The officer should maintain an active presence within the villages and Bro Brak Farmers Association to establish trustful working relationships with local people. Over time, improved communication may lead to greater participation, decrease conflict and lead to more effective management in the long-term. The legitimacy of protected areas, LEDET staff and the DEA as recognised by local farmers may improve through greater information sharing and increased responsibility of protected area management to address local concerns.

9.3.3 Common ground: Overcoming stereotypes and generating shared values and visions.

Stoll-Kleeman draws on theories from social identity theory to suggest that (1) setting common goals between user groups, (2) redrawing category boundaries and (3) establishing contact between groups may pave the way forward for reducing the tendency to stereotype (Stoll-Kleemann, 2001). The outcomes of traumatic nature result in the stigmatisation of different groups through the imposition of different stereotypes. Policy makers should not categorise the activities of other user groups. Wildlife authorities need to re-evaluate their definition of the term poaching for example, defining the differences between subsistence based activities and large-scale consumptive use by working in collaboration researchers to assess the the

ecological impacts of harvesting activities before denouncing them as environmentally destructive. Whilst the goals of The strategic plan for the Blouberg Nature Reserve (2012) includes management actions to assess the potential for targeted villages to harvest sickle bush and grass for thatching and fodder. These actions serve a dual purpose: villagers benefit from the natural resources and wildlife authorities are provided with free labour to manage bush encroachment. The potential for rural villagers to stand up against other forms of poaching (e.g. commercial use of hunting dogs) provides a step forward for taking collective action. Wildlife authorities need to establish contact with the headmen of villages and private landowners to discuss joint initiatives to curtail and manage poaching incidents when they occur and to develop strategies to increase awareness of the ecological impacts of poaching in villages (this Chapter, Section 9.3.9). Sharing the responsibility of poaching problems with community leaders may result in illegal poachers being fined through traditional institutions and encourages locals to take collective action against a common issue. Wildlife authorities should also also build relationships with surrounding communities by trying to assist them with other issues that local people prioritise as important. For example, by supplying firewood during funerals, assisting with the provisioning of water to the village Ga-Kgatla during times of drought and allowing monitored access through the Maleboch Nature Reserve to visit family and friends.

In other contexts, the participatory nature of the research process, allowed informants to openly discuss issues that they deemed important, resulting in the "co-production" of new types of knowledge of the environment which emerge due to a spiritual engagement with the land and its natural resources. The co-production of knowledge defined as:

"Working from the premise that knowledge is a dynamic process – that knowledge is contingent upon being informed, validated and adapted to changing circumstance – opens up the possibility for researchers to establish relationships with indigenous people as co-producers of locally relevant knowledge" (Davidson-Hunt and Michael O'Flaherty, 2007, p. 293).

Participatory approaches towards research build power-sharing relationships and assist in the development of locally appropriate resource management strategies (Arnold and Fernandez-Gimenez, 2007). The research process revealed that the spiritual values associated with the leopard expressed through reverence, fear and respect for the leopard in part, ensures its protection through the functioning of species-specific taboos. In turn, habitat-specific taboos also demonstrate the development of a local conservation ethic for managing natural

resources. These values align with the values of wildlife conservation and open up avenues for seeking common goals between local people and conservationists. Robinson and Sasu (2013) suggest that the process of local people seeing their values realised and reflected through the formal structures of governance to build trust, legitimacy and to lay the foundation for collective action. However, the inclusion of local values into existing conservation policies faces several difficulties because (1) biologists and government actors do not trust local knowledge, (2) unwritten knowledge is difficult to communicate and portray to government actors and biologists and (3) local knowledge often arises from a different worldview than western science (Berkes, 2009). Building organisations are defined as arenas for knowledge production, trust building, sense making and conflict resolution between government agencies and local people (Berkes, 2009) (Fig. 9.1). Anthropologists may serve a similar role to building organisations by bringing greater awareness of the contribution of local knowledge to provide common goals between local people and conservationists.

Figure 9.1: The role of bridging organisations in co-management. Taken from Berkes (2009)

The incorporation of the species-specific taboo into formal government policies to curtail lethal control measures would serve a dual purpose, protecting the leopard and preserving local values and knowledge. In turn, habitat-specific taboos resulted in the protection of particular sites, are recognised and defined as informal conservation areas by the Department of Environmental Affairs (2009) as "areas not formally protected by law but informally protected by the current owner and users, and managed partly for biodiversity conservation" (ibid, p. 10). Conservationists should engage with communal landowners to identify the biodiversity value of these sites and explore local interest in establishing these sites as formal conservation areas. Biodiversity Stewardship programmes in South Africa function to secure private and communally owned land for biodiversity conservation (Paterson, 2009). Shared goals such as these enable conservationists and local people to redefine themselves as belonging to the same group, thus re-categorising the outgroup to become part of a collective and allowing more favourable attitudes to develop between them (Brown, 1996).

9.3.4 Curtail lethal control measures

Sources of leopard mortality must be regulated to encourage the growth of the resident leopard population. A 3% offtake of leopards is considered a sustainable level of harvesting (Caro et al., 2009), but, the Blouberg population is currently too small to allow this amount on an annual basis. Trophy hunting, damage-causing animal permits and illegal killing need to be prohibited outside the borders of BNR, MNR and Lanjan Nature Reserve (LNR) to allow the population to recover. Programmes that encourage farmers to adopt non-lethal husbandry practices to reduce livestock attacks on livestock and game combined with changes in statutory legislation have been effective in allowing leopard populations to recover in Kwa-Zulu Natal (Balme, 2009). With restrictions on leopard harvesting and improved livestock and game management systems, leopard populations in the Blouberg have the potential to recover. Social factors influence the tendency for farmers to engage in lethal control measures and need to be addressed by the DEA, protected areas and local NGOs to improve perceptions of conservation. In the following sections, I propose several strategies to reduce lethal control measures, to reduce the frequency of attacks on livestock and game and improve tolerance for leopard depredations and conservation initiatives.

9.3.5 Improve institutional response to human-wildlife conflicts

A system should be created for managing human-wildlife conflicts that helps to establish legitimacy and credibility of the DEA and protected areas to improve adequate responses to human-wildlife conflicts. The decentralisation of authority to LEDET officers operating from local nature reserves, NGOs or other local agencies to respond and manage human-wildlife conflicts as joint teams may also improve responses to reported conflicts. In the Soutpansberg, a trained human-wildlife response team is planned for the future and funds are currently being sought to finance these operations through donor funding in collaboration with the Lajuma Environmental Research Centre, Durham University and the environmental charity, Earthwatch. Developing a hotline, which farmers can contact via phone, will reduce travel costs to report problem animals. Protected area wildlife authorities are the closest representatives of LEDET and have a responsibility to address local enquiries pertaining to wildlife problems and to build trustful relationships with surrounding farming communities. Human-wildlife conflicts should be addressed as a management issue in protected area committees. Wildlife authorities can use reserve committees to provide clarification on the procedures for reporting and managing human-wildlife conflicts, applying for damage-causing animal and trophy hunting permits and explaining the background, operation and benefits provided from these systems to farming communities.

9.3.6 Improve statutory legislation of trophy hunting and damage-causing animal permits

Management systems should prioritise the allocation of leopard trophy hunting and damage-causing animal permits to indvidual properties reporting high livestock damages that have also demonstrated efforts to improve livestock and game management systems. This approach legitimises claims for lethal control measures and rewards farmers that have invested efforts into improving livestock and game management as an incentive for changing farming behaviours. Following Balme et al. (2009), leopard trophy hunting permits should be issued to individual properties rather then hunting outfitters to ensure leopard hunts are conducted only once on the same property within a year, leopard hunts should be evenly distributed amongst properties, the likelihood of obtaining a trophy hunting permit should be greater for larger properties and trophy hunting should be restricted to adult males (> three years of age).

Balme et al. (2009) stipulate that professional hunters must accompany hunters, which are responsible for identifying the leopard as a male and reporting the hunt to the DEA. DEA officers are responsible for inspecting the trophy with 24 hours of the hunt to ensure all legal stipulations are adhered to before issuing Convention on International Trade in Endangered Trade in Endangered Species (CITES) permts for the export of leopard skins outside the country. Leopard populations are male biased in the Blouberg, so the reproductive growth rate of the population would be impeded by the harvesting of females in the area.

Damage-causing animal permits in Kwa-Zulu Natal are issued once depredation events have been investigated by wildlife officials to ensure that the same leopard has habitually killed livestock three times, over a two month period, by employing camera traps to identify individuals (Balme et al., 2009, 2010b). Farmers must also demonstrate efforts to improve livestock and game husbandry practices before permits are issued (Balme et al., 2009, Balme et al., 2010b). Considering the lack of management capacity of DEA officers to investigate reports of human-leopard conflicts, local response teams should be specifically employed to investigate these depredation events as outlined in this chapter (Section 9.3.5). The complex application procedures for applying for trophy hunting and damage-causing animal permits need to be simplified and made more accessible for non-literate communal farmers.

9.3.7 Improvement of livestock and game management strategies

I propose several strategies for improving the protection of livestock and game by emphasising the need to decentralise responsibility to farmers by improving livestock husbandry practices. Both farming communities will benefit from strategies that involve minimal behavioural change and build on existing forms of knowledge and cultural norms. Treves et al. (2009) suggest that local people are more likely to accept changes if they have identified the need for change themselves. Communal farmers identify solutions to overcome the high labour costs of shepherding by developing a communal fund to employ shepherds, and villagers suggest collaborating with other farmers to construct communal kraals on the mountain. Shepherds should be employed and livestock grouped together per village when grazed on the mountain during winter. Both farming communities should avoid grazing livestock close to water sources such as the Brak River, the forested river channels on the Blouberg Mountain and the borders of nature reserves by shepherding livestock away from these areas because they represent “hotspots” for leopard depredation.

Communal farmers should construct kraals from local materials (e.g. acacia thorn branches rather than wooden poles) and develop sleeping huts on the mountain to accommodate shepherds during the dry season (particularly June-September). Sleeping huts should be positioned close to kraals, and guarding dogs kept inside kraals with livestock. Electrical wires atop netted fences may be effective for reducing livestock attacks for commercial farms but are costly to power and maintain. Similar methods are deemed effective for mitigating leopard attacks on kraals from other studies in Africa (Bowland et al., 1993, Ogada et al., 2003, Kolowski and Holekamp, 2006).

Synchronised breeding seasons during the wet season may improve the growth rates of calves when the grasses are more abundant and nutritious. However, on communal land, this would require the cooperative support of villagers to separate bulls and females during the non-breeding season. Constructing artificial water points close to villages on communal land rather than the communal grazing areas may reduce attacks on predators. Kraaling calves spatially away from leopard environments and placing them in camps close to human activity (homesteads/villages) until they are large enough (> three months of age) will lower the risk of leopard predation. Commercial crop farmers should make use of open, recovering crop fields by grazing calves within these areas, away from leopard habitats, until they are large enough (> three months of age) to avoid predation by leopards. Similarly, communal farmers can make use of empty agricultural fields during the end of the wet season to extend seasonal grazing periods close to the village.

Game farmers should avoid purchasing expensive game species such as nyala. Game farmers engaged in livestock farming operations should cultivate habitats for game that are spatially concentrated away from livestock grazing areas. Increasing the number of natural prey species such as impala on game farms may reduce the risk of leopard predation on livestock. Communal farmers should attempt to improve wild game numbers on communal land. The success of these strategies will depend on the prohibition of lethal control measures and raising the tolerance of both farming communities to attacks on game species. Mitigation strategies, which raise people's tolerance for wildlife and conservation and protect human welfare and threats to wildlife, require explicit incentives for improving tolerance and sanctions imposed for retaliatory behaviours such as incentive and education schemes (Mishra et al., 2003).

9.3.8 Incentive schemes for modifying farming behaviours

Incentive programmes encourage farming communities to improve livestock and game husbandry practices by paying or rewarding farmers for changing their behaviour. Mishra et al. (2003) developed an incentive programme in the Spiti Valley, western Trans-Himalayas to change livestock management systems. An area of land was set aside, free from livestock grazing and human use, to assist in the recovery of wild prey populations for snow leopards. Villagers received monetary compensation for lost grazing land totalling $425 per annum. Over time, the snow leopards' main natural prey species, bharal (*Pseudois nayaur*), began to increase in the area. The fund is used to reward farmers for engaging in sustainable livestock farming practices through annual bonuses paid to individual herders.

Similar strategies could be applied in the Blouberg, to provide incentives for communal farmers to assist in the recovery of small and large game populations on communal land, however, incentives to prohibit lethal control measures will need to be made explicit. Incentive programmes are funded through external subsidies provided by NGOs and donors that agree to a dedicated length of time to fund projects and are not sustainable in the long term (Mishra et al., 2003, Treves et al., 2006). Incentive programmes need to develop self-sustaining solutions that are not entirely dependent on donor funding. For example, villagers in the Spiti Valley, western Trans-Himalayas, facilitated a wildlife tourism project linked with the set aside land, by developing and marketing handicrafts to subsidise the programme (Mishra et al., 2003).

Biodiversity stewardship programmes in South Africa provide an example of an incentive programme. The stewardship prgramme ensures that private and communally owned areas with high biodiversity value receive secure conservation status, expand biodiversity conservation areas and ensure landowners receive tangible benefits for their conservation actions and become empowered decision makers (Paterson, 2009). Income tax incentives are granted to landowners who forego development opportunities on their land in the interests of biodiversity conservation. For example, landowners are rewarded for their efforts by receicing tax levies on their properties (Paterson, 2009).

The Limpopo Department of Agriculture, through their Expanded Public Works Programme creates work opportunities for the unemployed to participate on projects to improve local environments. The Department's Land Care programme also involves "local people taking local action in their area" to achieve sustainable land use and management (Republic of South

Africa, 2013). These initiatives may encourage farming communities to alter or change their livestock and game management systems. Alternatively, government departments and NGOs (e.g Department of Agriculture, Department of Environmental Affairs, and Endangered Wildlife Trust) can assist by providing technical support and advice for improving livestock and game husbandry practices by hosting workshops at the Blouberg Tribal Authority and the Bo Brak Farmers Association.

The Endangered Wildlife Trust may serve as an example of a bridging organisation between local farmers and central governments, because they have the management capacity to assist farmers and build relationships with farmers that foster trust in the long term. The Endangered Wildlife Trust's existing Livestock Guardian Dog Project offers a cost-effective solution for commercial farmers to employ livestock guardians to protect free-ranging livestock herds. The Endangered Wildlife Trust should explore the potential for assisting communal farmers by advising farmers how to better care for and train local dogs as livestock guardians and to raise awareness of the ecological impacts of hunting wildlife.

9.3.9 Education programmes, marketing strategies and awareness campaigns

Education and outreach programmes have often served as an effective form of conflict mitigation because improved knowledge of wildlife has been associated with decreased fear and improved tolerance for wildlife (Ericsson and Heberlein, 2003, Marker et al., 2003, Prokop et al., 2009, Dickman, 2013). In the Blouberg, education workshops should target a wide range of groups from school children to older generation farming communities. Considering that young commercial farmers are more likely to improve livestock and game farming practices and support leopard conservation initiatives, this group should be recruited to assist in the development of education schemes amongst the Bo Brak Farmers Association. The strategic plan for both reserves includes management actions to assess the cost-effectiveness of developing an environmental education centre and establishing links with local educational institutions and networks to establish the reserves as an educational resource (NCC-Group, 2012a, NCC-Group, 2012c). Local nature reserves can serve as platforms to host educational awareness and environmental campaigns. Education programmes should focus on transmitting knowledge and information on the following themes:

- Leopard ecology and behaviour: Actual risks to human safety, leopard and prey dynamics, predatory behaviour, the ecological impacts of lethal control measures, leopard population status and distribution in the area.

- Biological knowledge of interactions between species and habitats to emphasise the connectivity of ecological systems: Keystone predators, predator-prey dynamics, species webs and food chains.

- Social-ecological factors driving livestock and game predation and strategies to improve livestock and game husbandry practices.

- Cultural knowledge of leopards in Bahananwa culture: Totem animals, species-specific taboos, habitat-specific taboos and their relevance to conservation.

Traditional healers and elders of the Bahananwa should assist in the cultivation and synthesis of cultural knowledge, in collaboration with researchers, for dissemination to the wider public by developing books, pamphlets and information containing narratives and illustrations of the leopard. This information could also be made accessible online and published on websites as a creative medium for preserving cultural knowledge. The expression of aesthetic and cultural values in marketing strategies and awareness campaigns may encourage support for leopard conservation. For example, representing the leopard as a flagship species for the preservation of the wider Blouberg landscape and the conservation of other species and habitats may serve as an effective marketing tool. Promoting the leopard as a poignant symbol of cultural history, landscape conservation and an important resource for future generations may foster support for leopard conservation by developing slogans and multimedia that represent these core values.

9.4 Future research work for the Blouberg

- Evaluate the efficacy of co-management agreements, policies and implementation to improve the participation of local people in protected area management decisions, benefit sharing and perceptions of conservation.

- Trial strategies suggested in this chapter for improving relationships between local people and wildlife authorities and evaluate their effectiveness for improving perceptions of protected areas and wildlife conservation.

- Explore the potential of incorporating spiritual values associated with the leopard and sacred sites into resource management strategies for the area.

- Pilot an education awareness scheme for the area that builds on scientific and local knowledge to improve awareness and tolerance for leopard conservation.

- Investigate the application and efficacy of detection dogs to improve the identification of leopard scats to improve knowledge of leopard feeding ecology and to measure the actual extent of livestock and game depredation.

- Investigate long-term temporal and seasonal differences in leopard density, occupancy and population structure between land use types, to identify sink and source populations at finite scales. GPS collaring would assist in improving knowledge of leopard home range sizes, sex-specific ecology, behaviour, and mortality rates, to inform camera trap design and to assist in the identification of localised sink populations. In future spatial capture-recapture models should incorporate age and sex specific covariates to calculate density, presuming adequate sample sizes and the age of individuals can be determined.

- Investigate the use of the Brak River and Blouberg Mountain as a habitat corridor for leopards from the north of the Soutpansberg to the Blouberg Mountain.

- Trial different strategies to mitigate human-leopard conflict as suggested in this chapter and investigate their impacts on the extent of depredation, leopard population status and farmers' tolerance for leopard conservation, before and after treatment.

- Collect empirical data to corroborate findings from discourse analysis to elucidate the relationship between values and the likelihood of engagement in behaviours that provide barriers or support for leopard conservation (e.g. the tendency to adopt lethal control measures).

9.5 Reflections on the interdisciplinary approach

Human-wildlife conflict practitioners advocate a need for interdisciplinary research and to move beyond the examination of species based conflicts to include research on understanding the human dimensions of the issue and its social, cultural, political and economic complexities (Dickman, 2010, Treves et al., 2009, Treves et al., 2006). Human-wildlife conflict can be envisaged as part of a larger environmental management problem made up of a confluence of multiple interrelated interactions that occur between humans and animals and between other humans, these collective processes create a series of impacts for wildlife species and human livelihoods and wellbeing; an essentially interdisciplinary concept (Mallegowda, 2013, Jochum et al., 2014).

Interdisciplinary research combines perspectives from other disciplines including ecology and the social sciences in order to provide a holistic overview of the problem rather than using a solely reductionist approach to research by encouraging researchers to move beyond disciplinary boundaries (Muhar et al., 2013). I was keen to expand my research background from biology, which depends on rigorous hypothesis testing in order to determine an objective truth to encompass anthropology, which generates greater contextual information by seeking patterns and themes that emerge from closer inspection of the data. However, interdisciplinary approaches require an understanding of different disciplinary perspectives including jargon, theories and concepts and the integration of different sets of data (Marzano et al., 2006). Initially, navigating a new subject was similar to learning a new language. New topics and approaches began to emerge through my reading of the literature that drew my interest and included other topics that encompassed geography, history and sociology. Building on these new approaches, encouraged me to develop a wide range of research questions in order to better understand the complexities of the issue. For example, through my reading on human-animal relationships I wanted to explore the cultural uses of leopard in local practices. However, in doing so I set myself an ambitious task with a wide range of research questions to address.

In the field, I found it difficult to divide my time between collecting biological and social data for example, setting out camera traps proved to be time consuming and labour intensive, as did travelling and conducting interviews. Undertaking interdisciplinary research involves trade-offs for example, I could not carry out a single large scale camera trapping study on leopard ecology, or a single detailed ethnography of human-environmental relationships that may have

yielded more comprehensive results if conducted by a dedicated biologist or anthropologist. However, I was able to conduct a detailed interdisciplinary study that produced a holistic overview of the human-leopard conflict issue. Several factors helped to assist me in my data collection activities firstly, learning Northern-Sotho allowed me to better understand and relate to local people and living in a village also allowed me to build trustful working relationships with my informants and to access a greater depth of information. Over time, I synergised my data collection activities. For example, during a lecture I was introduced to the concept of cultural mapping and I adopted a similar approach in my project. Cultural mapping saved time and resources and allowed me to access a richer data set, because I was able to collect biological and social data in situ, in an informal and relaxed environment.

There are many challenges associated with interdisciplinary work for example following different theories and explanatory models and differences in epistemology (Mallegowda, 2013). For me the most challenging aspect of the interdisciplinary work was the analysis and writing up process. During my ethnographic fieldwork, I had become fully immersed in the project and collected a wide range of data that extended beyond the scope of the project. I felt that I needed time to "step away" and dedicate time to reflect on the meanings behind the data. Initially the analysis of the social research required a lot of reading around different topics and talks with other anthropologists in the department to make sense of what I was observing. The writing up process was lengthy because I had to learn to write in a different style and my first social chapters required several revisions. In contrast, whilst the biological studies took time to analyse, the chapters were much quicker to write. These processes lengthened the duration of the study and many other interdisciplinary PhD students working in the Department completed their projects in four years. In future, I would recommend that NERC and ESRC allocate funding for interdisciplinary research projects to extend over a four year rather than a three year period.

As time progressed, I found that both the biology and anthropology could be fused together to provide complimentary findings that provided greater depth of understanding then could be understood from a purely mono-disciplinary approach. Although the biological data was often presented quantitatively, the anthropology data often provided greater contextual understanding of the biological findings. For example, livestock depredation was highest during the dry season, a time, associated with seasonal grazing patterns and a reduction in traditional livestock herding practices, a finding identified from the interviews. I found that greater depth of understanding evolved from the contextual and relational aspects of the research. For example, the impact of historical and current relationships with protected areas

emerged as fundamental for understanding wider issues related to local perceptions and actions towards leopards, protected areas and wildlife conservation. A range of interactive factors contributed to understanding these cumulative processes, which could not have been obtained by envisaging individual factors in isolation. This approach has generated novel research outputs by identifying the root cause of contemporary perceptions and actions towards wildlife and conservation and assisting in the development of recommendations for improving the management of human-leopard conflicts.

I found that interdisciplinary research involves learning to engage with a wide range of stakeholders outside of academia in order to offer other ways of seeing and understanding the world (Muhar et al., 2013). I learnt to listen to local people, their priorities and the topics they deemed important, by listening I was able to understand that past and present relationships with protected areas was a central topic for investigation. In turn, listening to people's stories and concerns raised many new topics for investigation including how local knowledge can be used as a tool for conservation. Through close engagement with a wide variety of stakeholders, I was also able to see the human-leopard conflict problem from multiple viewpoints. For example, I understood the economic and political limitations facing wildlife authorities to manage damage-causing animals and the frustrations of farmers impacted by carnivore depredation. I learnt that by working "*with*, rather than *for* society," (Muhar et al., 2013, p. 123), novel research questions were generated resulting in the co-production of knowledge and barriers and actions were identified that needed to be overcome in order to develop culturally appropriate mitigation strategies. In turn, the research process and the outputs generated from the project served to empower local actors that are usually marginalised from decision making processes.

For me, interdisciplinary research entails enthusiasm and commitment to learn a new subject, innovative forms of data collection, identifying areas for data complementarity, seeking the advice and support of colleagues and inspiration from other interdisciplinary projects, building trustful working relationships with colleagues and stakeholders and finally, examining other types of knowledge outside of one's subject area, and from non-academic communities. Overall conducting an interdisciplinary project was essential for understanding the core issues driving human-leopard conflict in the Blouberg Mountain Range and has allowed me to develop new skills and knowledge central to my career as a researcher.

9.6 Conclusion

A key challenge for managing human-wildlife conflicts is to develop sustainable solutions that abate negative impacts on the viability of ecological populations and also protect local livelihoods and wellbeing (Treves et al., 2006, Treves et al., 2009). In order to develop effective management strategies a detailed understanding of the complexities driving conflict is required through an examination of the ecological and social dimensions of the problem, as situated within the local context (Treves et al., 2006, Treves et al., 2009). Understanding large carnivore-human conflict resulting from livestock depredation begins by first understanding the extent and patterns of conflict as well as the impacts of conflict on local people (Treves et al., 2006, Treves et al., 2009). In turn, information on the predatory behaviour of the species and their population status is also important for anticipating depredation patterns and the resilience of the population to overcome anthropogenic perturbations evoked by retaliatory killings. The current study collects baseline data on the nature and characteristics of human-leopard conflict, but is novel in its application because it uses a historical and contextual approach and incorporates the viewpoints of different stakeholder groups to understand the root cause of current perceptions and actions towards leopards, protected areas and wildlife conservation. The core finding of the research is that historical and contemporary relationships between local people, protected areas and environmental institutions are negatively affected by conflicts of land and natural resource use; a traumatic nature. Traumatic nature exacerbates human-leopard conflicts and increase distrust of local people towards the conservation community. The outcomes of traumatic nature have wide ranging implications not only for leopard conservation but also the future sustainability of protected areas and the success of wildlife conservation initiatives. These issues need to be addressed and relationships between local people and the conservation community need to be strengthened in order to overcome many other problems generated from human-leopard conflicts. Another central finding of the thesis is that an understanding of leopard population ecology and local perspectives is crucial for developing mitigation strategies that are culturally appropriate, ecologically sustainable, economically viable and socially acceptable. The research findings contribute more widely to understanding the complexities of human-wildlife conflicts and developing sustainable strategies for mitigating conflicts for other projects worldwide.

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Appendix 1: Average market sale prices for livestock and game species calculated from local auctions in Vivo and auction websites in the Limpopo Province, accessed on the 2nd December 2012, covering the period from October, 2009-October, 2011. The market prices were used to determine the economic costs of livestock depredation by leopards in the Blouberg Mountain Range.

Livestock Species	**Market Value (ZAR)**	**Accessed**
Nguni Bull	8000	http://www.ngunicattle.info/Sales-Results.htm
Adult Female Bonsmara	4600	http://www.proveld.co.za/results.html
Adult Female Nguni	3500	http://www.ngunicattle.info/Sales-Results.htm
Bonsmara Calf	4777	http://www.proveld.co.za/results.html
Nguni Calf	3000	http://www.ngunicattle.info/Sales-Results.htm
Sheep	800	Estimates based on local vivo auctions
Goats	700	Estimates based on local vivo auctions
Donkeys	700	Estimates based on local vivo auctions
Game Species	**Market Value (ZAR)**	**Accessed**
Bushbuck	4304	http://www.wildlifeauctions.co.za/game_info.php
Gemsbok	5167	http://www.gamefarmnet.co.za/veiling.htm
Impala	694	http://www.gamefarmnet.co.za/veiling.htm
Kudu	3405	http://www.gamefarmnet.co.za/veiling.htm
Nyala	5171	http://www.gamefarmnet.co.za/veiling.htm
Ostrich	1952	http://www.wildlifeauctions.co.za/game_info.php
Warthog	696	http://www.wildlifeauctions.co.za/game_info.php
Waterbuck	2000	http://www.gamefarmnet.co.za/veiling.htm

Appendix 2: Summary of the number of captures, number of camera station, captures and relative abundance index (RAI) of all animal species captured from camera trap surveys in the Blouberg Nature Reserve (7th March-5th May 2011), commercial Farms (6th July-3rd September 2011) and communal land (28th October-26th December 2011). Prey species marked * are small prey (<40 kg), and species marked ** are large prey (> 40kg) to leopards.

Species	Latin name	Captures	No of camera stations	RAI	Captures	No of camera stations	RAI	Captures	No of camera stations	RAI
Aardvark**	*Orycteropus afer*	11	7	0.11	45	8	0.45	-	-	-
African Civet	*Civettictis civetta*	49	12	0.49	35	9	0.35	49	10	0.49
African Wildcat	*Felis silvestris lybica*	21	7	0.21	26	5	0.26	-	-	-
Baboon*	*Papio ursinus*	219	13	2.19	93	11	0.93	119	12	1.19
Banded Mongoose	*Mungos mungo*	40	9	0.4	2	2	0.02	1	1	0.01
Bat Eared Fox	*Otocyon megalotis*	-	-	-	1	1	0.01	-	-	-
Black Backed Jackal	*Canis mesomelas*	16	4	0.16	80	8	0.8	-	-	-
Booted Eagle	*Aquila pennata*	2	1	0.02	-	-	-	-	-	-
Brown Hyaena	*Hyaena brunnea*	76	13	0.76	75	12	0.75	20	8	0.2
Bush Baby	*Galago maholi*	-	-	-	3	2	0.03	-	-	-
Bush Pig**	*Potamochoerus larvatus*	7	4	0.07	4	4	0.04	9	4	0.09
Bushbuck*	*Tragelaphus scriptus*	16	6	0.16	91	8	0.91	16	5	0.16
Cape Buffalo**	*Syncerus caffer*	87	8	0.87	-	-	-	-	-	-

Cape Turtle Dove	*Streptopelia capicola*	9	5	0.09	3	2	0.03	-	-	-
Caracal	*Felis caracal*	1	1	0.01	23	6	0.23	1	1	0.01
Cow	-	1	1	0.01	46	4	0.46	166	9	1.66
Crested Francolin	*Dendroperdix sephaena*	68	10	0.68	96	10	0.96	2	2	0.02
Crested Guineafowl	*Guttera pucherani*	49	11	0.49	300	10	3	79	7	0.79
Crimson Crested Shrike	*Laniarius atrococcineus*	-	-	-	5	3	0.05	-	-	-
Domestic Dog	-	-	-	-	-	-	-	19	5	0.19
Donkey	-	1	1	0.01	5	1	0.05	22	6	0.22
Egyptian Goose	*Alopochen aegyptiacus*	-	-	-	5	3	0.05	-	-	-
Eland**	*Taurotragus oryx*	23	3	0.23	8	4	0.08	-	-	-
Gemsbuck**	*Oryx gazella*	86	8	0.86	13	5	0.13	-	-	-
Giraffe	*Giraffa camelopardalis*	135	11	1.35	5	2	0.05	-	-	-
Goat	-	-	-	-	3	3	0.03	11	2	0.11
Greater Cane Rat*	*Thryonomys swinderianus*	2	1	0.02	3	3	0.03	-	-	-
Grey Duiker*	*Sylvicapra grimmia*	25	7	0.25	193	4	1.93	69	6	0.69
Hadada Ibis	*Bostrychia hagedash*	2	1	0.02	-	-	-	-	-	-
Honey Badger	*Mellivora capensis*	10	5	0.1	21	9	0.21	8	4	0.08
Hoope	*Upupa africana*	6	1	0.06	1	1	0.01	-	-	-
Impala*	*Aepyceros melampus*	107	11	1.07	144	12	1.44	-	-	-
Klipspringer*	*Oretragus oreotragus*	1	1	0.01	-	-	-	17	6	0.17
Kori Bustard	*Ardeotis kori*	-	-	-	5	3	0.05	-	-	-
Kudu**	*Tragelaphus strepsiceros*	127	13	1.27	66	12	0.66	-	-	-
Large Spotted Genet	*Genetta tigrina*	54	10	0.54	69	11	0.69	35	9	0.35
Leopard	*Panthera pardus*	43	11	0.43	32	8	0.32	2	2	0.02
Leopard Tortoise	*Stigmochelys pardalis*	4	1.5	0.04	1	1	0.01	-	-	-

Mountain Rhebuck*	*Redunca fulvorufulu*	2	1	0.02	-	-	-	-	-	-
Mourning Collared Dove	*Streptopelia decipiens*	16	7	0.16	4	4	0.04	-	-	-
Nyala**	*Tragelaphus angasii*	-	-	-	177	7	1.77	-	-	-
Ostrich	*Struthio camelus*	-	-	-	6	2	0.06	-	-	-
Pied Babler	*Turdoides bicolor*	-	-	-	2	2	0.02	-	-	-
Pig	-	-	-	-	-	-	-	11	1	0.11
Porcupine*	*Hystrix africaeaustralis*	67	9	0.67	55	10	0.55	52	11	0.52
Red Crested Korhaan	*Lophotis ruficrista*	2	2	0.02	50	7	0.5	-	-	-
Red Hartebeest**	*Alcelaphus caama*	22	5	0.22	1	1	0.01	-	-	-
Red-billed Hornbill	*Tockus rufirostris*	29	7	0.29	5	2	0.05	-	-	-
Rock Dassie	*Procavia capensis*	-	-	-	-	-	-	8	2	0.08
Sable**	*Hippotragus niger*	19	8	0.19	-	-	-	-	-	-
Scrub Hare	*Lepus saxatilis*	6	4	0.06	321	12	3.21	-	-	-
Serval	*Leptailurus serval*	1	1	0.01	2	1	0.02	-	-	-
Slender Mongoose	*Galerella sanguinea*	11	3	0.11	1	1	0.01	-	-	-
Southern yellow billed hornbill	*Tockus leucomelas*	-	-	-	15	3	0.15	-	-	-
Steenbok*	*Raphicerus campestris*	32	6	0.32	71	9	0.71	-	-	-
Swaisons Spurfowl	*Pternistis swainsonii*	16	4	0.16	10	3	0.1	-	-	-
Tree Squirrel	*Paraxerus cepapi*	19	5	0.19	3	2	0.03	-	-	-
Vervet Monkey*	*Chlorocebus pygerythrus*	17	3	0.17	56	9	0.56	17	8	0.17
Warthog**	*Phacochoerus africanus*	58	14	0.58	161	8	1.61	1	1	0.01
Waterbuck**	*Kobus ellipsiprymnus*	14	5	0.14	7	3	0.07	-	-	-
Zebra**	*Equus quagga*	38	7	0.38	1	1	0.01	-	-	-

Appendix 3: SPACECAP results generated from a camera trap survey conducted from the 7th March-5th May 2011 in the Blouberg Nature Reserve to predict leopard densities for different buffer widths (km), forming the state-space around the camera trapping array. The definitions of each value are defined as: sigma (range parameter), lam0 (expected encounter frequency), beta (regression coefficient of behavioural response), psi (ratio of number of individuals present within the state-space of the maximum number stated in the model), NSuper (total number of individuals), density (number of individuals/100km^2), p1 (encounter probability of an individual before initial encounter) and p2 (encounter probability of individual after initial encounter).

Blouberg Nature Reserve	Posterior Mean	Posterior SD	95% Lower HPD Level	95% Upper HPD Level	Geweke Z Statistic
5.29km					
sigma	2.27	0.50	1.48	3.2609	0.68
lam0	0.06	0.02	0.03	0.1088	-0.46
beta	1.10	0.42	0.24	1.9022	0.47
psi	0.07	0.03	0.02	0.12	0.36
Nsuper	20.14	7.04	8	33	0.11
Density	5.55	1.94	2.48	9.3664	-
p1	0.06	0.02	0.03	0.1031	-
p2	0.64	0.16	0.32	0.8894	-
10.50km					
sigma	2.23	0.78	1.28	3.5762	-2.76
lam0	0.08	0.05	0.01	0.18	0.38
beta	0.93	0.59	-0.2	2.15	-2.76
psi	0.15	0.06	0.04	0.26	-0.61
Nsuper	44.54	17.71	13	79	-0.46
Density	5.53	2.20	1.61	9.80	-
p1	0.079	0.04	0.02	0.17	-
p2	0.53	0.29	-0.02	0.93	-
15.87km					
sigma	2.03	0.6	1.28	2.95	2.04
lam0	0.10	0.05	0.04	0.23	-1.15
beta	0.75	0.53	-0.2	1.72	3.93
psi	0.26	0.10	0.08	0.46	1.84
Nsuper	80.03	31.34	26	141	1.96
Density	5.69	2.22	1.85	10.02	-
p1	0.10	0.05	0.03	0.21	-
p2	0.46	0.33	-0.20	0.86	-
21.16km					

sigma	2.23	0.56	1.36	3.33	-5.26
lam0	0.08	0.04	0.03	0.16	0.65
beta	1.00	0.56	0.02	1.91	-1.80
psi	0.39	0.15	0.13	0.71	1.36
Nsuper	121.6	46.85	40	218	1.33
Density	5.47	2.11	1.80	9.82	-
p1	0.07	0.04	0.03	0.15	-
p2	0.59	0.22	0.13	0.99	-
26.40km					
sigma	2.14	0.55	1.37	3.10	-5.26
lam0	0.08	0.03	0.03	0.15	0.65
beta	0.82	0.47	-0.08	1.77	-1.80
psi	0.54	0.19	0.21	0.92	1.36
Nsuper	169.22	57.58	62	282	1.33
Density	5.36	1.82	2.03	9	-
p1	0.08	0.03	0.03	0.14	-
p2	0.51	0.23	0.08	0.89	-

Appendix 4: Interview Schedule

Personal Information

Form No:

GPS Location:

Interview ID: Date: Age:

Gender: Ethnicity: Religion: Home Language:

Education: None/ primary/ secondary/ university

Position and role on property:

Number of dependents:

Length of time living on the property:

Name and size of the property:

Land use (Crop/Game/Livestock)

Can you give tell me how you came to settle in this area and what factors motivated you to stay in this area?	
How has this area changed since you first arrived?	What is it that you like and dislike about living in this area from a farming perspective?

Property Characteristics

Questions	Prompts	Notes
Can you describe to me the land use of the property and give me some background information on how these activities are carried out? OR Can you give me a descriptive account of how you carry out your farming practices on a day to day basis?	How much livestock do you own? Each type? What are the primary reasons for owning livestock? Where and how do you graze your livestock? Do you use a defined calving season? When is it? How do you manage the calves during this period? Do you kraal your calves at night? Where are your livestock kept during the day and night? Do you kraal adult cattle at night?	

	Do you shepherd your livestock during the day/night? Do you use a livestock guarding dog? What are the main economic sources for the property/household? How many staff do you employ? Do you receive any government funding to support you? What are your future aspirations for your property/land?	
Can you give me some information about the history of this land in terms of how it was used previously?		

Extent of livestock losses

How many livestock have you gained/used from October 2009-October 2011?

	Species	No	Sex	Age
Births				
Purchased				
Gifts				
Sold				
Slaughtered				
Other				

How many livestock have you have lost due to the following reasons from October 2009-October 2011?

	Date	Species	No	Sex	Age
Stolen					

Predators					
Disease (type)					
Drought					
Accidental Deaths					
Other					

	Leopard	Spotted Hyaena	Brown Hyaena	Cheetah	Jackal	Caracal	Fox
When was the last time you noted the presence of the following species on your property?							
How did you identify their presence (tracks, sightings, kills, other)?							
Location							

How many livestock/game have you have lost due to the following predators from October 2009-October 2011?

	Leopard	Spotted Hyaena	Brown Hyaena	Cheetah	Jackal	Caracal	Fox
Location of attack (Get GPS Point)							
Date							
Livestock type attacked (sex/age)							
No livestock killed/ injured							

Who was with the livestock?							
How did you identify the predator? (sighting of predator, spoor, signs on carcass/environment?)							
What happened to the predator?							

How does livestock/game loss affect you?	Financially? Personally?	
How you cope and manage livestock/game loss?		
How you manage attacks on livestock/game?		

Leopards

How would you consider you knowledge of leopards?	Do you know anything about the biology of the leopard and its behaviour? Why do you think leopards kill livestock? What prey species are important for the leopard? What are the main threats to the leopard? Do you think leopard numbers are high or low? What would you consider to be the main characteristics of a problem leopard and why do you think problem individuals develop? Have you had any personal encounters with leopards? Please describe? Are leopards important in your culture? (Traditional medicine? Skins? Totems? Cultural practices?) Do you have any stories about	

	leopards? How does human-leopard conflict make you feel?	
What do you like/dislike about the leopard?	What features or characteristics do you like/dislike about the leopard?	
What do you think about leopard conservation?	Do you think it is important to protect leopards? Why? Would you participate in a leopard conservation programme in the area?	
What do you think about wildlife conservation?	Do you think it is important to protect the Blouberg Mountain? Why?	

Managing human-leopard conflicts

Can you please evaluate the following mitigation strategies according to the following: Cost-effectiveness: Is it expensive? Time consuming? Do you have the resources and knowledge to implement it? Effectiveness in preventing livestock depredations/game depredations? What are the effects of each practice on leopard populations/ other wildlife? Do you tolerate/support these methods? Why?	Shepherding? Livestock Guarding Dogs? Would you participate in the Endangered Wildlife Trusts programmes? Avoidance of leopard areas and managing habitats for leopards? Lethal Control Measures? Have you ever killed a leopard from October 2009-October 2011? If so how many? How? Please give details? Damage-causing animal permits? Trophy Hunting? Translocation of the predator? Who do you think is responsible for managing damage-causing animal permits? How do you report damage-	

	causing animals/ livestock depredations? Have you had any prior experiences with the Department of Environmental Affairs? Give details? What do you think of the Department of Environmental Affairs? Do you think the department is effective in managing damage causing animals?	

Nature reserves

Was the reserve established when you first came to settle in the area?	If not, can you tell me about the history of the land and how it was used before it became a nature reserve? Did the creation of the nature reserve change anything for you? How and why did the reserve become established? How did its creation influence the people living on the land? Were the people consulted about the establishment of the reserve?	
What benefits do you get from the reserve?	Please give some details? Are you aware of the 50:50 percent split from the MNR? If, so how do you think the money is spent?	
How do you communicate with the wildlife authorities?	Is poaching an issue? How is it managed?	
Have you had any personal experiences and interactions with the reserve and the wildlife authorities?		
What are the costs of having the reserve here?		

Why do we you think the reserves were established?	What is the role of a nature reserve?	
What does the word conservation mean to you?		
What do you think of the reserve?		
What would you like to see happen to the reserve in the future?		
Is there anything else you would like to tell me?		