An Assessment of Human Carnivore Conflict in the Kalahari Region of Botswana.

Dissertation submitted in fulfilment of requirements for the degree of Master of Science (M.Sc.)

Rebecca Klein

Rhodes University

2013

ABSTRACT

Human wildlife conflict is a considerable conservation challenge that threatens many carnivore species worldwide and is a result of complex socio-economic and ecological processes. An understanding of the drivers of conflict is essential for any efforts to achieve coexistence. This study investigated the levels of conflict, livestock management and tolerance amongst the farming communities of the Southern and Western Kalahari in Botswana.

A questionnaire survey was completed with 310 farmers throughout the region. The majority of respondents regarded coexisting with carnivores as a challenge, with losses due to depredation perceived as the greatest problem facing farmers. Conflict was widespread throughout the study area, with some spatial variations for certain species. Cattle management levels were low and while smallstock management was better, the use of improved levels of management could reduce current levels of conflict. Tolerance levels were generally low with few respondents seeing the benefits of coexistence with carnivore species. The results indicated that farm type, gender, education level, source of income, livestock numbers, location and land use all have an effect on perceived conflict and tolerance levels and strongly interact with each other. In general cattleposts were characterised by higher proportions of females, lower education levels, more benefits derived from wildlife and veld products and fewer livestock than fenced ranches. They also experienced more conflict, carried out more management and had better tolerance levels. It could be that closer connections to the land and deriving benefits from natural resources resulted in more tolerance and this is certainly worth further investigation. An improvement in the use of effective methods of livestock management, targeted environmental education programs to develop a greater awareness for the conservation value of carnivores and a diversification of livelihoods to include benefits from natural resources have the potential to reduce conflict and improve tolerance in the Kalahari region.

TABLE OF CONTENTS

Chapter 3. Methods

Chapter 4. Questionnaire Survey Results

Chapter 5. Spatial Analysis Results

Chapter 6. Discussion

ACKNOWLEDGEMENTS

I would like to thank the farming community of Botswana for their openness in participating in this study, the Department of Wildlife and National Parks for their ongoing support and collaboration and the Ministry of Environment, Wildlife and Tourism for permission to carry out research and issuing permits.

Many thanks to the staff of Cheetah Conservation Botswana who have been an inspiration and support during our 10 years of existence, particularly Dr Kyle Good and Ann Marie Houser who helped set up the project with me in 2003. Thanks to CCB's community outreach officers, Morulaganyi Kokole, Phale Seele and Thabang Segaetsho for assisting in the data collection. Much gratitude to Duma and Letotse, the 2 cheetah brothers I cared for at Mokolodi Nature Reserve that awakened my interest in human carnivore conflict. A significant thank you to my supervisor, Dr Ric Bernard, who provided guidance throughout and considerable patience.

Many thanks must go to my parents, Ken and Trudie, who exposed me to the world of wild places and cultures and set me on the path of conservation many years ago. My sister Samantha, who shared my vision of conserving the natural world and supported my every move along the way. My partner Dino, for serenading me during many a late night of work and my new baby, Eleni Amber, who I hope to inspire to love and protect nature into the future. Thank you to you all!

Chapter 1

1. General Introduction

1.1 Global conflict between humans and large carnivores

Throughout the world, populations of large mammalian carnivores, many of which are classified as threatened or endangered (Fuller, 1995; Nowell & Jackson, 1996), continue to decline (Macdonald & Sillero-Zubiri, 2002; IUCN, 2002; Maddox, 2003). These declines are largely the result of habitat degradation, diminishing prey populations, conflict with human populations, hunting, disease and commercial trade (Sillero-Zubiri & Laurenson, 2001; Woodroffe *et al*., 2005). As human populations expand and encroach on wildlife habitat, competition for natural resources increases, and human-carnivore conflict has become a primary concern for the long term conservation of large carnivore populations (Woodroffe & Ginsberg, 1998; Gittleman *et al.,* 2001; Kruuk, 2002).

Human-wildlife conflict is defined as any action by humans or wildlife that has an adverse impact upon the other (Conover, 2002). It has existed for as long as humans have existed and wild animals and people have shared the same landscapes and resources (Lamarque *et al*., 2008). It is a worldwide challenge, occurring across a range of situations and involving a wide array of species, from the small: insects and birds such as queleas (*Quelea queleas*, Bruggers & Elliott, 1989) to the large: such as lions (*Panthera leo*, Bauer, 2005) and elephants (*Loxodonta africana*, Hill, 1998). The smaller species, which often occur in vast numbers, are responsible for greater economic impacts on humans than the larger species (Knight, 2000; Lamarque *et al*., 2008). However, large carnivores are often responsible for generating the most intense conflict (Macdonald & Sillero-Zubiri, 2002; Dickman, 2005) and few other animals, with the exception of elephants (O'Connell-Rodwell *et al.*, 2000), have as great a capacity to negatively impact human livelihoods (Hemson, 2003).

The impact of large mammalian carnivores on humans takes several forms (Woodroffe *et al.,* 2005) including livestock predation (Marker *et al*., 2003a; Ogada *et al*., 2003; Patterson *et al*., 2004); human predation (Ginsberg, 2001; Packer *et al*., 2005; Baldus, 2008); predation upon game species (Thirgood *et al.,* 2000) and disease transmission

(Guan *et al*., 2004). Of these, livestock depredation and the resulting human retaliation are widely considered as the primary cause of population decline in large carnivores worldwide (Mishra, 1997; Naughton-Treves, 1997; Woodroffe & Ginsberg, 1998; Mazzolli, 2002; Van Bommel *et al*., 2007; Lamarque *et al*., 2008). In Pakistan, persecution of snow leopards (*Panthera uncia*) by local farmers, as a result of livestock depredation, is considered the greatest threat to the survival of the species (Fox *et al.,* 1991; Hussain, 2003). Many countries sanction the killing of 'problem animals' that either threaten the life of a human or destroy property (Nowell & Jackson, 1996).

The nature of the conflict and the ecology and behaviour of the species involved, affects the level of animosity. Large carnivores may represent a threat to human life (Quammen, 2003; Nijhawan, 2008) and their food requirements result in direct competition with humans for domestic and wild animals (Thirgood *et al*., 2000; Marker *et al*., 2003a). Thus large mammalian carnivores often generate hostile reactions, and retaliatory killings threaten many large carnivore populations and constitute a prominent human-wildlife conflict issue today (Marker & Dickman, 2004; Woodroffe *et al.,* 2005; Gusset *et al.,* 2009). Although conflict levels are often exaggerated (Breitenmoser, 1998; Rasmussen, 1999), human perceptions are shaped by costly, memorable events more than regular, small-scale losses to pests, even though these may represent higher long term economic impacts (Naughton-Treves & Treves, 2005).

1.1.2 Effects of Conflict on Carnivores

It is of significant worldwide conservation concern that the majority of the large carnivore species are threatened by conflict related factors (Sillero-Zubiri & Laurenson, 2001; Swarner, 2004). Threatened species include wolves (*Canis lupis,* Parsons, 1998), bears (*Ursus arctos*) and mountain lions (*Puma concolor*) in the USA and Canada (Musiani *et al*., 2003); jaguars (*Panthera onca*) and pumas (*Puma concolor*) in South America (Michalski *et al.*, 2001); wolves (Glenz *et al.,* 2001), bears (Sagor *et al.*, 1997) and lynx (*Lynx lynx*) in Europe (Stahl *et al.,* 2001); tigers (*Panthera tigris*) (Sekhar, 1998), and snow leopards in Asia (Jackson *et al*., 1996); and lions (Hemson, 2003; Van Bommel *et al*., 2007) , cheetahs (*Acinonyx jubatus*, Selebatso, 2006) and wild dogs (*Lycaon pictus*, Rasmussen, 1999) in Africa.

Human encroachment into unprotected wilderness areas has resulted in increasing numbers of large mammalian carnivores existing alongside human populations the consequences of which have often been reductions in numbers and distribution and even local extinctions of the carnivores (Treves & Naughton-Treves, 2005).

Such is the case for cheetahs, which were once one of the widest ranging carnivores. In 1900, approximately 100000 cheetahs occurred in at least 44 countries throughout Africa and Asia (Myers, 1975; Nowell & Jackson, 1996; Marker, 2002). The species has suffered considerable range reduction in the last century and the current population now exists in small, fragmented areas spread through 29 African countries and Iran. It is estimated that between 12000 and 15000 cheetahs remain (Nowell & Jackson 1996), representing a decline of nearly 90% over the century (Marker, 1998). The most viable remaining populations occur in Southern and Eastern Africa, although these are under threat primarily due to human conflict (Marker, 1998; Klein, 2007). Cheetahs have been nearly eliminated in Asia and in the northern part of Africa and the remaining sub-Saharan populations continue to be threatened (Myers, 1975; Nowell & Jackson, 1996).

Tigers have experienced similar catastrophic declines throughout their historical range, from approximately 100000 individuals at the beginning of the twentieth century to around 6000 at present (Johnsingh, 2003). Expanding human populations have reduced available suitable habitat and the resulting conflict is driving this species towards extinction (Miquelle *et al.,* 1999).

Twenty two of the world's 30 large carnivore species are considered endangered (Fuller, 1995) and all are threatened with increasing human conflict (Treves & Karanth, 2003). The large carnivores are particularly vulnerable to human conflict (Woodroffe, 2000; Gittleman *et al.,* 2001), due to certain biological characteristics. They have complex social behaviour, generally low reproductive rates and being at a high trophic level, often occur at low densities and require large areas to survive (Purvis *et al*., 2001; Dickman, 2008).

Lethal control is regularly used to reduce conflict levels (Mishra 1997; Marker & Dickman, 2004; Woodroffe & Frank, 2005) and it has become increasingly easy to remove large carnivores (Hemson, 2003). A large range of lethal methods for controlling carnivores exists, including regularly used methods of poisoning, trapping,

shooting and snaring (Treves & Naughton-Treves, 2005). These methods are cheap and effective and have considerable effects on large carnivore populations (Marker *et al*., 2003c; Woodroffe & Frank, 2005), as well as having substantial negative effects on non-target wildlife species (Maddox, 2003; Swarner, 2004). The use of lethal control methods may lead to removal of the conflict species or even total extinction, such as the marsupial wolf or thylacine (*Thylacinus cynocephalus*) in 1930 in Tasmania (Woodroffe & Frank, 2005).

1.1.3 Effects of Conflict on Humans

Numerous studies of large carnivore species such as, cheetahs (Marker & Dickman, 2004), leopards (*Panthera pardus*, Mizutani, 1993; Schiess-Meier *et al.,* 2007), wild dogs (Rasmussen, 1999; Muir, 2010), tigers (Sekhar, 1998, Sangay & Vernes, 2008), snow leopards (Nowell & Jackson, 1996, Bagchi & Mishra, 2006) jaguars (Hoogesteijn *et al.,* 1993; Hoogesteijn, 2002; Rabinowitz, 2005) and mountain lions (Beier, 1995, Mazzolli *et al.,* 2002) show that carnivore depredation upon livestock is the most common cause of human-carnivore conflict (Berger, 1999; Bekoff, 2001; Sillero-Zubiri & Laurenson, 2001).

Depredation upon livestock has economic consequences for communities living with carnivores and can have severe impacts on livelihoods (Nowell & Jackson, 1996; Kruuk, 2002; IUCN, 2002). In Nepal, losses attributed to snow leopards and wolves constituted 18% of stock holdings over an 18 month period, with a value of half the average per capita income (Mishra, 1997). In Zimbabwe, in the Gokwe communal land, adjacent to the Sengwa Wildlife Reserve, livestock depredation was responsible for an average loss per household of 12% of the total family income annually (Butler, 2000).

Threat of personal injury from large carnivores is also a key concern of people living alongside such species (Maddox, 2003). Although attacks are not common, they have a considerable effect on local perceptions. Large carnivores such as tigers, lions and mountain lions, with ranges frequently overlapping with high density human populations, are the main culprits (Nepal & Weber, 1995b; Sillero-Zubiri & Laurenson, 2001). It is understandable that this conflict creates strong negative perceptions towards the large carnivores and results in retaliatory killings (Marker *et al*., 2003a; Ogada *et al*., 2003; Baldus, 2004) and it is essential that these perceptions are

understood, as they drive the retaliatory actions of humans (Gittleman *et al.,* 2001). A high proportion of carnivore mortalities result from the deliberate killing by people who perceive them to be a threat to livestock (Ogada *et al*., 2003; Woodroffe & Frank, 2005). In Namibia, surveys revealed that in the 1990s, 22% of Namibian farmers confirmed that they were in conflict with cheetahs, which they considered to be a threat to their livestock, 84% of these said they had killed cheetahs (Marker *et al.,* 2003c). Where large carnivores adversely affect the profitability of livestock production and people's livelihoods, retaliatory killings represent a serious challenge to conservation (Treves & Karanth, 2003; Van Bommel *et al*., 2007). However, local people's perceptions of the level of conflict often outweigh actual rates of conflict (Frank, 1998). Many studies in Africa have shown that livestock loss to predation is minimal relative to the total stock holdings (McShane & Grettenberger, 1984; Rasmussen, 1999) and relative to losses from other causes such as disease (Mizutani, 1993; Frank, 1998). Despite this, where livestock husbandry is the main source of income, carnivores are rarely accepted but rather perceived as a threat and associated with large financial costs (Mishra, 1997; Butler, 2000; Patterson *et al.,* 2004; Frank *et al.,* 2005).

Conflict with carnivores has been exacerbated by changes in husbandry during the past century (Breitenmoser, 1998; Treves & Karanth, 2003). For instance, domestic livestock in Botswana is no longer regularly herded, kraaled or guarded by dogs and as such is more vulnerable to predation (Tjibae, 2001; Gusset *et al*., 2009). In many countries around the world, stockmen have lost the tradition of coexistence with large carnivores and modern protective legislation of carnivores is not matched by positive cooperative attitudes by livestock farming communities (Breitenmoser, 1998). Tolerating carnivores and accepting coexistence is a major challenge for people living with carnivores. Economic losses, even when small, can be considerable to small-scale producers and lethal control may be convenient, satisfying, and effective (Kruuk, 2002).

1.2 Importance of Carnivore Conservation

Declines in carnivore populations may have a range of cascade effects and conflict species, i.e. those with potential to have a negative effect on human populations, are often those whose declines have the most damaging environmental effects (Caro, 2003; Woodroffe & Frank, 2005). Large mammalian carnivores fulfil many important ecological functions, such as regulating prey numbers, controlling numbers of other carnivores through competition, limiting the spread of disease and maintaining biodiversity (Krebs *et al*., 1995; Brashares *et al*., 2001; Terborgh *et al.,* 2002). They are important indicators of functioning ecosystems and through predation, impact on all levels of the system, by diverting what they do not need to scavengers, detritivores, and microorganisms (Ricklefs, 1990). Due to their trophic level and large spatial requirements, their successful conservation automatically incorporates many other species (Sillero-Zubiri & Laurenson, 2001). Carnivores are essential in maintaining ecosystem processes (Berger, 1999) and the reduction of the impacts of apex carnivores can result in major shifts in ecosystem states and losses of diverse ecosystem services (Estes *et al*., 2011). Such high level trophic changes can lead to myriad effects on other species and ecosystem processes. Research in the Serengeti, Tanzania, showed that the presence of apex predators accounted for nearly all mortality in smaller herbivores, which showed dramatic increases in abundance and distribution after the local extinction of predators (Sinclair *et al.,* 2007). However, the relationship between trophic links is extremely complex, collapses in top carnivore populations are often associated with dramatic increases in the abundance of smaller predators, known as mesopredator release, which can lead to declining prey populations, even destabilizing communities and causing local extinctions (Prugh *et al.,* 2009). Mesopredators are often generalist carnivores that, in the absence of top-down control, can reach high population densities and result in high predation pressure on a wide range of small prey species. By controlling mesopredators, apex carnivores indirectly protect biodiversity at lower tropic levels from the effects of over-predation (Prugh *et al.,* 2009; Ritchie & Johnson, 2009). For example, the recovery of the lynx in Sweden and Finland controlling red fox populations and resulting in recovery of prey populations of hares and grouse (Helldin *et al.*, 2006; Elmhagen *et al*., 2010).

In addition, the removal of large carnivores can have socio-economic implications, such as in Ghana where the rate of lion and leopard population declines were shown to be closely correlated to baboon (*Papio ursinus*) population increase and conflict incidents involving crops and livestock. Villages suffering losses used school age children as guards, reducing school attendance rates and exposing children to harm. Along with this baboons and human share many parasites and pathogens, increasing encounter rates can create hot spots of infectious disease (Brashares *et al.,* 2010).

The disruption of trophic links caused by the removal of predation constitutes a threat to biodiversity, along with inherent economic and social costs. The best management solution is the costly restoration of effective predation regimes (Hayward & Somers, 2009; Ripple *et al*., 2010; Terborgh *et al*., 2010)

1.3 Limitations of Protected Areas

The protected area system of national parks and reserves has limitations when it comes to conserving large carnivores, as the reserves are rarely large enough to contain viable long term populations (Woodroffe & Ginsberg, 1998). Many carnivore species need large areas of suitable habitat to thrive (Sillero-Zubiri & Laurenson, 2001; Woodroffe *et al*., 2005). For example, the average home range of cheetahs in Namibia is 1600 km^2 (Marker, 2002) and the average territory size for wolves in Ontario is 480 km^2 and they seasonally leave reserve boundaries to follow migratory patterns of deer (Cook, 1999). Due to the large spatial requirements, most reserves are not large enough to avoid strong edge effects (Brashares *et al.,* 2001; Loveridge *et al.,* 2001). Mortality around reserve borders, where the carnivores come into contact and conflict with humans, represents a major threat to survival even within reserves (Parks *et al*., 2002). In addition, neighbouring unprotected areas act as population sinks and impact on long-term population viability for large carnivores (Woodroffe & Ginsberg, 1998).

Along with this, intra-specific competition between members of a large carnivore guild within a protected area may negatively affect certain carnivores, such as cheetahs and wild dogs (Creel, 1998; Durant, 2000a). In addition, the socio-economic effects of preventing people from accessing natural resources within protected areas can create negative feelings towards protected areas and wildlife (Nowell & Jackson, 1996;

Homewood & Brockington, 1999). Although 11% of the earth's surface is classified as protected, it is unwise to rely on such areas to maintain biodiversity. Less than 16% of remaining tiger habitat is protected, with less than 10% for leopards, pumas, jaguars and snow leopards (Dickman, 2005). It is estimated that 90% of the cheetah populations in Southern Africa exist outside protected areas (Marker, 2002). It is clear that conservation of large carnivores today must take place within a complex framework of fragmented wild areas within human-dominated lands (Linnell *et al.,* 2001; Muntifering *et al.,* 2006; Dickman, 2008).

1.4 Mitigating Conflict

For many large carnivore populations, continued existence relies on mitigating human-wildlife conflict and facilitating coexistence (Swarner, 2004). Reducing conflict is essential and it is possible for humans to coexist with large mammalian carnivores by implementing effective management techniques which can deter carnivores and reduce losses due to depredation (Bauer, 1995; Vos, 2000; Marker, 2002; Rabinowitz, 2005; Woodroffe, 2005b). These include low tech solutions such as effective kraal designs, the use of herders, livestock guarding dogs, patrols (Stander, 1997; Marker-Kraus, 1997; Frank, 1998; Ogada & Ogada, 2004), as well as more high tech solutions such as electric fencing, acoustic deterrents, livestock collars and conditioned taste aversion (Landry, 1999; Vos, 2000). Such techniques work to reduce carnivore-livestock encounter rates and associated losses. In Kenya, improved livestock husbandry has had a significant effect on reducing depredation rates. Livestock that are herded by day and enclosed in traditional thorn brush enclosures at night experience the lowest predation rates (Ogada *et al*., 2003). Similarly, in the USA, predation is a major problem for sheep and goat producers and is reduced by the use of livestock guarding dogs, llamas and donkeys (Andelt, 2001).

Along with effective livestock husbandry and non-lethal carnivore control, maintaining healthy wildlife populations can minimize livestock depredation by providing a natural food source (Woodroffe, 2005b). Programs designed to raise public awareness and which improve knowledge about carnivores and promote effective mitigation techniques can improve perceptions and reduce conflict (Marker *et al.,* 2003a).

Economic incentives can be used to promote coexistence. The potential for large carnivores to contribute to local economies through tourism or sustainable utilization is significant and can increase the desire to manage and conserve wildlife (Newmark *et al*., 1993; Baker & MacDonald, 2000; Walpole, 2001).

1.5 Factors Affecting Conflict

Devising effective strategies for resolving conflict depends upon a clear understanding of how and why such conflicts arise. Conflict between humans and carnivores is the product of complex ecological and socio-economic processes (Treves *et al.,* 2004, Hemson, 2009). If the underlying causes for conflict are not determined it can be difficult to determine the appropriate actions, as the success of mitigation techniques varies in different situations. Strategies that may work for large ranches in Kenya may not be applicable to the tribal people of Cameroon or stock owners in the Southern Kalahari (Hemson, 2003). It is therefore essential to investigate the factors which influence conflict levels, attitudes and tolerance. This is key to developing the most appropriate solutions, whether mitigation to reduce losses (Ogada *et al*., 2003), education to improve awareness (Marker *et al*., 2003c), or economic incentives (Mishra *et al*., 2003).

1.5.1 Socio-Economic Levels

The degree to which people tolerate carnivores can be influenced by various socio-economic factors, such as gender, age, wealth, level of education and level of costs associated with conflict (Oli *et al*., 1994; de Boer & Baquete, 1998; Lindsey *et al*., 2005a; Lindsey *et al.,* 2005b). Gender and age may affect human perceptions, as community roles for males and females of different ages are diverse and can bring them into contact with different species (Lamarque *et al*., 2008). Increased wealth can make people less economically vulnerable to the impact of carnivore losses and potentially more tolerant (Treves & Naughton-Treves, 2005; Zimmerman *et al.,* 2005). Although the relationship is not clear, higher levels of education may result in increased tolerance of carnivores (Conforti & Azevedo, 2003; Marker & Dickman, 2004). Sources of income are also important, as individuals reliant on livestock farming

as their only income generator are more vulnerable (Hazzah, 2006; Dickman, 2008). Diversifying income is an important requirement for mitigating conflict and can result in better tolerance to losses (Newmark *et al*., 1993; Sillero-Zubiri & Laurenson, 2001).

1.5.2 Cultural Values and Perceptions

There are various cultural values, beliefs, perceptions, and attitudes that predispose people to different levels of tolerance towards wildlife (Hutton & Leader-Williams, 2003). For example, in certain areas of Nepal, snow leopard depredation is tolerated as the cats are considered sacred (Ale, 1998). By contrast, in many countries in Africa, hyenas (*Crocuta crocuta, Hyaena brunnea*) are considered to be witches and are disliked (Maddox, 2003).

1.5.3 Location

Conflict is not evenly distributed in space and certain areas are 'hot-spots' due to combinations of variables that provide opportunities for conflict (Naughton-Treves, 1998). For example, in Brazil, incidents of conflict with jaguars and pumas are more common in areas close to forests (Palmeira *et al.,* 2008). In India, communities that suffer regular conflict with carnivores are commonly located in very remote wilderness regions (Sekhar, 1998) or adjacent to protected areas (Newmark *et al.,* 1994; Boomgaard, 2001). However, in the latter case, costs can be offset by economic benefits from the protected areas, which can improve tolerance and facilitate co-existence (Hemson, 2003; Dickman, 2008).

1.5.4 Local Environmental Conditions

The abundance of natural prey influences conflict (McNutt & Boggs, 1996; Treves *et al.,* 2002; Patterson *et al.,* 2004), with areas where prey populations have been significantly reduced often experiencing elevated conflict levels (Thirgood *et al.,* 2000; Patterson *et al.,* 2004). Seasonal climatic variations also affect the likelihood of conflict occurring (Hazzah, 2006) and in semi arid systems, wild carnivores are more likely to attack domestic animals in the dry season than in the wet (Butler, 2000; Van Bommel *et al.,* 2007).

1.5.5 Levels of Loss

Depredation levels are a key driver of conflict, with real or perceived losses motivating retaliation from communities (Mishra, 1997; Frank, 1998; Marker, 2002; Patterson *et al*., 2004). On Namibian farmlands, a program to improve livestock management was correlated with a drop in livestock losses and cheetah removals (Marker *et al.,* 2003a), demonstrating a link between stock loss and conflict. However, in Brazil, ranchers' attitudes to jaguars showed little variation with levels of stock loss (Zimmerman *et al.,* 2005) indicating that there is not a simple relationship between stock loss and conflict.

As well as depredation, attacks on humans generate extreme hostility and fear towards the conflict species and considerable retaliation (Thirgood *et al.,* 2005).

1.5.6 Local response to conflict

Many countries have policies and programs to support people to deal with carnivore conflict. These include sanctioning the killing of 'problem animals' (Nowell & Jackson, 1996), providing a state run wildlife conflict unit (Hemson, 2003) and financial compensation programs (Nyhus *et al.,* 2005; Lamarque *et al.,* 2008). State run wildlife conflict units are developed to provide a rapid response to conflict incidents and manage conflict levels through directly deterring carnivores, reducing livestock losses by promoting effective husbandry techniques and administering compensation payments (Hemson, 2003).

Compensation aims to better balance the costs and benefits of living with large carnivores (Naughton-Treves *et al.,* 2003) and is designed to increase the tolerance levels among the affected communities and reduce retaliatory killings (Muruthi, 2005; Nyhus *et al.,* 2005). However, compensation can have a negative impact on perceptions if inefficiently run (Bulte & Rondeau, 2005), and compensation schemes can be difficult to manage, requiring reliable and mobile personnel to verify damages over huge geographical areas (Lamarque *et al.*, 2008). In cases where communities are not satisfied with national governmental responses, intense hostility can develop.

Local people may react to conflict species extremely negatively if there is resentment with conservation laws, and feelings that governments do not recognize their cultures, values or resources (Treves *et al*., 2006).

Clearly, the issue of conflict resolution is key to carnivore conservation success, in order to reduce the damaging effects conflict can have on carnivore populations and community perceptions.

This is a particular challenge in African savannah ecosystems, which combine substantial carnivore diversity and threats of habitat and species loss, alongside the development needs of expanding human populations (Homewood & Brockington, 1999). Increasing population pressure prompts rural people to cultivate more marginal lands and overstock rangelands (Muir, 2010), resulting in human resource needs coming into conflict with the habitat requirements of wildlife (Kreuter & Workman, 1997). This particular study will investigate this situation in Botswana, a country which is widely considered to be an important reservoir for African biodiversity (White, 1993; Boggs, 2000).

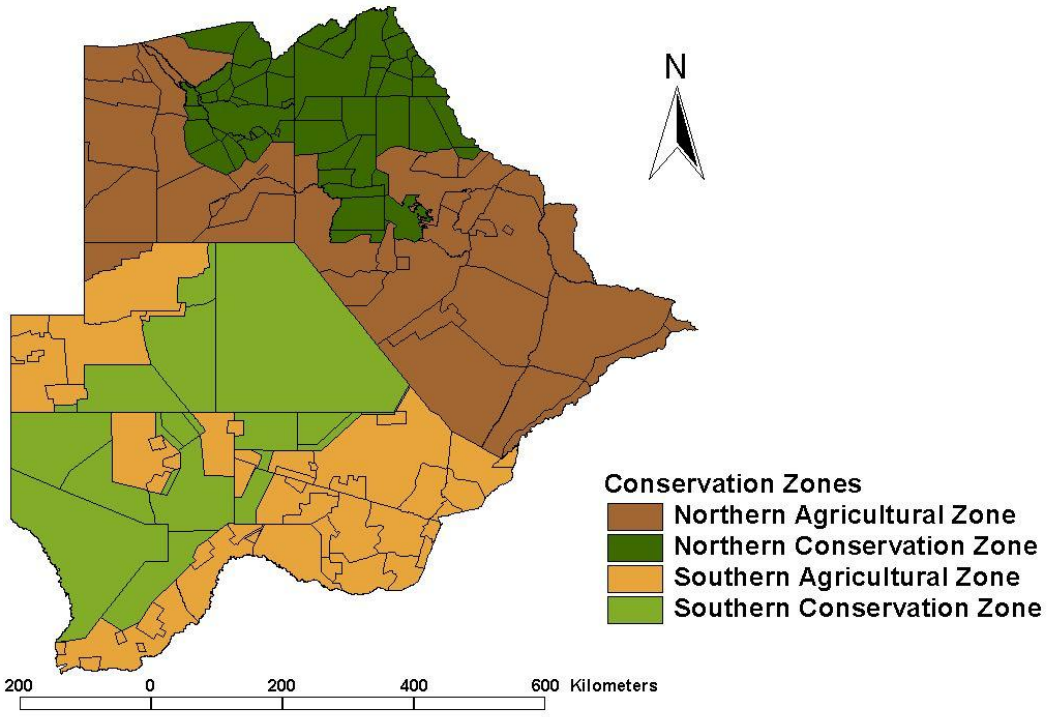
1.6 Botswana – Conservation Haven for Africa's Carnivores?

Botswana holds key populations of threatened large African carnivores (Winterbach, 2001). The country has one of the largest African cheetah populations with approximately 1768 (±803) individuals (Winterbach, 2001), representing approximately 12% of the world's population (Marker, 1998). Cheetahs remain widespread throughout Botswana and the country is situated in the centre of the current cheetah range in Southern Africa (IUCN, 2007). The highest densities are found in the Kalahari ecosystem and in areas were lions are not present in high numbers (Table 1.1).

African wild dogs are now one of the world's most endangered carnivores, numbering fewer than 5000 individuals, with only six populations thought to hold over 100 animals (Woodroffe, 2002; Maddox, 2003). Botswana has the largest population of African wild dogs in Africa today, with approximately 1658 individuals concentrated in the Northern part of the country but widespread through the Kalahari region at low densities (Table 1.1).

Lions have suffered a substantial population decline and range contraction over recent decades, and have disappeared from much of their historic range (Bauer & Kari, 2001). Botswana holds key populations of lions with approximately 2918 (±563) individuals,

although predominantly limited to conservation zones (Table 1.1). Botswana's large carnivore population estimates are primarily based on opportunistic observation, ground count surveys and indices of abundance derived from various observational techniques (Winterbach, 2001; Kabaija, 2005). These estimates are based on management zones. Ecologically, Botswana is divided into the Northern and Southern regions (Crowe, 1995). These regions are further subdivided based on land use. In the Conservation zones the primary land use is wildlife and in the Agricultural zones the primary land use is a combination of pastoral, arable, farms, residential and ranches (Figure 1.1).



F*igure. 1.1.* *Conservation zones and existing management units (Winterbach, 2001).*

Table 1.1. *Estimated population sizes for the large mammalian carnivores in different regions of Botswana (Winterbach, 2001). The zones are shown in Figure 1.1.*

Zone	**Area (km^2)**	**Population Estimate**					
		Cheetahs	Wild dogs	Lions	Leopard	Brown Hyena	Spotted Hyena
Northern Conservation Zone	81561	290	866	1918	1998	220	1920
Southern Conservation Zone	164694	618	621	990	1955	2265	601
Northern Agricultural Zone	204383	368	102	10	840	74	154
Southern Agricultural Zone	138743	493	69	0	823	76	156
Total		**1768**	**1658**	**2918**	**5617**	**2636**	**2831**
Estimated Population Range		965-2571	unknown	2355-3481	4404-6830	1990-3282	2056-3603

Botswana's protected area network is extensive with 18% of the country's land area designated as Game Reserves and National Parks that are reserved for the conservation of biodiversity. In addition, a further 21% of the country's land area is designated as Wildlife Management Areas (WMA's), which are primarily for the purpose of wildlife conservation. The WMA's act as buffer zones and migratory corridors to support the natural ecological functions of Game Reserves and National Parks. In total, 39% of Botswana's total land area is reserved for ensuring the sustainability of the country's wildlife resources (Kabaija, 2005). However, as discussed earlier protected areas are rarely large enough to support adequate populations of large carnivores without experiencing significant edge effects (Loveridge *et al.,* 2001; Woodroffe, 2005) and this is certainly the case in Botswana (Verlinden *et al*., 1998). Species such as cheetahs and wild dogs require huge areas, (cheetah 700–2000km^2 (Houser *et al*., 2009a) ; wild dog 450-650 km^2 per pack in southern Africa (IUCN, 2007; Woodroffe & Ginsberg, 1998)), for their populations to be maintained and require land use planning on a large scale, including conservation management outside of protected areas (IUCN, 2007).

However, throughout the country all large carnivore species are sources of increasing conflict with livestock owning people (Gadimang, 2005; DWNP, 2007). Increasing human population size coupled with the expansion of human settlements and livestock farming activities, especially into the WMA's, are leading to this increase (Winterbach, 2001). Occasionally carnivores will prey upon livestock opportunistically and this leads to widespread removal (Hemson, 2003). This ongoing conflict is now raising concerns that the country's large carnivore species are in decline (Winterbach, 2001). Botswana may appear to have significant wilderness areas with limited human impact on the environment. However, habitats are under threat and the main impact on the land and wildlife is grazing by livestock under free-ranging conditions, leading to overgrazing, water utilization and increasing human wildlife conflicts (Herremans, 2000).

1.7 A Historical Perspective to Human Wildlife Conflict in Botswana

1.7.1 Changing Land Use and Range Degradation

Livestock have a strong cultural and economic value to most rural citizens of Botswana (Twyman, 2001) and are widespread throughout the country. Small-scale farming is the primary economic activity for the majority of rural communities (Gibson *et al*., 2003, Stringer & Reed, 2007). With a national livestock herd of over 3 million in 2001, livestock outnumbered people, with two tropical livestock units for every person in the country (CSO, 2001).

Since the 1970's, cattle farmers in Botswana have benefited economically under the European Union Beef Protocol Agreement, which paid above world prices for Botswana's beef. Along with the development of deep borehole drilling technology and good rainfall years in the 1970s, this provided a strong incentive for the expansion of permanent livestock keeping into Kalahari pastures and a move from low density usage by hunter-gatherer populations to borehole-centred livestock keeping (Perkins, 1996; Boggs, 2000). More recently, there has been a reversal of this trend, with migrations away from cattleposts to villages and from villages to larger urban centres, in search of employment (Wilson, 2002). Despite this, the human impact on the landscape increases (Verlinden *et al.,* 1998). In response to concerns of overgrazing and degradation resulting from the communal land system (Abel *et al.,* 1989, Makepe, 2006), the 1975 Tribal Grazing Land Policy (TGLP) promoted the expansion of commercial cattle ranches (BGG, 1975). Later, the 1991 National Policy on Agricultural Development (NPAD) reinforced TGLP and called for increased use of fencing in the communal areas (Thomas & Sporton, 2002; Adams *et al*., 2003). Hunter-gatherers and other non-cattle owners found their lands reclassified under the TGLP, for use as cattle ranches (Figure 1.2). There is no history of private rangeland ownership among Kalahari pastoralists and the carrying capacity concept on which ranch sizes were based is inapplicable under such variable rainfall (Perkins, 1996; Motlopi, 2006). Consequently, both communal rangelands and private ranches have continued to be overstocked and over grazed and although the changes were introduced to prevent

further habitat degradation this has not been the outcome (White, 1998a; Cullis & Watson, 2005). In addition, these changes resulted in the replacement of large herds of wild ungulates over large areas of the Kalahari with livestock (Cooke, 1985; Perkins 1996; Adams *et al*., 2001).

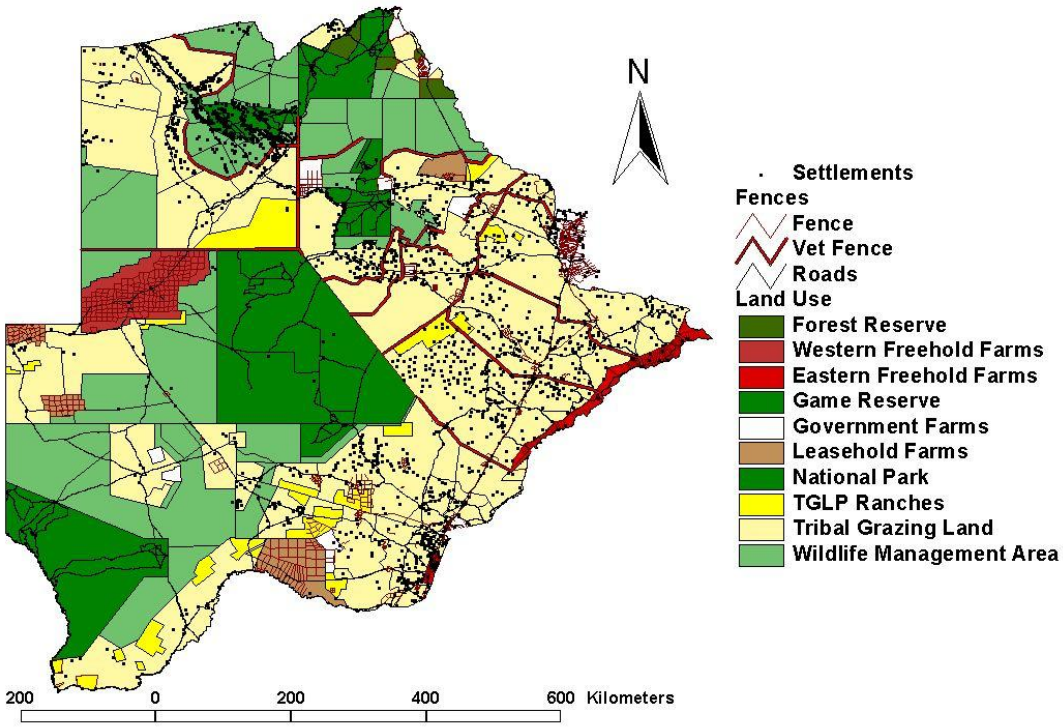


Figure 1.2. *Land use, farms, fences, roads and settlements in Botswana (Klein 2007).*

The change in land use in the Kalahari has resulted in considerable landscape changes. Studies on grazing in the Kalahari show that as more boreholes are established more bush encroached zones appear, this is an increase in woody plants at the expense of grasses, characterised by dense thickets of aggressive acacia species and severely restricts grazing areas (Perkins et al., 2002). In 1936, rangelands used for grazing occupied about 20% of Botswana's land area and by 1986 this had increased to 45% (Arntzen, 1998). The expansion of farming into the Kalahari, with considerable areas of new land being used for grazing, has continued for many decades and has resulted in a significant increase in the national cattle herd, from 1.2 million in 1934 to about 3 million in 1998 (White, 1998a). The maximum sustainable herd is about 3.3 million cattle (White, 1998a). High rates of

stocking eventually result in widespread thornbush encroachment (Verlinden, 1997), sometimes generating woodland in as little as two decades. In view of the current livestock distribution and densities, thornbush encroachment probably affects most of the unprotected land in Botswana (Bonica, 1992).

The thornbush encroachment decreases the overall productivity of the land (Perkins & Thomas, 1993; Reed & Dougill, 2002) and this will affect populations of large mammalian herbivores and this in turn will threaten carnivore populations (Arntzen, 2002). There is also a cascade effect on the productivity of livestock operations, as the declining quality of grazing affects fertility and increases the threat of losses during drought (Perkins, 1996; Arntzen, 1995). As less natural prey becomes available, livestock encounter rates with carnivores are likely to increase. As livestock farming becomes more challenging, attitudes towards carnivores and carnivore-human conflict are likely to worsen.

1.7.2 Declining Wildlife Populations

Before the land use changes of the 1970's, Botswana had one of the largest surviving reservoirs of African plains game left on the continent (White, 1993). It is now generally accepted that there have been drastic reductions in the wildlife population (Table 1.2, Figure 1.3) over the last 40 years (Thouless, 1997; Boggs, 2000).

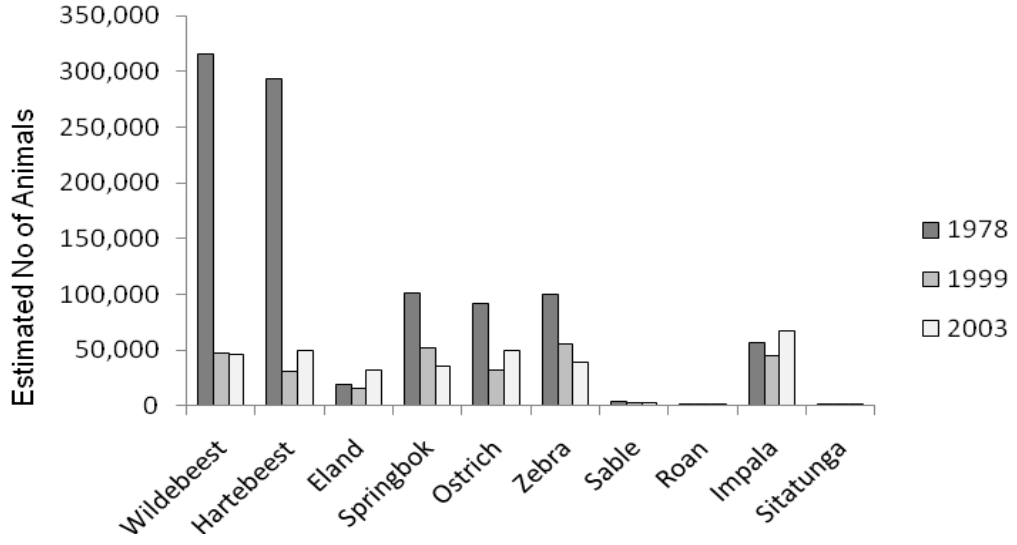


Figure 1.3. *Changing population sizes for certain large mammalian species in Botswana (Perkins, 1996; DWNP, 2003; Kabaija, 2005).*

Table 1.2. *Changing population sizes for certain large mammalian species in Botswana (Perkins, 1996; DWNP, 2003; Kabaija, 2005).*

Species	1978	1999	2003
Wildebeest	315,058	46,741	45,858
Hartebeest	293,462	31,114	49,978
Eland	18,832	15,163	31,598
Springbok	101,408	51,792	35,811
Ostrich	92,286	32,499	49,406
Zebra	100,295	55,406	39,308
Sable	3,636	2,052	2,877
Roan	1,228	884	188
Impala	56,773	45,183	67,040
Sitatunga	1,541	1,234	167

Although populations of some species are recovering, the reduction in wildlife since the 1970's has been catastrophic (Perkins & Ringrose, 1996; Thouless, 1997; Campbell, 2005; Mbaiwa & Mbaiwa, 2006). The decline has been attributed to several reasons, including loss of habitat to growing human and livestock populations (Gibson *et al.,* 2003); installation of veterinary cordon fences to prevent transmission of disease between wildlife and cattle (Wilson, 2002; McGahey, 2011) and between regions; drought; poaching and over hunting (Kabaija, 2005). Competition for grazing and water between wildlife and livestock is also a factor, with studies showing inverse relationships between cattle and wildlife numbers, suggesting that wildlife disappears from areas encroached upon by livestock (Perkins & Ringrose*,* 1996; Arntzen & Fidzani, 1998). As a result of these factors, wildlife is increasingly restricted to protected areas, which are insufficient in size and wealth of resources to support the current numbers of wildlife without seasonal movement (Verlinden, 1997). In addition, due to high carnivore populations in National Parks, changes in prey abundance in unprotected areas and introduction of artificial water points throughout the Kalahari, wildlife movements have significantly altered (Darkoh & Mbaiwa, 2005). The high stocking rates and water points have made farmlands in Botswana potential sinks for carnivore populations nationwide, particularly cheetah (Verlinden *et al.,* 1998).

Despite the low human population and the high percentage (39%) of land devoted to conservation and wildlife utilization, the conservation status of most mammals continues to deteriorate (Boggs, 2000; Campbell, 2005). In this environment of decreasing wild prey populations, increasing livestock herds and human movements into wilderness areas, there has been a gradual increase in human-wildlife conflict throughout Botswana and this is likely to continue to increase with the current land use systems (Jones, 1999; Nijhawan, 2008).

1.8 Current Livestock Production Practices in Botswana

Small scale subsistence livestock farming is the prevalent form of agriculture in Botswana and the principle economic activity for the majority of rural communities (Twyman, 2001). Nationally, the central statistics office identified 742 commercial fenced ranch operations and 120,583 traditional cattle posts in 2004 with 2.15 million cattle, 1.55 million goats and 0.24 million sheep (CS0, 2006).

Commercial cattle operations are generally ranches of 6000ha in size which are bought as freehold land or leased from the government. Large numbers of cattle are often kept in such areas with no close monitoring of carrying capacity and range conditions (Thomas *&* Shaw, 1991; Thomas *et al.,* 2000). Most ranchers employ an open range method where cattle are left out in the veld (open grazing areas) to graze for long periods of time without checks. This lack of management makes livestock more susceptible to predation. A growing challenge is the number of absentee farmers (White, 1993; Motlopi, 2006). As cattle are an important cultural symbol it is a common goal to have a herd for the family, even if the family is now based in a town or city. As a result, many people have a ranch or cattlepost that is only visited occasionally and does not receive the necessary focused management. Motlopi's study on Central district ranches in 2006 showed that only 36% of ranchers were resident at the ranch, while 64% stayed 20-340km away. These ranchers engaged farm workers to ensure livestock was watered and cared for. No activities such as rotational grazing or controlled breeding were done (Motlopi, 2006).

Cattle posts are typically 2-10 huts and associated kraals (livestock pens), with access to a well or borehole (Perkins, 1996; Twyman, 2001). Cattle post dwellers are either owner herders or herders employed at often sub-minimum wages by absentee owners (Hemson, 2003). The traditional practices of livestock management are falling into disuse (Tjibae, 2001). Very few people carry out effective herding practices and farm workers have little incentives to perform optimally. This reduction in herding practices has been further exacerbated by the introduction of compensation which reimburses farmers for losses due to predation even in cases which could have been avoided by better management (Gadimang, 2005). This has reduced the feeling of personal responsibility that communities feel towards conflict.

1.9 Current Human Wildlife Conflict in Botswana

National human wildlife conflict levels have been monitored by The Department of Wildlife and National Parks (DWNP) since 1998. All districts in Botswana experience conflict. It is most pronounced in areas surrounding protected areas and in expanding farming areas (Klein, 2008). The most common conflict species include carnivores such as lions, leopards, wild dogs, hyenas, cheetahs, caracals (*Caracal caracal*) and jackals (*Canis mesomelas*), which are associated with livestock conflict (Figure 1.4). Elephants are a large problem in Northern Botswana where they threaten agricultural initiatives, subsistence farming and human life. Other conflict species are associated with raiding crops and include kudu (*Tragelaphus strepsiceros*), baboon, porcupine (*Hystrix africaeaustralis*), or threatening human life including species such as hippo (*Hippopotamus amphibius*), buffalo (*Syncerus caffer*), and crocodile (*Crocodylus niloticus*) (DWNP, 2007). However, the large carnivores occupy the top of the list for most problematic conflict species (Figure 1.4).

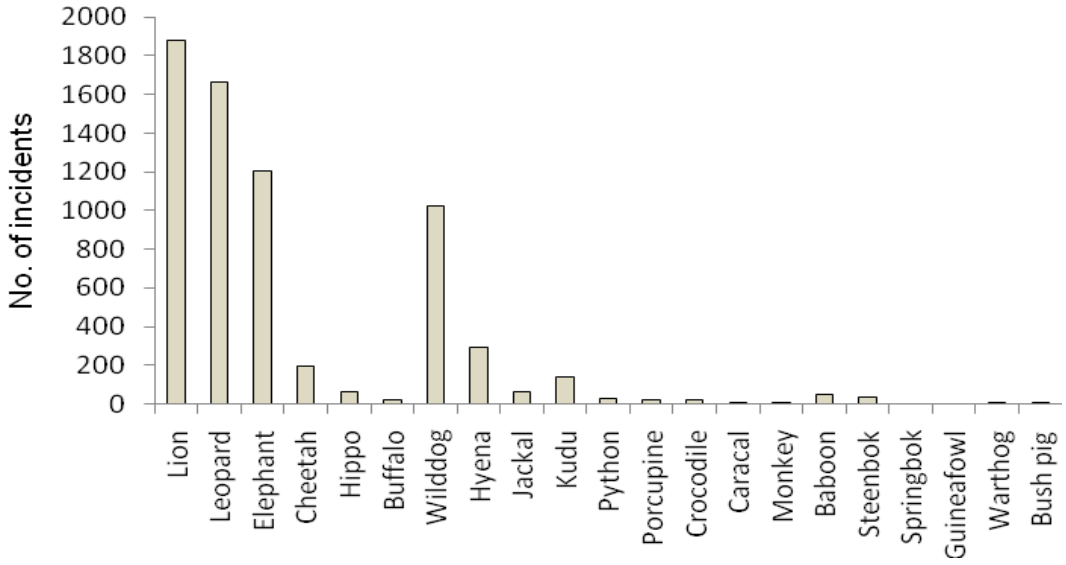


Figure 1.4. *Compiled PAC reports for Botswana 2005. Showing highest conflict species nationally* (DWNP, 2006).

1.10 Carnivores and Conflict in the Kalahari region

The Kalahari region of Botswana has been internationally recognised as an area of significant conservation importance (WKCC, 2007). Its maintenance is required to conserve semi-arid savannas ecosystems and key populations of migratory herbivores, as well as threatened carnivore species for the nation as a whole (Klein, 2007; WKCC, 2007). Estimates provided in the Botswana Carnivore Management Strategy indicate that high numbers of lions, leopards, cheetahs, and wild dogs are supported by the Kalahari region (Table 1.3). These are a valuable resource for ecotourism and sustainable utilisation. However, these species are also among the highest conflict species and for this area to maintain carnivore populations it is essential that conflict is reduced. Currently, the majority of human wildlife conflict in the Kalahari region occurs with carnivores and results from depredation of livestock (Herremans, 2006; DWNP, 2007).

The region is semi arid savannah and not ideal for long term livestock operations (WKCC, 2007). There is no surface water for much of the year, low grazing productivity and a scarcity of underground water with often high salinity levels (WKCC, 2007). Overstocking and lack of livestock management have resulted in overgrazing and bush encroachment in

many areas, decreasing the overall productivity of the habitat (Perkins, 1996). Issues such as range degradation, declining prey populations, competition for grazing and water and the erection of ranch and veterinary fencing affect the integrity of the ecosystem health as well as exacerbating human carnivore conflict (Arntzen, 1995; Arntzen, 1998; Reed, 2007). Furthermore, illegal trade in live cheetahs and lions has been increasing in the region, to supply the South African canned hunting trade and the global wild animal trade (pers comm. Ann Marie Houser, CCB; Deon Cilliers, NCMP, South Africa).

Table 1.3. *Estimates of large carnivore numbers for WMA's, farming areas and reserves in the Kalahari region of Botswana (Winterbach, 2001). CKGR–Central Kalahari Game reserve. KTP–Kgalagadi Transfrontier Park. WMA's–Wildlife Management Areas.*

Management Unit	Lions	Leopards	Cheetahs	Wild Dogs
Ghanzi Farms	0	363-573	57-214	19
CKGR	166-458	1063-1643	84-141	422
Kgalagadi WMA's	200-250	350-552	191-412	147
Kgalagadi Agricultural 1	0	202-319	128-476	43
Kgalagadi Agricultural 2	0	74-117	23-87	8
KTP	428-478	151	204	52
Total in Kalahari region	**794-1186**	**2203-3355**	**687-1534**	**691**

For conservation to succeed in the Kalahari region there needs to be a significant reduction in human wildlife conflict (WKCC, 2007). Even if the benefits of natural resource utilization may be directed to communities through various community based natural resource management programs, wildlife threats to human life and property weaken these benefits and intensify negative attitudes towards the wildlife resource (Boggs, 2000).

As well as being essential for ecosystem function, large carnivores play an important role in Botswana's development. Species such as lion, leopard and cheetah are essential to the photographic safari industry in Botswana. It is estimated that wildlife tourism in Botswana contributes close to 18% to the national Gross Domestic Product (Winterbach, 2001). In addition to revenue generated by photographic tourism, Botswana has a thriving safari hunting industry. Large carnivores are key species to this industry, and also a major

contributor to the economic viability of several community based wildlife management areas in Botswana (Kabaija, 2005). Understanding their importance, Botswana has shown much interest in conserving its large carnivore species and has developed a range of solution to mitigate human-carnivore conflict.

1.11 Botswana's Solutions to Human Carnivore Conflict

1.11.1 State Run Initiatives

1.11.1.1 Problem Animal Control

Reducing levels of human-wildlife conflict is the responsibility of the DWNP Problem Animal Control (PAC) officers (Tjibae, 2001; Selebatso *et al*., 2008). After an initial complaint, PAC officers advise the complainants of methods that can reduce the problem. Livestock owners are advised to herd stock during the day and kraal animals at night. PAC officers also address communities through traditional council (kgotla) meetings (Gadimang, 2005). The second stage in PAC is non-lethal control. If initial methods have not been successful, PAC teams may chase the problem animal, shoot over the animal's head and use non lethal explosives to move the animal away, normally towards a protected area. Translocations may also occur if a carnivore returns, which must be done in the presence of a licensed veterinarian (Hemson, 2003). Occasionally, with persistent problem animals or when there is threat to human life, lethal control may be considered (Sechele & Nzehengwa, 2002). There is no clear evidence that these methods are effective in decreasing conflict, although it is the hope that these measures will reduce the number of wild animals killed by farmers (Selebatso, 2006). However, there are concerns that the DWNP does not have the capacity to provide the necessary response in view of the increasing conflict and large areas with dispersed communities to be covered.

1.11.1.2 Compensation

The DWNP is responsible for the state funded compensation scheme for livestock depredation or crop destruction by wild animals (DWNP, 1998). A claim must be filed at the DWNP, and then validated by investigating the evidence and ensuring that the

damage was caused by one of the compensated species. In practice, it is very difficult to verify all claims (Hemson, 2003) and communities are not satisfied with the current compensation system (Sechele & Nzehengwa, 2002; Gussett *et al.,* 2009). It is felt that the reimbursements are insufficient and untimely (Tjibae, 2001), with only partial compensation paid to reduce the financial cost of property loss and damage. Sometimes the DWNP officers have logistical difficulties such as lack of transportation which makes travelling to the report site challenging. This can cause friction with local farmers (Selebatso, 2006). The DWNP is currently reviewing the compensation policy and although it is generally accepted that the current policy is not ideal and does not encourage good management (Gussett *et al.,* 2009), there is strong political will to keep current government run compensation in place (Tjibae, 2001; Gadimang, 2005).

1.11.2 Community Initiatives

1.11.2.1 Range and Livestock Management

Various methods are employed by the farming community in attempts to reduce livestock loss. Within Botswana these can be divided into methods aimed at keeping problem animals separated from property and those that reduce the numbers of problem animals in the area (Hemson, 2003). Methods to deter carnivores include kraals at the cattlepost for enclosing livestock, particularly at night. Kraal structures are variable including acacia thorn bush walls, gum poles and wire or wooden stockades depending upon the local availability of materials. People may also employ herders or guard dogs to alert them to a carnivores presence, may use maternity kraals and calving seasons, or may attempt to deter carnivores with fires close to kraals, torches, pots and pans or firearms (Tjibae 2001; Gadimang 2006). Traditional healers are also believed to deter carnivores and will be paid to set up an invisible 'spiritual' barrier around the homestead (KCS, 2002). However, an increasingly common method to minimise conflict is by reducing carnivore numbers through lethal control (Hemson, 2009). This can be done legally if it can be shown to be necessary in the defence of human life or property (BGG, 1992). Various methods are employed including trapping and shooting. Although it is not legal, people also use

hunting dogs, poison and snares to remove carnivores from their land (Klein, 2007). Mortality from retaliatory killing due to livestock conflict is a serious concern (Winterbach, 2001). Certain species have protected species status, i.e. cheetahs, wild dogs, brown hyenas are protected predator species that may be hunted or captured only under the Director's permit. Leopards and lions are partially protected species that may be hunted or captured under a licence or permit (Wildlife Conservation and National Parks Act (Act No. 28 of 1992)). However, this does not afford much protection as any species may be lethally removed if it is considered to be threatening human life or property (BGG, 1992). From compiled carnivore mortality reports available from 1997-2003 (Figure 1.5), the highest mortality due to PAC efforts was incurred by lions (37.1% of reports), then leopards (34.7%) and cheetah (11.0%). The only other species with similar levels of removal was the elephant (11.2%). Wild dogs followed with 2.9%. This situation is not ideal and in 2001 a moratorium was placed on the killing of lions and cheetahs for any reason (BGG, 2001), resulting in a reduction of reported mortality for the 2 species, compared to previous years. However, concerns are raised that such policies cause communities to become resentful of carnivores and the DWNP and retaliatory killings are then done by the communities themselves and not reported (Hemson, 2003; Selebatso, 2008).

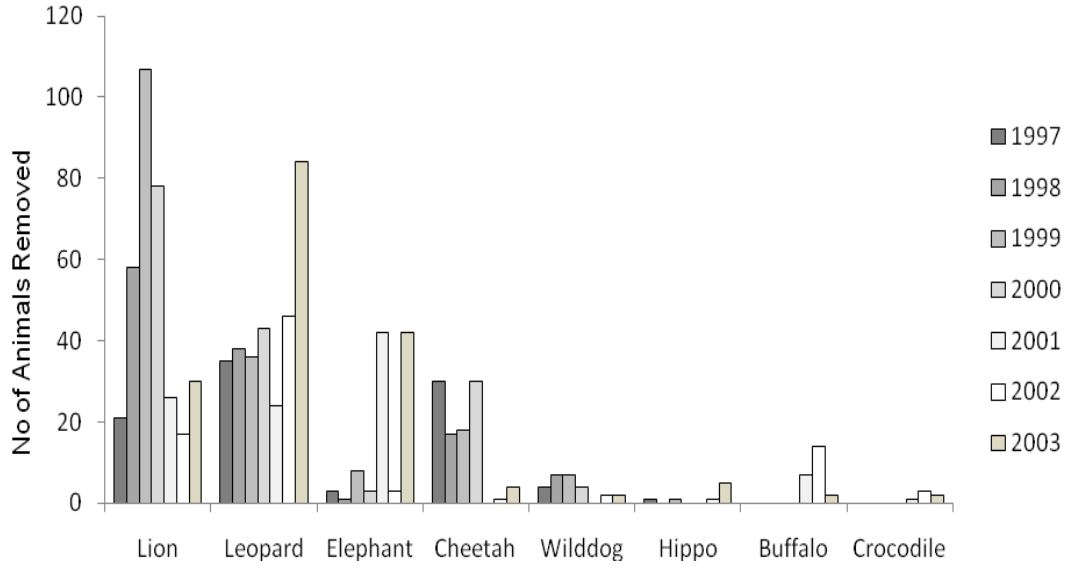


Figure 1.5. *Number of conflict species removed by the DWNP PAC unit from 1997-2003 (Kabaija, 2005).*

1.11.2.2 Community Based Natural Resource Management

Botswana has also initiated a community based natural resources management (CBNRM) program to enable communities to utilise their natural resources through community trusts (Twyman, 2000; Arntzen & Chigodora, 2002; Rozemeijer, 2003) with the view that communities involvement in the management of natural resources and their ability to derive economic rewards will foster greater tolerance towards conflict species.

1.12 Aims and Objectives of Study

It is essential to better understand the factors affecting conflict in order to identify the most appropriate mitigation methods. Such studies are a global priority for carnivore conservation (Dickman, 2005). This study aims to assess current levels of large carnivore conflict in the livestock farming communities of the Kalahari region of Botswana, an area with some of the highest incidence of carnivore-livestock conflict in the country, (DWNP, 2007).

This study will assess current levels of carnivore conflict; effectiveness of farm management and perceptions of local communities towards carnivore species. It aims to increase the understanding of human-carnivore conflict in these areas and how this varies with socio-economic factors such as age, gender, income levels; management factors such as farm type, water availability, livestock numbers and farm management practices; environmental factors such as location, wildlife abundance and vegetation; along with rural community perceptions.

1.12.1 Key Questions

- What is the relationship between socio-economic variables such as gender, age, family number, education level, income and conflict levels experienced, use of effective management practices and tolerance towards carnivore species?

- What is the relationship between land management variables such as farm type, human presence, water availability, livestock stocking numbers and conflict levels,

management practices utilised, tolerance towards conflict species and carnivore presence?

- What are the current livestock management techniques utilized and how do they affect the frequency of livestock predation and levels of conflict?

- What is the intensity of carnivore conflict occurring on farmlands over the last year? What are the perceived levels of loss, what other factors cause livestock loss, what is the economic impact of predation to the farmer?

- What are the attitudes of rural communities towards living with carnivores? Do they see a potential value in carnivores? Do they have a sense of responsibility for the conflict?

- What is the presence and abundance of wildlife on Kalahari farmlands and how does this affect levels of conflict?

- How do spatial variables such as location, land use, habitat type and human population density affect carnivore presence, conflict levels, management practices and tolerance?

It is felt this study will have timely and significant conservation implications. A clearer understanding of the level of conflict occurring on farmlands is required, in order to adapt current policies to better meet the needs of rural communities and conservation of carnivores in the Kalahari region.

Chapter 2

2. Study Area

2.1 Botswana

2.1.1 Physical Characteristics

Botswana is an arid to semi-arid landlocked country bordered by Namibia, South Africa, Zimbabwe and Zambia, covering 581,730km^2 (Gaobotse, 2008; Madzwamuse, 2007). The North-West of Botswana is dominated by the large inland delta and permanent wetland of the Okavango Delta, while the Central-North East consists of a large area of calcrete plains and salt pans (Figure 2.1). The East and South-East is hardveld. The remaining three quarters of the country is covered by deep Kalahari sands (Jones, 1999; Greenway, 2001; Madzwamuse, 2007). 'Kalahari' is derived from the Setswana word 'Kgalagadi', meaning 'always dry'. (WKCC, 2007).

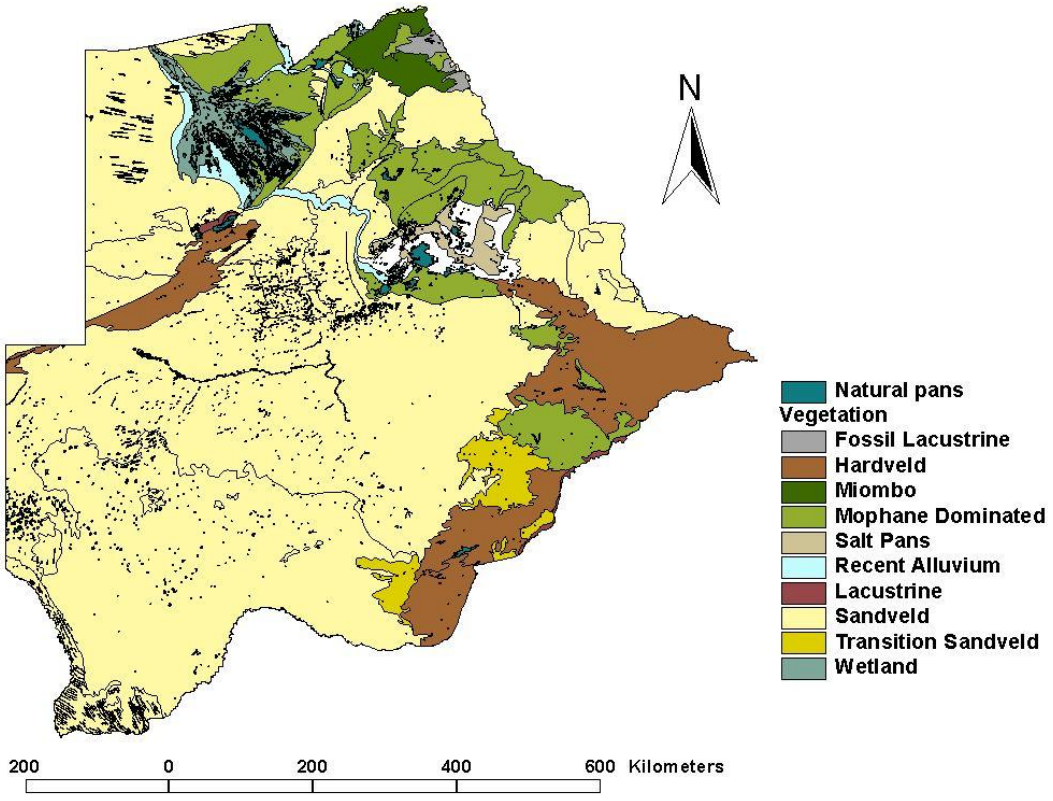


Figure 2.1. *Habitat classes throughout Botswana. (Klein, 2007, DWNP, 2003)*

2.1.2 Climate

The mean annual rainfall ranges from over 650mm in the extreme northeast to less than 250mm in the extreme southwest (Herremans, 1998; WKCC, 2007). Almost all rainfall occurs during the hot summer months, from October to April. However, rainfall is highly variable temporally and spatially and the country is subject to frequent droughts (Madzwamuze, 2007). This climatic gradient results in the requirement for seasonal movement of certain species of large ungulates in search of grazing and water, which is now hampered by fencing and human encroachment (Thouless, 1997; WKCC, 2007).

Temperatures are very high in summer and low during winter, often falling below zero°C at night. Winter days are mild. The mean monthly maximum temperatures range between 23°C to 25°C in the Northern parts of the country and 21°C to 23°C in the Southern parts (CSO, 2006). The tropical climate and high altitude, on average 950m above sea level, cause extreme temperature variations, both seasonally and daily, with record temperatures of -10°C to + 45 °C (WKCC, 2007).

2.1.3 Land Use and Tenure

The land is categorized into three main tenure systems: communal land (54.8%), freehold land (3.4%) and state land (41.8%). State land incorporates protected areas, including National Parks and Game Reserves, which occupies 18% of Botswana. An additional 21% is designated as wildlife management areas (WMA's), where it is intended that the main form of land use will be sustainable wildlife utilization (Herremans, 1998; Hemson, 2003; Gaobotse, 2008) (Figure 1.2).

2.1.4 Human population distribution and growth

The human population of Botswana is estimated at 1,773,240 and is growing at ca. 2.3% per year (CSO, 2006). More than 80% of the population is concentrated in the east (Figure 2.2) on more fertile soils in the hardveld. The majority (60%) live in urban areas, while the rural population is 40% (CSO, 2006). The average population density is low (three

inhabitants per km^2) suggesting there is potential for larger species of wildlife to coexist with people in the rural areas, particularly in the West (Newmark *et al.,* 1994).

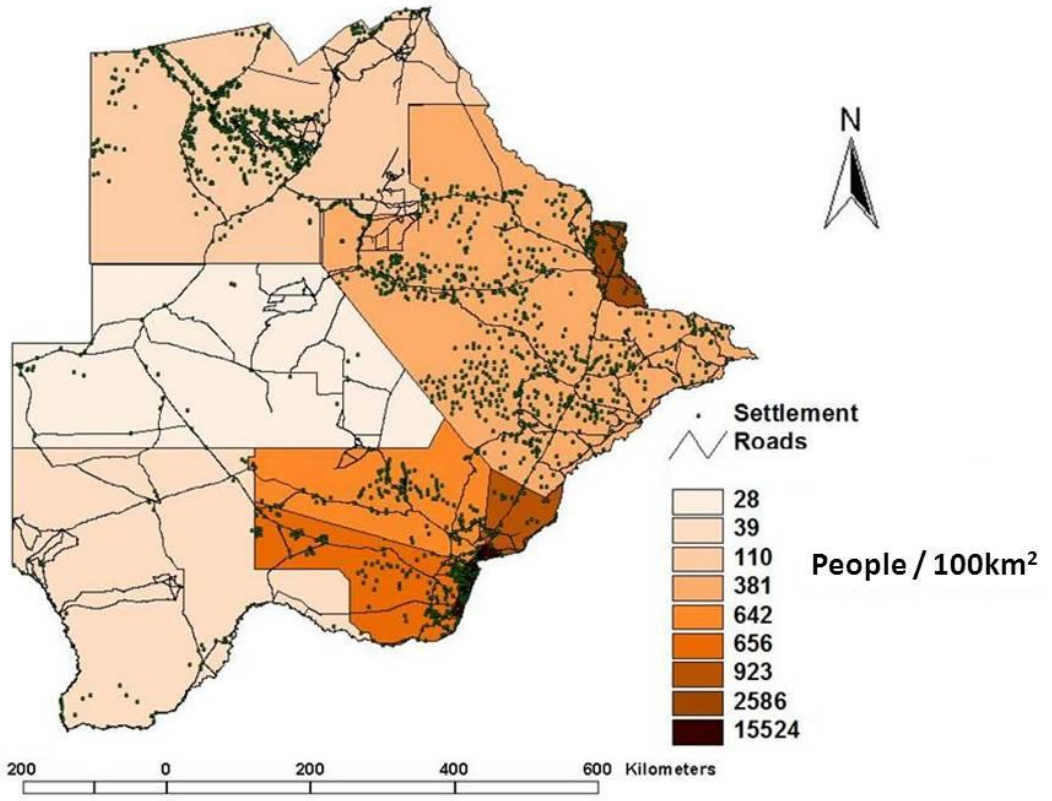


Figure 2.2. *Human population density by district showing settlement distribution and roads. (Klein, 2007).*

2.2 The Kalahari region

The Kalahari sandveld covers the Western, Central and Southern areas of the country (Figure 2.1). It is a vast (approximately 436,300km^2) semi-arid region of low relief, consisting mainly of infertile red arenosols overlying discontinuous calcrete layers (Thomas, 2002). The calcrete is exposed within pans and dry riverbeds and these areas have a vegetation of better nutritional quality and contain water seasonally. However, no permanent water exists within the region (Verlinden *et al*., 1998). It ranges from semi-desert savannah (*Acacia melifera, Acacia luederitzii*, *Boscia albitrunca*) bushveld

(*Terminalia sericea, Acacia erioloba, Lonchocarpus nelsiia)* and woodland (*Acacia melifera, Acacia erioloba, Terminalia prunioides, Catopharactes alexandri;* DWNP, 2003).

The Kalahari region has varied land use (Figure 1.2) with a significant area comprising National Parks (Central Kalahari Game Reserve, 52,800 km^2 (12%); Kgalagadi Transfrontier Park, 28,400 km^2 (6.5%) and Wildlife Management Areas (WMA's; 94,204 km^2 (21.6%). The WMA's are areas of multiple land use acting as "buffer" areas and wildlife corridors between protected areas (Hemson, 2003). Communities within the WMA's are allowed to sustainably utilise the natural resources for income generation, and land use is encouraged to be wildlife orientated (Herremans, 1998; Twyman, 2000). However, these areas do not exclude livestock farming. The remainder of the Kalahari region is composed of freehold and leasehold fenced ranching areas and communal lands with cattleposts (Figure 1.2).

The human population varies from 6.56 people / km^2 in the East to 0.28 people / km^2 in the West. (Figure 2.2) The population is predominantly comprised of Tswana tribes, as well as a smaller population of Bakgalagadi, Baherero and San tribes (Selebatso, 2006; WKCC, 2007).

The fauna of the Kalahari consists of 101 species of mammals, 338 species of birds and a rich herpetofauna of 88 species (Mittermeier *et al.,* 2002). The region supports an array of large mammals that are not water dependent (gemsbok (*Oryx gazelle*), eland (*Taurotragus oryx*), wildebeest (*Connochaetes taurinus)*, hartebeest (*Alcelaphus buselaphus)*, springbok (*Antidorcas marsupialis*), kudu, steenbok (*Raphicerus campestris*), lion, leopard, cheetah, hyena, wild dog, caracal, jackal) and numerous savannah bird species, including ostrich (*Struthio camelus*), kori bustards (*Ardeotis kori*) and numerous raptor species (Selebatso 2006; WKCC, 2007). The wildlife populations are characterised by high mobility in search of better quality food patches and water (Thouless, 1997). The increased human pressure through fencing and increasing livestock populations has reduced the natural ranges and inhibited seasonal movements of indigenous ungulates and their access to resources (Verlinden *et al*., 1998; Mittermeier *et al*., 2002).

2.3 Study Area

The study area covered approximately 170,000 km^2 of this region and was located amongst the livestock farming communities of the Southern and Western Kalahari. The study was undertaken as part of the Community Outreach and Education program of Cheetah Conservation Botswana and covered the livestock farming regions where CCB operates. It covers a range of land uses (Table 2.1, Figure 2.3), vegetation associations (Figure 2.4) and population densities (Figure 2.5).

Table 2.1. *The land use types of the study area.*

Land use	Area km^2	Area %
Communal	69547	39
WMA	70421	40
Fenced ranch	36472	21
Total	**176440**	**100**

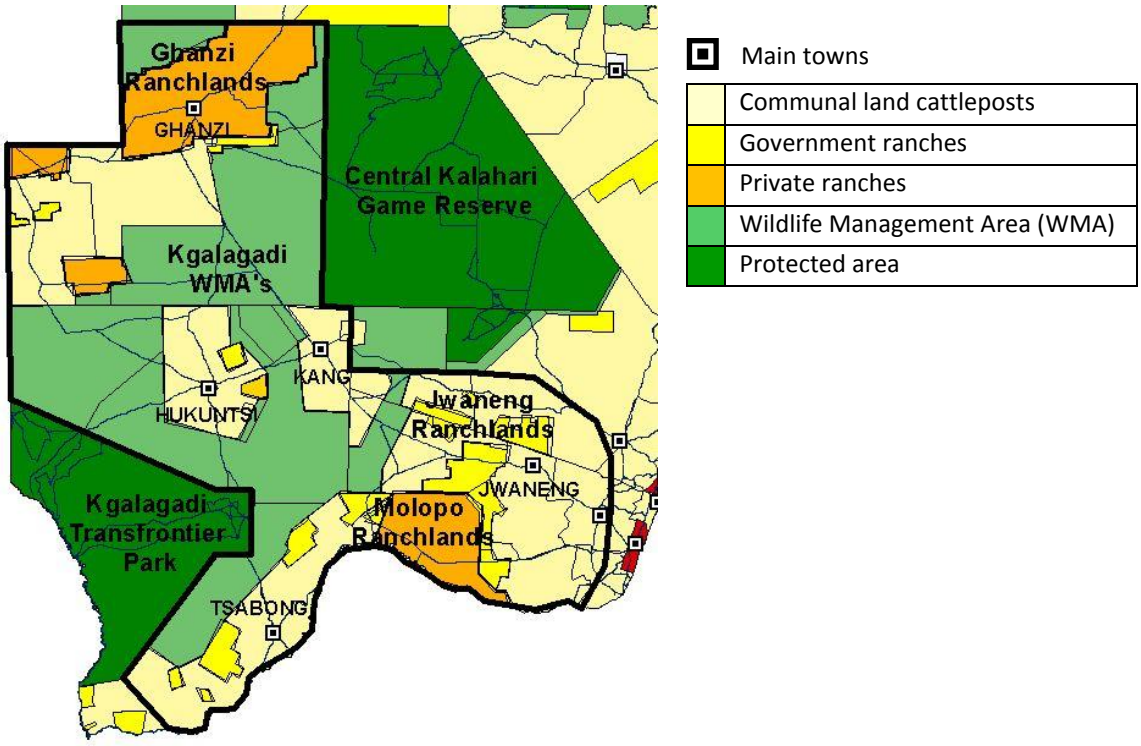
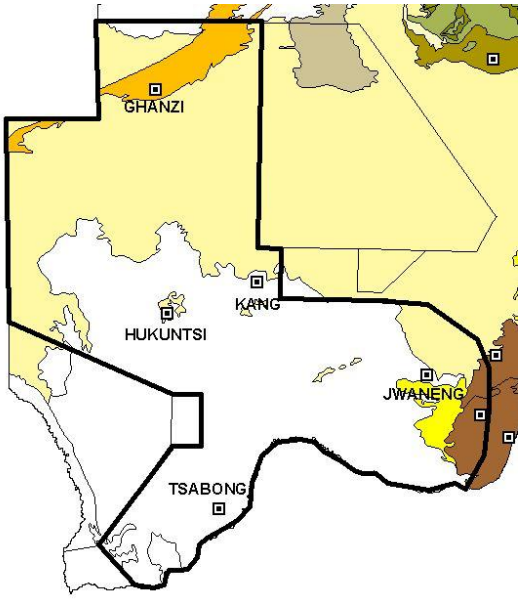


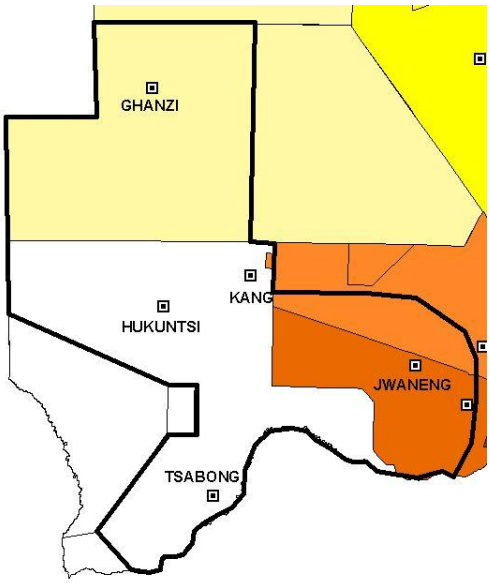
Figure 2.3. *The study area (outlined in black) and the current land use (DWNP, 2003).*



Main towns

	Sandveld - Acacia spp
	Sandveld - Terminalia spp
	Transition sandveld - Acacia/Terminalia spp
	Hardveld – Acacia spp
	Hardveld - Peltophorumafricanum spp

Figure 2.4. *The study area and vegetation associations (DWNP, 2003).*



Main towns

	0.28 people/km^2
	0.39 people/km^2
	6.42 people/km^2
	6.56 people/km^2

Figure 2.5. *The study area and population (DWNP, 2003; CSO, 2006).*

Chapter 3

3. Methods

3.1 Introduction

Farmers throughout the world act upon strong perceptions towards large carnivores. An important tool in understanding this human dimension of conservation is to use questionnaires and interviews to assess the farmers' activities, opinions and perceptions (Marker, 2003c; White, 2005).

A structured questionnaire survey approach was considered to be an effective method to collect information on the status of carnivores, their interactions with the farming community and human perceptions. The use of questionnaires in ecology is growing as they are increasingly being recognized as suitable tools for quantifying certain factors such as community perceptions, human behaviour, human impacts on wildlife and assessing human wildlife conflicts (Walpole, 2001; Maddox, 2003; Wang & Macdonald, 2006, Dickman, 2008; Whittington Jones, 2011). As well as providing an effective means of obtaining quantitative data from a large number of sites (Berry, 1999; White *et al.,* 2005), quantifying public perceptions is becoming a key component in translating ecology into management (Knight *et al.,* 2001; Hazzah, 2006).

As well as behaviours and perceptions, the status of large carnivores can be investigated, and comparison of carnivore densities from interviews and long term field studies is a valid approach to assessing large carnivore abundance (Gros, 1996; Gros, 2002). Carnivores are unique enough to ensure sightings of them are usually remembered and the long standing associations of males and family groups in some species allow the identification of specific groups (Caro, 1994).

In Africa, questionnaire surveys have been used effectively to assess human carnivore conflict and community perceptions and enable informed management decisions to be made (Marker, 2002; Maddox, 2002; Dickman, 2005; Hazzah, 2006; Selebatso, 2008; Stein

et al., 2010). For example, investigating the socio economic causes and perceptions of the Maasai towards livestock depredation by lions in Southern Kenya (Hazzah, 2006); quantifying farmers attitudes towards coexistence with cheetah in the Western Kalahari of Botswana (Selebatso, 2006); investigation of factors affecting tolerance towards large carnivores in communities surrounding Ruaha National Park, Central Tanzania (Dickman, 2008).

Local community perceptions are an essential element in developing realistic conservation solutions (Walpole, 2001; White, 2005; Van Bommel *et al.,* 2007), without such investigations and subsequent involvement of local people in conservation management, the future of large carnivores will continue to be threatened (Marker, 2002; Treves *et al.,* 2006).

3.2 Questionnaire survey process

A survey was conducted by use of a detailed structured questionnaire interview (Appendix 1) targeted at farming communities in the Kalahari region of Botswana. The area was selected due to increasing human carnivore conflict over the last 10 years with a range of carnivore species (DWNP, 2002). This provided a strong impetus to better understand the drivers of conflict in the region and also the importance of the region for conservation of Botswana's biodiversity (Selebatso, 2006; WKCC 2007; Klein 2008). 310 questionnaires were completed from Jan 2006-Dec 2008 (Figure 3.1).

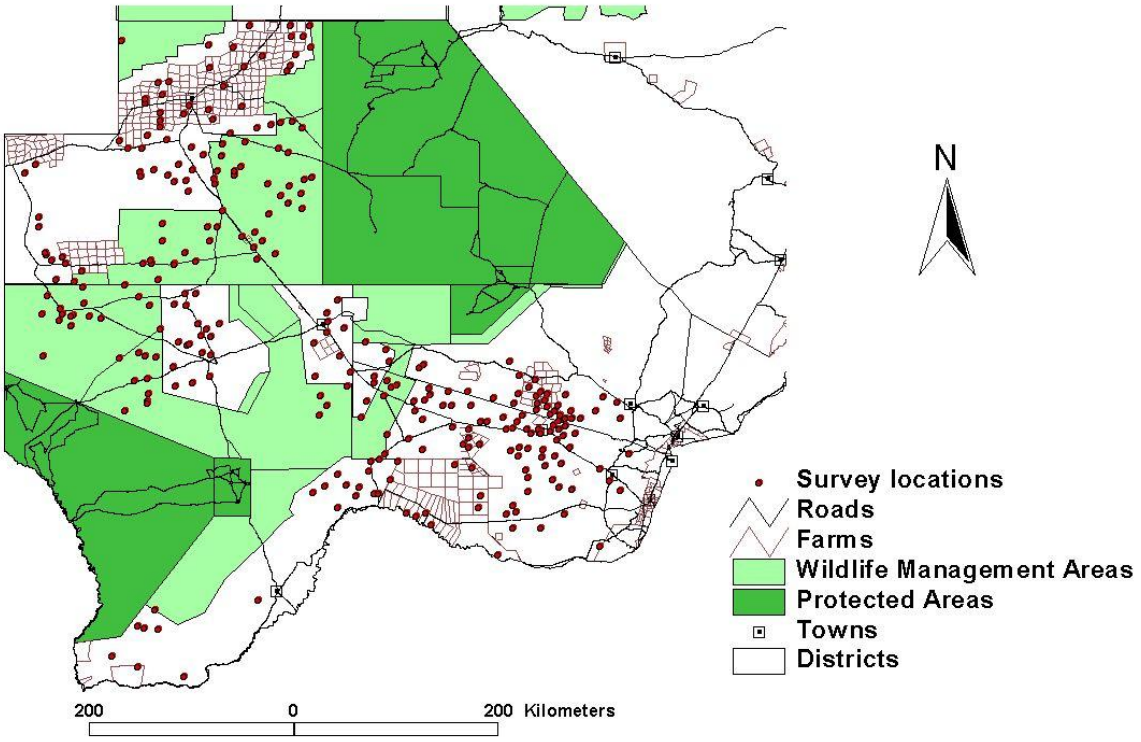


Figure 3.1. *Interview locations*

3.2.1 Questionnaire design

The questionnaire was divided into 6 sections and designed to gather information that would allow the key questions (Chapter 1) to be addressed:

1. Socio-demographic and socio-economic questions were used to determine gender, age, education level, monthly income, sources of income (Table 3.1) and the main problems experienced by the local livestock farming community.

Table 3.1. *Definitions for sources of income groups.*

Source of income	Definitions
Employment	External engagement in a salary paying occupation
Mixed	Derived from a range of sources
Own business	Income from sale of goods (i.e. food, products, crafts, liquor, not livestock, veld, game) and services
Farm products	Income from sale of livestock and by-products
Veld products	Income from sale of wild veld products and by-products
Wildlife products	Income from sale of wild game products and by-products

2. These were followed by questions concerning farm characteristics, including farm type, number of people staying on the farm, access to boreholes, distance of kraals from boreholes and livestock holdings.

3. Details of current livestock management strategies were then recorded to assess which practices were currently being utilized. Respondents were asked how their livestock are managed during the day and night and then asked to further detail their livestock management practices through a series of trichotomous (yes / no / don't know) and open ended questions.

4. This was followed by accounts of wildlife trends in the area of small and large game species, then collection of more detailed information of frequency of carnivore sightings and perceived trends over the last 10 years. The term 'predator' was utilised in the questionnaire as this is locally utilised rather than 'carnivore'. It was made clear that this referred to the following species: lion, leopard, cheetah, wild dog, brown hyena, spotted hyena, caracal and jackal and did not include birds of prey, baboons or any other species. A carnivore identification sheet was provided for interviewees to ensure they had adequate knowledge of the species in question (Appendix 2).

5. Detailed accounts of livestock losses due to depredation events over the last 12 months were requested to record the details of the livestock species taken, the carnivore responsible, circumstances of the attack and the overall perception of the main problem

carnivores in the area. Livestock losses due to other reasons were also recorded to determine the relative impact of depredation events, along with the value of livestock losses over a 12 month period to enable assessment of the economic impact of livestock losses to carnivores.

6. Perceptions towards carnivores were then gathered through questions concerning attitudes (Table 3.2), understanding of value, awareness as a national resource and finally opinions on the solutions (Table 3.3) and responsibilities of reducing human carnivore conflict.

Table 3.2. *Definitions for attitudes.*

Attitude	Definitions
benefit	have a strongly positive attitude towards predators
like	have a positive attitude towards predators
dislike	have a negative attitude towards predators
kill when see	have a strongly negative attitude towards predators

Table 3.3. *Definitions for best solutions.*

Best solution	Definitions
compensate	provide compensation pay outs for livestock losses
conservation	conservation of wildlife species for ecosystem balance
decrease numbers	remove predators until numbers are reduced
educate	provide information on predators and management
improve management	improve methods of livestock management to protect stock
sustainable use	enable the use of predators for sustainable hunting
tourism	promote the presence of predators for tourism
translocation	capture and relocate predators

Questions comprised a series of open ended and closed questions (Maddox, 2003; White *et al.,* 2005; Dickman, 2005; Stein *et al.,* 2010). Open ended questions were structured and specific, to enable it to be possible to classify answers into similar or identical groups of answers, which could then be given numeric states to facilitate statistical analysis. Trichotomous questions (yes / no / don't know) were conducted as a series of statements upon which the interviewee responded (Walpole & Goodwin 2001).

The questionnaire was piloted by the primary researcher accompanied by a trained translator in 20 locations in the Southern district of Botswana in order to identify ambiguous questions and those that were confusing or hard to answer. The questionnaire was further reviewed by researchers experienced in the use of questionnaires at Rhodes University before use. After this the questionnaire was refined and certain questions were restructured or removed. The pilot questionnaires were not included in the final total of completed questionnaires (White *et al.,* 2005; Whittington-Jones., 2011).

3.2.2 Questionnaire administration

Questionnaires were conducted by a local Cheetah Conservation Botswana community outreach officer, trained by the primary researcher, who was fluent in the local language Setswana, tribal customs and familiar with farming in the region. The interviewees were asked if they were willing to take part in the survey and the series of structured questions was asked. The questionnaire was administered one on one to remove the influence of other individuals' opinions. Responses were recorded on the questionnaire sheet directly by the interviewer in English and later entered into a database by the primary researcher. Respondents were given an option to state 'no response' to any question to avoid any discomfort with certain questions (White *et al.,* 2005) i.e. socio-economic details or livestock numbers. Questions which were not relevant to the individual were classed as 'not applicable' i.e. number of small stock when none were owned. Each questionnaire took approximately 1 hour to complete.

The questionnaires were conducted in the farming areas of the South East, Kgalagadi and Ghanzi districts during CCB community site visits, at the cattlepost, ranch or settlement. Interviews were located in each of the main land uses of region i.e. communal land (50% of total questionnaires), ranches (25%) and Wildlife Management Areas (25%). A minimum of 5km distance was kept between each interview location. When individuals were not available the next available site was interviewed. In areas where the population was very sparse the first available location was interviewed. The location of each

questionnaire was mapped using a hand held GPS (Garmin Etrex, Kansas, USA). When the interview did not take place directly at the cattlepost or ranch the interviewee was asked to plot their location on a map and provide the road distance from the nearest settlement to enable locations to be recorded. Where ever possible, the person who had resided for the longest duration at the site was interviewed to best represent the most reliable opinion at the location. The minimum time required in the area was 2 years.

The number of questionnaires carried out in each area was approximately 10% of the total population of the area based on the most recent government census information available (CSO, 2006).

3.2.3 Questionnaire reliability

In order to ensure positive identification of carnivore species interviewees were asked to identify species from a set of picture cards and provide information on behaviour and habits (Dickman, 2008; Whittington-Jones, 2011). This included lion, leopard, cheetah, brown hyena, spotted hyena, caracal and jackal (see Appendix 2).

Questionnaires were scored for reliability on a 0–4 scale as follows:

Respondents received 0 - 1 point for four aspects of their interview (Gros, 2002):

1. knowledge of the species (from picture recognition and behavioural description)

   One point was awarded if all responses were 100% correct, 0.5 was awarded if there was any hesitation or the respondent was unclear but reached the correct identification. 0 was awarded if any identification was mistaken or not possible.

2. precision of answers (from concise descriptions of livestock numbers, management methods, predator sightings, conflict incidents)

   One point was awarded if respondent was confident and clear on all responses. 0.5 was awarded if respondent was unsure on any aspects but overall had a clear recollection. 0 was awarded if the respondent was not consistently sure.

3. absence of error or contradiction in answers (from cross-referencing)

One point was awarded if respondent made no errors or contradictions. 0 was awarded if an error or contradiction was made.

4. willingness to participate (from general motivation, readiness to answer questions)

One point was awarded if respondent was motivated and interested to participate. 0.5 was awarded if the respondent participated but did not come across as engaged in the process. 0 was awarded if there was a clear disinterest in participating.

Questions for cross referencing were included in the questionnaire to assist in the assessment of the accuracy of responses. Questionnaires from respondents ranking lower than 3.0 points, or misidentifying carnivore species, were not utilised in the analysis. The remaining data set was then statistically and spatially analysed.

3.3 Development of Indices for Conflict, Livestock Management, Tolerance and Carnivore Presence

In order to enable overall conflict, livestock management, tolerance and carnivore presence levels to be analysed against various socio-economic, physical, environmental and management related factors, five indices were developed for conflict, cattle management, smallstock management, tolerance and carnivore presence (Walpole 2001, Marker *et al.,* 2003c, Zimmerman *et al*., 2005). Index scores were created by assigning weighted values to series of questions concerning the respective index (Appendix 3). The value for each index for each respondent was calculated as the sum of the scores for each question.

3.4 Data analysis

3.4.1 Statistical analyses

Descriptive statistics were used to illustrate various results when statistical testing was not appropriate. Statistical analyses were undertaken using SPSS (SPSS Inc., Chicago, USA), Excel (Microsoft Corporation, CA, USA) and STATISTICA 8.0 software (Statsoft, Tulsa, USA). A Kolmogorov-Smirnov test was used to test if continuous variables were normally

distributed. Where two continuous variables (e.g. conflict Index and monthly income) were compared linear regression or the non-parametric correlation were utilised.

Where continuous and categorical variables with two states (e.g. conflict Index and gender or farm type) were compared, t-tests or Mann-Whitney U tests were selected. For comparisons of continuous and categorical variables with multiple states (e.g. conflict Index and education level or source of income) an ANOVA or Kruskal Wallace ANOVA were utilised. Post hoc multiple comparison testing was utilised to further analyse comparisons of variables.

Chi^2 tests were used to compare proportions (proportions of respondents on two farm types with different levels of education). Spearman's Rank Correlations were utilised to determine correlations between variables. Multiple regressions were then conducted to determine the significance of relationships. All tests were 2-tailed and the statistical significance was set at $P<0.05$). Figures given after the mean are $\pm$ one standard deviation. A general linear model was utilised to assess the importance of various factors in affecting the conflict, cattle and smallstock management and tolerance indices. A logistic regression was used to determine which variables, when tested in combination, best predicted the 4 indices. The Akaike Information Criterion (AIC) was applied to select the best model from these variables (Archibald et al. 2005; Hazzah, 2006).

3.4.2 Spatial analyses

Spatial information was mapped using ArcGIS 9 (ESRI, CA, USA) allowing relationships between factors such as location, human population density, habitat type and land use to be investigated. Local and national population sizes were extracted from the Botswana government Central Statistics Office (CSO, 2001; CSO, 2006).

Chapter 4

4. Questionnaire Survey Results

4.1 Summary of Characteristics of the Respondents and the Farm Types

Seventy five percent of respondents were located on cattleposts and 25% on fenced ranches. Of the 310 respondents, 69.4% were male and 30.6% female. The percentage of male respondents was significantly lower on cattleposts (62.9%) than fenced ranches (88.5%; χ^2=-17.9; df = 1; P<0.05; Table 4.1). The average age of respondents was 45.1 ±14.8 years (range, 19-93 years; Table 4.1). There was no significant difference between the ages of male and female respondents (t = -1.6; df = 286; P>0.05) or of the ages of respondents from cattleposts or fenced ranches (t =-1.38; df = 286; P>0.05).

Table 4.1. *Details of 310 respondents surveyed. (Data are numbers with either percentages or standard deviations (±1 SD) in brackets).*

		Cattlepost	**Fenced Ranch**	**Total**
Gender	male	146(62.9%)	69(88.5%)	215(69.4%)
	female	86(37.1%)	9(11.5%)	95(30.6%)
Age	mean age (years)	44.33(±15.2)	47.05(±13.6)	45.06(±14.8)
Family No.	mean number in family	4.93(±2.8)	4.8(±2.9)	4.91(±2.8)
	mean number of adults	3.41(±2.5)	2.59(±1.9)	3.26(±2.4)
	mean number of children	1.59(±2.1)	2.38(±2.3)	1.72(±2.2)
Education	no schooling	90(38.8%)	11(14.1%)	101(32.6%)
	primary	39(16.8%)	17(21.8%)	56(18.1%)
	secondary	80(34.5%)	26(33.3%)	106(34.2%)
	tertiary	7(3.0%)	21(26.9%)	28(9.0%)
	no response	16(6.9%)	3(3.8%)	310 (100%)
Income	mean monthly income	762(±1232)	2273(±3094)	1000(±1746)

The number of family members (number in family) ranged from 1-15 ($\overline{X}$ = 3.3±2.4 adults and $\overline{X}$= 1.7 ±2.2 children; Table 4.1). There was no significant relationship between gender of the respondent and the number in family (Mann-Whitney U test; Z=-1.65, P>0.05) or of farm type on number in family (Mann-Whitney U test; Z= 0.65, P>0.05). However, there

was a significant correlation between family size and age of respondent, and family size increased with increasing age (Rs= 0.37, P<0.01).

The highest level of education ranged from no schooling (32.6% of respondents), primary schooling only (18.1%), secondary (34.2%) and tertiary (9%). The proportions of respondents with the different levels of education differed significantly on the two farm types (χ^2 =47.8; df = 3; P<0.05, Table 4.1, Figure 4.1). While 39% of respondents from cattleposts reported no education, only 14% of respondents from fenced ranches had no schooling. Only three percent of respondents from cattleposts had received some tertiary education while 27% of those from fenced ranches had tertiary education.

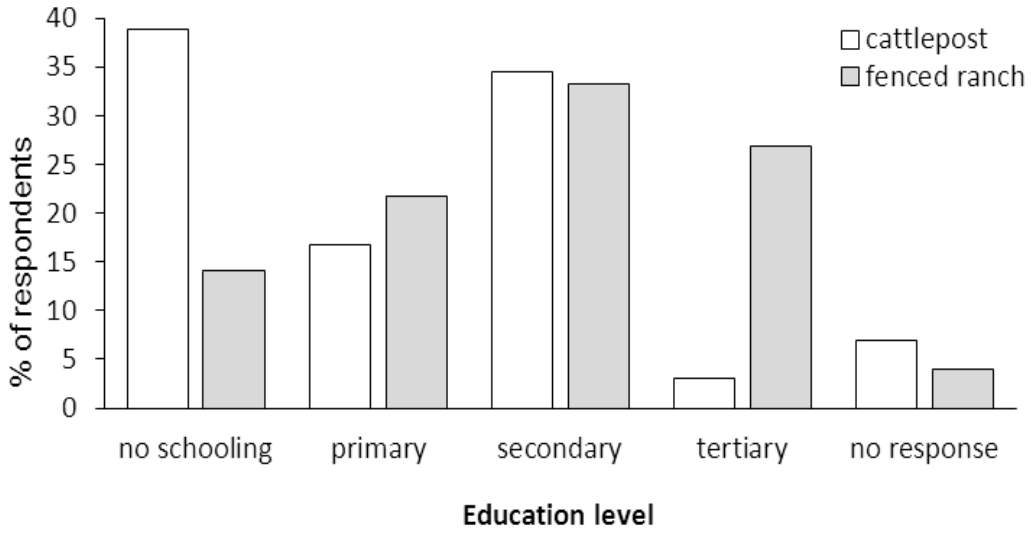


Figure 4.1. *Education levels experienced by survey respondents from cattleposts and fenced ranches.*

There was a significant relationship between gender and education level (χ^2= 21.1; df = 3; P<0.01) with female respondents reporting higher percentages of no schooling and generally less education than males (Figure 4.2).

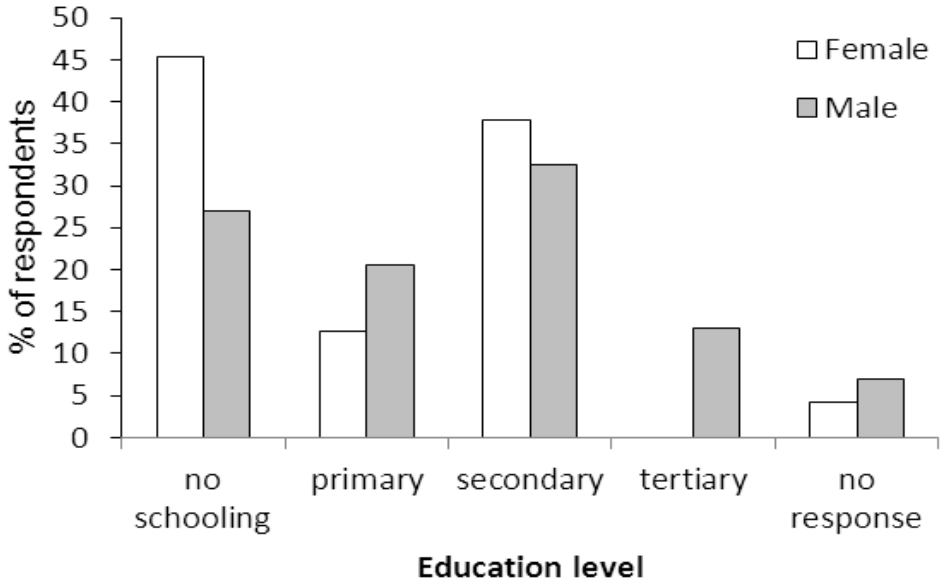


Figure 4.2. *Levels of education amongst male and female respondents.*

There was a significant relationship between age and education level (ANOVA; $F_{3,268} = 8.5$; $P<0.005$) and respondents with no schooling were significantly older than those with secondary education ($P<0.05$; Figure 4.3). No other pairs were significantly different ($P>0.05$ for all).

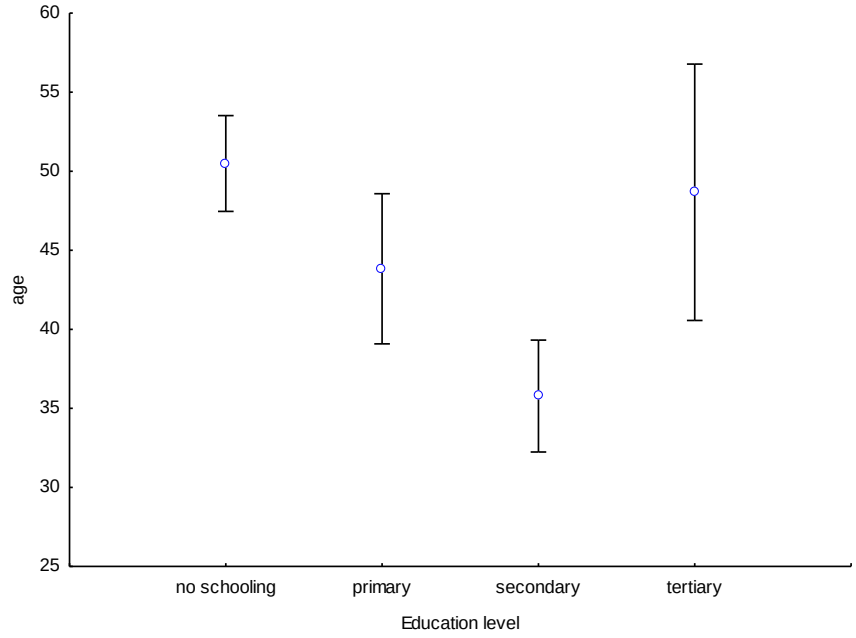


Figure 4.3. *The relationship between the age of respondents and level of education. Data are means with 95% CI.*

There was no significant relationship between education level and number of family members (KW ANOVA; $H_{3,196} = 6.48$; $P>0.05$).

Monthly incomes ranged from BWP 0 – BWP 11000, with an average of BWP1000±1746 (Table 4.1). One BWP is equivalent to US$0.15. Monthly incomes differed significantly on the two farm types (Mann-Whitney U test; Z=-3.45, P<0.01), ranging from BWP 0 – BWP 7500 on cattleposts ($\overline{X}$= BWP647±1026) and from BWP 100 – BWP 10000 ($\overline{X}$= BWP1911 ±1965) on fenced ranches (Table 4.1, Figure 4.4).

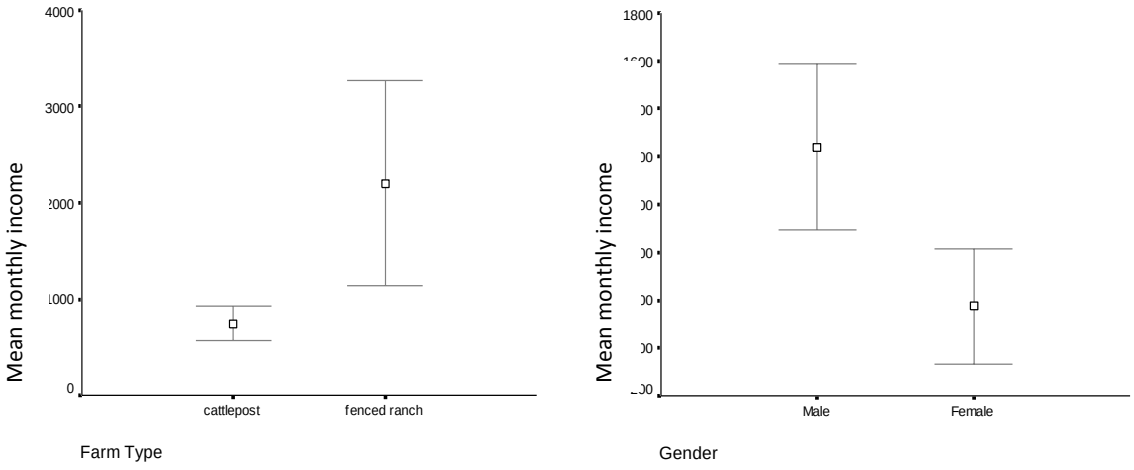


Figure 4.4. *The relationship between monthly income and farm type, and monthly income and gender. Data are means with 95% CI.*

Monthly income was significantly higher for male respondents ($\overline{X}$=1240 ±1931, range 0-10000) than females ($\overline{X}$=574 ±1073, range 0-7000, Figure 4.4; Mann-Whitney U test; Z = -3.9; P<0.01). Monthly income was not correlated with age (Rs= -0.11, P>0.05) or number in family (Rs= -0.10, P>0.05). However, there was a significant relationship between monthly income and education level (KW ANOVA; $H_{3,197} = 40.49$; P<0.01), with those with tertiary education reporting a significantly higher income than all others (P<0.05; Figure 4.5) and those with secondary education earned significantly more than those with no schooling (P<0.05).

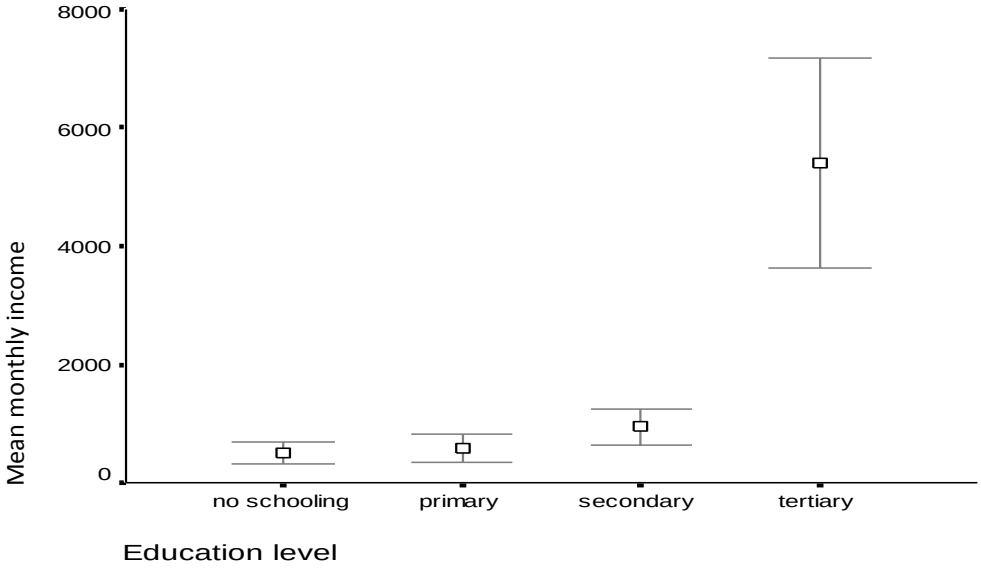


Figure 4.5. *Average monthly incomes (BWP) for different levels of education. Data are means with 95% CI.*

These results were supported by a GLM analysis with farm type, gender and education level as categorical predictors and income level as the dependent variable. Only education level had a significant effect on income level ($F_{3,189}$ = 19.8, P<0.05) and there were no significant interactions. Respondents with tertiary education had significantly higher income than all other education levels (P<0.05) and no other pairs were significantly different.

Six different income sources (see Methods 3.2.1 for definitions) were identified and the relative importance of these differed significantly between cattleposts and fenced farms (χ^2= 18.72; df=5; P<0.05, Table 4.2). A greater proportion of respondents on fenced ranches gained an income through the sale of farm products, while more people on cattleposts received an income through wildlife products (Table 4.2). The proportions of respondents with incomes derived from veld products, employment, own business and mixed incomes were similar between cattleposts and fenced ranches.

Table 4.2. *Sources of income on cattleposts and fenced ranches. (Data are number of respondents and proportions).*

Source of income	Farm type			
	Cattlepost		Fenced ranch	
	n	prop	n	prop
Employment	36	0.16	9	0.12
Mixed	29	0.13	7	0.90
Own business	46	0.20	15	0.19
Farm products	72	0.31	42	0.54
Veld products	16	0.07	4	0.05
Wildlife products	33	0.14	1	0.01

There was a significant relationship between source of income and gender (χ^2 = 21.14; df=5; P<0.05) and more female respondents received income from their own business and sale of veld products than did male respondents (Table 4.3). More male respondents received income from employment and the sale of farm products than did female respondents.

Table 4.3. *Summary of the relationship between gender and source of income of the respondents.*

	Gender of respondents			
	male		female	
Source of income	n	prop	n	prop
employment	50	0.23	11	0.12
mixed	25	0.12	11	0.12
own business	21	0.10	24	0.25
farm products	87	0.40	27	0.28
veld products	19	0.09	15	0.16
wildlife products	13	0.06	7	0.07

There was a significant relationship between source of income and age of respondents (ANOVA; $F_{5,282}$ = 3.37; P<0.05; Figure 4.6) and respondents who received income from formal employment were significantly younger than those who received their income from the sale of farm products (P<0.05). No other pairs were different (P>0.05 for all).

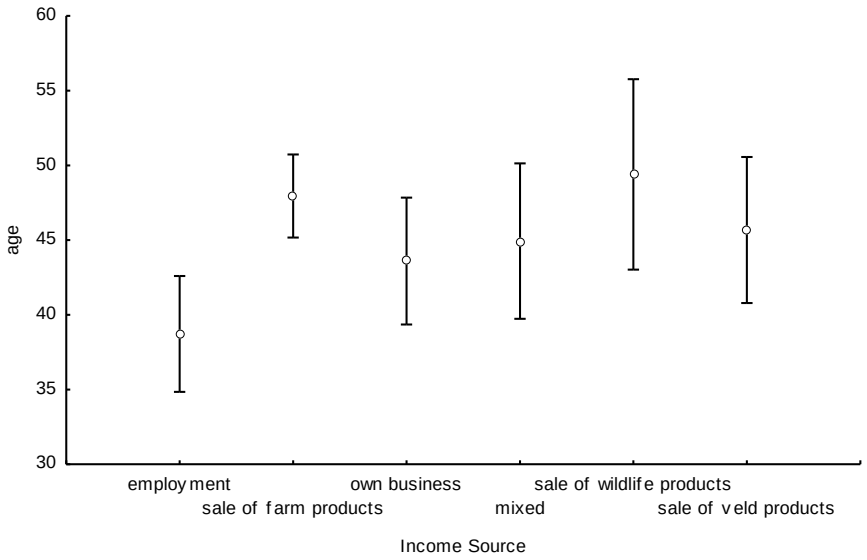


Figure 4.6. *The relationship between source of income and age of respondents. Data are means with 95% CI.*

There was a significant relationship between number in family and source of income ($H_{5,221}$ = 12.8; P<0.05) with the average family size of those gaining income from the sale of wildlife products being greater than those gaining income from formal employment (Figure 4.7).

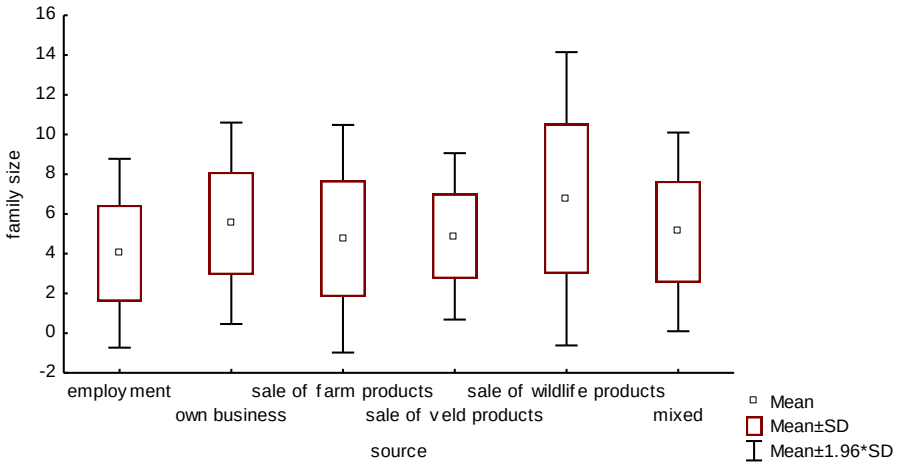


Figure 4.7. *The relationship between source of income and number in family.*

There was no significant effect of source of income on annual income of respondents ($H_{5,197}$ = 6.39; P>0.05).

There was a significant relationship between source of income and education level (χ^2 =40.12, df=15, P<0.05). A greater proportion of respondents with some education received income from employment than those with no education. Of the respondents with no education, about 24% received income from the sale of veld and wildlife products while for respondents with some education, the proportions were lower (Table 4.4). No respondents with tertiary education received income from the sale of veld products but half received income from the sale of farm products (Table 4.4).

Table 4.4. *The relationship between education level and source of income.*

	Education level							
	no		1		2		3	
Source of income	N	prop	N	prop	N	prop	N	prop
employment	12	0.11	18	0.33	20	0.19	4	0.14
mixed	8	0.07	9	0.16	16	0.15	2	0.07
own business	16	0.15	9	0.16	15	0.14	5	0.18
farm	35	0.33	14	0.25	40	0.38	14	0.50
veld	18	0.17	4	0.07	12	0.11	0	0.00
wildlife	18	0.17	1	0.02	3	0.03	3	0.11
Totals	107	1.00	55	1.00	106	1.00	28	1.00

The mean total number of livestock owned was 452±1291. The number of livestock on cattleposts was significantly lower ($\overline{x}$=120 ±263; range 0-2159) than on fenced ranches ($\overline{x}$ =1441 ±2272; range 0-14200; Table 4.5; Mann-Whitney U test; Z=-8.89; P<0.01). The most common livestock species kept were cattle and goats, followed by sheep, horses and donkeys (Table 4.5).

Table 4.5. *Summary of livestock holdings (data are numbers of animals with ±1SD in brackets)*

	Total	**Cattlepost**			**Fenced Ranch**		
Livestock	**mean**	**mean**	**median**	**range**	**mean**	**median**	**range**
cattle	388 (±1265)	74 (±202)	13	0-2000	1315 (**±**2261)	550	0-14000
goat	40 (±85)	28 (±56)	12	0-450	74 (±134)	40	0-1000
sheep	20 (±63)	10 (±35)	0	0-327	48 (±106)	14	0-800
horse	9 (±37)	6 (±38)	0	0-400	16 (±35)	4	0-200
donkey	4 (±10)	3 (±7)	0	0-60	7 (±15)	1	0-100
Total	452 (±1291)	120 (±263)	32	0-2159	1441 (±2272)	665	0-14200

There was a significant difference in the total number of livestock owned by different genders (Mann-Whitney U test; Z=-4.85, P<0.01), with males owning more livestock ($\overline{x}$ =594.9±1512.8) than females ($\overline{x}$=129.9±347.9).

There was no significant correlation between age of respondents and total number of livestock owned (Rs = 0.03, P>0.05). However, there was a weak but significant correlation between number of family members and livestock holdings (Rs = -0.19, P<0.05) with livestock numbers increasing with increasing family size.

The relationship between education level and total number of livestock owned was significant (KW ANOVA; $H_{3,285}$ = 34.58; P<0.05) and livestock holdings increased with increasing education (Table 4.6). Respondents with tertiary education owned significantly more livestock than those with no schooling or secondary education, and respondents with no schooling had significantly fewer livestock than those with primary education (Table 4.6; P<0.05 for all). No other groups differed significantly.

Table 4.6. *Summary of livestock holdings for different education levels (n = number of respondents).*

Education level	n	Mean ± 1SD
no schooling	101	154(±348)
primary	56	351(±680)
secondary	106	347(±678)
tertiary	28	2131(±3490)

In a GLM, with numbers of livestock held as the dependent variable and farm type and education level as categorical predictor variables, there were significant effects for farm type ($F_{1,310}$ = 34.1, P<0.05) and education level ($F_{4,310}$ = 4.83, P<0.05) and a significant interaction between them ($F_{4,310}$ = 2.87, P<0.05). Respondents on fenced farms had significantly more livestock than those on cattleposts and those with tertiary education had more livestock than those with other levels of education. Respondents with tertiary education on fenced farms had significantly greater numbers of livestock than all other respondents. Those with tertiary or secondary education on fenced farms had significantly greater numbers of livestock than respondents with the same level of education on cattleposts.

Monthly income was significantly correlated with the total number of livestock owned ($Rs= 0.33$, $P<0.05$) with respondents with higher monthly income, owning more livestock than those with lower monthly income.

General Summary: The results presented in the preceding section can be summarised by gender of respondent and by farm type. Cattleposts were characterised by having a greater proportion of female respondents, who generally had a lower level of education than male respondents. Older people had less schooling, bigger families and earned a greater proportion of income from farm products, than younger people who had higher education levels and were more likely to be in formal employment. Education levels were higher on fenced ranches, which had the greatest proportion of tertiary level respondents. Income was lower on cattleposts, lower for female respondents and lower for respondents with lower levels of education, this variable having the most significant effect. Males had higher levels of education, income and numbers of livestock than females. Males on ranches with tertiary education had the highest incomes.

Male respondents were more likely to be in formal employment and earn an income from the sale of farm products than female respondents who made more of an income from the sale of veld and wildlife products. Respondents with less education made more income from veld and wildlife products than formal employment, tertiary level respondents made most from farm products. Fenced ranches received a greater proportion of income from farm products, while cattleposts had higher proportions of income gained from wildlife products. Greater numbers of livestock were found on ranches amongst male respondents and the amount of livestock owned increased with education and income levels.

4.2 The Conflict, Livestock Management and Tolerance Indices

In order to investigate the influences of gender, age, number in family, farm type, education and number of livestock owned on perceived levels of conflict, management practices, tolerance towards predators and carnivore presence, several variables from the questionnaire were weighted and combined into Indices (Table 4.7) as discussed in the methods.

Table 4.7. *Summary of the mean Index values where n = number of respondents for whom it was possible to calculate the Index with ±1SD in brackets)*

		Livestock management			
	Conflict	**Cattle**	**Smallstock**	**Tolerance**	**Carnivore Presence**
n	310	279	249	310	310
mean	6.5 (±3.5)	8.3 (±4.0)	13.0 (±5.4)	3.3 (±2.0)	16.4(±7.7)
median	6.0	8.0	14.0	3.0	16.0

Conflict Index

The mean Conflict Index was 6.5 ±3.5 (range 0-17; Table 4.7), with a possible maximum value of 18 and minimum value of 0. The Conflict Index will increase with increasing levels of conflict. The majority of respondents experienced low to medium levels of conflict, with fewer individuals reporting higher conflict levels (Figure 4.8). For eighty one percent of respondents, conflict values were less than 10, with a further 15% scoring from 10-12 and only 5% with a conflict value more than 12.

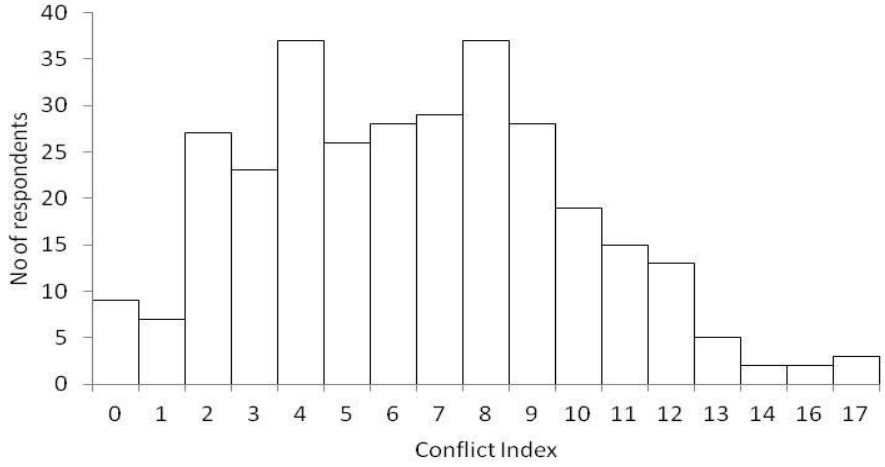


Figure 4.8. *Histogram showing the number of respondents reporting the different levels for the Conflict Index.*

Management Index

The Management Index was calculated separately for cattle and smallstock, and the value will increase with increasing levels of management. The mean Management Index for cattle was 8.3 (±4.0; range 0-19), with a possible maximum value of 24 and minimum value of 0. For smallstock it was 13.0 (±5.4; range 0-26; Table 4.7), with a possible maximum value of 22 and minimum value of 0 (Figure 4.9). There was a significant difference in mean Management Index values for cattle (7.43±3.23) and Smallstock (12.99 ±5.41), with levels of management significantly greater for smallstock than for cattle (Mann-Whitney U test; Z =-11.82; P<0.01).

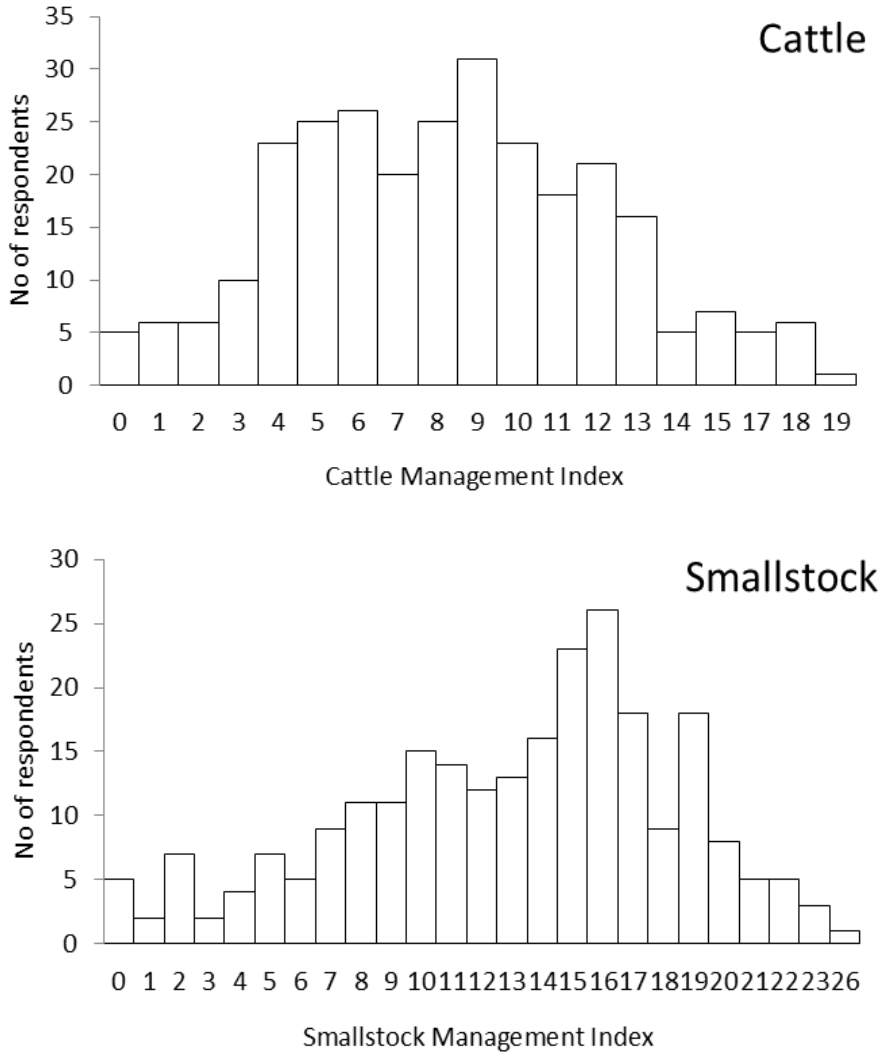


Figure 4.9. *Histograms showing the number of respondents reporting the different levels for the Management Index for cattle and smallstock.*

Tolerance Index

The mean Tolerance Index was 3.3 (±2.0; range 0-8; Table 4.7; Figure 4.10), with a possible maximum value of 8 and minimum value of 0. The Tolerance Index will increase with increasing levels of tolerance towards predators. The majority of respondents had low Tolerance Indices and 72% had an index of four or less. Only 15% of respondents had a Tolerance Index of greater than five (Figure 4.10).

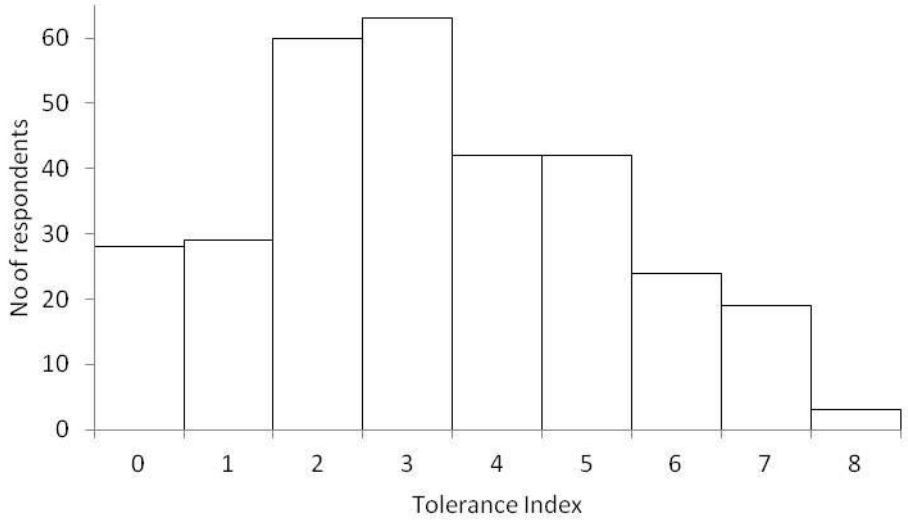


Figure 4.10. *Histogram showing the number of respondents reporting different tolerance levels.*

Carnivore Presence Index

The mean Carnivore Presence Index was 16.4 (±7.7; range 0-37; Table 4.7; Figure 4.11), with a possible maximum value of 56 and minimum value of 0. The higher the value, the greater level of carnivore presence reported by respondents.

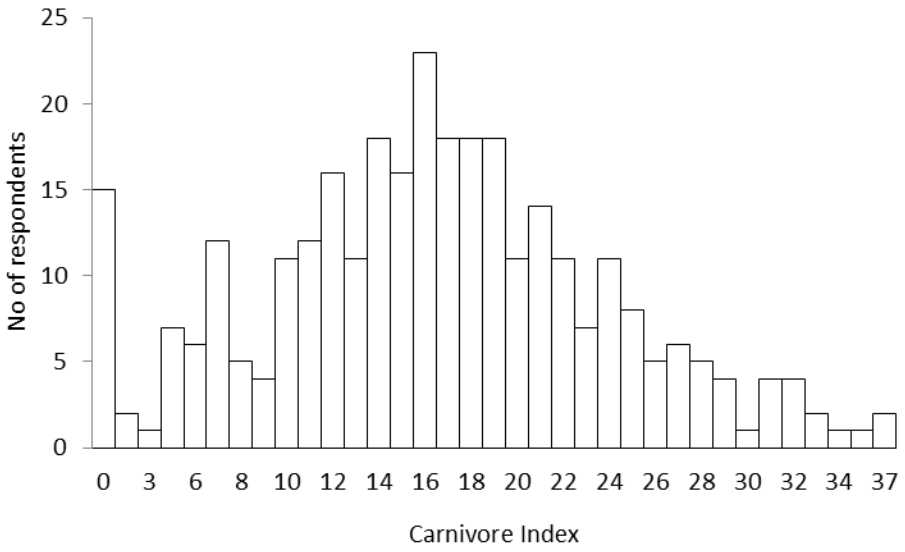


Figure 4.11. *Histogram showing the number of respondents reporting different Carnivore Presence levels.*

In the following section, the relationships between these indices and a range of independent predictor variables that could have an effect on conflict, management and tolerance levels is assessed, as is the relationships between the indices. The aim is to assess the drivers of human carnivore conflict, management and tolerance in Kalahari communities and investigate the influences of socio-economic, management and environmental variables.

Relationships between the Indices

The relationships between the indices were tested using parametric or nonparametric tests as appropriate (Table 4.8). In all cases, the relationships were statistically significant but in most cases they were weak or very weak. However, there was a strong positive correlation between Cattle and Smallstock Management Indices ($R_s = 0.56$; $P<0.05$; Figure 4.12).

Table 4.8. *Summary of statistical analyses of relationships between the Indices.*

Indices	Smallstock	Cattle	Tolerance	Carnivore
Conflict	Rs=0.16; P<0.05	R^2 = 0.08; $F_{1,277}$ = 25.4; P<0.05	Rs=0.19 P<0.05	R^2 = 0.07; $F_{1,308}$ = 24.3; P<0.05
Smallstock		Rs=0.56; P<0.05	Rs= 0.19; P<0.05	Rs=0.22; P<0.05
Cattle			Rs =0.14; P<0.05	R^2 0.02; $F_{1,278}$ = 6.33; P<0.05
Tolerance				Rs = 0.21; P<0.05
Carnivore				

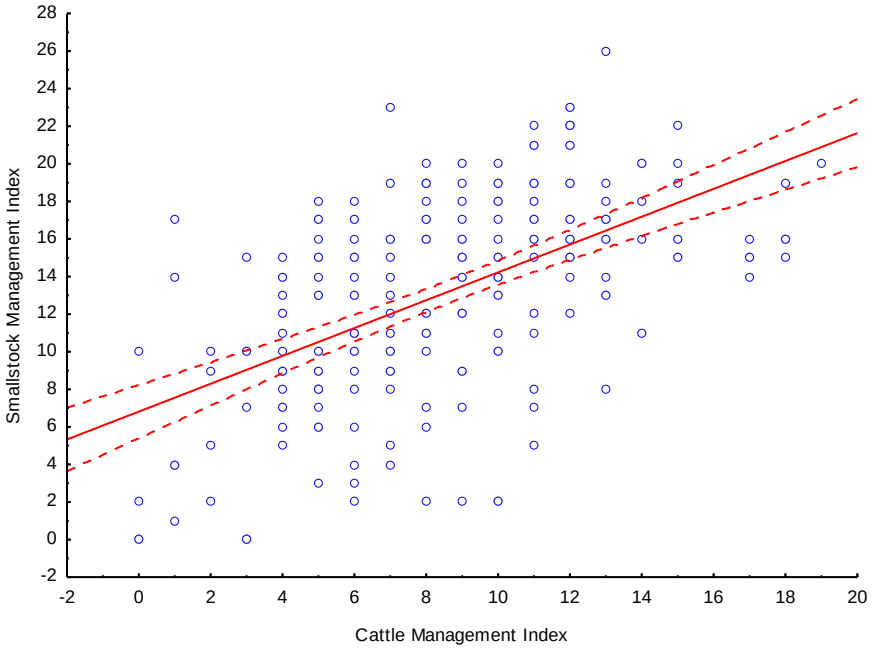


Figure 4.12. *The relationship between Cattle and Smallstock Management Indices. (Dashed lines are 95% CI's).*

4.3 Relationship between Socio Economic Characteristics and the Indices

Gender

The gender of the respondents was significantly correlated with the Conflict Index ($t = 2.45$; $df = 308$; $P<0.05$) Cattle Management Index ($t = 3.37$; $df = 277$; $P<0.01$) and the Tolerance Index (Mann-Whitney U test; $Z=-2.02$, $P<0.05$). Female respondents had higher mean Conflict, Cattle Management and Tolerance Indices than males (Table 4.9). The mean Smallstock Management Indices of male and female respondents were not significantly different (Mann-Whitney U test; $Z=-0.424$, $P>0.05$).

Table 4.9. *Conflict, Management and Tolerance levels of male and female respondents. n = number of respondents, data are given as mean±1SD.*

		Indices			
			Livestock management		
Gender		**Conflict**	**Cattle**	**Smallstock**	**Tolerance**
M	n	215	194	172	215
	mean	6.3 (±3.8)	7.8 (±3.7)	12.8 (±5.6)	3.2 (±1.9)
F	n	95	85	77	95
	mean	7.2 (±3.3)	9.5 (±4.4)	13.4 (±5.1)	3.6 (±1.9)
Total	n	310	279	249	310
	mean	6.6 (±3.7)	8.3 (±4.0)	13.0 (±5.4)	3.3 (±1.9)

Age

The age of the respondent was not significantly correlated with any of the indices (Conflict; $R^2 = 0.002$; $F_{1,286} = 0.56$; $P>0.05$; Cattle Management $R^2 = 0.011$; $F_{1,257} = 2.91$; $P>0.05$; Smallstock Management $Rs = -0.13$, $P>0.05$ or Tolerance $Rs = -0.01$, $P>0.05$).

Family number

The correlations between the family number and Conflict ($Rs = 0.10$, $P>0.05$), Cattle Management ($Rs =-0.06$, $P>0.05$), Smallstock Management ($Rs = -0.09$, $P>0.05$) and Tolerance Indices ($Rs = 0.06$, $P>0.05$) were not statistically significant.

Education Level

There was a significant correlation between the highest level of education and the Conflict Index (ANOVA; $F_{3,287} = 9.95$; $P<0.01$; Table 4.10, Figure 4.13).

Table 4.10. *The relationship between education level and Conflict, Management and Tolerance Indices. (n = number of respondents with 1 SD in brackets)*

Education level		Conflict Index	Management Index Cattle	Management Index Smallstock	Tolerance index
no schooling	n	101	89	82	101
	mean	7.8(±3.7)	9.3(±3.8)	13.7(±4.8)	3.5(±2.1)
primary	n	56	51	50	56
	mean	5.3(±3.3)	7.9(±3.5)	12.7(±5.4)	2.9(±1.9)
secondary	n	106	94	79	106
	mean	6.7(±3.7)	8.1(±4.4)	12.5(±5.8)	3.0(±2.2)
tertiary	n	28	27	21	28
	mean	4.3(±2.8)	6.9(±3.7)	12.4(±5.9)	3.0(±2.2)

The Conflict Index was significantly lower in respondents who had received some tertiary education than those who had received no education and also significantly lower in those that had received primary education than those that had received no education ($P<0.05$). No other pairs were significantly different (Figure 4.13).

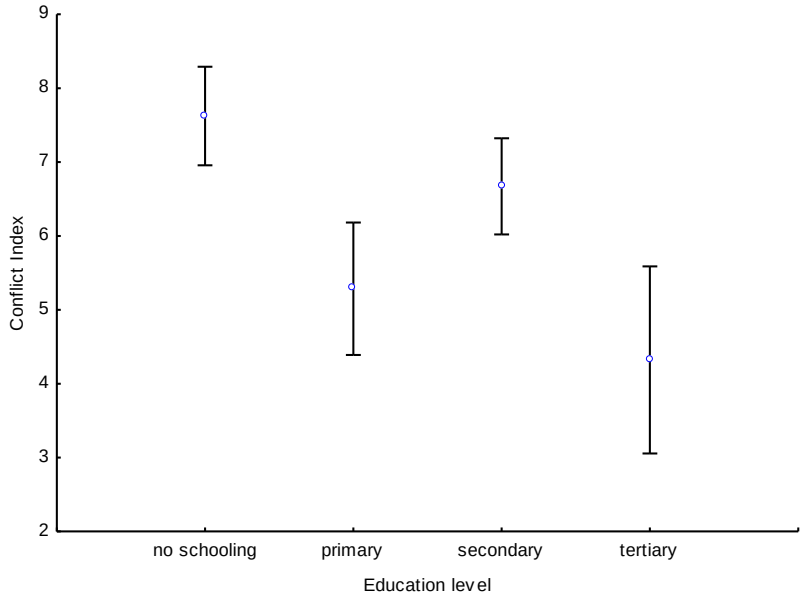


Figure 4.13. *Relationship between Conflict Index and education levels. Data are means with 95 % CI.*

Education level was significantly correlated with the Cattle Management Index (ANOVA; $F_{3,256} = 3.29$; $P<0.01$), which was significantly greater in respondents who had no schooling than those who had tertiary education (Table 4.10, Figure 4.14).

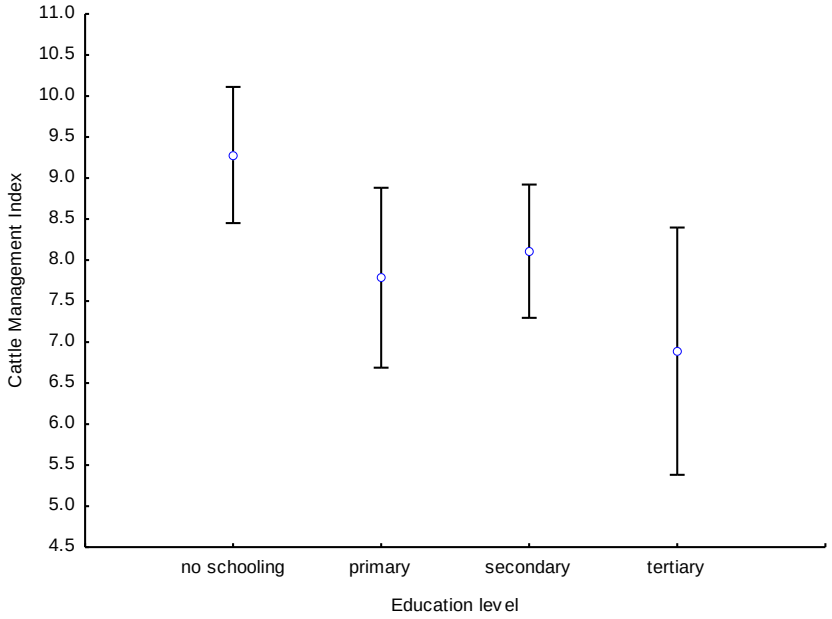


Figure 4.14. *Relationship between Cattle Management Index and education levels. Data are means with 95% CI.*

The relationships between education level and Smallstock Management Index ($H_{3,232} = 1.6$; $P>0.05$), and Tolerance Index ($H_{3,291} = 2.52$ $P>0.05$) were not statistically significant.

Monthly income

Monthly income was weakly correlated with Conflict Index ($Rs = -0.26$, $P<0.01$) with conflict values decreasing as monthly incomes increased. There was no significant effect of monthly income on Management (Cattle $Rs = 0.034$, $P>0.05$; Smallstock $Rs = 0.15$, $P>0.05$) and Tolerance Indices ($Rs = 0.04$, $P>0.05$).

Source of Income

The sources of income were categorized and analysed for their relationship with Conflict, Management and Tolerance Indices (Figure 4.15).

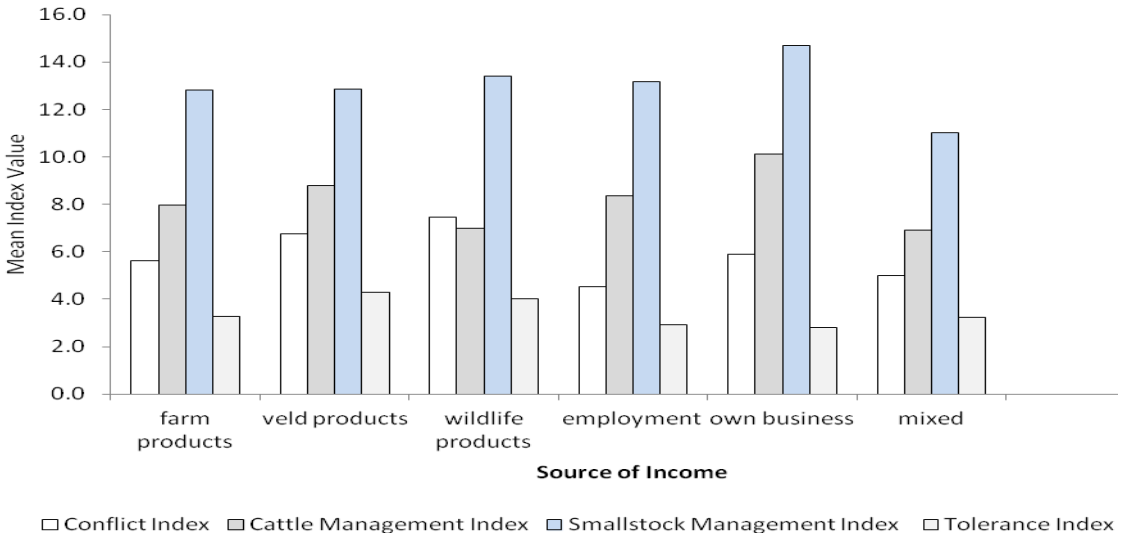


Figure 4.15. *Index levels for respondents with different primary sources of income.*

There was a significant relationship between source of income and Conflict Index ($F_{5,304}$ = 9.2; P<0.05). Respondents whose income was from sale of veld and wildlife products had greater conflict than those with income from all other sources (P>0.05 for all; Figure 4.16).

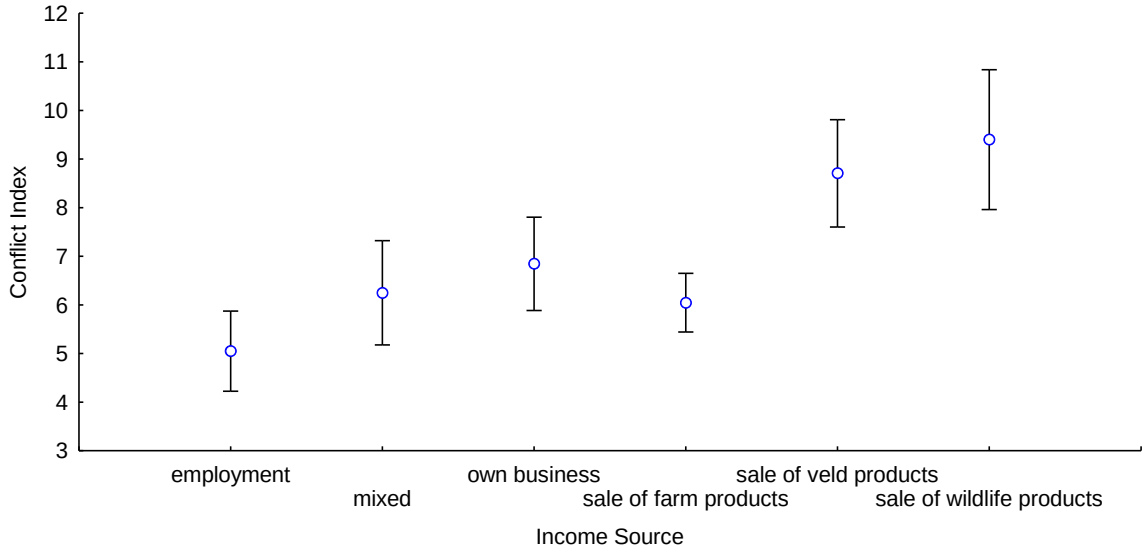


Figure 4.16*. Relationship between Conflict Index and income source. Data are means 95% CI.*

There was a significant relationship between source of income and Cattle Management Index ($F_{5,272}$ = 2.78; P<0.05). The Cattle Management Index of respondents whose income was from an own business was significantly greater than for respondents whose income was from mixed sources or from employment (P<0.05; Figure 4.17).

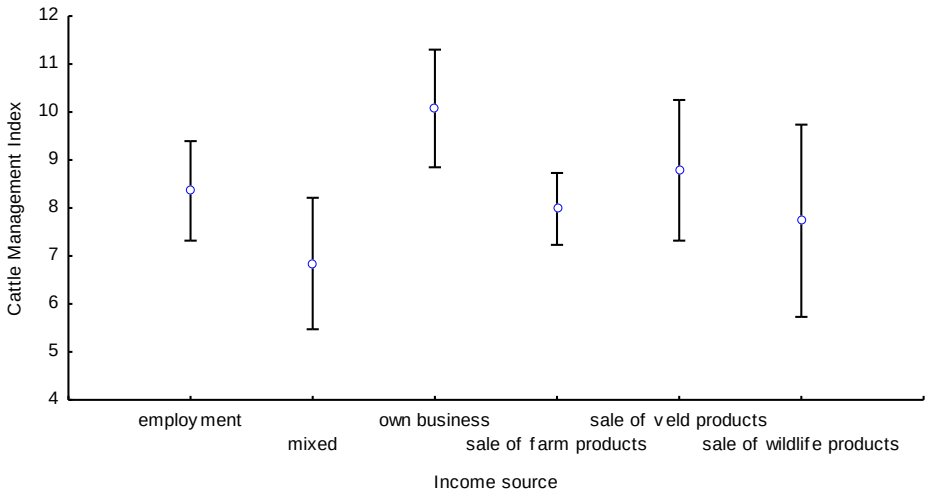


Figure 4.17. *The relationship between Cattle Management Index and source of income. Data are means with 95% CI.*

The relationship between source of income and Smallstock Management Index was not statistically significant ($H_{5,249}$ = 6.9; P>0.05). There was a significant relationship between source of income and Tolerance Index ($H_{5,310}$ = 14.36; P<0.05), but no pairs were significantly different (P>0.05 for all pairs).

Key Results Summary - Socio Economic factors and the Indices

Gender, education, income and source of income were significantly related to one or more Index, while age and family number were not. Female respondents had higher Conflict Index than males but also had higher Cattle Management and Tolerance Indices. By contrast, respondents with tertiary education had the lowest Conflict Index and the lowest Cattle Management Index. Respondents with no schooling experienced the greatest conflict but had the highest Cattle Management Index. The Conflict Index decreased slightly with increasing monthly income. High levels of conflict were reported by respondents who gained most of their income from veld and wildlife products and the same respondents had relatively high Cattle Management Indices. The lower Cattle Management Indices was characteristic of respondents who gained most of their income from mixed and farm products and the same respondents had relatively low Conflict Index.

4.4 Relationship between Physical Farm Characteristics and the Indices

Farm Type

The Conflict Index varied significantly between the farm types (t = 5.27; df = 308; P<0.05; Figure 4.18) and was greater on cattleposts than fenced ranches.

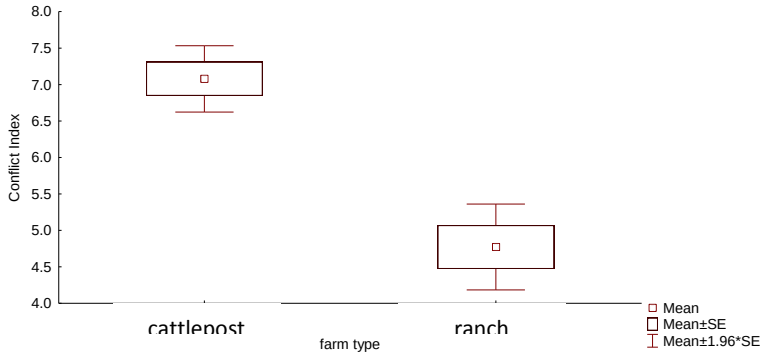


Figure 4.18. *Conflict Indices on different livestock farm types.*

The Cattle Management Index was significantly higher on cattleposts than on fenced ranches (t = 5.07; df = 277; P<0.05; Figure 4.19) but Smallstock Management Index did not differ significantly (Mann-Whitney U test; Z =-1.14; P>0.05).

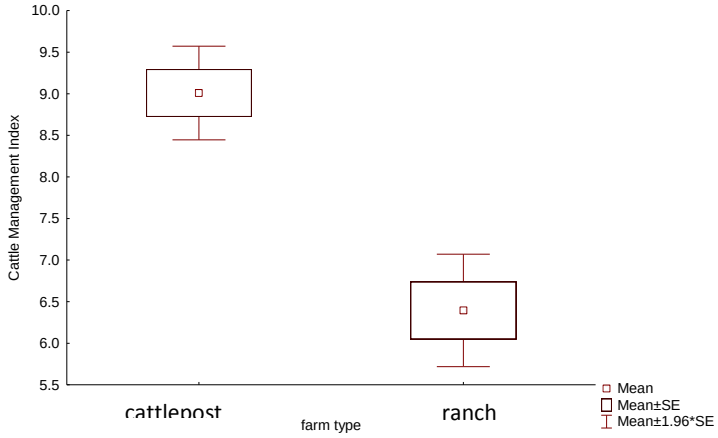


Figure 4.19. *The relationship between farm type and Cattle Management Index.*

The relationship between farm type and Tolerance Index was not significant (Mann-Whitney U test; Z = 0.8; P>0.05).

The Carnivore Index was significantly greater on fenced ranches than on cattleposts (t = -2.67; df = 308; P<0.05; Figure 4.20).

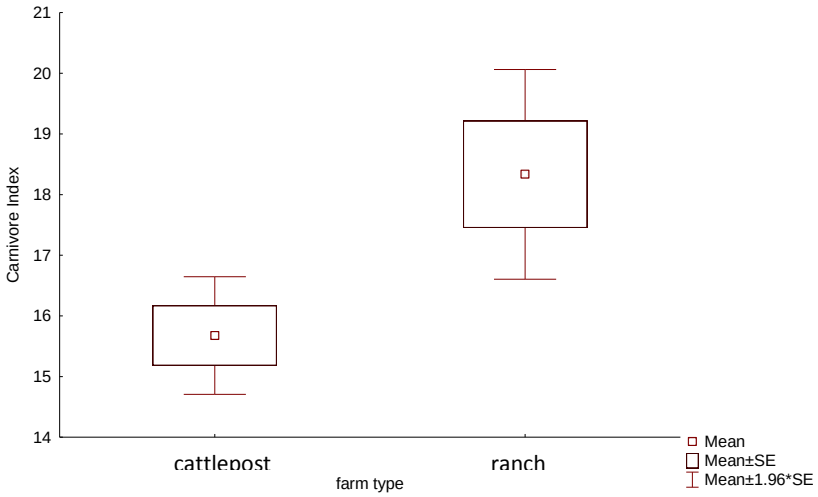


Figure 4.20. *The relationship between farm type and Carnivore Index.*

No of people staying on the farm

The number of people on the farm was significantly correlated with the Cattle Management (Rs =-0.13; P<0.05) and the Carnivore Indices (Rs =0.15; P<0.01), although not with the Conflict (Rs =-0.09; P>0.05), Smallstock Management (Rs = -0.05, P>0.05) or Tolerance Indices (Rs = -0.04, P>0.05). The Cattle Management decreased with increasing numbers of people staying on the farm and the Carnivore Index increased slightly with increased numbers of people on the farm.

Access to boreholes

There was a small positive correlation between the number of boreholes and Conflict Index (Rs = 0.222, P<0.05) and between Carnivore Index and number of boreholes (Rs=0.14; P<0.05), but no significant relationships between borehole numbers and Cattle Management (Rs = -0.01, P>0.05), Smallstock Management (Rs = 0.08, P>0.05) and Tolerance Indices (Rs = 0.03, P>0.05).

There was a weak but significant positive correlation between distance of boreholes from the kraals and the Conflict Index (Rs = 0.25, P<0.05), Cattle Management Index (Rs = 0.2, P<0.05) and Tolerance Index (Rs = 0.16, P<0.05). There was no effect on Smallstock Management (Rs = -0.04, P>0.05) or on Carnivore Index (Rs=0.06; P>0.05).

Livestock Numbers

The total number of livestock owned was a significant driver for many of the indices, except the Carnivore Index (Rs=0.05; P>0.05) and Smallstock Management Index (Rs = 0.076; P>0.05). There were negative correlations between the numbers of livestock owned and the Conflict Index (Rs = -0.43, P<0.05; Figure 4.21), the Cattle Management Index (Rs = -0.19, P<0.05) and the Tolerance Index (Rs = -0.19; P<0.05).

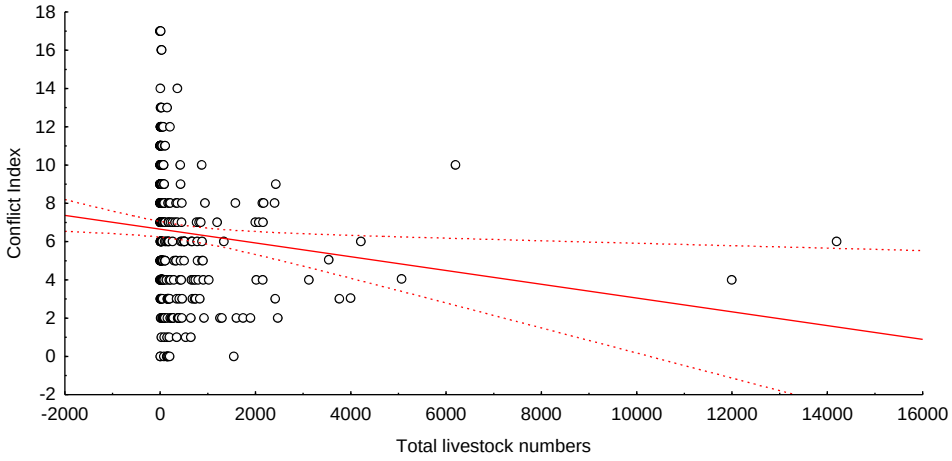


Figure 4.21. The relationship between total numbers of livestock owned and the Conflict Index. (Dashed lines are 95% CI's).

Key Results Summary – Physical

On cattleposts, the Conflict Index and Cattle Management Index were greater than on fenced ranches. The number of people staying on ranches was higher than on cattleposts and there was a weak negative relationship between number of people on a farm and the Cattle Management Index. Fenced ranches had more boreholes that were closer to the kraals than did cattleposts and there was a positive relationship between number of boreholes and Conflict Index. Fenced ranches had larger herds than cattleposts and there were negative relationships between the number of livestock owned and the Conflict Index, the Cattle Management Index and the Tolerance Index.

4.5 Relationship between Livestock Management Strategies and the Indices

The Livestock Management Indices were calculated from the answers to questions about a number of management strategies and in the next section some of these are examined individually in order to establish if a particular strategy was successful.

For cattle, kraaling at night was used by 30.6% of respondents, herding by 12.5% and guard animals such as dogs or donkeys by 1.4%. Calving seasons were employed by 51.4% of respondents (Table 4.11). For smallstock, kraaling at night was used by 83.8% of respondents, herding by 24.6% and guard animals such as dogs by 40.1%. Lambing seasons were used 61.3% of respondents (Table 4.11). For each management strategy, there was a significant difference in the proportion of respondents using it for cattle versus smallstock (kraal at night, $\chi^2 = 150.6$; df=1; P<0.05; herders, $\chi^2 = 23.6$; df=1; P<0.05; guard animals, $\chi^2 = 123.8$; df=1; P<0.05; calving/lambing season, $\chi^2 = 5.2$; df=1; P<0.05). The greatest differences were for kraaling at night and the use of guard animals which were used far more for smallstock than for cattle (Table 4.11).

Table 4.11. *Summary of livestock management practices for cattle and smallstock. n = number of respondents who replied yes or no. Prop is that number as a proportion.*

		Cattle		Smallstock	
		n	prop	n	prop
Kraal at night	Y	86	0.31	207	0.84
	N	193	0.69	40	0.16
Herders	Y	35	0.13	73	0.25
	N	244	0.88	173	0.75
Guard animals	Y	4	0.01	99	0.40
	N	275	0.99	148	0.60
Calving/lambing season	Y	144	0.51	151	0.61
	N	135	0.49	95	0.39

The number of respondents using the different livestock management strategies was similar in most cases on cattleposts and on fenced ranches (Table 4.12; P>0.05). However, a significantly greater proportion of respondents from cattleposts (40%) kraaled cattle at

night, compared to on fenced ranches (5.0%; χ^2 = 32.5; df=1; P<0.05). A significantly greater proportion of respondents from fenced ranches used guard dogs for smallstock (57%) than on cattleposts (35%; χ^2 = 9.07; df=1; P<0.05).

Table 4.12. *Summary of livestock management practices for cattle and smallstock on cattleposts and fenced ranches.*

		Cattle				Smallstock			
		Cattlepost		Ranch		Cattlepost		Ranch	
		n	prop	n	prop	n	prop	n	prop
Kraal at night	Y	82	0.40	4	0.05	159	0.85	48	0.80
	N	121	0.60	73	0.95	28	0.15	12	0.20
Herders	Y	29	0.14	6	0.08	56	0.30	17	0.28
	N	174	0.86	71	0.92	130	0.70	43	0.72
Guard animals	Y	3	0.01	2	0.03	65	0.35	34	0.57
	N	199	0.99	75	0.97	122	0.65	26	0.43
Calving season	Y	108	0.53	36	0.47	111	0.59	40	0.68
	N	95	0.47	41	0.53	76	0.41	19	0.32

There was no significant relationship between gender and the use of several of the livestock management practices (P>0.05; Table 4.13). However, a significantly greater proportion of female respondents kraaled both cattle and smallstock at night (χ^2 = 7.7; df=1; P<0.05) and used calving seasons than did male respondents (χ^2 = 5.8; df=1; P<0.05).

Table 4.13. *Summary of use of livestock management practices by males and females.*

		Cattle				Smallstock			
		Female		Male		Female		Male	
		N	prop	N	prop	N	prop	N	prop
Kraal at night	Y	36	0.42	50	0.26	70	0.92	137	0.80
	N	49	0.58	145	0.74	6	0.08	34	0.20
Herders	Y	13	0.15	22	0.11	22	0.29	51	0.30
	N	71	0.85	174	0.89	54	0.71	119	0.70
Guard animals	Y	0	0.00	4	0.02	27	0.36	72	0.42
	N	85	1.00	189	0.97	49	0.64	99	0.58
Calving seasons	Y	53	0.62	91	0.47	45	0.59	106	0.62
	N	32	0.38	104	0.53	31	0.41	64	0.37

There were no significant relationships between level of education and livestock management strategies for either cattle of smallstock (χ^2 tests, P>0.05 for all).

There was no significant relationship between livestock management strategies for cattle ($F_{3,267}$ = 0.71; P>0.05) or smallstock ($F_{3,526}$ = 2.39; P=0.06) and the Conflict Index.

Kraal Design

The most often used kraal designs were wooden posts with wire (cattle = 58.9%, smallstock = 49.1%) and acacia bomas (cattle = 19.9%, smallstock = 37.7%). Fewer respondents used metal posts with fencing (cattle = 15.5%, smallstock = 6.4%), wood uprights (cattle = 4.8%, smallstock = 4.1%) or a combination of wood, wire and acacia (cattle = 0.8%, smallstock = 2.7%; Figure 4.22).

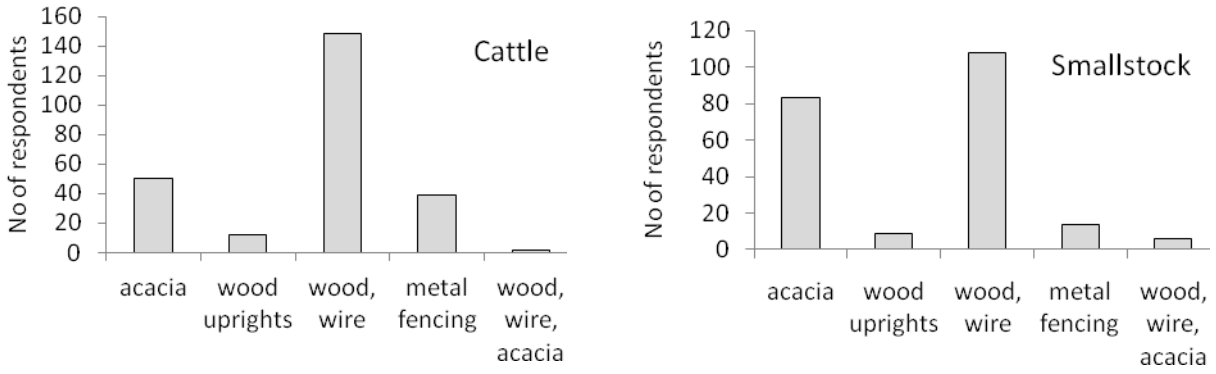


Figure 4.22. *Kraal designs utilised by farmers for cattle and smallstock.*

For cattle, there was a significant relationship between kraal design and Conflict Index ($F_{4,246}$ = 5.66; P<0.05; Figure 4.23). Respondents who built cattle kraals from metal poles and wire, and wood and wire had significantly lower Conflict Index than those who built their kraals from acacia wood and other wood (P<0.05).

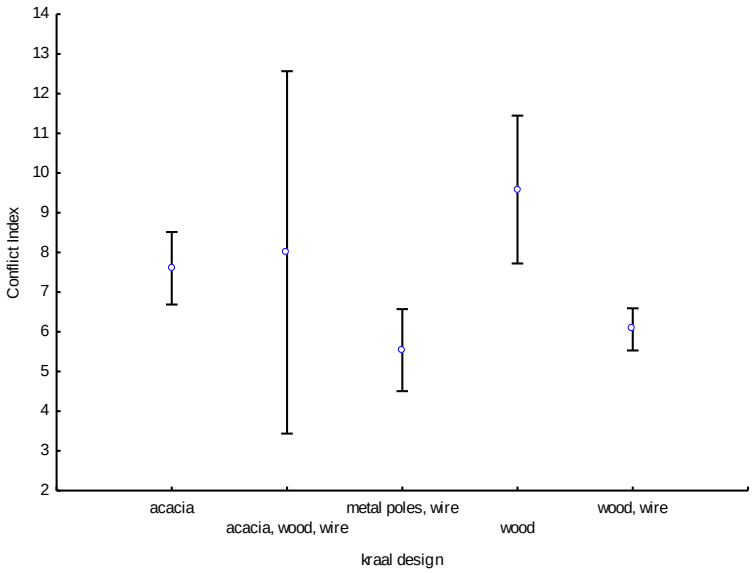


Figure 4.23. *The relationship between kraal design for cattle and Conflict Index. Data are means with 95% CI.*

For smallstock, there was a significant relationship between kraal design and Conflict Index ($F_{4,215}$ = 3.83; P<0.05) and respondents who built kraals from wood and wire had significantly lower Conflict Index than those who built their kraals from acacia wood (Figure 4.24).

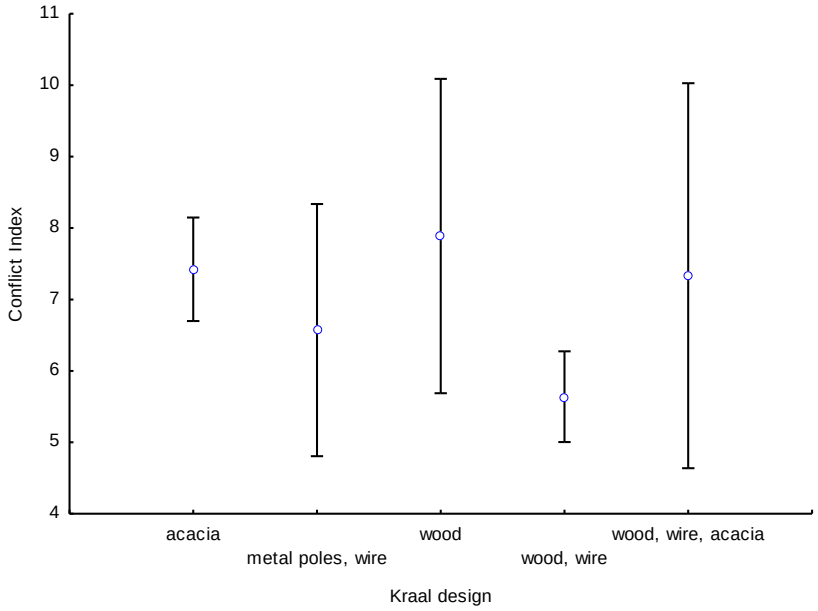


Figure 4.24. *The relationship between kraal design for smallstock and the Conflict Index. Data are means with 95% CI.*

There was no significant relationship between kraal design, livestock type (cattle, sheep and goats), and livestock loss ($F_{7,230}$ = 0.49; P>0.05).

Calving/Lambing Activities

Respondents were requested to detail their management practices during the calving or lambing, a time when livestock are most vulnerable to predation. There was some evidence of an improvement in management at this time. For cattle, 55.9% kraaled their livestock closer to the homestead, 60.6% checked the herds more often, while 57.0% kept the young kraaled both day and night (Table 4.14). For smallstock, 53.2% kraaled their livestock closer to the homestead, 58.9% checked the herds more often, while 60.5% kept the young kraaled day and night (Table 4.14).

In a two way ANOVA with Conflict Index as the dependent variable, and cattle management strategy during the calving season and whether or not each strategy was used (yes or no) as categorical variables, there was no significant relationship between management strategy and Conflict Index ($F_{5, 1608}$ = 1.00; P>0.05) while those who used a strategy had a significantly greater Conflict Index than those who did not ($F_{1,1608}$ = 30.70; P<0.05). There was a significant interaction between the two factors ($F_{5,1608}$ = 4.56; P<0.05) and for the strategies of checking more often, kraaling at night and kraaling young, those who used these strategies had significantly greater Conflict Indices than those who did not (P<0.05; Figure 4.25).

Table 4.14. *Summary of livestock management methods during calving and lambing. (n = number of respondents).*

		kraal closer to homestead		check more often		accurate records		kraal all at night		kraal young always		maternity kraal	
		n	%	n	%	n	%	n	%	n	%	n	%
Cattle	Yes	156	55.9	169	60.6	30	10.8	117	41.9	159	57.0	88	31.5
	No	123	44.1	110	39.4	249	89.2	162	58.1	120	43.0	191	68.5
	total	279	100.0	279	100.0	279	100.0	279	100.0	279	100.0	279	100.0
Small stock	Yes	132	53.2	146	58.9	22	8.9	118	47.6	150	60.5	70	28.2
	No	116	46.8	102	41.1	226	91.1	130	52.4	98	39.5	178	71.8
	total	248	100.0	248	100.0	248	100.0	248	100.0	248	100.0	248	100.0

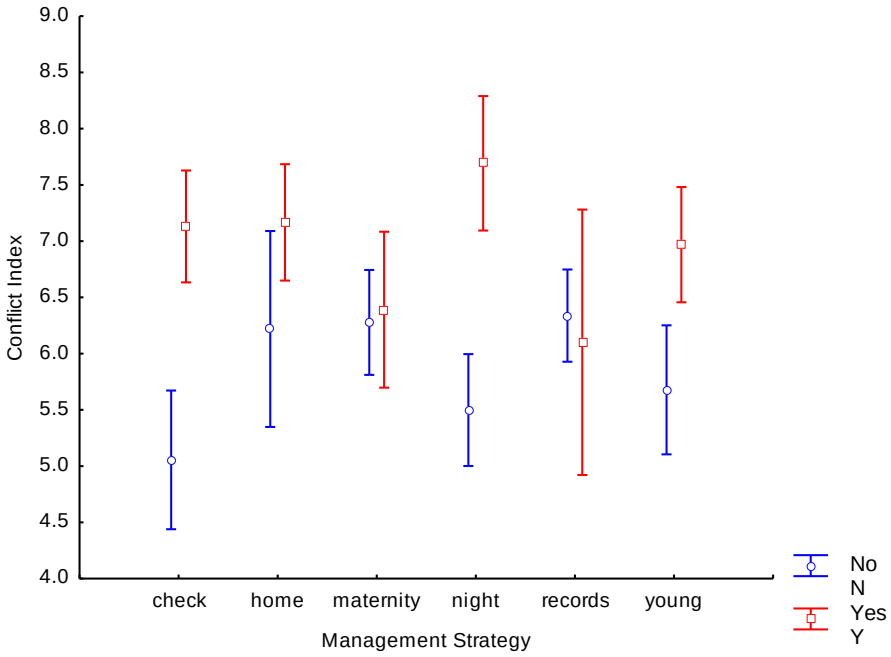


Figure 4.25. *The relationship between management during the calving season for Cattle and Conflict Index. Data are means with 95% CI. On the x axis, the management strategies are check (checking animals more often), home (kraaling closer to the homestead), maternity (use of a maternity kraal), night (kraaling all animals at night), records (keeping improved records), young (kraal young always).*

In a two way ANOVA with Conflict Index as the dependent variable, and smallstock management strategy during the lambing season and whether or not each strategy was used (yes or no) as categorical variables, there was no significant relationship between management strategy and Conflict Index ($F_{5.1446}$ = 0.24; P>0.05), a significant effect of whether or not the strategy was used ($F_{1,1446}$ = 64.8; P<0.05) and no interaction ($F_{5,1446}$ = 1.89; P>0.05). For all strategies except keeping better records, respondents who used the strategy had significantly higher Conflict Index than those who did not (Figure 4.26).

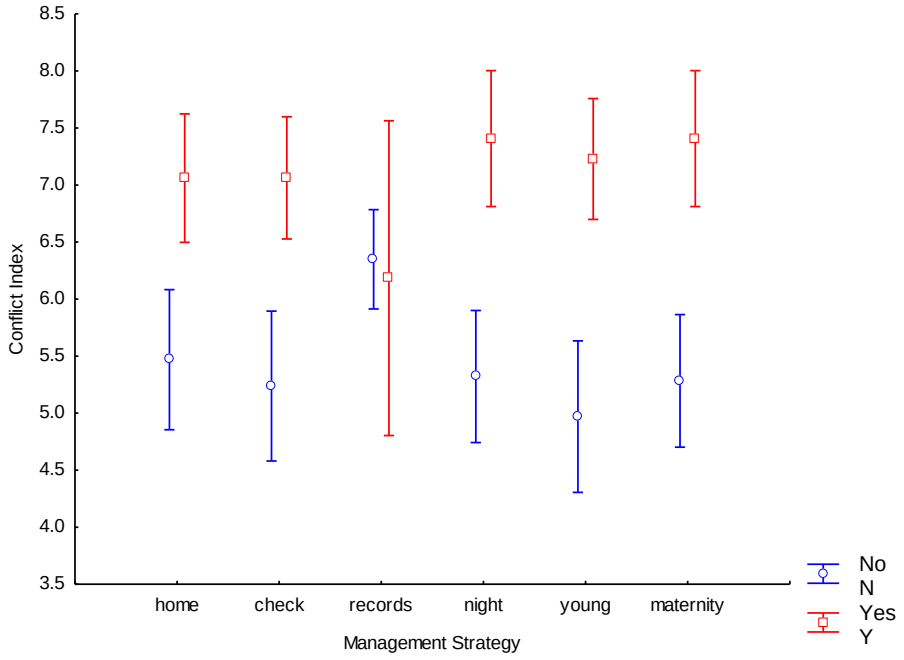


Figure 4.26. *The relationship between management during the lambing season for Smallstock and Conflict Index. Data are means with 95% CI. Legends on the x axis are as for Figure 4.20.*

Key Results Summary – Livestock Management Strategies

Management strategies were more regularly employed for smallstock than cattle, particularly kraaling at night and livestock guarding dogs. The proportion of respondents using the different management strategies was similar on cattleposts and ranches, although kraaling cattle at night was more often employed on cattleposts, while livestock guarding dogs was more often employed on ranches for smallstock. Female respondents kraaled cattle, smallstock and used calving seasons more regularly than males. The level of education was not significantly related to the amount of management occurring. There was no significant relationship between the use of these management practices and the Conflict Index. Kraals constructed from wood, metal and wire were associated with lower levels of conflict than kraals made from acacia wood. For cattle and smallstock, respondents who improved their management practices during calving and lambing also experienced higher conflict levels. The relationship between high Conflict Index and

improved or better livestock management practices has appeared regularly through these results.

4.6 Relationship between Predation, Conflict, Livestock Losses and Indices

Problems Encountered by Livestock Farmers

Respondents were asked to rank the four most problematic challenges for livestock farmers. For all farmers, the top ranked problem was predation (Tables 4.15, 4.16), followed by disease, insufficient grazing, drought and theft. There were significant differences in which challenge was ranked first, second and not ranked between the two farm types (rank 1, χ^2 = 22.61; rank 2, χ^2 = 21.46; rank 0, χ^2 = 20.49, df=9; P<0.05 for all) but not for rank 3 (χ^2 = 8.4; df=9; P>0.05). The rankings for disease (χ^2 = 29.68; df=4; P<0.05) and insufficient grazing (χ^2 = 10.38; df=4; P<0.05) were significantly different on the two farm types and there were no differences in ranking for the other challenges. Of the respondents on cattleposts, 69% ranked disease as a problem compared to only 23% on fenced ranches. The availability of grazing was a greater challenge on fenced ranches than on cattleposts.

Respondents were asked to rank carnivore species based on their experience of livestock losses, as the 1st, 2nd 3rd and 4th most problematic to farmers (Table 4.17, 4.18). Overall, jackal had the highest ranking, followed by leopard, brown hyena, wild dog, cheetah, lion, caracal and spotted hyena. There were significant differences in which carnivore species was ranked first, second and third between the two farm types (rank 0, χ^2 = 59.51; rank 1, χ^2 = 52.73; rank 2, χ^2 = 29.96; rank 3 , χ^2 =16.8, df=7; P<0.05 for all) but not for rank fourth (χ^2 = 7.38; df=7; P>0.05). The rankings for all the carnivores except the caracal and spotted hyena were significantly different on the two farm types. Lions (χ^2 = 20.03), brown hyenas (χ^2 = 22.56), wild dogs (χ^2 = 31. 15) and jackals (χ^2 = 56.6; df=4; P<0.05 for all) were perceived to be a problem more often on cattleposts than fenced ranches. Cheetahs were perceived to be a problem more often on fenced ranches than on cattleposts (χ^2 = 23; df=4; P<0.05).

Table 4.15. *Ranked problems experienced by livestock farmers on cattleposts. Data are number of respondents and that number as a proportion of those who responded.*

	Disease		Drought		Infertility		Predation		Insuff. grazing		Poor quality		Low yields		Market		Extension visits		Theft	
Rank	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop
0	53	0.30	119	0.66	167	0.93	12	0.07	129	0.72	169	0.94	178	0.99	171	0.96	169	0.94	120	0.67
1	32	0.18	17	0.09	4	0.02	81	0.45	18	0.10	0	0.00	0	0.00	1	0.01	2	0.01	23	0.13
2	58	0.32	24	0.13	1	0.01	51	0.28	13	0.07	2	0.01	0	0.00	1	0.01	3	0.02	15	0.08
3	34	0.19	18	0.10	5	0.03	33	0.18	17	0.09	8	0.04	1	0.01	5	0.03	5	0.03	17	0.09
4	2	0.01	1	0.01	2	0.01	2	0.01	2	0.01	0	0.00	0	0.00	1	0.01	0	0.00	4	0.02
total	179	1.00	179	1.00	179	1.00	179	1.00	179	1.00	179	1.00	179	1.00	179	1.00	179	1.00	179	1.00

Table 4.16. *Ranked problems experienced by livestock farmers on fenced ranches. Data are number of respondents and that number as a proportion of those who responded.*

	Disease		Drought		Infertility		Predation		Insuff. grazing		Poor quality		Low yields		Market		Extension visits		Theft	
Rank	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop
0	28	0.78	27	0.75	36	1.00	3	0.08	18	0.50	31	0.86	36	1.00	36	1.00	36	1.00	32	0.89
1	2	0.06	7	0.19	0	0.00	19	0.53	5	0.14	2	0.06	0	0.00	0	0.00	0	0.00	0	0.00
2	4	0.11	0	0.00	0	0.00	11	0.31	8	0.22	1	0.03	0	0.00	0	0.00	0	0.00	3	0.08
3	2	0.06	2	0.06	0	0.00	3	0.08	5	0.14	2	0.06	0	0.00	0	0.00	0	0.00	1	0.03
4	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
total	36	1.00	36	1.00	36	1.00	36	1.00	36	1.00	36	1.00	36	1.00	36	1.00	36	1.00	36	1.00

Table 4.17. *The ranking of predators in terms of problem for respondents on cattleposts.*

Rank	Lion		Cheetah		Leopard		Brown Hyena		Spotted Hyena		Wild dog		Jackal		Caracal	
	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop
0	144	0.75	156	0.81	60	0.31	113	0.59	188	0.98	96	0.50	10	0.05	188	0.98
1	4	0.02	17	0.09	36	0.19	18	0.09	2	0.01	42	0.22	102	0.53	0	0.00
2	13	0.07	9	0.05	52	0.27	29	0.15	1	0.01	37	0.19	50	0.26	1	0.01
3	24	0.13	7	0.04	38	0.20	29	0.15	1	0.01	16	0.08	24	0.13	3	0.02
4	7	0.04	3	0.02	6	0.03	3	0.02	0	0.00	1	0.01	6	0.03	0	0.00
Total	192	1.00	192	1.00	192	1.00	192	1.00	192	1.00	192	1.00	192	1.00	192	1.00
Ranking score*	130		68		278		175		7		168		298		11	
Rank	5		6		2		3		8		4		1		7	

Table 4 18. *The ranking of predators in terms of problem for respondents on fenced ranches.*

Rank	Lion		Cheetah		Leopard		Brown Hyena		Spotted Hyena		Wild dog		Jackal		Caracal	
	N	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop	n	prop
0	63	0.94	35	0.52	20	0.30	60	0.90	67	1.00	59	0.88	28	0.42	63	0.94
1	4	0.06	18	0.27	29	0.43	0	0.00	0	0.00	4	0.06	15	0.22	0	0.00
2	0	0.00	8	0.12	9	0.13	5	0.07	0	0.00	1	0.01	13	0.19	3	0.04
3	0	0.00	5	0.07	7	0.10	2	0.03	0	0.00	3	0.04	9	0.13	0	0.00
4	0	0.00	1	0.01	2	0.03	0	0.00	0	0.00	0	0.00	2	0.03	1	0.01
Total	67	1.00	67	1.00	67	1.00	67	1.00	67	1.00	67	1	67	1.00	67	1.00
Ranking score*	4		53		76		16		0		15		76		10	
Rank	7		3		1		4		8		5		1		6	

**Ranking score is calculated as the sum of rank multiplied by number of respondents reporting that rank for all ranks.*

Experience of Livestock Losses

Of the 310 respondents, 244 (78.7%) reported having lost livestock to carnivores in the preceding months, while 66 (21.3%) did not report loss of livestock. A significantly greater percentage of respondents from cattleposts (83.2%) reported livestock loss as compared to those from fenced ranches (65.4%; χ^2= 82.6; df=1; P<0.05). However, there was no significant difference in the mean number of livestock lost over the preceding 12 months, per respondent on cattleposts or fenced ranches (Mann-Whitney U test; Z = -0.68; P>0.05; Table 4.19).

There was no significant relationship between gender (χ^2= 3.51; df=1; P>0.05), number in family (Mann-Whitney U test; Z = -1.49; P>0.05) or monthly income (Mann-Whitney U test; Z = -1.16; P>0.05) and whether or not (yes or no) respondents lost livestock. Respondents who had not lost livestock were significantly older than those who had (t-test; t= -2.28; df=286; P<0.05; Figure 4.27).

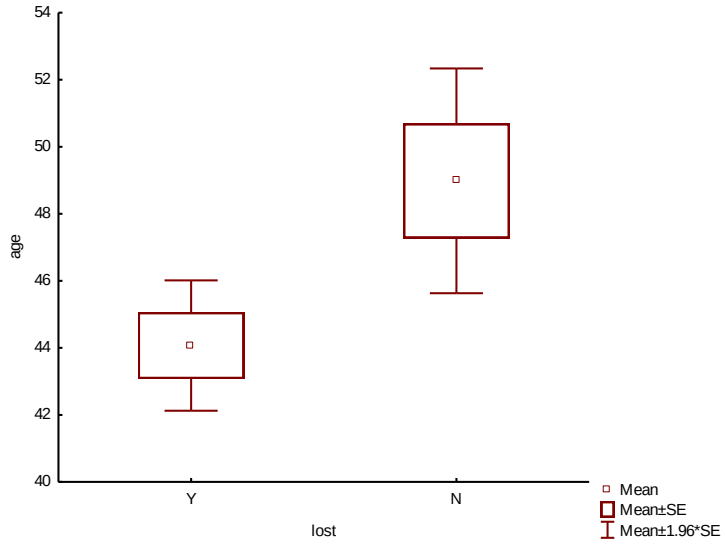


Figure 4.27. *The relationship between respondent's age and whether or not they had experienced stock loss.*

There was no significant relationship between gender (Mann-Whitney U test; Z = 0.49; P>0.05), age (Rs=-0.02, P>0.05), number in family (Rs=-0.03, P>0.05), monthly income (Rs=0.04, P>0.05) or level of education (KW ANOVA; $H_{3,291}$ = 2.05; P>0.05) and mean annual stock loss.

Table 4.19. *Summary of the percentage of respondents reporting livestock loss. n = number in that category reporting loss.*

		Livestock Loss		Mean no.	Proportion
		n	%	livestock lost	livestock lost
All respondents		244	78.7	4.2 ±6.8	11.2 ±18.9
Cattleposts		193	83.2	3.9 ±6.8	14.2 ±19.9
Fenced ranches		51	65.4	5.0 ±6.8	2.3 ±18.9
Male		163	75.8	4.5 ±7.6	10.2 ±19.7
Female		81	85.3	3.5 ±4.5	13.5 ±16.7
Education level	None	89	88.1	3.8 ±6.3	14.0 ±19.4
	Primary	39	69.6	3.5 ±5.4	8.7 ±16.8
	Secondary	80	75.5	4.2 ±5.7	13.4 ±21.7
	Tertiary	18	64.3	5.6 ±7.6	1.3 ±2.8
Source of income	Farm products	84	73.7	4.9 ±8.9	8.2 ±15.8
	Veld products	18	90.0	6.5 ±8.9	24.5 ±28.9
	Wildlife products	34	100.0	3.1 ±3.1	18.9 ±22.8
	Employment	38	84.4	3.3 ±4.6	10.2 ±13.2
	Own business	46	75.4	4.1 ±5.4	7.2 ±12.9
	Mixed income	24	78.7	2.9 ±3.5	14.2 ±25.6

There was a relationship between highest education level and whether or not respondents had experienced stock loss (χ^2 =11.62, df=3, P<0.01) with respondents who had no schooling reporting stock loss significantly more often than those who had received primary, secondary or tertiary education (P<0.05; Table 4.19).

There was a significant relationship between source of income and whether or not stock loss was experienced (χ^2 =20.9, df=5, P<0.01; Table 4.20). A smaller proportion of respondents who received an income from employment and the sale of farm products had experienced stock loss than those in their own business and veld product groups.

Table 4.20. *Summary of the relationship between source of income and whether or not stock loss had been experienced.*

Source of	YES		NO	
income	N	prop	n	prop
Employment	46	0.75	15	0.25
Mixed	48	0.80	12	0.20
Own Business	76	0.92	7	0.08
Farm products	84	0.74	30	0.26
Veld products	34	1.00	0	0.00
Wildlife products	18	0.90	2	0.10

Respondents who had experienced stock loss had significantly greater Management Indices (Cattle: t = -3.68; df=277; p<0.05, Smallstock: Mann-Whitney U test; Z = -3.50, P<0.01), Tolerance Index (Mann-Whitney U test; Z = 2.63; P<0.01) and Carnivore Index (t = 3.78; df=308; P<0.05) than those that had not lost livestock (Table 4.21).

Table 4.21. *The relationship between livestock loss and Management, Tolerance and Carnivore Presence Indices (n = number of respondents, SD in brackets).*

	Yes		No	
	n	**Mean**	**n**	**Mean**
Management Index Cattle	219	8.8 (±4.0)	60	6.7 (±3.5)
Management Index Smallstock	202	13.6 (±5.2)	47	10.3 (±5.7)
Tolerance index	244	3.4 (±1.9)	66	2.7 (±2.1)
Carnivore Presence Index	244	17.2 (±7.2)	66	13.2 (±8.7)

Conflict Incident Reports

Respondents were asked to detail their conflict experiences over the last year of their operations. A total of 1325 livestock were lost in the preceding 12 months (Figure 4.28), in 303 separate conflict incidents. The mean total number of livestock lost to predation per respondent was 4.3 (±6.9; range 0-63) animals in a 12 month period (Table 4.22), representing approximately 0.9% of mean total livestock owned.

Table 4.22. *Total livestock owned lost to carnivores. (SD in brackets)*

	Mean	**Median**	**Range**	**Sum**
total livestock owned	452.4(±1291.5)	62.0	0-14200	140234
total livestock lost to carnivores	4.3(±6.9)	2.0	0-63	1325

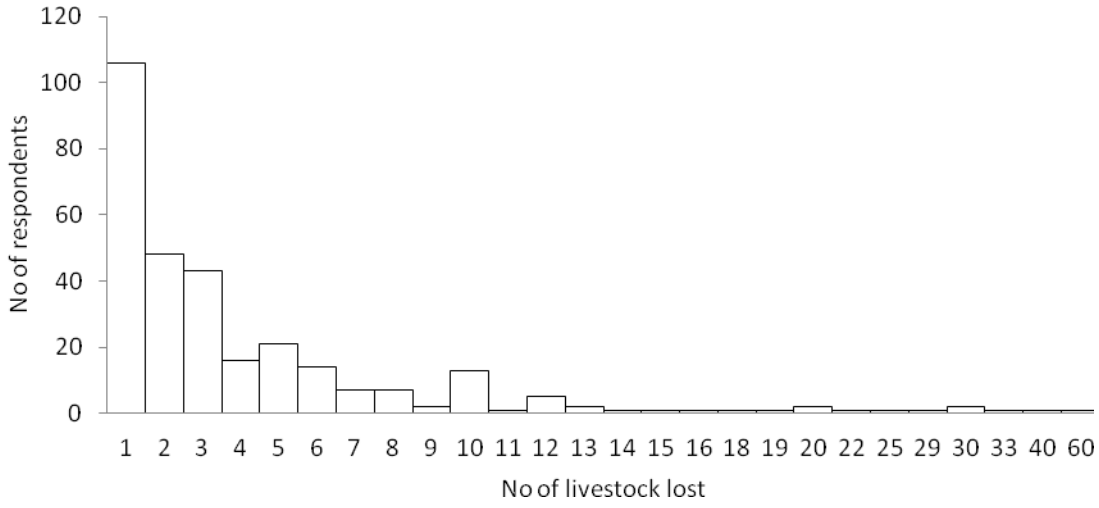


Figure 4.28. *Frequency of numbers of livestock lost to carnivores as reported by respondents.*

There was a weak but significant, positive correlation between the number of livestock lost to carnivores per respondent and the Cattle Management (Rs = 0.16, P<0.01) and Carnivore Indices (Rs = 0.15, P<0.01) but not Smallstock Management (Rs=0.08, P>0.05) or Tolerance Indices (Rs = 0.007, P>0.05). When stock loss was expressed as a proportion of total livestock owned, there was a weak but significant correlation with Cattle Management (Rs = 0.27, P<0.05), Tolerance Indices (Rs=0.14, P<0.05) but not with the Carnivore Index (Rs = 0.11; P>0.05) or Smallstock Management Index (Rs = 0.024, P>0.05).

There was no significant relationship between gender and the total number of livestock lost (Mann-Whitney U test; Z = -0.49; P>0.05) but there was a significant difference in the proportion of livestock lost (Mann-Whitney U test; Z = -3.38, P<0.01) with females experiencing higher levels of loss than males.

Farm type had a significant effect on proportion of livestock lost (Mann-Whitney U test; Z = 6.21; P<0.05) with a greater proportion being lost from cattleposts than from fenced ranches (Mann-Whitney U test; Z = -0.68; P>0.05).

There was no significant relationship between total stock loss and level of education (KW ANOVA; $H_{3,291}$ = 2.05; P>0.05) however, proportional stock loss was related to education

level (KW ANOVA; $H_{3,291}$ = 18.59; P<0.01). Respondents who had received tertiary education reported significantly less stock loss as a proportion of total livestock holdings than those with no schooling or secondary schooling (Figure 4.29).

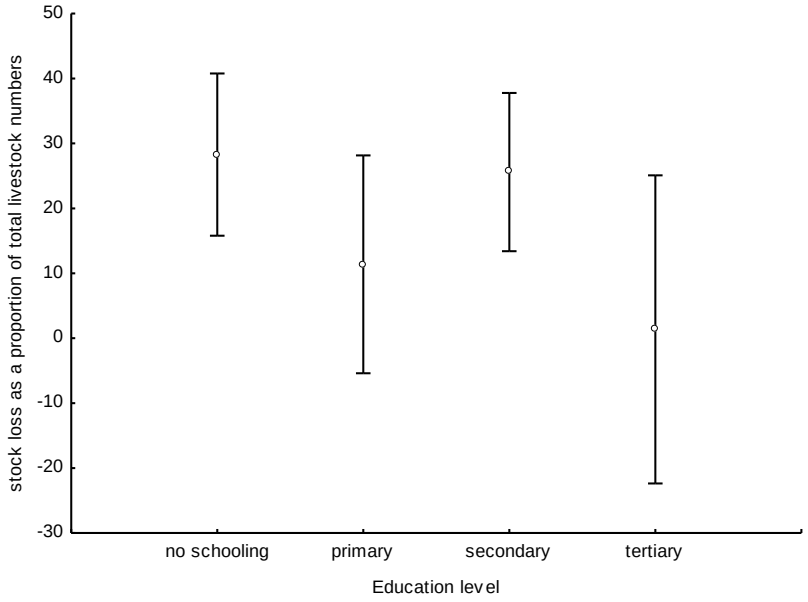


Figure 4.29. *Proportional losses over the last 12 months in different education group. (Data are mean ±95%CI)*

Livestock Species Taken

Of the respondents, 236 reported livestock loss with 303 events of loss and 1325 animals killed. Most predation events were of goats and cattle with more than twice as many goats being killed than cattle (Table 4.23).

Table 4.23. *Summary of Livestock Species Taken by Carnivores in last 12 months. (n = sample size).*

	Depredation events		Livestock lost	
	N	%	N	%
Cattle	126	41.6	372	28.1
Goats	143	47.2	864	65.2
Sheep	19	6.3	56	4.2
Horses	6	2.0	10	0.8
Poultry	6	2.0	17	1.3
Donkeys	3	1.0	6	0.5
Totals	303		1325	

There was a significant difference in the proportions of adults and young killed of the livestock species (χ^2 = 164.75; df=10; P<0.05). Adult sheep were predated upon more often than young, while for cattle and goats the young were killed more often than adults (Table 4.24).

Table 4.24. *Summary of the numbers of adult and young livestock killed by predators. In the mixed age group; livestock killed were of mixed ages.*

	cattle		goat		sheep		horse		fowl		donkey	
Age	N	prop	N	prop	N	prop	N	prop	N	prop	N	prop
adult	51	0.17	153	0.20	33	0.60	3	1.0	11	1.0	4	1.0
young	228	0.78	444	0.58	19	0.35	0	0	0	0	0	0
mixed	14	0.05	167	0.22	3	0.05	0	0	0	0	0	0
total	293	1.00	764	1.00	55	1	3	1	11	1	4	1

There was no clear preference for gender of the livestock killed, although in 140 single sex depredation reports, females (79; 56.5%) were taken slightly more often than males (61; 43.6%).

Carnivore Species Responsible

Of the 303 predation events reported by respondents over the preceding 12 months, leopards were reported to be responsible for the greatest number of depredation events, followed by jackals, cheetahs and wild dogs (Table 4.25).

Table 4.25. *Summary of Carnivore Species identified as being responsible for livestock losses in the preceding 12 months. (n = number of respondents reporting loss to that predator species).*

Species	**n**	**%**
leopard	91	30
jackal	84	27.7
cheetah	42	13.9
wild dog	42	13.9
brown hyena	22	7.3
lion	19	6.3
spotted hyena	2	0.7
caracal	1	0.3
Total	303	

Circumstances of Predation

Over the preceding 12 months, the majority of livestock losses occurred during the winter months (62%) compared to summer (38%). Depredation took place throughout the day and night, although a greater number of events occurred at night (41%), followed by the afternoon (35%) and morning (24%). The majority of cases occurred in the veld (82%) as opposed to in the kraals (16%) and 85% of depredation events happened in the absence of a herder (85%) (Table 4.26).

Table 4.26. *Summary of common circumstances of attacks on livestock.*

			Time of day			**Location**			**Presence of herder**		
Season	**n**	**%**		**n**	**%**		**n**	**%**		**n**	**%**
summer	89	37.71	morning	60	24.39	veld	214	82.31	present	10	14.9
winter	147	62.29	afternoon	86	34.96	kraal	41	15.77	absent	139	85.1
			night	100	40.65	borehole	3	1.15			
						road	2	0.77			

Respondents were also asked if they perceived livestock losses to have been seasonal over the last ten years. The majority of respondents confirmed that winter was the most common season for livestock losses (57%), while only 14% regarded summer as the period of more frequent conflict. Twenty nine percent reported they experienced livestock losses all year round.

Proportional Livestock Losses to Predation and other causes

Respondents were asked to detail their total livestock losses to all causes, over the preceding 12 months. Overall, predation was perceived to be responsible for 46% of all annual livestock losses, followed by disease, theft, starvation during drought, accidents and calving problems (Table 4.27). There was a significant difference between cattleposts and fenced ranches ($\chi^2 = 99.49$; df=5; $P<0.05$), and predation and starvation were greater causes of death on cattleposts than on fenced ranches (Table 4.27). Disease and calving were greater causes of death on fenced ranches than on cattleposts (Table 4.27).

Table 4.27. *Summary of the reported causes of livestock death on cattleposts and ranches*.

Causes of death	Cattlepost		Fenced Ranch		Combined	
	N	prop	N	prop	N	prop
Predation	933	0.49	392	0.41	1325	0.46
Disease	404	0.21	305	0.32	709	0.25
Calving	57	0.03	67	0.07	124	0.04
Accident	123	0.06	36	0.04	159	0.06
Starvation	215	0.11	50	0.05	265	0.09
Theft	168	0.09	109	0.11	277	0.10
Total	1900		959		2859	

Value of Livestock Losses to Predation

The total value of livestock loss to all causes in the preceding year was BWP 922,115.00. Respondents reported that predation was the cause of considerable financial losses (BWP 1673 ±4086 per respondent) with a total value of BWP 379,665.00(Table 4.28).

Table 4.28. *Value of livestock losses per year. (n=226 respondents, SD in brackets).*

	Mean	**Range**	**Sum**
value of total livestock losses (BWP)	4062 (±6931)	0-58250	922115
value of livestock losses to carnivores (BWP)	1673 (±4086)	0-49289	379665
proportion of income lost to predation (%)	31% (±37%)	0-100	-

There was a weak but significant correlation between the value of livestock lost and the Carnivore Index ($R_s = 0.17$; $P<0.05$). There was no significant correlation between the value of stock lost to carnivore depredation and the Cattle Management Index ($R_s = 0.11$; $P>0.05$), Smallstock Management Index ($R_s = 0.025$; $P>0.05$) or the Tolerance Index ($R_s = 0.05$, $P>0.05$). When losses were expressed as a proportion of income, there was a significant positive correlation with the Cattle Management Index ($R_s = 0.21$, $P<0.05$) and the Carnivore Index ($R_s = 0.17$; $P<0.05$). However, there was no significant correlation with the Smallstock Management Index ($R_s = -0.02$; $P>0.05$) or Tolerance Index ($R_s = 0.02$, $P>0.05$).

Trends in Levels of Livestock Loss

Of 310 respondents, 150 (48.4%) believed that levels of livestock loss had increased over the last 10 years (Table 4.29).

Table 4.29. *Perceived trends in conflict over the last 10 years. (n = number of respondents).*

Trends	n	%
decrease	21	6.8
stable	44	14.2
increase	150	48.4
unknown	95	30.6

There were no significant relationships between perceived change in stock loss and the Cattle Management ($F_{2,190}$ = 2.85; P>0.05), Smallstock Management ($F_{2,169}$ = 1.07; P>0.05), Tolerance (KW ANOVA; $H_{2,215}$ = 1.09; P>0.05) or the Carnivore Indices ($F_{2,212}$=2.07; P>0.05).

Actions Taken in Response to Livestock Losses

The majority of respondents took some form of action after a depredation event. These included reporting the loss to DWNP (58.1%) or to the owner (1.6%); while only 3.9% admitted to shooting a carnivore. No action at all was taken by 8.4% of respondents. (Figure 4.30). Twenty eight percent of respondents did not wish to answer this question as government prosecution can take place if a carnivore is removed without DWNP permits and permissions.

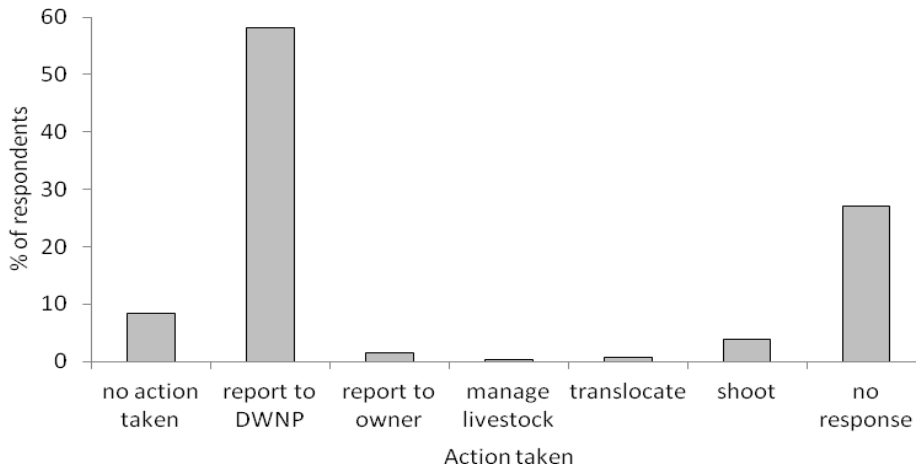


Figure 4.30. *Summary of actions taken in response to livestock loss.*

There was a significant relationship between the action taken to stock losses and the Cattle Management Index (ANOVA; $F_{7,271}$ = 5.76; P<0.01; Figure 4.26), and those who reported incidents to the DNWP had significantly higher Cattle Management Indices than those who did not respond or shot the predator (Figure 4.31).

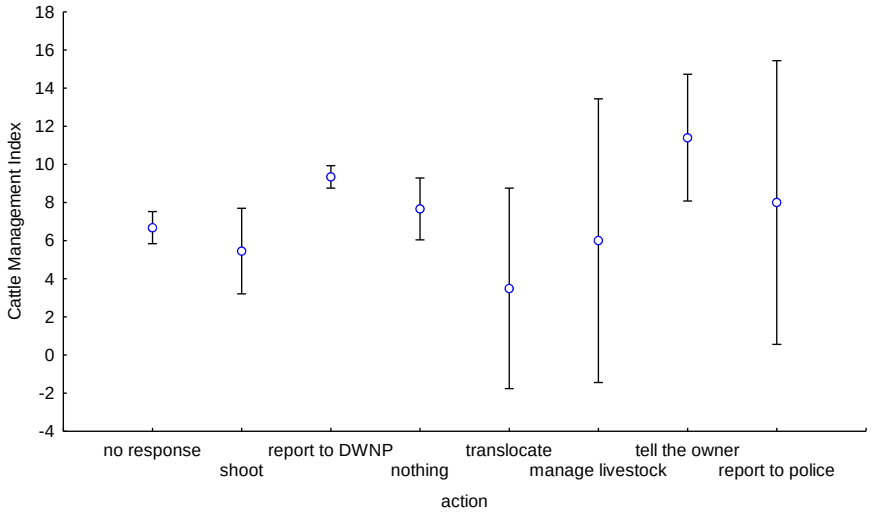


Figure 4.31*. The relationship between action taken in response to stock loss and the Cattle Management Index. Data are means with 95% CI.*

For Smallstock, there was a significant relationship between management and the action taken ($H_{6,249} = 15.8$; $P<0.01$). The only significantly difference was for those who reported incidents to the DWNP whose Smallstock Management Index was greater than those who did not respond (Figure 4.32).

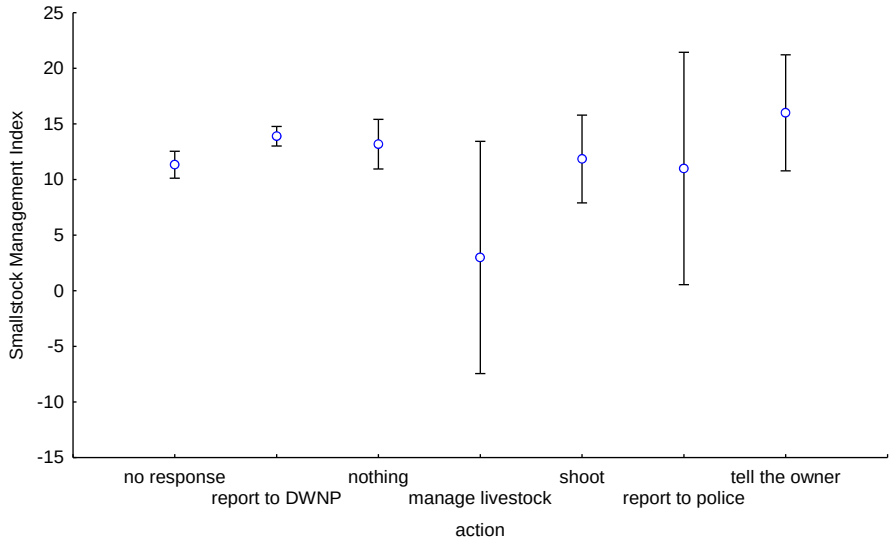


Figure 4.32. *The relationship between action taken in response to stock loss and the Smallstock Management Index. Data are means with 95% CI.*

There was a significant relationship between the action taken to losses and the Tolerance Index (KW ANOVA; $H_{7,310} = 43.47$; $P<0.05$) and those who reported the incident to the DNWP had a significantly greater Tolerance Index than those who did not respond. No other pairs were significantly different ($P>0.05$ for all).

There was also a significant relationship between the action taken to losses and the Carnivore Index ($F_{7,302} = 8.19$; $P<0.05$) and those who shot carnivores had significantly higher Carnivore Index than those who did not respond, did nothing or reported the incident to the DWNP (Figure 4.33).

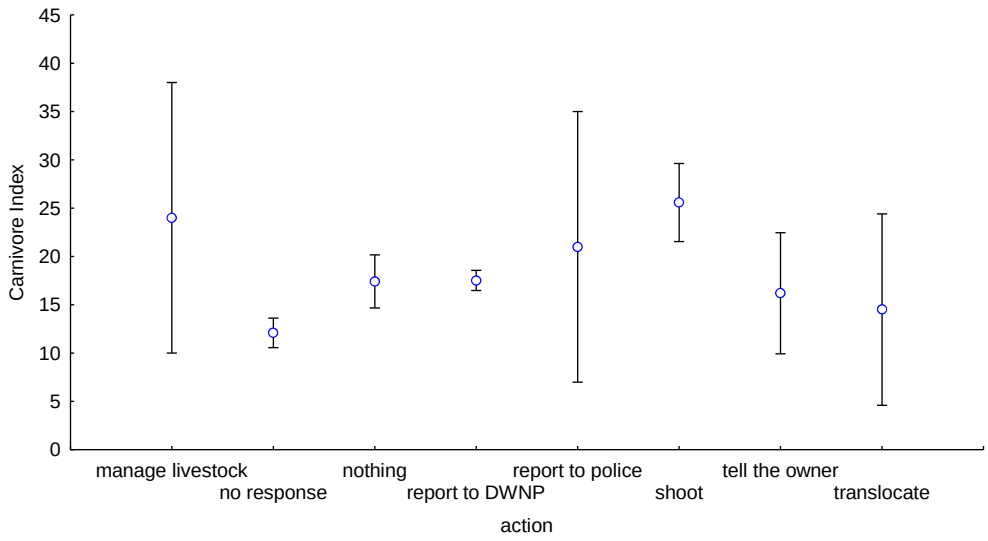


Figure 4.33. *The relationship between action taken in response to stock loss and the Carnivore Index. Data are means with 95% CI.*

Respondents were also asked if they had removed a carnivore over the last 10 years. The majority claimed they had not removed a carnivore (51.0%) while 23.9% admitted they had done so. The most common method of removal was shooting (36.4%), 29.1% used box and gin traps to trap and then killed the carnivore, 20% drove the carnivore away with the assistance of DWNP, 9.1% hunted the culprit with dogs and 5.5% used poisoned carcasses. There was no significant relationship between whether or not a carnivore was removed (Mann-Whitney U test; Z=-0.09, P>0.05) or method of removal (KW ANOVA; $H_{6,55}$ = 6.07; P>0.05) and the Tolerance Index. As expected, the respondents who had a predator removed had a significantly higher Conflict Index than those who had not (t = -2.12; df= 230; P<0.05).

Compensation

Respondents were asked if they had received compensation for their losses over the last 12 months and 77 (31.3%) respondents answered yes. There were significant relationships between compensation and Conflict Index, with compensated respondents having higher Conflict Index than those who had not (Yes $\bar{x}$=7.1, ±1.5; No $\bar{x}$=4.9, ±2.9; t = -8.51; df=308; P<0.01), Cattle Management Index (Yes $\bar{x}$=9.0, ±3.7; No $\bar{x}$=7.9, ±4.1; t=-2.10; df=277; P<0.05), Tolerance Index (Yes $\bar{x}$=13.8, ±5.4; No $\bar{x}$=12.7, ±5.4; Z=-3.03 P<0.01) and Carnivore Index (Yes $\bar{x}$= 18.6 ± 1.3; No $\bar{x}$= 15.3 ± 1.7; t=-3.66; df=308; P<0.05). The relationship between compensation and Smallstock Management Index was not significant (Mann-Whitney U test; Z=-1.57 P>0.05).

Key Results Summary – Predation, Conflict and Livestock Losses

Of all losses due to any reason over the last 12 months predation was the most often reported, followed by disease, theft, lack of grazing and drought. Respondents reported that the worst problems for farmers were predation, disease, lack of grazing, drought and theft. This varied between cattleposts and ranches, with disease being a greater problem on cattleposts than on ranches, while lack of grazing was more often a problem on ranches than on cattleposts. Cattleposts reported that lions, brown hyenas, wild dogs and jackals were a problem more often than respondents from ranches, while respondents on ranches reported greater problems with cheetahs. Cattleposts reported more incidents of losses although there was no difference in average number of livestock lost. Mean annual stock loss was not related to gender, age, number in family, education, income or source of income, although respondents who had not experienced stock loss were older than those that had lost livestock. Those with no schooling reported losses more often than those with any level of education. More loss reported by respondents who made a living from veld products and own business than employment and the sale of farm products. Those that had lost livestock had higher Carnivore, Management and Tolerance Indices. The number lost was weakly positively correlated to the Carnivore Index and both the

number lost and proportion of total livestock holdings lost were weakly positively correlated to the Cattle Management Index.

Although there was no difference in total livestock lost between genders, the proportional loss was greater for female respondents. Greater proportional loss also occurred on cattleposts than ranches. Other socio-economic variables did not affect proportional loss except education where those with some tertiary education reported the loss of a smaller proportion of their total livestock holdings than other education groups. The proportion of income lost to predation was positively correlated with Carnivore and Cattle Management Indices.

Adult goats and cattle were predated upon the most, while females were taken slightly more than males. The carnivore species responsible for most losses over the preceding 12 months were leopards, jackals, cheetahs and wild dogs. Livestock losses were more common in winter, at night, out in the veld away from kraals and in the absence of a herder.

Most respondents perceived livestock loss to be increasing over time although this was correlated with any of the indices. Most respondents claimed that they reported losses to DWNP rather than removing or shooting a carnivore, and this group had higher Management and Tolerance Indices. However, over the preceding 10 years 24% of respondents had removed a predator and most commonly through shooting. Individuals who had received compensation had higher Tolerance Conflict, Cattle Management and Carnivore Indices.

4.7 Relationship between Perceptions and the Indices

Attitudes

Most respondents had a negative attitude towards living with carnivores, with 55.8% disliking them and a further 9.4% killing them whenever possible (see Methods 3.2.1 for definitions). A positive attitude was reported by 26.5% of respondents with 21.9% liking carnivores and 4.5% believing them to be a benefit to the region (Table 4.30).

Table 4.30. *Respondents' attitudes to carnivore species. (n = number of respondents).*

Attitude	n	%
kill	29	9.4
dislike	173	55.8
like	68	21.9
benefit	14	4.5
unsure	26	8.4

There was a significant positive relationship between attitude and Cattle Management Index (ANOVA; $F_{4,274}$= 3.82; P<0.01; Figure 4.34) and level of cattle management was significantly higher for respondents who claimed to like carnivores than those that killed them.

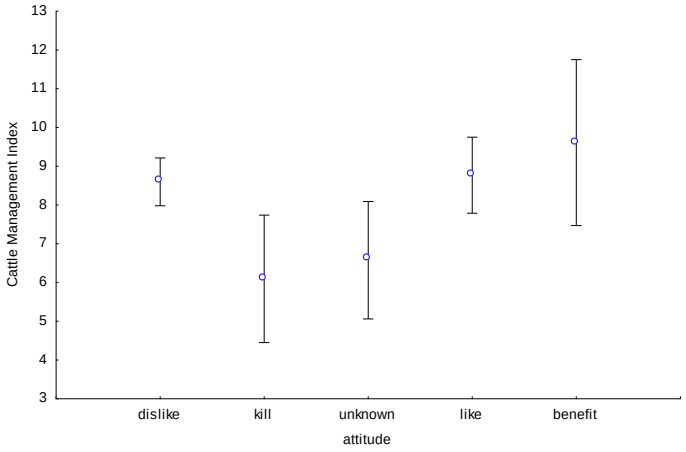


Figure 4.34. *The relationship between attitude and cattle management Index. Data are means with 95% CI.*

Similarly, there was a significant positive relationship between attitude and Smallstock Management Index (KW ANOVA; $H_{4,249}$ = 13.61; P<0.05; Figure 4.35). Values were significantly higher for respondents who claimed to like carnivores than those who killed them.

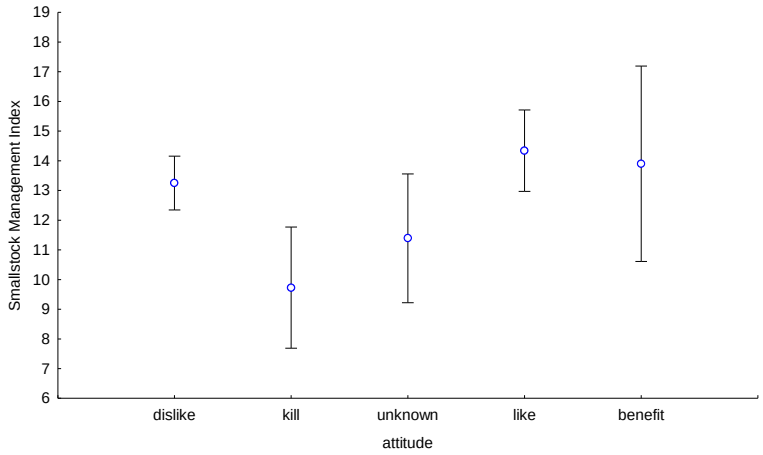


Figure 4.35. *The relationship between attitude and smallstock management Index. Data are means with 95% CI.*

Since there was a significant relationship between the respondents' attitude towards carnivores and the Management Indices, and it is assumed that good management is a goal, then an important question is what drives attitude.

Attitude differed significantly between farm types (χ^2 = 25.84; df=4; P<0.05; Table 4.31). A greater proportion of respondents from cattleposts claimed to dislike carnivores than those from fenced ranches while a greater proportion of respondents from fenced ranches claimed to like carnivores.

Table 4.31. *The relationship between attitude towards carnivores and farm type.*

	Cattlepost		Fenced ranch	
	N	prop	N	prop
Benefit	8	0.03	6	0.08
Like	44	0.17	24	0.31
Dislike	146	0.58	27	0.35
Kill	42	0.17	8	0.10
Unknown	13	0.05	13	0.17
Totals	253	1.00	78	1.00

There was no significant effect of gender on attitude (χ^2 = 5.72; df=4; p>0.05) or of age (ANOVA; $F_{4,283}$ = 0.15; P>0.05). There was a relationship between number in family and attitude (KW ANOVA; $H_{4,221}$ = 9.8; P= 0.043) where respondents who saw a benefit in carnivores had a significantly larger family size than those who were unsure (P<0.05; no other pairs significantly different).

There was no relationship between monthly income and attitude towards predators (KW ANOVA; $H_{4,197}$ = 7.66; P>0.05) or between the source of that income and attitude (KW χ^2 = 23.22, df=20, P>0.05).

Respondents' attitude towards predators was significantly related to education levels χ^2 = 21.4, df= 12, P= 0.045). Those with tertiary education had the highest proportion of respondents who saw benefit in predators and who liked predators, and the lowest proportion that disliked them. However, respondents with no education had the lowest proportion that reported killing predators (Table 4.32).

Table 4.32. *The relationship between schooling of the respondents and their attitude towards carnivores.*

	Attitude					
Schooling	benefit	like	dislike	kill	unknown	totals
None	5	19	68	3	6	101
Primary	2	11	29	8	6	56
Secondary	4	26	54	14	8	106
Tertiary	3	7	9	4	5	28
Proportions						
None	0.05	0.19	0.67	0.03	0.06	1
Primary	0.04	0.20	0.52	0.14	0.11	1
Secondary	0.04	0.25	0.51	0.13	0.08	1
Tertiary	0.11	0.25	0.32	0.14	0.18	1

There was no significant relationship between the total number of livestock owned and attitude (KW ANOVA; $H_{4,304} = 0.21$; $P>0.05$) or between the proportion of livestock lost to predation and attitude towards predators (KW ANOVA; $H_{4,184} = 4.8$; $P>0.05$).

There was a significant relationship between attitude and whether or not the respondents had received compensation ($\chi^2 = 24.99$, df=4, $P>0.0005$). The proportion of those who had received compensation, who disliked predators, was almost double that of those who had not received compensation yet of those who received compensation, a very low proportion claimed that they would kill a predator (Table 4.33).

Table 4.33. *The relationship between attitude towards carnivores and whether or not the respondents had received compensation.*

	Attitude					
compensation	benefit	dislike	kill	like	unknown	totals
yes	7	68	1	19	2	97
no	7	105	28	49	24	213
Proportions						
yes	0.07	0.70	0.01	0.20	0.02	1
no	0.03	0.49	0.13	0.23	0.11	1

The reasons stated for negative perceptions towards carnivores were that they were a threat to livestock (57.7%) and a threat to human life (21.1%). Reasons for positive attitudes were that they were an assett for tourism (9.9%), part of nature and the environment (9.4%) and a resource for future generations (1.9%).

Overall 68.4% of respondents believed carnivores were a national resource to the country. There was no significant difference in Conflict ($F_{1, 259}$ =2.1 P>0.05), Cattle Management ($F_{1, 230}$ = 1.65; P>0.05), or Carnivore Indices ($F_{1,259}$ =1.7; P>0.05) between those who believed carnivores were a national resource and those who did not. However, those who believed that carnivores were a national resource had significantly greater Smallstock Management Index (KW ANOVA; $H_{1,214}$ = 13.47 ; P<0.05) than those who did not.

Responsibility of Reducing Conflict

Respondents were asked to indicate who they felt was responsible for reducing livestock losses. Most respondents felt that the responsibility for reducing livestock losses to carnivores belonged to the government (45.0%) or farmers (37.9%) with fewer believing conservation groups (13.3%) and finally herders (3.8%) were responsible (Table 4.34).

Table 4.34. *Summary of how the respondents allocated responsibility for controlling livestock loss.*

	Responsibility								
Respondents	conservation		farmers		government		herders		
n	52		148		176		15		
%	13.30		37.85		45.01		3.84		
Schooling	n	prop	n	prop	n	prop	n	prop	total
No schooling	17	0.10	67	0.40	78	0.46	7	0.04	169
Primary	14	0.20	22	0.31	32	0.45	3	0.04	71
Secondary	16	0.13	51	0.40	56	0.44	5	0.04	128
Tertiary	5	0.22	8	0.35	10	0.43	0	0.00	23

Perceptions of responsibility were not influenced by farm type (χ^2 = 17.4; df = 11; P>0.05), gender (χ^2 =15.8; df = 11; P>0.05), education level (χ^2 = 7.11, df = 9, P >0.05), monthly

income ($H_{11,198}$ = 7.4; P>0.05), source of income (χ^2 =3.62, df=5, P>0.05) or total livestock owned ($H_{13,310}$ = 0.48; P>0.05).

Best Solutions to Reduce Conflict

Respondents were asked to suggest the best solutions (see Methods 3.2.1 for definitions). to reduce carnivore conflict (Table 4.35). Suggested best solutions differed significantly between the farm types (χ^2 =31.7, df =7; P<0.05). A greater proportion of respondents on cattleposts favored improved management and compensation than those on fenced ranches, while more respondents from fenced ranches favored sustainable use of the carnivores than those from cattleposts (Table 4.35).

Table 4.35. *The relationship between farm type and suggested best solution to managing conflict. Data are numbers and proportions of respondents on each farm type.*

	cattlepost		fenced ranch	
Best solution	n	prop	n	prop
compensate	32	0.15	5	0.08
conservation	1	0.00	1	0.02
decrease numbers	20	0.09	2	0.03
educate	1	0.00	3	0.05
improve management	79	0.37	14	0.23
sustainable use	23	0.11	19	0.31
tourism	3	0.01	4	0.07
translocation	52	0.25	13	0.21
Totals	211	1.00	61	1

There was no relationship between gender and suggested best solution (χ^2 = 5.33; df= 7; P>0.05). There was a significant relationship between level of education and best solution (χ^2 = 40.56; df= 21; p<0.005). A greater proportion of respondents with no schooling suggested improving farm management and translocation of predators than did those with tertiary education. A greater proportion of those with tertiary education suggested sustainable utilization of the predators and did not support translocation (Table 4.36).

Table 4.36. *The relationship between schooling and suggested best solution to the predator problem.*

	Schooling							
	none		1		2		3	
Best solution	n	prop	n	prop	n	prop	n	prop
compensate	13	0.14	8	0.17	13	0.14	3	0.14
conservation	0	0.00	1	0.02	0	0.00	1	0.05
decrease numbers	10	0.11	3	0.06	7	0.07	0	0.00
educate	1	0.01	1	0.02	2	0.02	0	0.00
improve management	36	0.40	15	0.32	30	0.32	4	0.18
sustainable use	8	0.09	5	0.11	17	0.18	9	0.41
tourism	1	0.01	0	0.00	3	0.03	3	0.14
translocation	21	0.23	14	0.30	22	0.23	2	0.09
Totals	90	1.00	47	1.00	94	1.00	22	1.00

There was no significant relationship between annual income of respondents and their suggested best solutions to the problems caused by predators (KW ANOVA; $H_{6,178}$=11.48; P>0.05), or between source of income and suggested solutions (χ^2 =35.44, df=30, P>0.05). There was no relationship between the number of livestock owned and suggested best solutions (KW ANOVA; $H_{7,267}$ = 12.36; P>0.05).

Key Results Summary – Perceptions

Most respondents had negative attitudes towards living with carnivore. Improved attitudes were found amongst those with higher Cattle and Smallstock Management indices and a greater proportion of respondents from ranches had a positive attitude towards carnivores. Education was significantly related to attitude and those with tertiary level education saw the most benefit in carnivores. However, respondents with no education had the lowest proportion or respondents which killed predators. Respondents who had received compensation for stock loss were more likely to dislike carnivores (but very few reported that they would kill them), than respondents who had not received compensation. No other factor was significantly related with attitudes.

The reasons for negative perceptions were the threat to livestock and humans, while tourism, being part of nature and important for future generations were reasons for positive attitudes. Most respondents felt that carnivores were a national resource and

such respondents were had higher Smallstock Management Index. Responsibility for livestock conflict was mostly considered to be the governments and farmers followed a close second. This perception was not significantly affected by any of the socio-economic variables. The best solutions to reduce conflict amongst cattlepost respondents were improved management and compensation, while respondents on ranches wanted sustainable utilization to be considered. Education also affected this perception with those with no schooling favouring farm management and translocation as ideal solutions, while tertiary level respondents were against translocation but preferred sustainable utilization.

4.8 Relationship between Wildlife Populations and the Indices

Trends in Game Populations

The majority of respondents did not answer this question and of those that did, the numbers and proportions who reported an increase, decrease or no change in the populations of large and small game animals were similar (Table 4.37). There were no significant differences in the proportions, between regions or between large and small game animals (χ^2 tests, P>0.05 for all).

Table 4.37. *Summary of reported trends in the populations of large and small game animals in the southeast (SE), Kgalagadi (K) and Ghanzi (G) regions of Botswana.*

	SE		K		G		totals	
	n	p	n	p	n	p	p	n
Large game animals								
increase	24	0.25	5	0.38	11	0.52	40	0.31
stable	25	0.26	3	0.23	3	0.14	31	0.24
decrease	29	0.31	4	0.31	6	0.29	39	0.30
unsure	17	0.18	1	0.08	1	0.05	19	0.15
Totals	95	1	13	1.00	21	1.00	129	1.00
Small game animals								
increase	30	0.30	4	0.29	15	0.45	49	0.34
stable	32	0.32	4	0.29	3	0.09	39	0.27
decrease	25	0.25	5	0.36	11	0.33	41	0.28
unsure	12	0.12	1	0.07	4	0.12	17	0.12
Totals	99	1	14	1.00	33	1.00	146	1.00

There was no significant relationship between Conflict Index and respondents' perceptions of change in wildlife populations for both large ($F_{3,124}$ = 1.48; P>0.05) and small game animals ($F_{3,142}$ = 2.57; P= 0.56). Perceptions of trends in game populations were not significantly related to Cattle Management (Large game ANOVA; $F_{3,124}$ = 1.40; P>0.05; Small game ANOVA; $F_{3,142}$ = 0.87; P>0.05), Smallstock Management (small game, KW ANOVA; $H_{3,146}$ = 4.4 P>0.05, large game, $H_{3,128}$ = 5.2; P>0.05) or Tolerance indices (Large game KW ANOVA; $H_{3,128}$ = 6.58 P>0.05, Small game KW ANOVA; $H_{3,146}$ = 3.44 P>0.05).

Presence of Carnivore Species

Respondents were asked to indicate how often (daily, weekly, monthly) they saw the eight focus carnivore species, selecting a single frequency per carnivore. Jackals were sighted most frequently (combined daily, weekly, monthly sightings), followed by leopards, brown hyenas, wild dogs, cheetahs, caracals, lions and spotted hyenas (Table 4.38). Species with regular daily, weekly and monthly sightings were presumed to be more common and abundant than species that were reported as seen on a yearly basis.

Trends in carnivore population size

Respondents were asked if they believed the populations of the eight target carnivore species to be increasing, decreasing or stable over the last 10 years. For all species except the leopard and jackal, most respondents were uncertain with the level of uncertainty ranging from 81% for spotted hyena to 36.5% for the jackal (Table 4.39). Of those who reported either a change or a stable population (i.e. excluding the unknown group), between 54% and 84% reported increasing populations (Table 4.39). Eighty four percent of respondents reported that jackal populations were increasing while between 70 and 75% of respondents reported that populations of wild dogs, brown hyenas and leopards were increasing. By contrast, 29% of respondents reported that lion populations were declining while 10-15% of respondents reported declining populations of leopards, cheetahs, spotted hyenas, wild dogs and caracal (Table 4.39).

Table 4.38. *Carnivore sighting frequencies for main conflict species in WKCC. (n = number of respondents).*

	Lions		**Leopards**		**Cheetahs**		**Brown Hyenas**		**Spotted Hyenas**		**Wild Dogs**		**Caracals**		**Jackals**	
Frequency	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
daily	4	1.3	7	2.3	0	0	19	6.1	0	0	15	4.8	0	0	103	33.2
weekly	4	1.3	33	10.6	7	2.3	36	11.6	3	1	29	9.4	14	4.5	79	25.5
monthly	13	4.2	69	22.3	37	11.9	43	13.9	14	4.5	29	9.4	13	4.2	53	17.1
sum of daily – monthly	**21**	**6.3**	**109**	**26.0**	**44**	**12.4**	**98**	**24.0**	**17**	**5.2**	**73**	**19.1**	**27**	**8.0**	**235**	**43.1**
every 3 months	15	4.8	43	13.9	12	3.9	24	7.7	11	3.5	19	6.1	10	3.2	18	5.8
every 6 months	23	7.4	34	11	32	10.3	17	5.5	16	5.2	19	6.1	10	3.2	8	2.6
yearly	46	14.8	20	6.5	33	10.6	17	5.5	19	6.1	21	6.8	17	5.5	1	0.3
every few years	0	0	2	0.6	1	0.3	1	0.3	1	0.3	5	1.6	2	0.6	1	0.3
never	127	41	30	9.7	120	38.7	72	23.2	186	60	53	17.1	117	37.7	11	3.5
unknown	78	25.2	72	23.2	68	21.9	81	26.1	60	19.4	120	38.7	127	41	36	11.6

Table 4.39. *Trends in carnivore populations for the main conflict species (n = number of respondents). The first % column is number of respondents as a percentage of all respondents. The second % column is number of respondents as a percentage of all respondents excluding the unknown group.*

	increase			stable			decrease			unknown	
	n	%	%	n	%	%	n	%	%	n	%
Lion	69	22.3	57.5	16	5.2	13.3	35	11.3	29.2	190	61.3
Leopard	131	42.3	70.8	27	8.7	14.6	27	8.7	14.6	125	40.3
Cheetah	67	21.6	62.6	24	7.7	22.5	16	5.2	14.9	203	65.5
Brown Hyena	93	30.0	73.2	72	7.1	17.3	12	3.9	9.5	183	59.0
Spotted Hyena	35	11.3	60.3	17	5.5	29.3	6	2	10.3	252	81.3
Wild dog	95	30.7	75.4	13	4.2	10.3	18	5.8	14.3	184	59.4
Caracal	40	12.9	54.8	22	7.1	30.1	11	3.6	15.1	237	76.5
Jackal	166	53.6	84.3	20	6.5	10.2	11	3.6	5.6	113	36.5

There was a significant relationship between the perceived changes in lion abundance and Conflict Index and ($F_{3,306}$ = 13.60; P<0.05) with those believing that lion numbers were increasing, having a significantly greater Conflict Index than those who thought numbers were stable or who were unsure (P<0.05). There were also significant relationships between perceived changes in spotted hyena abundance ($F_{3,306}$ = 3.19; P<0.05) and caracal abundance ($F_{3,306}$ = 3.12; P<0.05) and the Conflict Index, but no pairs were significantly different (P>0.05 for all). There were no significant relationships between perceived changes in the abundances of cheetahs, ($F_{3,306}$ = 2.51; P>0.05), Leopards ($F_{3,306}$ = 0.59; P>0.05), brown hyenas ($F_{3,306}$ = 0.75; P>0.05), wild dogs ($F_{3,306}$ = 0.86; P>0.05) or jackals ($F_{3,305}$ = 0.36; P>0.05) and the Conflict Index.

There were significant relationships between the perceived changes in the abundances of brown hyenas ($F_{3,275}$ = 7.27; P<0.05), spotted hyenas ($F_{3,275}$ = 3.47; P<0.05) and wild dogs ($F_{3,275}$ = 3.56; P<0.05) and the Cattle Management Index with respondents who perceived increasing predator populations having significantly higher Cattle Management Index than others. There was no significant relationship between perceived changes in the abundances of Lions ($F_{3,275}$ = 0.99; P>0.05), Cheetahs ($F_{3,275}$ = 1.22; P>0.05), Leopards $F_{3,275}$ = 0.82; P>0.05) and Caracals ($F_{3,275}$ = 0.79; P>0.05) and the Cattle Management Index.

The Smallstock Management Index was significantly related to perceived changes in the abundance of cheetahs ($H_{3,249}$ = 7.93; P = 0.47), brown hyenas ($H_{3,249}$ = 26.85; P<0.05), caracals ($H_{3,249}$ = 15.61; P<0.05) and jackals ($H_{3,249}$ = 38.18; P<0.05) and in all cases, respondents who perceived an increase in predator population had significantly higher Smallstock Management Index than those who did not. The relationship was not significant for lions ($H_{3,249}$ = 3.66; P>0.05), leopards ($H_{3,249}$ = 3.19; P>0.05, spotted hyenas ($H_{3,249}$ = 6.25; P>0.05) or wild dogs ($H_{3,249}$ = 5.30; P>0.05).

Key Results Summary – Wildlife Populations

There was a general lack of local knowledge and a high proportion of respondents were unsure. No clear trends were reported for populations of small or large game species and where there were trends, these were not related to any of the Indices.

For the carnivore species, most respondents were uncertain, but where trends were reported they were of increasing populations. Respondents who perceived increasing lion populations had significantly greater Conflict index than respondents who perceived a stable or declining lion population. Respondents who perceived increases in the populations of brown hyenas, spotted hyenas and wild dogs had significantly higher Cattle Management Indices. Respondents who perceived increases in cheetah, brown hyenas, caracals and jackal populations had significantly greater Smallstock Management Indices. Of those reporting declining populations, lions were most often reported to be declining.

Chapter 5

5. Spatial Analysis Results

5.1 Spatial analyses of key socio-economic characteristics

Although there were three locations and three land use types, only two land use types occurred in the Kgalagadi and as a result it was not possible to use two way ANOVAs. There was a significant relationship between location and livestock holdings (KW ANOVA, $H_{2,304}$ = 33.12; P<0.05) with livestock holdings being significantly greater in Ghanzi than in the Kgalagadi (P<0.05). There was also a significant effect of land use type (KW ANOVA, $H_{2,304}$ = 84.29; P<0.05) with significantly more livestock on the fenced ranches than on communal or WMA areas (Figures 5.1 & 5.2).

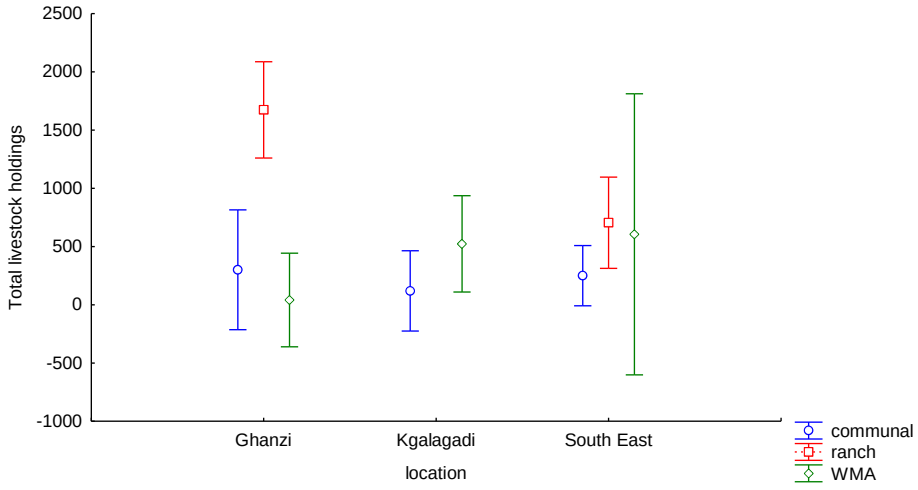


Figure 5.1. *The relationship between location, land use and total livestock holdings. Data are means with 95% CI's.*

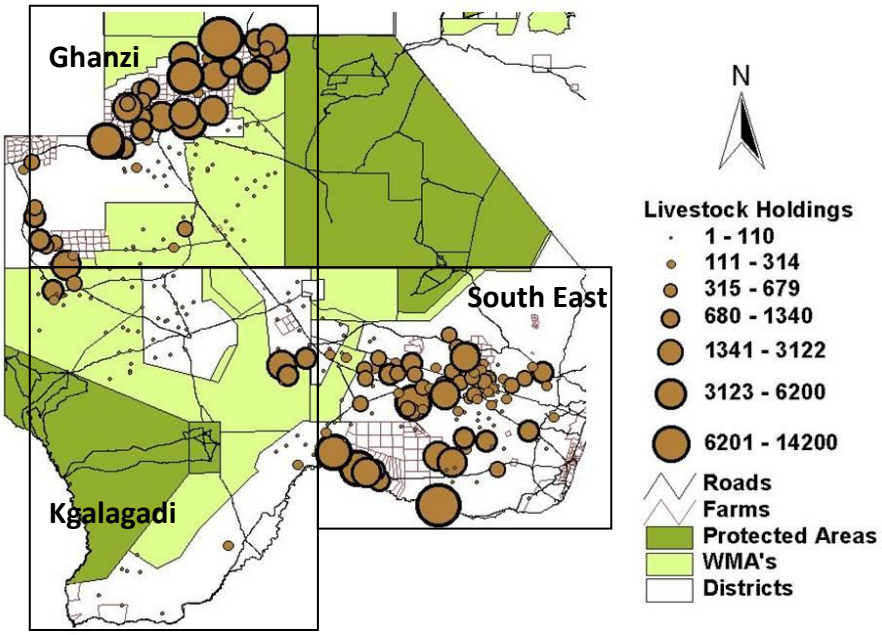


Figure 5.2. *Distribution of respondents' livestock holdings throughout study area.*

Education levels and monthly income did not vary significantly with location. However, the source of income did (χ^2 = 73.3; df = 10; P<0.0005; Table 5.1), with more respondents in Ghanzi and Kgalagadi making an income from the sale of veld and wildlife products than the South East, while in the South East a greater proportion of respondents made an income through formal employment.

Table 5.1. *The relationship between source of income and location. Data are the number of respondents indicating each source of income.*

	Ghanzi		**Kgalagadi**		**South East**	
Source of income	number	proportion	number	proportion	number	proportion
employment	5	0.05	10	0.12	46	0.35
mixed	11	0.12	11	0.13	14	0.11
own business	8	0.08	16	0.19	21	0.16
sale of farm products	39	0.41	27	0.32	48	0.37
sale of veld products	17	0.18	15	0.18	2	0.02
sale of wildlife products	15	0.16	5	0.06	0	0.00
Totals	95		84		131	

Education level (χ^2 =40.45; df = 6; P<0.05) and monthly income ($H_{2, 197}$ = 8.33; P<0.05) varied with land use, and communal areas and WMAs reported lower levels of education (Table 5.2) and monthly income (Figure 5.3) than ranches.

Table 5.2. *The relationships between land use and level of schooling reported by respondents. Data are the number of respondents reporting a level of education.*

	Communal areas		**Ranch**		**WMA**	
schooling	number	proportion	number	proportion	number	proportion
no schooling	48	0.48	8	0.29	32	0.45
primary	19	0.19	9	0.33	4	0.06
secondary	29	0.29	3	0.11	33	0.46
tertiary	3	0.03	7	0.26	2	0.03
Totals	99		27		71	

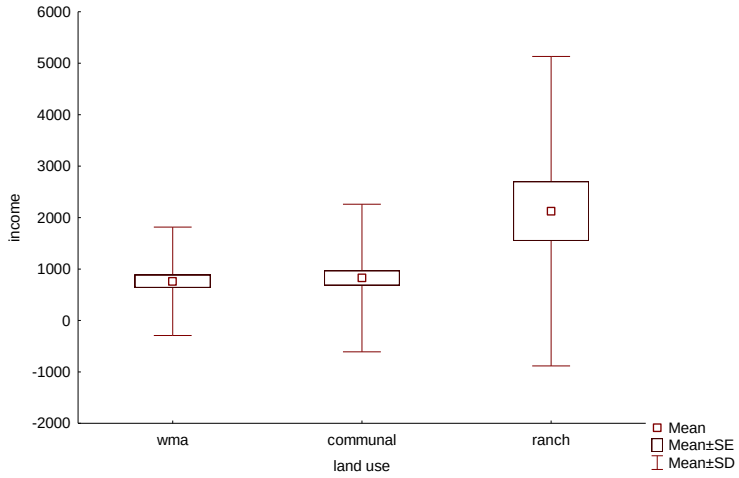


Figure 5.3. *Income levels of respondents from different land uses. Data are means with standard errors and standard deviations.*

Source of income also differed, and in communal areas and WMA's, the sale of veld and wildlife products were more important than on ranches (χ^2 =24.68; df 10; P<0.05; Table 5.3). Formal employment and the sale of farm products were more important on ranches.

***Table 5.3**. The relationship between source of income and land use types. Data are the number of respondents indicating each income source.*

	Communal land		**WMA**		**Ranch**	
Source of income	number	proportion	number	proportion	number	proportion
employment	21	0.2	5	0.1	7	0.3
mixed	11	0.1	7	0.1	2	0.1
own business	16	0.2	15	0.2	6	0.2
sale of farm products	30	0.3	16	0.2	12	0.4
sale of veld products	13	0.1	20	0.3	0	0.0
sale of wildlife products	8	0.1	8	0.1	0	0.0
Totals	99		71		27	

5.2 Location, land use and conflict

There were significant relationships between location ($F_{2,307} = 34.9$; $P<0.005$; Table 5.4; Figures 5.4 & 5.5) and land use ($F_{2,307} = 30.10$; $P<0.005$; Table 5.5; Figures 5.4 & 5.5) and the Conflict Index. Conflict was significantly greater in the Kgalagadi than the other areas and significantly greater in Ghanzi than the South East ($P<0.05$ for all pairs). The Conflict Index was significantly lower on ranches than the other land use types and significantly greater in Wildlife Management Areas ($P<0.05$ for all pairs).

***Table 5.4.** Mean Index Values for the different regions surveyed. (n = number of respondents, SD in brackets).*

	South East		**Kgalagadi**		**Ghanzi**	
Indices	n	mean	n	mean	n	mean
Conflict Index	131	4.8 (±2.9)	84	8.3 (±3.0)	95	7.2 (±3.6)
Cattle Management Index	125	8.1 (±4.0)	67	9.6 (±3.7)	87	7.6 (±4.0)
Smallstock Management Index	111	13.0 (±5.7)	70	14.2 (±4.4)	68	11.7 (±5.7))
Tolerance index	131	2.7 (±2.0)	84	4.1 (±1.8)	95	3.3 (±1.9)
Carnivore Presence Index	131	15.5 (±7.9)	84	16.8 (±7.1)	95	17.2 (±7.8)

Table 5.5. *Mean Index Values for the different land use types surveyed. (n = number of respondents, SD in brackets).*

	Communal		Ranches		WMA	
Indices	n	mean	n	mean	n	mean
Conflict Index	161	6.3 (±3.5)	72	4.7 (±2.7)	77	8.7 (±2.9)
Cattle Management Index	147	8.8 (±4.1)	69	6.3 (±3.1)	63	9.2 (±3.9)
Smallstock Management Index	138	12.9 (±5.5)	54	13.4 ±5.2)	57	12.8 (±5.5)
Tolerance index	161	3.1 (±2.0)	72	2.8 (±1.8)	77	4.1 (±1.9)
Carnivore Presence Index	161	15.3 (±7.8)	72	17.9 (±8.3)	77	17.0 (±6.5)

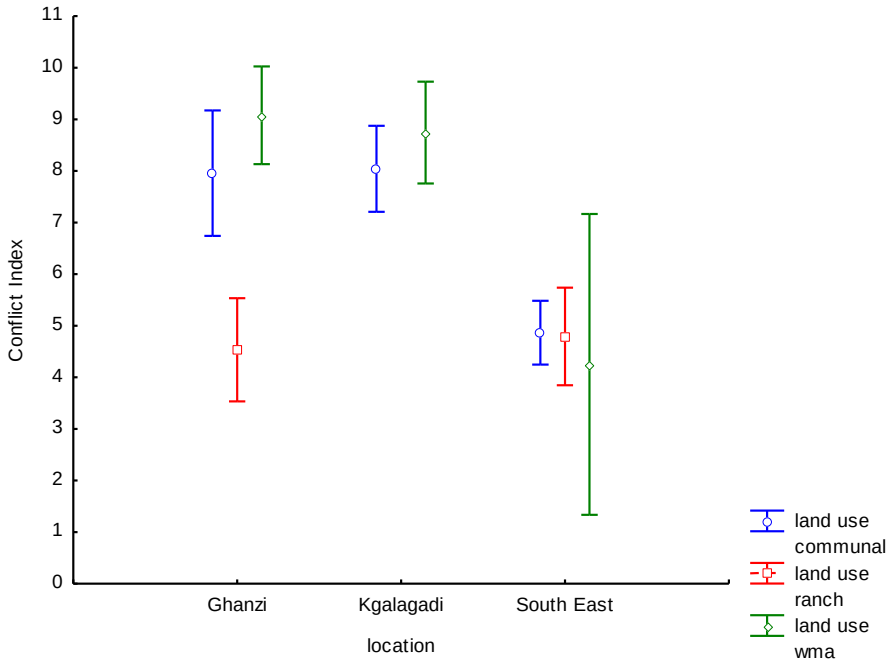


Figure 5.4. *The relationship between location, land use type and the Conflict Index. Data are means with 95% CI's.*

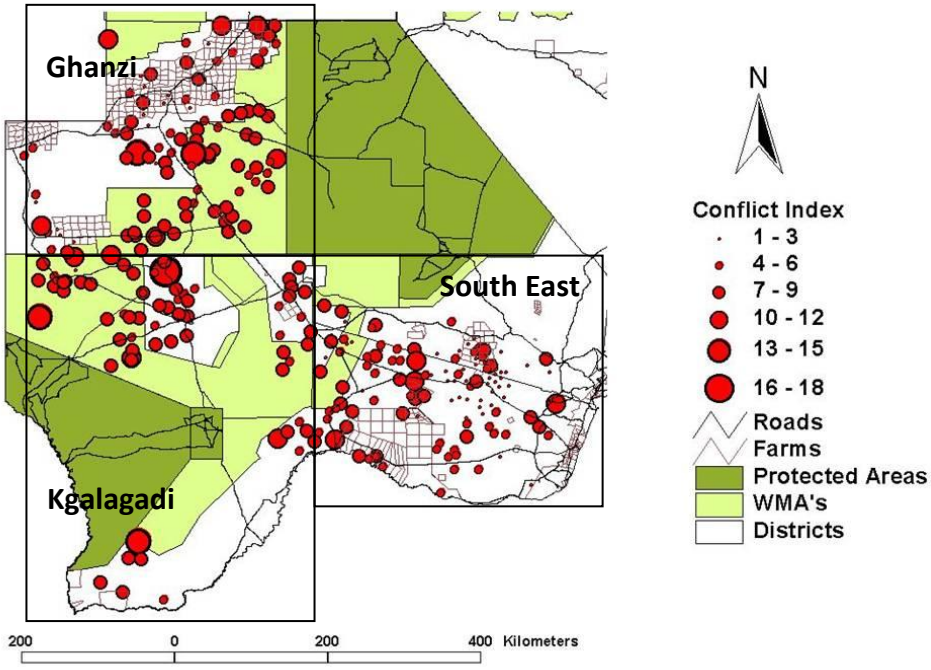


Figure 5.5. *Distribution of respondents' conflict levels throughout study area.*

5.3 Location, land use and livestock management

The Cattle Management Index was significantly higher in the Kgalagadi than Ghanzi which was not significantly different from the South East ($H_{2,310}$ = 21.90; P<0.05; Figure 5.6) however, there was no significant effect of location on Smallstock Management Index ($H_{2,310}$ = 1.42; P>0.05; Table 5.4). The Cattle Management Index was significantly lower on ranches than in communal areas and WMAs ($H_{2,310}$ = 27.47; P<0.05; Table 5.5; Figure 5.6). There was no effect of land use on Smallstock Management Index ($H_{2,310}$ = 3.27; P>0.05).

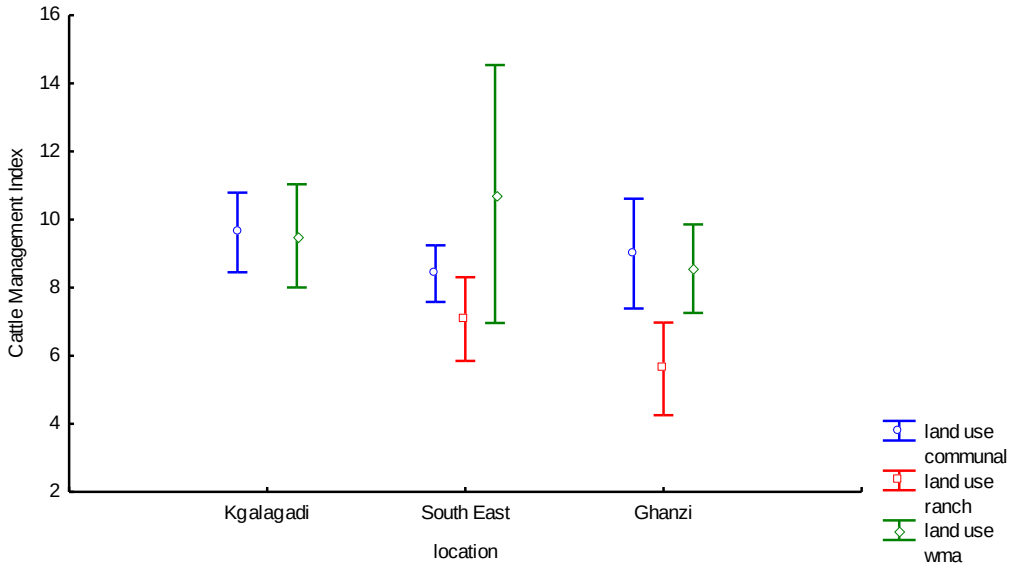


Figure 5.6. *The relationship between location, land use type and the Cattle Management Index. Data are means with 95% CIs.*

5.4 Location, land use and tolerance

There was a significant effect of location on Tolerance Index (KW ANOVA, $H_{2,310}$ = 26.16; P<0.05) and tolerance levels were significantly lower in the South East than in the other areas (P<0.05 for all; Table 5.4). There was also an effect of land use on Tolerance Index (KW ANOVA, $H_{2,310}$ = 16.79; P<0.05) and the Tolerance Index was significantly higher on WMA's than the other land use types (P<0.05 for all; Table 5.5, Figures 5.7 & 5.8).

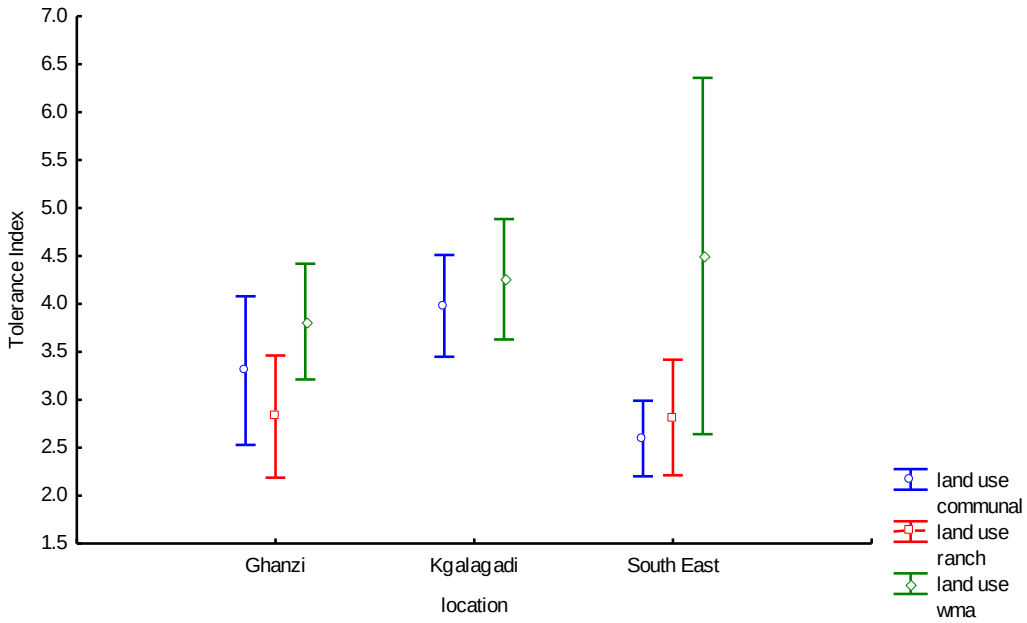


Figure 5.7. *The relationship between location, land use types and Tolerance Index. Data are means with 95% CI's.*

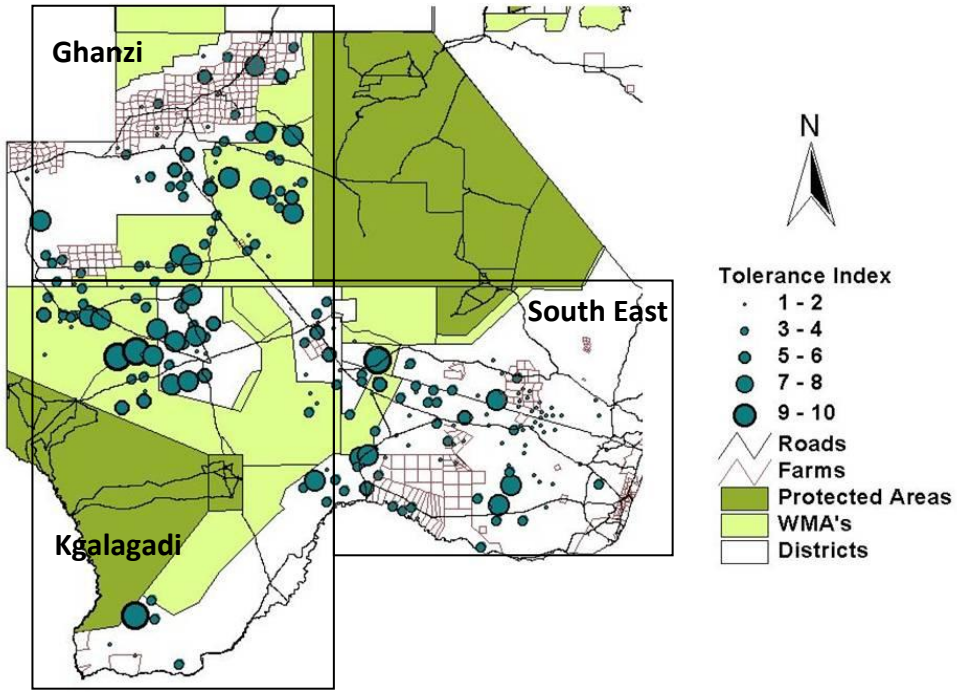


Figure 5.8. *Distribution of respondents' tolerance levels throughout study area.*

5.5 Location, land use and carnivore presence

There was no significant difference in Carnivore Index in the different locations ($F_{2,307}$ = 1.62; P>0.05). However, when the data for the smaller carnivores (jackal, caracal) was removed, the Carnivore Index was significantly greater in Ghanzi than the South East ($F_{4.62}$ = 0.11; Figure 5.14).

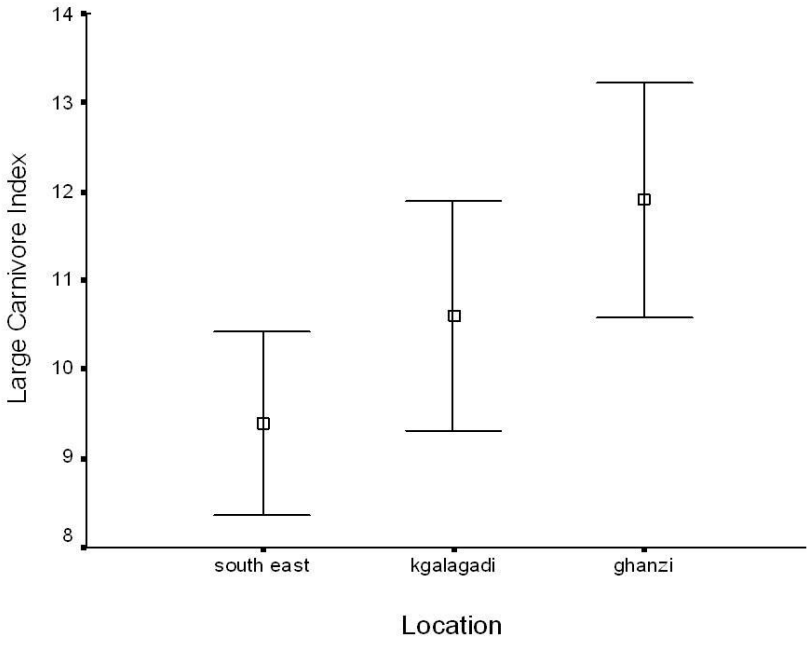


Figure 5.14. *The relationship between location and the Carnivore Index (jackals and caracals removed). Data are means with 95% CI's.*

There was an effect of land use ($F_{2, 307}$ = 3.31; P<0.05) on the Carnivore Index, with values being significantly lower on communal lands than that reported for ranches (P<0.05; Figure 5.9).

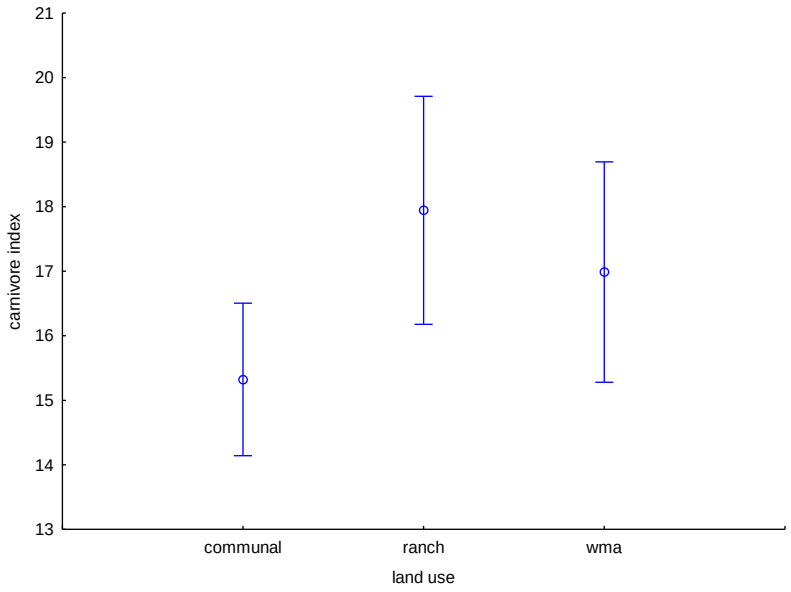


Figure 5.9. *The relationship between Carnivore Index and land use type. Data are means with 95% CI's.*

Key Results Summary

Total livestock holdings were greater in Ghanzi than the Kgalagadi and the South East, and greater numbers of livestock were kept on ranches than communal areas and WMA's. Education and monthly income were lower on communal lands and WMA's than ranches. Source of income varied with location, with more respondents in Ghanzi and Kgalagadi benefitting from veld and wildlife products than the South East. Communal areas and WMA's had lower education levels and monthly incomes than ranches and generated an income more often through the sale of veld and wildlife products than ranches.

The Kgalagadi reported the highest conflict levels, followed by Ghanzi and the South East. Conflict was greatest on the WMA's followed by communal areas and ranches. Cattle management was greatest in the Kgalagadi and lowest on ranches but there was no effect of location or land use on smallstock management. Tolerance was lowest in the South East ranches and cattleposts and highest in the Kgalagadi WMA's. Carnivore presence was lower in the communal areas than the WMAs and ranches.

5.6 Vegetation type, carnivore presence and conflict

Three vegetation type were recognised (hardveld acacia, sandveld acacia, sandveld terminalia, Figure 5.10) and their relationship with the Carnivore Index and Conflict Index examined. There was a significant relationship between vegetation type and the Carnivore Index ($F_{2,307}$ = 5.08; P<0.05) which was significantly higher in hardveld acacia than sandveld terminalia (P<0.05; Figure 5.11). However, there was no significant relationship between vegetation type and the Conflict Index ($F_{2,307}$ = 2.62; P>0.05).

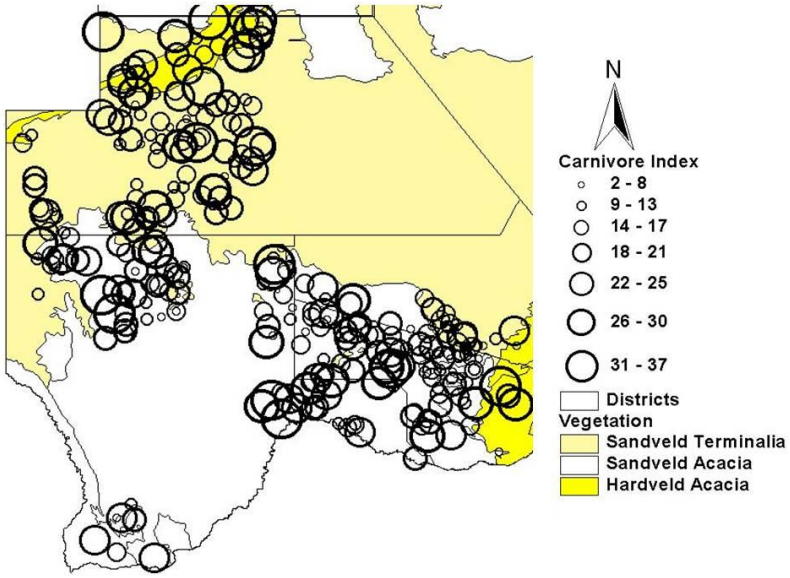


Figure 5.10. *Distribution of respondents' Carnivore Index throughout study area.*

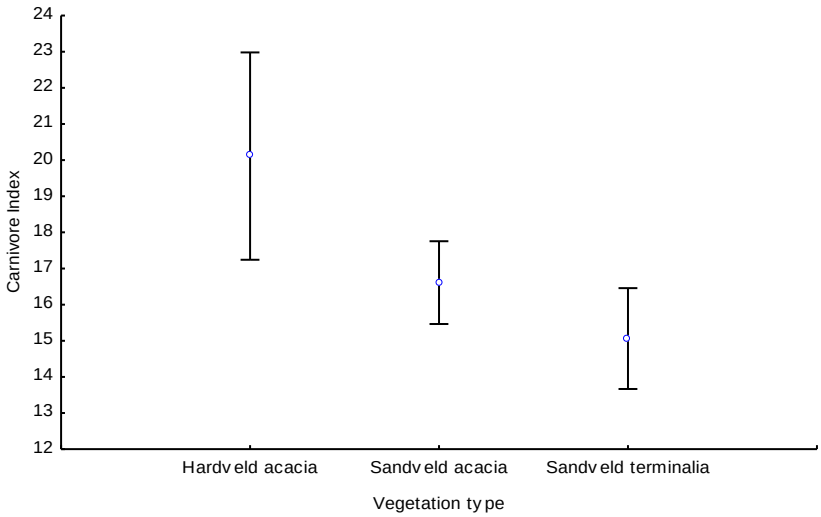


Figure 5.11. *The relationship between vegetation type and Carnivore Index. Data are means with 95% CIs.*

5.7 Human population density, carnivore presence and conflict

There were 4 categories for human population density: 0.28/100km^2, 0.39/100km^2, 6.42/100km^2 and 6.56/100km^2 and these were pooled to create a low density group (<0.4 people/100km^2) and a high density group (6-7 people/100km^2). The Carnivore Index was significantly greater in the low population density group than the high density group ($t = 3.27$; $df = 308$; $P<0.05$; Figure 5.12). The Conflict Index was also significantly greater in the low population density group than the high density group ($t = 8.43$; $df = 308$; $P<0.05$; Figure 5.13).

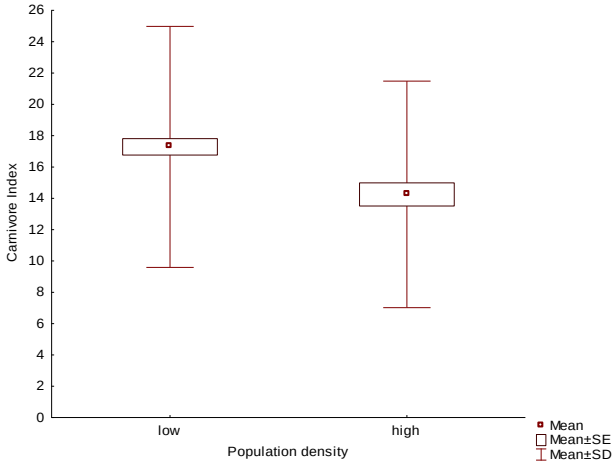


Figure 5.12. *The relationship between population density and Conflict Index. Data are means with 95% CI's.*

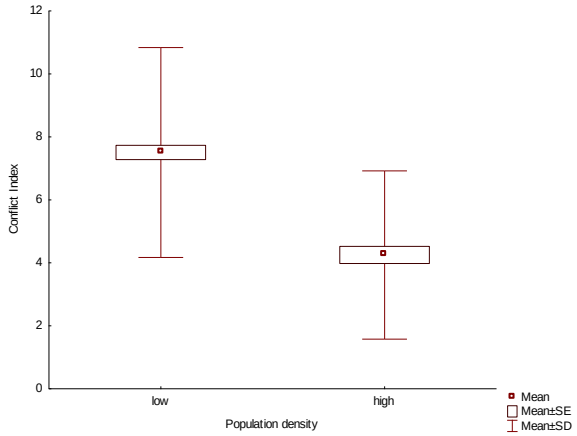


Figure 5.13. *The relationship between population density and the Carnivore Index. Data are means with 95% CI's.*

5.8 Spatial distribution of carnivores

The frequency with which respondents reported seeing the different predator species varied significantly with location (weekly sightings; $\chi^2 = 60.15$; df = 14; P<0.005; never sighted $\chi^2 = 167.38$; df = 14; P<0.005; Table 5.6; Figure 5.15).

Ghanzi was characterised by relatively frequent sightings of jackals, wild dogs and brown hyenas, while lions, leopards, spotted hyenas, cheetahs and caracals were reported less often. In the Kgalagadi, jackals and brown hyenas were sighted relatively frequently followed closely by leopards and wild dogs. Lions, cheetahs, spotted hyenas were not regularly seen. In the South East, jackals and brown hyenas were seen most frequently, with less regular sightings of leopards, wild dogs, cheetahs and caracals. Lions and spotted hyenas were reported to be seen less frequently in the South East than in the other areas (Table 5.6).

Table 5.6. *The proportions of respondents from the different locations reporting sightings of carnivores on a weekly basis or never.*

Carnivore species	Ghanzi		Kgalagadi		South East	
	weekly	never	weekly	never	weekly	never
lions	7.6	31.8	4.3	40.0	0.0	81.3
leopards	0.0	70.6	18.3	22.5	9.1	5.7
cheetahs	0.0	54.1	1.5	80.0	5.8	27.2
wild dogs	38.5	3.1	17.7	48.4	12.7	33.3
brown hyenas	18.8	50.0	22.4	43.3	28.6	11.2
spotted hyenas	0.0	70.6	4.5	55.2	0.0	87.8
caracal	1.9	59.3	6.9	70.8	14.0	59.6
black backed jackals	66.3	3.8	61.4	2.9	69.4	4.8

Lions were not regularly seen at any site and were least rare in Ghanzi (Figure 5.16). Leopards, which were also never regularly seen, were more common in the Kgalagadi than other areas (Figure 5.17). Cheetahs were rare throughout, but were reported most in the South East (Figure 5.18). Wild dogs had most reports in Ghanzi then Kgalagadi, followed by the South East (Figure 5.19). Brown hyenas were reported most often in the South East (Figure 5.20). Spotted hyena were rare throughout but had the most reports in the Kgalagadi (Figure 5.21). Caracals were rarely seen though more in the South East, followed by Kgalagadi (Figure 5.22). Jackals were more regularly seen

at all sites than all the other predator species with 60 – 70% of respondents seeing them either daily or weekly (Figure 5.23).

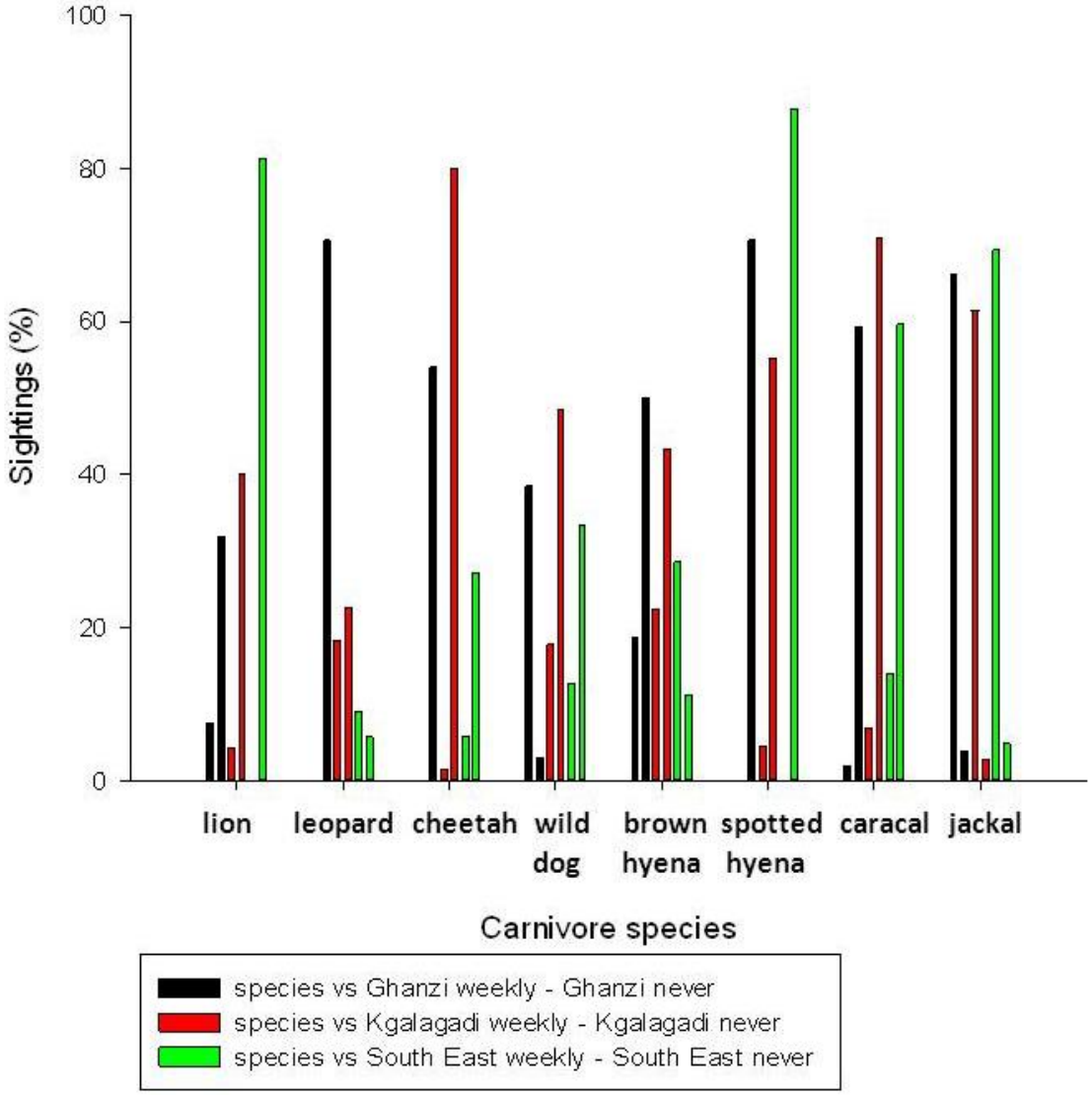


***Figure 5.15**. Summary of the frequency of sightings of carnivores in Ghanzi, Kgalagadi and the South East of Botswana. For each species there are three pairs of bars representing data from the three regions. For each pair the first bar shows the number of respondents reporting weekly sightings and the second bar the number reporting never seeing the species*

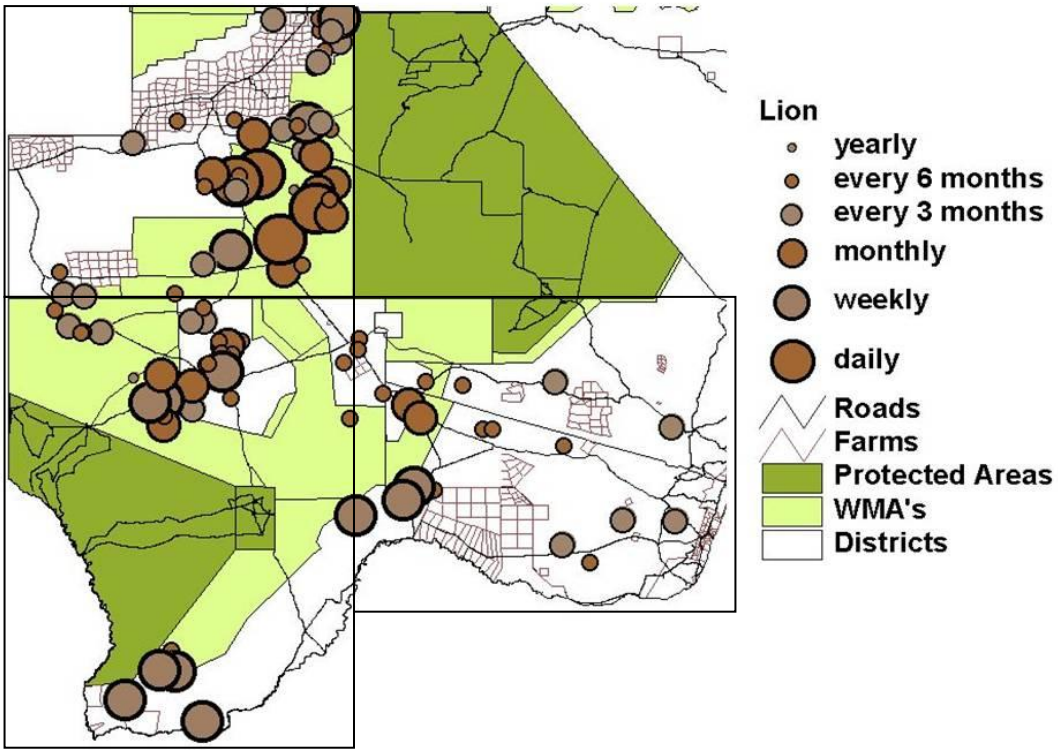


Figure 5. 16. *Spatial distribution of lions from respondent sightings.*

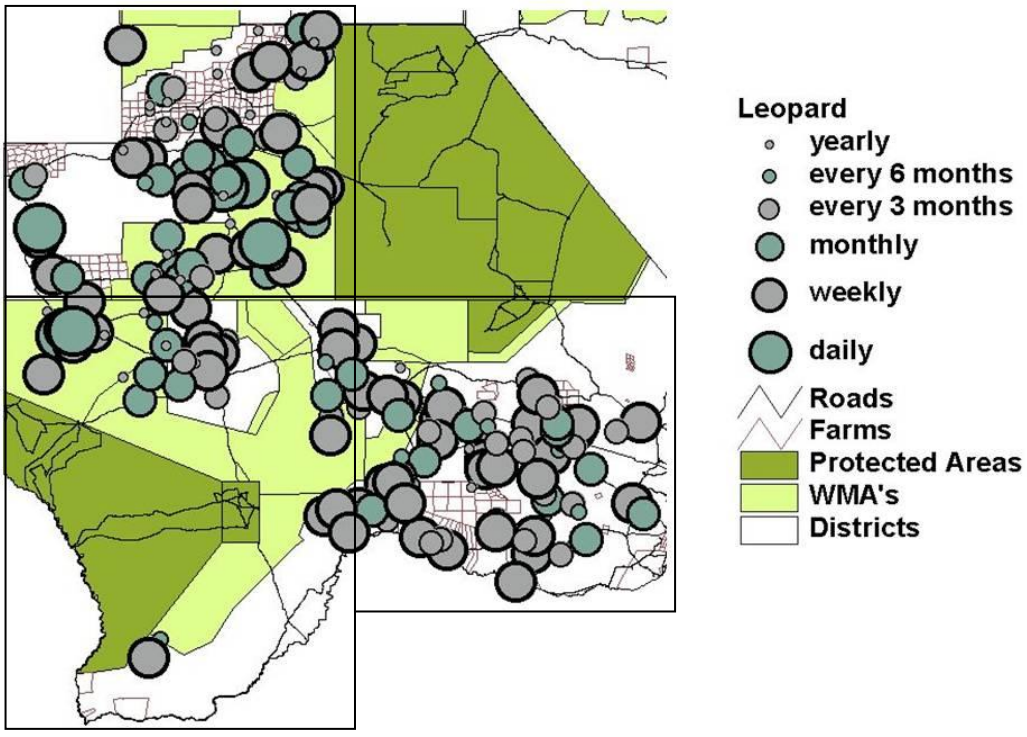


Figure 5.17. *Spatial distribution of leopards from respondent sightings.*

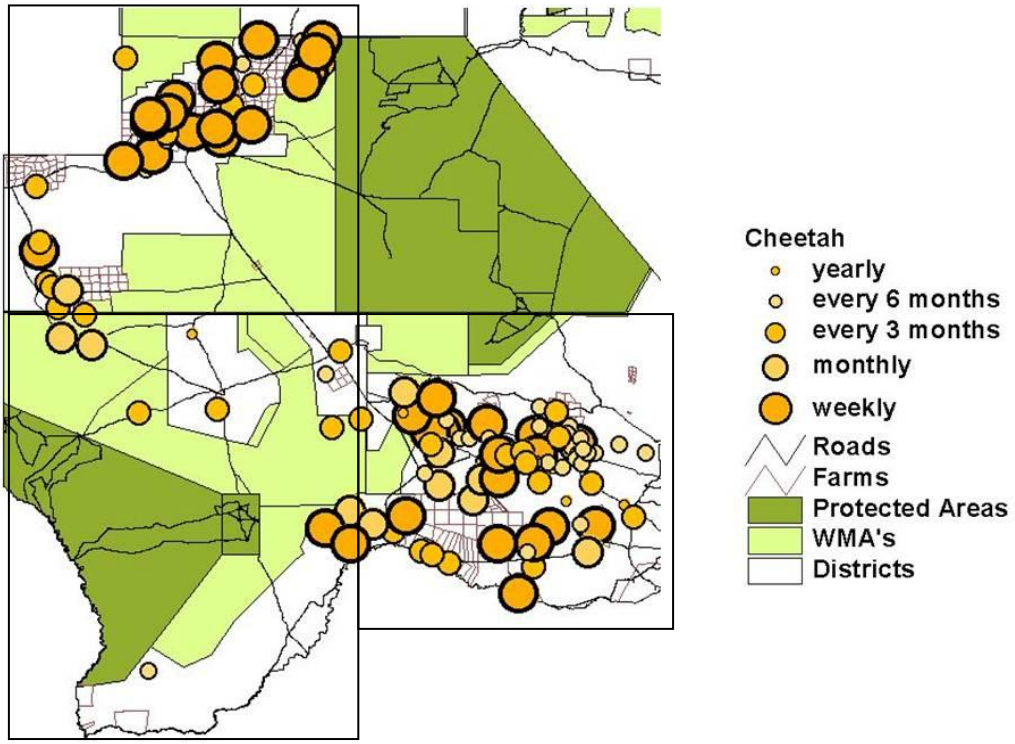


Figure 5.18. *Spatial distribution of cheetahs from respondent sightings.*

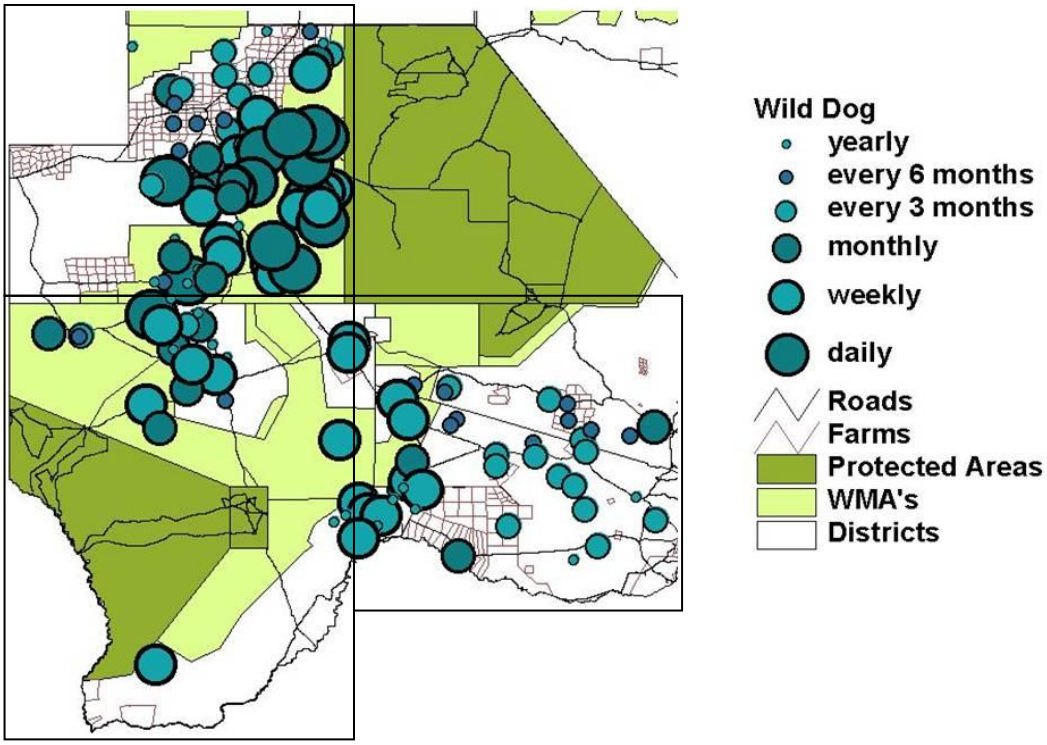


Figure 5.19. *Spatial distribution of wild dogs from respondent sightings.*

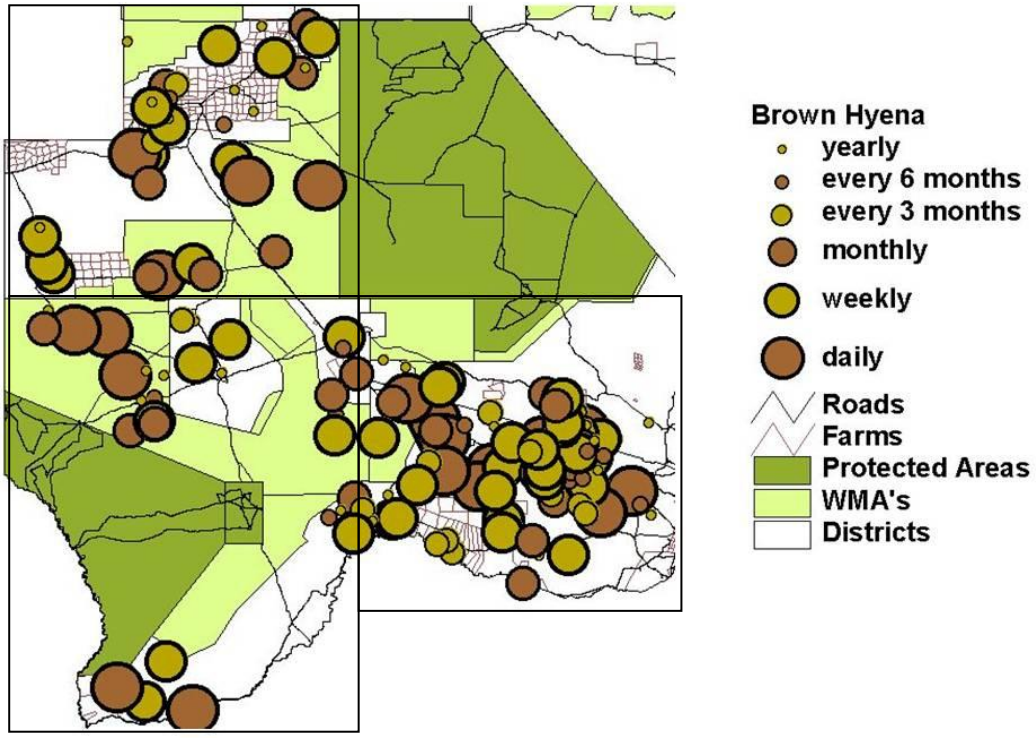


Figure 5.20. *Spatial distribution of brown hyenas from respondent sightings.*

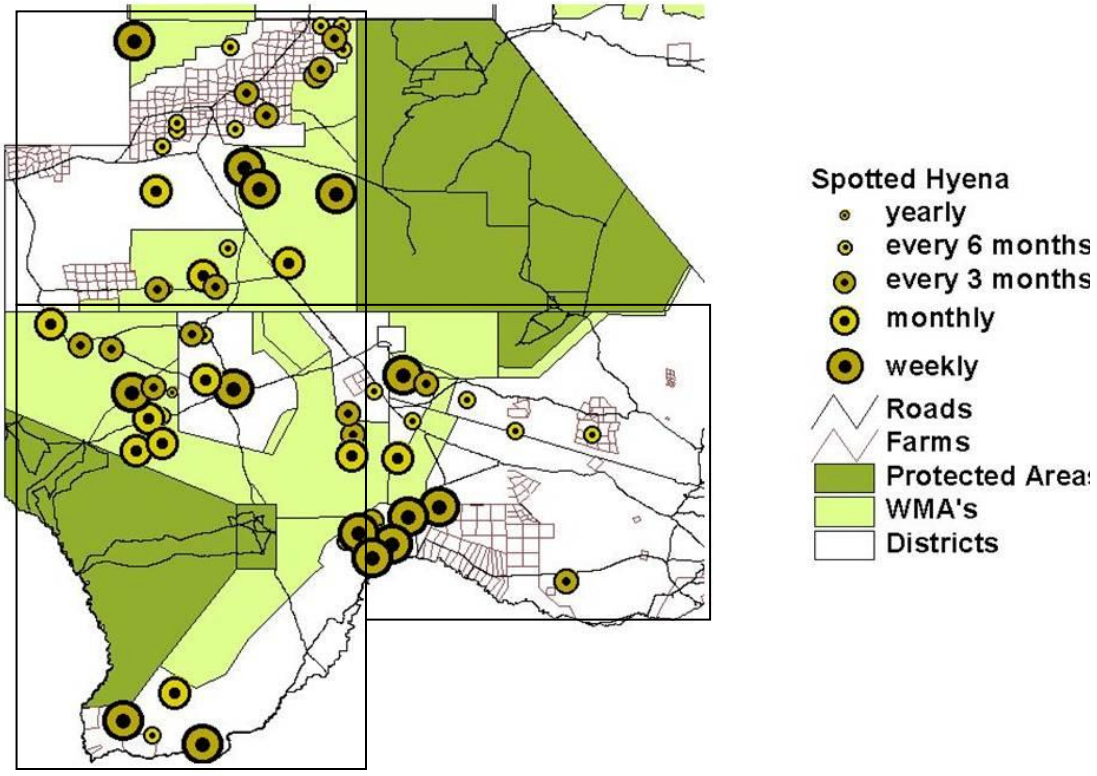


Figure 5.21. *Spatial distribution of spotted hyenas from respondent sightings.*

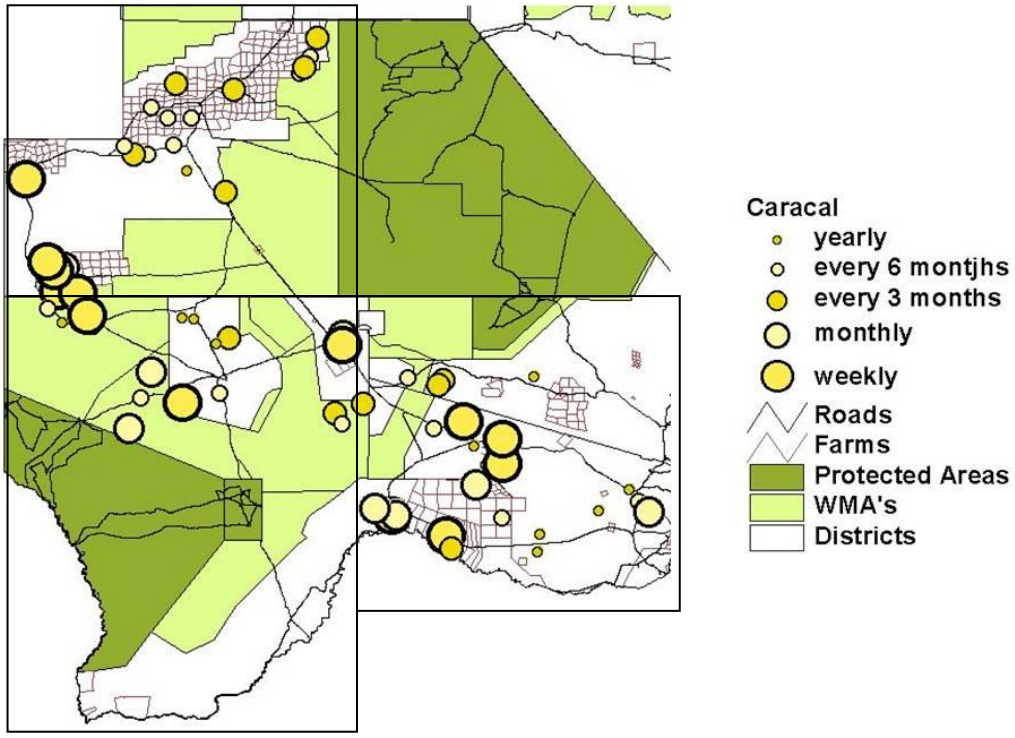


Figure 5.22. *Spatial distribution of caracal from respondent sightings.*

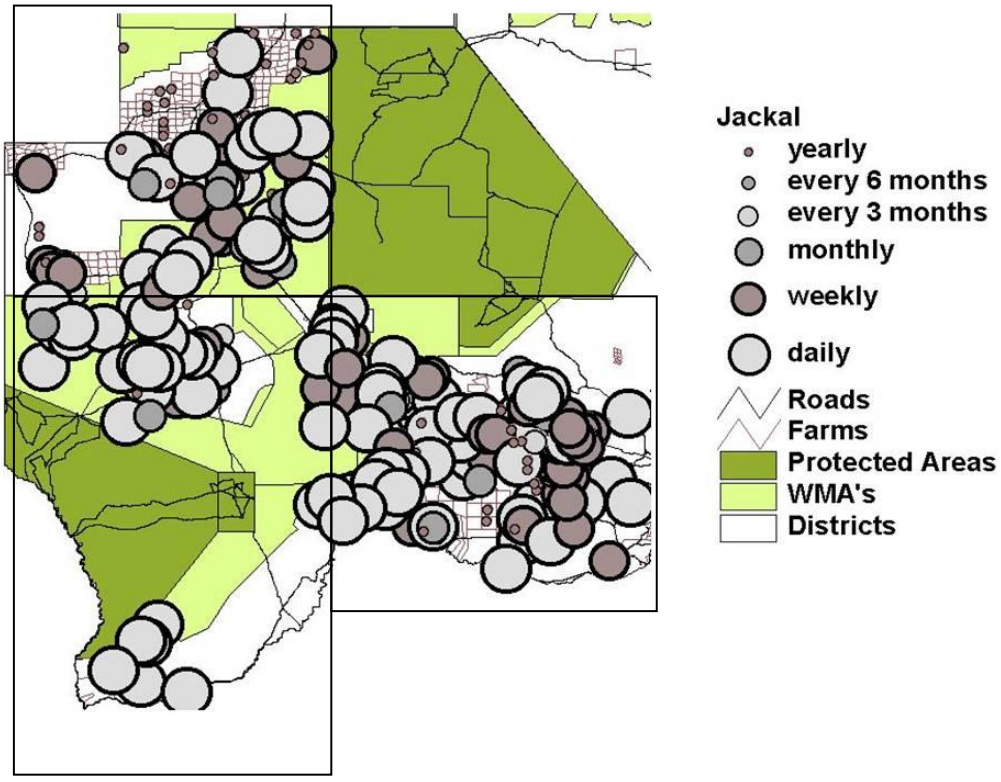


Figure 5.23. *Spatial distribution of jackals from respondent sightings.*

Key Results Summary

The Carnivore Index was higher on hardveld acacia areas than sandveld terminalia. In regions where human population density was low, more sightings of carnivores were reported, as well as higher conflict levels than where population density was higher. Ghanzi had the greatest frequency of large carnivore sightings, followed by Kgalagadi and the South East. In all locations jackal was sighted more frequently than any other carnivore. In Ghanzi, the next most commonly seen carnivore was wild dog and brown hyena. In Kgalagadi, brown hyena, leopard and wild dog were sighted the most often and in the South East, it was brown hyena, wild dog and leopard.

Chapter 6

6. Discussion

6.1 General

The threats of human wildlife conflict to wildlife populations and rural livelihoods are a global concern and it is essential to understand the main drivers of conflict, management practices and tolerance (Conforti & Azevedo, 2003; Romañach *et al*., 2007; Selebatso *et al*., 2008). Attitudes and behaviours are influenced by a range of socioeconomic and environmental factors which interact in complex ways (Mehta 1998; Loveridge *et a*l., 2001). In order for conservation interventions to have a chance of success such factors, drivers, and their interactions, need to be investigated and understood (Treves *et al*., 2004; Dickman, 2008).

6.2 Socio-economic Influences

In this study, male respondents reported lower conflict, cattle management and tolerance levels than female respondents. Thus, while females had higher conflict levels, they also utilised more cattle management methods and had higher tolerance than males. Gender is generally accepted to be an important socioeconomic factor affecting conflict and attitudes towards wildlife (Hill 1998; Mehta 1998; Zimmerman *et al.,* 2001: Ericsson & Heiberlein, 2003; Lamarque, 2008), although other studies have found no relationship between gender and conflict or attitude (Conforti & Azevedo, 2003; Dickman, 2005; Gusset *et al*., 2009). Kellert and Berry (1987) investigated attitudes, knowledge and behaviour towards wildlife in the USA and concluded that gender was among the most important demographic variables in perceptions towards wildlife. Males have a significantly greater knowledge of wildlife but women exhibit much higher moralistic and protectionist tendencies (Kellert & Berry, 1987). Attitudes towards wolves in Europe and the USA were most positive amongst females (Williams *et al*., 2002). Conversely, in countries such as India, where there are distinct gender based roles, women show more negative attitudes towards wildlife possibly because they spend more time in areas where conflict species such as tigers and elephants occur (Bandara & Tisdell, 2003; Ogra, 2007). Around Selous Game Reserve in Tanzania, women have more negative opinions towards wildlife and this was attributed to the

marginalisation of women in the predominantly Muslim study villages (Gillingham & Lee, 1999). In recent times, Botswana has put considerable focus into gender equality and is in a better position than many African countries (Siphambe & Bakwena, 2001) with women becoming increasingly empowered in all sectors. However, the women surveyed in this study usually had lower livestock numbers, lower incomes and levels of education, demonstrating there is still much progress needed to bridge the gender gap (Siphame & Bakwena, 2001). By contrast, males had higher monthly incomes, education levels and owned more livestock and reported lower levels of conflict, management and tolerance. It is likely that the gender effect reported in this study results from many factors, including gender based roles for women in Botswana that may result in women having less education and being more likely to own smaller numbers of animals and maintain them on cattleposts.

Age was not a strong driver of conflict or tolerance although in similar studies in USA and Europe, they are significant contributors, with attitudes declining with increasing age (Williams *et al*., 2002; Bjerke *et al*., 2002; Ericsson & Heiberlein, 2003). Likewise, in the Brazilian Pantanel attitudes to jaguars become increasingly negative with age (Zimmerman *et al.*, 2005). In this study, age was only associated with cattle management, with values decreasing with increasing age. Family size was also not a significant driver in this study and this was also the case in similar studies in Nepal (Wang & Macdonald, 2006) and Burma (Allendorf *et al.,* 2006).

Improved education has often been linked to improved perceptions towards wildlife (Conforti & Azevedo, 2002; Marker & Dickman, 2004) and it is often considered that increased education brings a greater awareness of wildlife (Kellert, 1985; Infield, 1988; Oli *et al*., 1994; Holmern *et al*., 2006; Gusset *et al.,* 2008). In Norway, the number of people wanting wolves reduced in abundance or extirpated decreases with increasing education levels (Bjerke *et al*., 2002). In Europe and the USA, people with higher levels of education have more positive attitudes (Ericsson & Heiberlein, 2003; Williams *et al.*, 2002). In this study, a lack of education was associated with higher conflict levels experienced. However, most respondents with lower levels of education were from cattleposts, with only 3% of cattlepost respondents having tertiary education

compared to 27% of respondents from ranches. Lower education levels were also found amongst women. However, despite experiencing lower conflict levels with carnivores, the tolerance levels of respondents with higher education levels were not improved and cattle management practices were reduced. This suggests that formal education may not necessarily benefit conservation strategies. The relationship between tolerance and education has been found in similar studies. Around the Ruaha National Park in Tanzania, people with increased formal education actually exhibited higher animosity towards wildlife and conservation. In Selous Game Reserve, people with more education were more likely to oppose the community conservation program (Songorwa, 1999). This implies that standard education does not necessarily improve attitudes. However, it is possible that targeted environmental education programs dealing with specific local challenges may improve community perceptions (Infield, 1998; Taylor, 2004; Treves, *et al*., 2006; Gusset *et al*., 2008). This was found in the Northern KwaZulu Natal region of South Africa, where wild dog specific education significantly improved attitudes towards the species (Whittington-Jones, 2011). In the Eastern USA, providing people with species specific education effectively improved attitudes towards coyotes (Dramheim *et al*., 2011). In Namibia, it has been demonstrated that local attitudes and actions can be positively influenced through long term conservation education programmes (Marker & Dickman, 2003; Marker at al., 2003c).

The effect of education reported in this study may result from several interacting factors, including farm type, gender, size of livestock holdings and sources of income. Indeed, it is possible that increased levels of formal education result in significant amounts of time being spent away from the land and a loss of traditional practices for coexisting with carnivores. As people spend more time focusing on education they spend less time living close to the land, resulting in a loss of an understanding of wildlife and historical practices of livestock protection. In Maddox (2003) study of the Maasai it was suggested that their lifestyle has the potential to facilitate coexistence with carnivores. Although more recently, they exhibit some negative attitudes towards conflict, they still show a greater appreciation of wildlife than other groups (Maddox, 2003). Lifestyles on cattleposts tend to be more traditional and closer to the land than those on fenced ranches. Similarly, respondents who make a living from veld and

wildlife products will have a closer connection to the land than those making a living from the commercial sale of cattle or from other businesses. The closer one is to the land the better one understands it and therefore is more likely to be able to live in coexistence with wildlife. It has been suggested that certain beliefs and traditional practices may result in improved attitudes even in the midst of conflict (Kellert *et al*., 1996; Ale, 1998; Infield, 2001). In this study, a similar effect may result in increasing levels of formal education being associated with poorer management and lower tolerance. In Botswana there is a growing number of absentee farmers (White, 1993; Darkoh & Mbaiwa, 2005; Motlopi, 2006), who are well educated, formally employed or have other income generating activities elsewhere but maintain large herds on ranches or cattleposts. Management is often poor and done by employees on low wages with little incentive to perform (Thomas *et al.,* 2000; Hemson, 2003; Motlopi, 2006).

Wealth and income are often cited as significant determinants of conflict, behaviour and attitudes towards wildlife (Oli *et al*., 1994; Treves & Naughton-Treves, 2005; Kidgehesho *et al*., 2006; Blekesaune & Ronningen, 2010). In the present study, higher monthly incomes were associated with decreasing conflict levels, although there was no effect on management or tolerance. Increasing incomes were also coupled with increasing livestock numbers, with males having higher incomes particularly on fenced ranches. The influence of wealth on perceptions of conflict has been found in several studies (Gillingham & Lee, 1999; Zimmerman *et al*., 2001) including the Ruaha National Park in Tanzania where wealth is the most significant factor in the reduction of intense conflict (Dickman, 2005). This is understandable as for poorer farmers with less livestock any losses may become unsustainable (Ikeda, 2004; Hazzah, 2006). It is also possible that the greater number of livestock owned the less likely it is that individual depredation events are even noticed. This may be the case on fenced ranches where livestock management levels are very low and livestock, particularly cattle, are often left in the veld for weeks at a time.

Although conflict decreased with increasing monthly incomes in this study, tolerance was not affected. However, studies in Nepal (Mehta & Kellert, 1998) and the USA (Williams *et al*., 2002) have shown that higher levels of wealth result in more positive attitudes towards carnivores.

As well as actual income and wealth, the source of income is a key factor (Naughton-Treves & Treves, 2005; Bagchi & Mishra, 2006; Dickman, 2008; Lagendijk & Gusset, 2008). In the present study, the least conflict was reported by respondents whose main source of income was their own business, in employment or mixed incomes. Individuals depending primarily on their own business and employment certainly have less economic dependency on livestock and have an alternative income stream. However, they also have the lowest tolerance indicating that decreased conflict does not necessarily lead to improved tolerance. The mixed income group reported lower conflict levels and it is well documented that people dependent on a single livelihood are particularly hostile towards conflict species as they have a lack of alternative income strategies and increased vulnerability to a carnivore attack or other unexpected event (Naughton-Treves & Treves, 2005; Hazzah, 2006; Dickman, 2010). Even where the source of income is not wildlife-related, diversification can have a positive impact by improving financial status and lessening the relative impact of a depredation event (Stander, 1997).

Tolerance levels were highest amongst respondents who made a living from wildlife and veld products even though they also experienced the highest conflict levels. The positive relationship between conflict levels and tolerance is interesting and may be in part due to respondents receiving direct benefits from wildlife and natural resources. This is likely to result in improved attitudes as has been demonstrated elsewhere in Africa (Lewis & Alpert, 1996; Frank, 1998; Kiss, 1990), such as in Laikipia in Kenya where ranchers are more tolerant of large carnivores when they receive direct benefits from wildlife tourism. (Frank & Woodroffe, 2002). In addition, the government runs a Community Based Natural Resource Management program where communities can gain a quota to sustainably utilise their natural resources (Arntzen, 2003). A certain amount of training and environmental awareness raising takes place, and these individuals may have a deeper understanding of the importance of wildlife and conservation, although, formal levels of education were low in these groups. In Nepal, communities experiencing the greatest levels of livestock loss to snow leopards were comparatively more tolerant towards the snow leopard then villages with less conflict. The discrepancy was explained by differences in the economic roles of livestock. The

former was more dependent on cash crops as a source of income, while the latter were more dependent on livestock and thereby less tolerant of leopard (Mishra, 2003).

In this study, higher incomes were associated with decreased conflict but not improved tolerance. However, source of income was associated with tolerance and this was greatest amongst the veld and wildlife products groups who presumably saw benefits in coexisting with wildlife despite the conflict that can arise.

6.3 Effects of Physical Farm Characteristics

One of the main factors affecting conflict was the number of livestock owned. Farmers with greater numbers of livestock reported less conflict and there are several possible reasons for this. The perception of conflict might be reduced when total livestock holdings are high, as the proportional loss is low (Oli *et al*., 1994; Mishra, 1997; Dickman, 2005). It could also be that less management takes place as livestock numbers increase as reported in the present study for cattle. In Botswana an open range system is often practiced particularly for cattle on fenced ranches (Perkins, 1996). The livestock will not be seen on a daily basis and few records are kept (Hemson, 2003; Schiess-Meier, 2007) and individuals may not be aware of livestock losses due to predation. Most surprisingly the tolerance index decreased with increasing livestock numbers, despite respondents with more livestock reporting less conflict, having higher education levels and greater wealth. Once again this could be as a result of a lack of connection to the land resulting from spending more time in formal education. Increasing livestock numbers do not necessarily result in improved attitudes (Dickman, 2005). In Tanzania interviewees who reportedly owned more stock were no more tolerant than those with fewer stock (Dickman, 2008).

Farm type was significantly associated with a number of variables. Respondents on cattleposts generally had lower education levels, lower incomes with a greater component from natural resources, less people present and less water access, as well as, significantly higher conflict and higher cattle management. This was also found to be the case in a similar study in Kweneng region of Botswana, with cattleposts

experiencing higher proportional livestock losses (11.7% total livestock holdings) compared to fenced ranches (1.0% total livestock holdings) (Schiess-Meier, 2007).

Water access is often stated as a key concern for Kalahari communities (Abel, 1997; Arntzen & Fidzani, 1998; Thomas, 2003; Motlopi, 2006; Arntzen & Chigodora, 2008). Fenced ranches had access to a greater number of boreholes although this was not strongly linked to conflict, management or tolerance levels. However, perhaps a more significant concern is the distance that livestock have to travel from the kraals to the boreholes (Darkoh & Mbaiwa, 2005). Cattlepost owners have to go significantly further to the nearest borehole from the kraal and this was associated with increasing conflict levels. This is a key reason why farmers state that they cannot kraal livestock since they have to travel far to find water and this restricts their management options. Kideghesho *et al.* (2006) found a similar issue of lack of water access in villages in the Western Serengeti and reported that lack of water was one of the key factors in determining levels of conflict and shaping people's attitudes (Kideghesho *et al*., 2006). In the present study, the greater the distance required traveling to access water the greater the conflict experienced, presumably since the livestock was left unprotected in the veld for longer durations.

Several factors affect conflict, management and tolerance, including gender, farm type, education, incomes, size of livestock holdings and water access. However, these are all inter-dependent and it is not possible to state that any particular factor is individually responsible for these effects (Table 6.1).

Table 6.1. *Summary of the typical characteristics of cattleposts and fenced ranches.*

Cattleposts	Fenced Ranches
Higher conflict	Lower conflict
Better livestock management	Poorer livestock management
Higher tolerance	Lower tolerance
More women	Less women
Less formal education	Better formal education
Lower incomes	Higher incomes
Smaller herds	Larger herds
Livelihood from wildlife, veld products	Livelihood from own business
Less access to water	More access to water

On cattleposts and for women, conflict was higher. A low income would make it difficult to increase and maintain a larger herd and improve formal education. However, it is these respondents who used the better management methods and had the best tolerance levels. On fenced ranches and for men, conflict was lower and higher income enabled the acquisition of larger herds and improved formal education. However, this did not result in improved management practices or tolerance.

6.4 Livestock Management Strategies

The levels of livestock management were low throughout the study area, with only 27% of cattle farmers kraaling, 10% using herders and 15% using dogs. This was much better for smallstock with 68% kraaling, 13% using herders and 30% using dogs. Such low levels are surprising considering the presence of carnivores throughout the area. Overall, management of smallstock was better than for cattle and this may be because the smaller size of goats and sheep resulted in an increased vulnerability to predation. Breeding seasons were a more widely applied management technique with 46% using calving seasons and 49% using lambing seasons. Management of both cattle and smallstock was better on cattleposts than ranches, possibly due to the respondents experiencing higher conflict levels and therefore having a stronger incentive to implement improved management. This could also be due to respondents on cattleposts having a closer connection to the land and traditional methods of livestock protection.

The design of kraals was important and metal poles and fencing made the most effective barriers and was associated with reduced conflict levels. Acacia and wood kraals were not as effective at reducing stock loss. This is unfortunate as metal and fencing kraals are expensive to build while acacia and wood kraals can be made at little costs with locally available materials. Well-made acacia kraals reduce conflict in other studies in Africa (Ogada *et al*., 2003). However, there are several factors required for an effective acacia kraal i.e. strength, height, width of walls. Although these details were not collected for this study it is often the case that acacia kraals in Botswana are not strongly built with high enough walls and are not adequately maintained (Tjibae, 2001).

In this study, the application of many of the management methods was not associated with a reduction in conflict levels and in some cases conflict was actually higher. Such paradoxical results, where better management is associated with higher conflict, could imply that such techniques are not being effective in reducing conflict. Although the respondent reported utilising the techniques they may not be well applied. If kraals are not strongly built, of sufficient height, well maintained and sited close to human habitation they will not be effective (Ogada *et al*., 2003). Likewise, if herders are not attentive or livestock guarding dogs are not carefully monitored and cared for they will not have the requirements to be effective in reducing conflict (Dickman, 2005). Similar results were found in the Makgadikgadi communities of Botswana where livestock losses due to depredation were not improved with the application of livestock protection methods (Hemson, 2003) and lack of correct application was stated as a possible reason for this. By contrast, properly applied techniques of kraaling, herding, livestock guarding dogs and breeding seasons have all been demonstrated to be effective (Kruuk, 1980; Hermann *et al*., 2001; Ogada *et al*., 2003; Woodroffe *et al*., 2007). Simple changes to cattle husbandry practices in Venezuela helped to reduce the risk of jaguar depredation (Hoogesteijn, 2002). In Laikipia district, Kenya, construction of strong kraals, human presence and the use of guard dogs were all associated with lower losses to predators (Frank *et al*., 2005). In Namibia, a study to assess the effectiveness of livestock guarding dogs placed on farms showed that 73% of participants reported a large decline in losses since acquisition of the dog (Marker *et a*l., 2005). Such techniques have been widely used to combat large carnivore

depredation in Africa (Ogada *et al*., 2003; Graham *et al*., 2003; Breitenmoser *et al*., 2005; Woodroffe *et al*., 2007). Similarly, studies in Northern Botswana demonstrated that leaving livestock unattended during the day increases losses and that kraaling livestock at night was effective in their reduction (Gusset *et al*., 2008). Breeding seasons timed to coincide with rains improve growth rates and decrease mortality, as there is more wild prey available and grasses are more abundant and nutritious. It also facilitates livestock protection against carnivores by allowing herds to be concentrated spatially during this vulnerable period (Dougill, 2002; Fynn & O'Connor, 2000; Motlopi, 2006; Lamarque, 2008).

An alternative interpretation of the absence of a positive relationship between improved management practices and reduced conflict is that individuals are only driven to improve management when experiencing significant levels of conflict. Thus it is a reactionary response to livestock losses to carnivores rather than a preventative response. The lack of livestock management in Botswana is an ongoing national conservation concern (Nagafela & Kalikawe, 1993; Gusset *et a*l., 2009). Not only due to depredation by carnivores but also due to issues of range degradation from overgrazing, bush encroachment, disease transmission and declines in fertility (Darkoh & Mbaiwa, 2002; BGG, 2006; BGG, 2009). Few farmers keep accurate records and apply careful management (Schiess-Meier, 2007; Hemson *et al*., 2009). It was reported by Hemson (2003) that the 'laissez faire' herding strategy ensures that many unherded livestock are available to carnivores away from the kraals thus minimising any role that defences could play (Hemson *et al*., 2009). He suggests that this approach to livestock husbandry is inappropriate in areas where livestock must coexist with carnivores and the application of suitable methods should be the target of efforts to reduce stock loss. Based on such information, the government planned to set certain management technique criteria in order for farmers to qualify for eligibility to the compensation program, in an attempt to encourage the proper application of relevant methods. However, this was met with widespread discontent and failed to become part of the revised compensation program (DWNP PAC officer, S.Sekute, *pers. comm.*).

One aspect of this study's results which demonstrates that livestock management methods are indeed effective is the circumstances of losses. Most of the depredation occurred at night, out in the veld, in the absence of a herder or a guarding dog and in

the winter. This was also found in other studies in Botswana (Hemson, 2003; Schiess-Meier, 2007; Gusset *et al*., 2008) with losses predominantly reported at night, away from the kraals and without herders. Herding was uncommon and the usual practice was to let livestock out of kraals in the morning where they are left untended all day. Stock is then left to return to the cattlepost in the evening (Hemson, 2003). This lack of herding is surprising considering the presence of carnivore species in the region. In Laikipia, Kenya, livestock is herded closely at considerable cost for protection against carnivores and thieves (Frank, 1998; Ogada, 2003). Although theft is a concern in Botswana, a state service exists to find and care for stray livestock and attempts to locate the owners (Hemson, 2003). The costs of not herding are likely to be higher in Kenya where theft is a common threat and straying is more likely to result in loss (Frank, 1998; Hemson, 2003). The comparative rarity of stock theft, state care of stray livestock and compensation, all reduce the costs of not implementing better practices. Unless the cost-benefit ratio to livestock owners of herding or not herding are changed there is not a strong likelihood for improvements in herding practices to occur (Hemson, 2003).

In summary, although this study did not clearly demonstrate that many of the individual methods were effective in reducing conflict levels, it is likely that well applied livestock management methods have the potential to reduce losses. This is supported by the circumstances of the depredation events reported here, the majority of which occurred at night, out in the veld and in the absence of a herder or a guarding dog and as such implies that such techniques have the potential to reduce conflict levels.

6.5 Predation, Conflict and Livestock Losses

The worst problems perceived by farmers were predation, disease, lack of grazing and theft. While this is a common perception in Botswana it should be acknowledged that the number of animals lost to predation may have been exaggerated, especially where large carnivores are concerned (Nabane, 1995; Rasmussen 1999; Naughton-Treves & Treves, 2005; Nyayhongo & Roskaft, 2007). The cause of death could have been unknown but attributed to predation due to negative perceptions (Wagner, 1988). It

may also be in response to the hope for support or compensation for losses (Nyhus, 2005; Bulte & Rondeau, 2005). However, the perception of loss is still a key factor to consider as this is what motivates individuals to take retaliatory action (Marker *et al*., 2003a; Dickman, 2005).

All the carnivores considered in this study caused losses, with jackals, leopards and wild dogs being the most problematic followed by lions, cheetahs and brown hyenas. Few conflicts where reported for spotted hyenas and caracals. Livestock losses most commonly involved goats and then cattle, probably due to the increased vulnerability as a result of their smaller size.

The level of livestock predation documented in this study was high (*c*. 11% of total livestock holdings) and much higher on cattleposts (*c*. 14%) than fenced ranches (*c*. 2%). A similar high level of conflict was found in the Indian Himalaya, with 18% of total livestock holdings lost to snow leopards and wolves (Mishra, 1997). The proportion of livestock lost on cattleposts was considerably higher than levels recorded in many other carnivore studies. In villages surveyed adjacent to Serengeti National Park in Tanzania, households reported losses of a total of 4.5% of their livestock to carnivores over 12 months (Holmern *et al*., 2006). In Nepal, studies on depredation by snow leopard showed losses to vary between 2.6% and 5.1% in different villages of the study area (Oli *et al*., 1994). In central Bhutan, a similar 2.3% was found to be lost to all carnivores including leopards, tigers, bears and dholes (Wang & MacDonald, 2006).

The smaller proportional loss on fenced ranches has been reported in other studies. On ranches in Tsavo in Kenya, 2.4% of cattle were lost to predation (Patterson *et al.*, 2004). In the Brazilian Pantanal ranches, cattle predation by jaguar represented 2.3% of the annual cattle holdings (Zimmermann *et al*., 2005).

The level of livestock loss is frequently cited as one of the primary reasons for negative perceptions and retaliatory killings (Newmark *et al*., 1993; de Boer & Baquete, 1998; Sillero-Zubiri & Laurenson 2001; Marker *et al*., 2003b). In Norway, sheep farmers are more antagonistic towards large carnivores in areas with a high degree of depredation (Roskaft *et al*., 2003). It is be expected that more negative attitudes would be apparent where losses are higher, but attitudes towards and perceptions about carnivores develop as a result of a wide range of socio economic, cultural, political and ecological

factors. It is not a simple case of cause and effect as demonstrated in Ruaha National Park, Tanzania where Maasai pastoralists showed no relationship between levels of loss and attitude (Dickman, 2005). This has also been found in Brazil where the level of loss was not correlated to perceptions of jaguars and pumas. In fact several respondents who held the most positive attitudes towards conservation and the protection of jaguars actually suffered extensive cattle losses and did not enjoy supplementary income from conservation (Zimmerman *et al*., 2005). Similarly, in the present study levels of livestock loss were not significantly correlated with attitudes and simply reducing levels of carnivore conflict may not be enough to improve attitudes (Dickman, 2005). This effect could also be due to a greater appreciation for wildlife resulting from living closer to the land. It is possible that certain cultural beliefs and traditional practices may result in improved attitudes despite depredation events taking place (Kellert *et a*l., 1996; Ale, 1998).

Livestock losses were also reported as a result of disease, theft, starvation, accidents and calving problems. After predation, disease was the most significant problem. In previous studies in East Africa and South America, disease, malnutrition and accidents have a greater impact than depredation (Mazzolli *et al*., 2002; Kidgehesho *et al*., 2006; Holmern *et al*., 2007; Palmeira, 2008). Carnivores will take injured or sick individuals and scavenge carcasses (Oli *et al*., 1994; Mwangi, 1997; Kruuk, 2002) so that where disease, malnutrition and accidents are common, loss to carnivores may be exaggerated. It is important that such issues are considered when quantifying livestock loss and developing potential solutions to reduce conflict. In villages surrounding the western Serengeti, diseases contributed, about five times more to livestock loss than depredation (Nyayhongo & Roskaft, 2007). In a number of studies in Africa, loss to disease is three to six times greater than loss to predation (Holmern *et al*., 2007). Nevertheless, livestock depredation represents an economic strain on individuals living with carnivores (Mishra, 1997) and the present study reported an average income loss of 31% (median 13%). In Nepal, livestock damage from predators averaged 25% of the per capita income (Oli *et al*., 1994). In Tanzania, stock loss to carnivores was reported by Western Serengeti villagers as two thirds of the average annual income (Borge, 2003).There are also the additional costs of filing for and receiving a compensation

claim, finding and buying a replacement animal and less quantifiable costs of sharing space with and losing livestock to large carnivores (Loveridge *et al.,* 2002).

This study showed a clear seasonality, with most losses reported during the winter months, a pattern that has been reported previously in several countries (Karani, 1994; Butler, 2000; Schiess-Meier, 2007). For example, in Nepal, livestock losses are higher (42%) during the winter months (Oli *et al*., 1994). The seasonality is likely to have several causes including seasonal changes in wild prey such as small mammals for the jackals and seasonal changes in livestock body condition.

The perceived high levels of conflict are a significant concern for conservation managers as retaliatory killings threaten key populations of carnivore species (Kissui, 2008; Inskip & Zimmerman, 2009). Livestock keepers in many regions of Africa kill and poison carnivores with the goal of reducing livestock depredation and reducing conflict (Holekamp & Smale, 1992; Berry, 1999). In the present study, the majority of respondents believed that conflict was increasing and there was little appreciation of the potential benefits of coexistence with carnivores. This could result in an unsustainable level of predator removal (Stander, 1997; Wint, 2000) which may compromise important carnivore populations (Woodroffe & Ginsberg, 2000; Brashares, 2001). However, in this study, despite widespread negative perceptions, only 4% of respondents stated that they have killed a carnivore after a depredation event, with most reporting to the DWNP. Furthermore, only 14.2% claimed to have lethally removed a carnivore over the last 10 years, with shooting, box and gin traps, hunting down with dogs and poison being the commonly used methods. Although this may not be as high as expected it is important to consider that people are often wary to discuss illegal activity and the true scale of lethal removals is likely to be higher than reported. Similar results were found in the Ruaha National Park, Tanzania with less than 10% of people admitting to killing carnivores. However, this was much lower than a similar study in Northern Tanzania which reported 25-40% retaliatory mortality (Maddox, 2003). Carnivores have limited value to livestock owners and it is currently more cost effective to eliminate them rather than invest in management (Hemson, 2003).

Overall, predation was reported as one of the worst problems to farmers and this was caused by all predator species particularly jackals, leopards and wild dogs. The levels of loss were relatively high compared to similar studies, being highest on cattleposts although this did not affect tolerance. Reports of retaliatory killing were not as high as expected, however this could be under reported and should remain an important concern for the maintenance of carnivore populations. That losses were higher on cattleposts is interesting and may be a result of generally smaller livestock holdings that are more closely monitored, therefore there is a greater awareness of depredation events when they occur.

6.6 Perceptions of Living with Carnivore Species

In the present study, most respondents (65%) had negative attitudes towards living with carnivores which were seen as a threat to livestock and human life. Although 68% of respondents understood that wildlife was a national resource, very few people had an appreciation of the direct benefits that could accrue to them through tourism or sustainable utilisation. In general people think that Botswana benefits from tourism, but may not feel that they or their local community benefit directly (Mbaiwa *et al.,* 2008). The common perception is that government and tourism operators are the main beneficiaries of wildlife and should be responsible for limiting its costs (Hemson, 2003).

The receipt of compensation influenced attitudes and respondents who had received compensation were more likely to dislike carnivores but were less likely to kill them. This initially appears to be surprising, however, as in many countries, compensation is a difficult issue. Previous studies in Botswana have shown that the majority of farmers are not satisfied with the existing compensation scheme and often want more money for losses (Sechele & Nzehengwa, 2002; Hemson, 2003). In the present study, most respondents felt that responsibility for stock loss was with the government, although a significant number also felt this lay with the farmers. This is important as resentment towards wildlife is often considerable if people feel it is the government's responsibility (Woodroffe *et al.,* 2005). This is prevalent in Botswana where people feel wildlife is the state's concern and livestock is for the people (Parry & Campbell, 1992;

Hemson, 2003). This is often an issue where people may feel that their traditional rights to utilise natural resources have been reduced by centralized control and powerful elites (Dickman, 2005).

The solutions to carnivore conflict suggested by respondents were encouraging in so far as 23% felt that improving livestock management was the best way forward. The implementation of focused education programs aimed at providing information on the use of improved management practices could be well received (KPMG, 2007).
However, translocation and removal of carnivores were also regularly suggested. Cattlepost respondents preferred improved management and compensation, while more respondents on ranches wanted sustainable utilization (i.e. hunting) to be considered.

The generally negative attitudes towards living with carnivores and the low appreciation of potential benefits from wildlife is a concern that needs to be addressed. Compensation did not appear to improve attitudes but may have been effective in reducing retaliatory killings. The general feeling was that wildlife conflict is the government's responsibility although the improvement of livestock management practices was regularly stated as a potential solution, along with compensation and sustainable utilisation. Indeed, these could be included in the development of management recommendations to reduce conflict.

6.7 Wildlife Populations

The respondents showed a general lack of knowledge about game and carnivore populations. No clear trends were reported for populations of small or large game species and where there were trends, these were not related to any of the Indices. Despite no apparent relationships in this study, similar studies have shown that wild prey abundance can reduce livestock predation by large carnivores (Sillero-Zubriri & Laurenson, 2001; Hermann, 2002; Hemson & Macdonald, 2002), such as lions in Botswana (Hemson *et al*., 2008), tigers in Laos (Johnson *et al.,* 2006), pumas in Venezuela (Polisar *et al*., 2003), wolves in Portugal (Vos *et al*., 2000) and coyotes in Idaho (Stoddard *et al*., 2001) and declining prey bases are likely to increase predator

attacks on livestock (Fritts *et al*., 2003; Woodroffe *et al*., 2005). In Botswana, the density of ungulate species is lower outside of protected areas than inside (Verlinden *et al*., 1998; Walgren *et al.*, 2009). This is often thought to be due to an incompatibility between livestock and wild ungulates (Spinage & Matlhare, 1992; DWNP, 1995), however it is argued that poaching and overutilization outside the protected areas have caused the declines (Thouless, 1998). Any increase in the need for game hunting to supplement financial income or food supplies could reduce the abundance of natural prey and aggravate existing conflict with predators (Lindsey *et al.,* 2005b). Despite this research, the potential for wild prey populations to mitigate livestock loss conflicts is not emphasised in IUCN conservation action plans (e.g. Mills, 1998; Nowell & Jackson, 1996) perhaps due to lack of reliable information. In addition, there is an alternative view that increases in wild prey could increase carnivore populations and contribute to a rise in livestock loss (Carbone & Gittleman, 2002; Hemson, 2003). In order to reduce conflict, any increases in wild prey should be aligned with a decrease in livestock availability through increased protection.

The density of the carnivores is also likely to be an important factor in determining the local levels of livestock depredation (Lugton, 1993; Glenz *et al*., 2001). For example, in New South Wales, Australia, sheep depredation is the most severe where red fox densities are highest.

Overall, there was a lack of knowledge about wildlife amongst the respondents and no clear trends could be found. However, the likelihood that healthy wild prey populations can play a role in lessening conflict has been reported in various studies globally and thus should be considered as an important factor in Botswana. In addition, areas of high carnivore density are likely to result in substantial losses and should be the focus of intervention programs both to protect rural livelihoods and conserve key carnivore populations.

6.8 Spatial variations due to location, land use and human density

Spatial variations in land use can influence the occurrence and scale of conflict (Lindsey *et al.*, 2004; Treves *et al*., 2004; Dickman, 2005; Inskip & Zimmerman, 2009). This appeared to be the case in this study, with the Kgalagadi reporting the highest conflict

levels, followed by Ghanzi and the South East. Conflict was greatest on the WMA's followed by communal areas and ranches. However, the relationship is complex and it is not easy to establish whether this is a spatial effect or if it is due to other factors. For example, respondents in Kgalagadi WMA's are cattlepost owners and are characterised by lower levels of education, monthly incomes and higher numbers of respondents generating an income through the sale of veld and wildlife products. All of these factors are also associated with higher levels of conflict. Ranches in Ghanzi had the lowest conflict levels but they also had the greatest livestock holdings which may result in the perception of less conflict.

Tolerance was lowest in the South East ranches and cattleposts and highest in the Kgalagadi WMA's. There could be potential for conserving carnivore species in WMA's despite conflict occurring, as the respondents may be more responsive to conservation initiatives. However, despite the fact that a large proportion of the Kgalagadi and Ghanzi regions are zoned as WMA's, some are not gazetted or well managed for wildlife conservation (Selebatso, 2006). Furthermore, there are concerns that due to pressure from cattle interests these areas may be rezoned for cattle ranching, particularly in the Kgalagadi (Twyman, 2002; WKCC, 2007). This would be unfortunate as the WMA's play a significant role in acting as wildlife corridors between protected areas (Meyer & Bourquin, 2010).

Results from the present study also support the theory that depredation rates tend to increase with decreasing proximity to human habitation (Mazzoli *et al*., 2002; Rao *et al*., 2002; Kolowski & Holekamp, 2006), with more conflict and more carnivores being reported in areas of lower human population density. This is similar to findings in Tanzania in a survey of people living around National Parks. The relative frequency of reported conflict with wildlife was significantly and inversely related to human density (Newmark *et al.*, 1994).

6.9 Potential solutions and management recommendations

Clearly, wildlife conflict is a problem with many layers of economic, sociological, ecological and political variables, to which there is no all-encompassing solution. There is a need for local solutions to local conflicts and for this to be managed

adaptively. Adaptive management requires that as the solution or intervention to a problem is implemented, so the effectiveness is monitored and the solution adapted as necessary. Mitigation of carnivore conflict includes interventions that minimise the amount of livestock lost and those that increase tolerance for those losses. The most effective approach is one that can achieve both (Macdonald & Sillero-Zubiri, 2002). Interventions should seek to reduce livestock conflict, improve attitudes to wildlife and ensure that communities actively participate in, and gain benefits from, wildlife management (Hemson, 2003). Communities and governments need to perceive wildlife and natural resources as a productive land use and believe that there is a real opportunity for it to make a significant contribution to livelihoods. Both the challenge and the opportunity being that the main conflict species are also those which hold the most value for communities in terms of ecotourism and sustainable utilisation.

6.9.1 Utilisation of Effective Livestock Husbandry

Most losses took place in the absence of appropriate livestock management methods and there is considerable opportunity to implement better practices. Techniques such as incentives for herders, the use of guarding dogs and donkeys, kraaling, calving seasons, maternity kraals for pregnant females, increased vigilance in dry periods, communal guarding of livestock, the keeping of accurate records, human presence at kraals and in camps, healthy wild prey populations, have all been shown to be effective in controlling losses to carnivores (Marker, 1996; Ogada, 2003; Schumann, 2003).

6.9.2 Conservation Education

Targeted conservation education programs are needed to provide information on the importance of carnivores, management methods that are effective in minimizing livestock losses and the potential benefits of coexistence. Methods used should include workshops for the communities, particularly in hot spot areas of conflict, distribution of structured extension material on conflict prevention and awareness raising through media particularly radio, events and competitions. Collaborations with existing structures such as DWNP PAC officers, police, land boards, agricultural outreach officers and existing community trusts will increase capacity. Conservation education has the potential to improve attitudes. In Kwazulu-Natal, South Africa

attitudes towards wild dogs were improved following wild dog specific education (Whittington-Jones, 2011). In the Namibian farmlands, Cheetah Conservation Fund has for many years, successfully promoted initiatives designed to reduce predation and increase tolerance of cheetahs (Marker *et al.*, 2010).

6.9.3 Compensation, Insurance Schemes and Performance Payments

At present, farmers are not satisfied with the compensation system, stating low levels of reimbursement and delays in provision of funds as problems (Hemson, 2003; Gadimang, 2005). Compensation can improve tolerance, although conversely it can reduce tolerance if programs are not efficient (Nyhus, 2005). It can also run the risk of decreasing people's motivation to protect stock from carnivores, thereby increasing losses and further exacerbating conflict (Dickman, 2010). A restructuring of the current compensation program is recommended, with the introduction of a requirement to implement relevant livestock management methods in order to qualify for compensation. This would ensure that farmers are playing their part in protecting their livestock. In addition, all medium and large carnivores should be included in the list of species that attract compensation (Gusset *et al.,* 2008). Another approach is the provision of an insurance scheme, where farmers pay a premium for cover against a defined risk, such as predation of livestock. Although they often have low levels of community buy-in and local interest (Miquelle, 2005), such schemes have been successful in Namibia on communal conservancies in Kunene and Caprivi (Esterhuizen, 2004). However, these programs do not address the underlying causes of conflict and may not even improve tolerance (Naughton-Treves *et al*., 2003; Sillero-Zubiri *et al.,* 2007). An increasingly common approach is to involve conservation performance payments where farmers are rewarded for the presence of carnivores on their land or if they manage land in a way that is likely to conserve threatened populations (Zabel & Holm-Müller, 2008; Nelson, 2009). These initiatives provide an obvious incentive for tolerating potentially problematic species. However, payments to individual farmers require well defined land ownership and collective payments, such as to a village, require functional systems of collective action (Dickman, 2010)

6.9.4 Diversification of livelihoods

The source of income was significantly related to tolerance in this study, with respondents benefitting from natural resources through veld and wildlife products having improved perceptions towards carnivores. Direct benefits could come from several different approaches.

Community ecotourism

This has been shown to be effective elsewhere in the Kalahari and Southern Africa (Jones, 1999; Sebele, 2010). For example, in the Nyae Nyae Conservancy in Namibia, eco-tourism was evaluated as an option to balance the cost of living with leopards. A programme was developed whereby the San community linked up with eco-tourism ventures to offer specialised leopard tours to tourists. The program was very effective and generated significant income for the community (Barnes *et al*., 2001). With current government plans to facilitate ecotourism in the WMA's and build capacity within existing community trusts to better meet the requirements for tourism (WKCC, 2007), this option is a possibility that has the potential to succeed in generating direct benefits to communities through coexisting with and conserving wildlife species.

Sustainable utilisation of conflict species

In cases where tourism may not be viable, well managed trophy hunting can have a minimal impact on population numbers and increase community perceptions towards large carnivore species (Lindsey *et al.,* 2007; Packer *et al.,* 2009). This can be an effective tool as it begins to give a value to conflict species, rather than them being viewed only as a threat and having negative impacts on livelihoods (Marker *et al.,* 2003). However, sustainable utilisation of wildlife needs to include clear means of monitoring populations, using methods sensitive enough to detect significant declines (Loveridge *et al.,* 2006). The programmes should have definite, enforceable limits on the number and type of animals that can be harvested, as well as on the timing, location and methods of hunting and allow for the distribution of benefits to stakeholders.

Wildlife friendly products

Schemes that eco-label products can provide incentives for coexistence, where in return for various conservation commitments communities are paid a premium on their local products (Treves & Jones, 2010). Such as in Mongolia, where communities in remote areas of snow leopard habitat receive a premium for local handicrafts, thereby increasing household income (Mishra *et al*., 2003). In Namibia the concept of Predator Friendly Beef is being developed where farmers will receive a premium for implementing best practices in livestock management and non-lethal carnivore control (Marker *et al*., 2003; Ndhulukula *et al*., 2009). Such programs can ensure communities see a direct economic incentive from living with carnivores.

6.10 Conclusion

The aim of this project was to assess the relationships between socio-economic, physical and management variables with conflict and tolerance levels in the farmlands of the Kalahari region of Botswana. The majority of respondents regarded coexisting with carnivores as a considerable challenge, with losses due to depredation perceived as the greatest problem facing farmers throughout the region. Conflict was widespread throughout the study area, with some spatial variations for certain species. Cattle management levels were low and while smallstock management was better, there is an opportunity to implement greater levels of management to reduce current levels of conflict. Tolerance levels were generally low with few respondents seeing the benefits of coexistence with carnivore species. Overall, several different factors affected the level of reported conflict and tolerance. Gender, education, source of income, livestock numbers, farm type, location and land use all had an effect on perceived conflict and tolerance levels. In many cases these strongly interact with each other, further demonstrating the complexity that community conservation must seek to understand. It appeared that livelihood benefits from wildlife and veld products resulted in higher tolerance and this is worth further investigation. An improvement in the use of effective methods of livestock management, targeted environmental education programs to develop a greater awareness for the conservation value of carnivores and a diversification of livelihoods to include benefits from natural resources have the potential to reduce conflict and improve tolerance in the region.

References

Abel, N., Blaikie, P. 1989. Land degradation, stocking rates and conservation policies in the communal rangelands of Botswana and Zimbabwe. Land Degradation and Rehabilitation 1, 101-123.

Adams, W. M., Hulme, D. 2001. If community conservation is the answer in Africa, what is the question? Oryx 35, 193-200.

Ale, S. 1998. Culture and conservation: the snow leopard in Nepal. International Snow Leopard Trust newsletter, 16, 10-15.

Andelt, W. F. 2001. Effectiveness of livestock guarding animals for reducing predation on livestock. Endangered Species Update 18, 182-185.

Allendorf, T., Swe, K. K., Oo, T., Htut, Y., Aung, M., Aung, M., Wemmer, C. 2006. Community attitudes toward three protected areas in Upper Myanmar (Burma). Environmental Conservation, 33(4), 344-352.

Archibald, S., Bond, W. J., Stock, W. D., Fairbanks, D. H. K. 2005. Shaping the landscape: fire-grazer interactions in an African savannah. Ecological Applications, 15(1), 96-109.

Arntzen J. 1995. Economic Instruments for sustainable resource management: the case of Botswana's water resources. Ambio, 24, 6, 335-342.

Arntzen J. 1998. Global change and subsistence Rangelands in Southern Africa: Resource variability, access and use in relation to rural livelihoods and welfare. Final Report of the environmental economics subcomponent in the BNCS Action Plan. National Development Plan. University of Botswana. Private Bag 0022 Gaborone, Botswana.

Arntzen, J., Fidzani H. 1998. Incentives for sustainable natural resource management. final report of the environmental economics subcomponent in the BNCS Action Plan. National Development Plan. University of Botswana. Private Bag 0022 Gaborone, Botswana.

Arntzen, J. 1998. Economic value of communal rangelands in Botswana: a case study CREED Working Paper Series No.17. International Institute for Environment and Development, London.

Arntzen, J. 2002. An economic view on wildlife management areas in Botswana. In: Rozemeijer, N. (Ed.), CBNRM Support Programme Occasional Paper No. 10. IUCN/SNV CBNRM Support Programme. Gaborone, Botswana, p. 31.Arntzen, J. W., Ed. (2003). An Economic View on Wildlife Management Areas in Botswana. CBNRM Support Program, Occasional Paper No. 10. Gaborone Botswana, IUCN Botswana.

Arntzen, J., Chigodora, K. 2002. The Impact of government policies on rangeland conditions and rural livelihoods in the Matsheng Area, Kgalagadi North, Botswana. National CBNRM Forum. Centre for Applied Research, PO Box 70180, Gaborone, Botswana.

Bagchi, S., C. Mishra. 2006. Living with large carnivores: predation on livestock by the snow leopard (Uncia uncia). Journal of Zoology 268, 217-224.

Baldus, R. 2008. Best practices in sustainable hunting. A guide to best practices from around the world. CIC Technical Series Publication. International Council for Game and Wildlife Conservation, Vienna; FAO, Rome.

Baldus, R. 2004. Lion conservation in Tanzania leads to serious human-lion conflicts with a case study of a man-eating lion. Tanzania Wildlife Discussion Paper 41, 1-63.

Baker, S.E., Macdonald, D.W. 2000. Foxes and foxhunting in Wiltshire; a case study. Journal of Rural Studies, 16, 185–201.

Bandara, R., C. Tisdell. 2003. Comparison of rural and urban attitudes to the conservation of Asian elephants in Sri Lanka: empirical evidence. Biological Conservation 110, 327-342.

Bauer, H. 2005. Lion (*Panthera leo*) home ranges and livestock conflicts in Waza National Park, Cameroon. 2005 African Journal of Ecology, 43, 208–214

Bauer, H. 1995. Carnivores and cattle-raising: Report of a survey on predation by carnivores of Waza National Park on livestock in the surroundings, IUCN Waza Logone Project, Leiden, The Netherlands.

Bauer, H., Kari S. 2001. Assessment of the people-predator conflict through thematic PRA in the surroundings of Waza National Park, Cameroon. PLA Notes, 41, 9-13.

Barnes, J. I., MacGregor, J., Weaver, L. C. 2001. Economic analysis of community wildlife use initiatives in Namibia (No. 42). Directorate of Environmental Affairs, Ministry of Environment and Tourism.

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. Journal of Wildlife Management 59, 228-237.

Bekoff, M. 2001. Human-carnivore interactions: adopting proactive strategies for complex problems. In Carnivore Conservation (eds Gittleman, J.L., Funk, S.M., Macdonald, D., Wayne, R.K.), pp. 179–195. Journal of Wildlife Management, 59, 388–397.

Berger, J. 1999. Anthropogenic extinction of top carnivores and interspecific animal behaviour: implications of the rapid decoupling of a web involving wolves, bears, moose and ravens. Proceedings of the Royal Society of London, Series B 266, 2261-2267.

Berry, R. S. Y. 1999. Collecting data by in-depth interviewing. British Educational Research Association Annual Conference, University of Sussex at Brighton.

BGG (Botswana Government Gazette), 1975. National Policy on Tribal Grazing Land Government Paper No. 2 of 1975. Government Printer.

BGG (Botswana Government Gazette), 1992.Wildlife Conservation and National Parks Act no. 28 of 1992. Government Printer, Gaborone.

BGG (Botswana Government Gazette), 2001. Statutory Instrument No. 69 of 2000 restricting the killing of lions and Cheetahs by both public and wildlife staff. Ministry of Commerce and Industry, Government of Botswana.

BGG (Botswana Government Gazette), 2006. Botswana National Action Programme to Combat Desertification. Department of Environmental Affairs: Gaborone, Botswana.

BGG (Botswana Government Gazette), 2009. Botswana Fourth National Report to the Convention of Biological Diversity.

CSO (Central Statistics Office) 2001. www.cso.gov.bw.

CSO (Central Statistics Office) 2006. www.cso.gov.bw.

Bjerke, T., Reitan, O., Kellert S. 2002. Attitudes towards wolves in Southeastern Norway. Society and Natural Resources: An International Journal, 11: 2, 169-178

Blekesaune, A., Rønningen, K. 2010. Bears and fears: Cultural capital, geography and attitudes towards large carnivores in Norway. Norsk Geografisk Tidsskrift-Norwegian Journal of Geography, 64(4), 185-198.

Boggs, L. 2000. Community power, participation, conflict and development choice: Community wildlife conservation in the Okavango region of northern Botswana. Evaluating Eden Series Discussion Paper No.17. IIED. International Institute for Environment and Development, London.

Bonica, M. 1992. Aerial surveys of Botswana 1989-1991. Final Report. Technical Assistance to the Department of Wildlife and National Parks. Gaborone, 145 pp.

Boomgaard, P. 2001. Frontiers of fear: Tigers and people in the Malay World, 1600-1950. Yale University Press, New Haven, CT.

Borge, A. 2003. Essays on the economics of African wildlife and utilization and management. Thesis, Norwegian University of Science and Technology, Trondheim, Norway, 187pp.

Brashares, J.S. Arcese, P., Sam, M.K., 2001. Human demography and reserve size predict wildlife extinction in West Africa. Proceedings of the Royal Society of London B, 268, 2473-2478.

Brashares, J. S., Prugh, L. R., Stoner, C. J., Epps, C. 2010. Ecological and conservation implications of mesopredator release. Trophic Cascades: Predators, Prey, and the Changing Dynamics of Nature, 221-240.

Breitenmoser, U. 1998. Large predators in the Alps: the rise and fall of man's competitors. Biological Conservation 83, 279-289.

Breitenmoser, U., Angst, C., Landry, J. M., Breitenmoser-Wursten, C., Linnell, J.D.C., Weber, J. M. 2005. Non-lethal techniques for reducing depredation. In (eds Woodroffe, R., Thirgood, S., Rabinowitz, A.). People and wildlife: conflict or coexistence? pp. 49-71. Cambridge, UK. Cambridge University Press, 516 pp.

Bruggers, R.L., Elliot, C.C.H. 1989. Quelea quelea: Africa's bird pest. Oxford University Press, Oxford, UK, 402 pp.

Bulte, E. H., D. Rondeau. 2005. Why compensating wildlife damages may be bad for conservation. Journal of Wildlife Management 69, 14-19.

Butler, J.R.A. 2000. The economic costs of wildlife predation on livestock in Gokwe communal land, Zimbabwe. African Journal of Ecology, 38, 23.

Campbell, B. 2005. Changing protection policies and ethnographies of environmental engagement. Conservation and Society 3, 280-322.

Carbone, C., Gittleman, J.L. 2002. A common rule for the scaling of carnivore density. Science, 295, 2273-2276.

Caro, T. M. 2003. Umbrella species: critique and lessons from East Africa. Animal Conservation 5, 171-181.

Caro, T. M. 1994 Cheetahs of the Serengeti Plains: Group living in an asocial species. Chicago: University of Chicago Press.

Conforti, V.A., De Azevedo, F.C.C. 2003. Local perceptions of jaguars (*Panthera onca*) and pumas (*Puma concolor*) in the Iguacu National Park area, south Brazil. Biological Conservation, 111, 215-221.

Conover, M., 2002. Resolving human-wildlife conflicts: The science of wildlife damage management. CRC Press, Boca Raton, Florida, 418 pp.

Cooke H. 1985. The Kalahari today: a case of conflict over resource use. Geographical Journal, 151, 75–85.

Cook, S. J., Norris, D. R., Theberge, J. B. 1999. Spatial dynamics of a migratory wolf population in winter, south-central Ontario (1990-1995). Canadian Journal of Zoology, 77(11), 1740-1750.

Creel, S. 1998. Social organisation and effective population size in carnivores. In Behavioural Ecology and Conservation Biology (ed T.M. Caro), pp. 246-265. Oxford University Press, Oxford.

Crowe, D. 1995. Present Status of Wildlife. In: The present status of wildlife and its future in Botswana. Proc. of a Symposium /Workshop. Kalahari Conservation Society/Chobe Wildlife Trust. 11-28.

Cullis A, Watson C. 2005. Winners and Losers: Privatising the commons in Botswana. Briefing Paper, International Institute for Environment and Development and Resource Conflict Institute, London.

Darkoh, M., Mbaiwa, J. 2005. Globalisation and the livestock Industry in Botswana. The Geographical Journal, Vol. 168, No. 3, September 2002. pp149-166.

De Boer, W. F., D. S. Baquete. 1998. Natural resource use, crop damage and attitudes of rural people in the vicinity of the Maputo Elephant Reserve, Mozambique. Environmental Conservation 25,208-218.

Dickman, A. 2005. An assessment of pastoralist attitudes and wildlife conflict in the Rungwa-Ruaha region, Tanzania, with particular reference to large carnivores. Page 95. Biodiversity, Conservation and Management. University of Oxford, Oxford.

Dickman, A. 2008. Key determinants of conflict between people and wildlife, particularly large carnivores, around Ruaha National Park, Tanzania. PhD Thesis. University College London and Zoological Society of London.

Dickman, A. 2010. Complexities of conflict: The importance of considering social factors for effectively resolving human–wildlife conflict. Animal Conservation 13, 458-466.

Dougill A. J., 2002. Ecological change in Kalahari rangelands: permanent or reversible? In Sustainable Livelihoods in Kalahari Environments, (eds Sporton D., Thomas D.). Oxford University Press. 91–110.

Draheim, M. M., Rockwood, L. L., Guagnano, G., Parsons, E. C. M. 2011. The impact of Information on students' beliefs and attitudes toward coyotes. Human Dimensions of Wildlife, 16(1), 67-72.

Durant, S. M. 2000a. Living with the enemy: avoidance of hyenas and lions by cheetahs in the Serengeti. Behavioural Ecology 11, 624-632.

DWNP, 1995. Status and trends of selected wildlife species in Botswana. Gaborone: Department of Wildlife and National Parks. Gaborone.

DWNP, 1998. Guidelines for compensation. Department of Wildlife and National Parks, Gaborone.

DWNP, 2002. Department of Wildlife and National Parks, Problem Animal Control Records from 1998-2002.

DWNP, 2003. Department of Wildlife and National Parks, Gaborone. National Predator Strategy Botswana. Gaborone: 1-64.

DWNP, 2007. Department of Wildlife and National Parks, Problem Animal Control Records from 2003-2007.

Elmhagen, B., Ludwig, G., Rushton, S. P., Helle, P., Lindén, H. 2010. Top predators, mesopredators and their prey: interference ecosystems along bioclimatic productivity gradients. Journal of Animal Ecology, 79(4), 785-794.

Esterhuizen, A. 2004. Perspectives on problem causing animals. IRDNC Kunene Region, Namibia IRDNC Kunene.

Estes, J. A., Terborgh, J., Brashares, J. S., Power, M. E., Berger, J., Bond, W. J., Wardle, D. A. 2011. Trophic downgrading of planet earth. Science, 333(6040), 301-306.

Ericsson, G., Herbelein, T.A. 2003. Attitudes of hunters, locals, and the general public in Sweden now that the wolves are back. Biological Conservation 111(2), 149-159.

Fox, J., S. Sinha, R. Chundawat, P. Das. 1991. Status of the snow leopard (*Panthera uncia)* in northwest India. Biological Conservation 55, 283-298.

Frank, L.G. 1998. Living with lions: Carnivore conservation and livestock in Laikipia District, Kenya, Development Alternatives Inc., Bethesda, Maryland.

Frank, L.G., Woodroffe, R. 2002. Managing predators and livestock on an East African rangeland. In Lion Conservation Research. Workshop 2: Modelling Conflict (eds Loveridge, A.J., Lynam, T., Macdonald, D.W.), Wild CRU, Oxford.

Frank, L.G., Woodroffe, R., M. Ogada. 2005. People and predators in Laikipia District, Kenya in R. Woodroffe, S. Thirgood, and A. Rabinowitz, editors. People and wildlife-conflict or coexistence?

Fritts, S.H., Stephenson, R.O., Hayes, R.H., Boitani, L. 2003. Wolves and humans. In: (eds Mech, L.D., Boitani, L.), Wolves; Behaviour, Ecology and Conservation. University of Chicago Press, Chicago.

Fuller, T. K. 1995. An international review of large carnivore conservation status. In Integrating people and wildlife for a sustainable future: 410–412. (eds Bissonette, J. A., Krauseman, P. R.). Proceedings of the First International Wildlife Management Congress. Bethesda, MD: The Wildlife Society.

Fynn, R., O'Connor, T. 2000. Effect of stocking rate and rainfall on rangeland dynamics and cattle performance in a semi-arid savannah, Journal of Applied Ecology, Vol. 37, No. 3 pp. 491-507.

Gadimang, P. 2005. Monitoring of predator livestock conflicts (July 2000-January 2002) in Ngamiland. In Proceedings of the Botswana lion workshop. Kasane 18th-19th March. Kalahari Conservation Society.

Gaobotse, D. 2008. Botswana environment statistics 2006. Gaborone, Botswana: Central Statistics Office.

Gibson, C., Hadfield, P., Rice, M. 2003. A briefing document on the Construction of a Game Proof Fence around the Makgadikgadi National Park, Botswana. www.eia-international.org.

Gillingham, S., Lee. P. 1999. The impact of wildlife-related benefits on the conservation attitudes of local people around the Selous Game Reserve, Tanzania. Environmental Conservation 26 (3), 218–228 © 1999

Ginsberg, J.R. 2001. Setting priorities for carnivore conservation: what makes carnivores different? In: (eds Gittleman, J.L., Funk, S.M., Macdonald, D.W., Wayne, R.K.), Carnivore Conservation. University of Cambridge, Cambridge.

Gittleman, J.L., Funk, S.M., Macdonald, D.W., Wayne, R.K. (eds) 2001. Carnivore Conservation. Conservation Biology series. Cambridge University Press, Cambridge, U.

Glenz, C., Massolo, A., Kuonen, D., Schlaepfer, R. 2001. A wolf habitat suitability prediction study in Valais (Switzerland). Landscape and Urban Planning 55, 55-65.

Graham, K., Beckerman, A.P., Thirgood, S. 2005. Human–predator–prey conflicts: ecological correlates, prey losses and patterns of management. Biological Conservation 122, 159-171

Greenway, P. 2001. Botswana, 1st edn. Australia: Lonely Planet Publications Pty Ltd.

Gros, P. M., Kelly, M. J., Caro, T. M. 1996 Estimating carnivore densities for conservation purposes: Indirect methods compared to baseline demographic data. Oikos 77, 197-206.

Gros, P., Rejmanek, M. 1999. Status and habitat preferences of Uganda cheetahs: An attempt to predict carnivore occurrence based on vegetation structure. Biodiversity and Conservation 8, 1561-1583.

Gros, P. M. 2002. The status and conservation of the cheetah Acinonyx jubatus in Tanzania. Biological Conservation 206, 177-185.

Guan, Y, Zhuang, Z Cheung C, 2004. Isolation and characterization of viruses related to the SARS coronavirus from animals in Southern China. Science: 302, 276–8.

Gusset, M., Maddock, A.H., Gunther, G.J., Szykman, M., Slotow, R., Walters, M., Somers, M.J. 2008. Conflicting human interests over the re-introduction of endangered wild dogs in South Africa. Biodiversity Conservation. 17, 83–101.

Gusset, M., Swarner, M.J., Mponwane, L., Keletile, K., McNutt, J.W., 2009. Human wildlife conflict in northern Botswana: livestock predation by Endangered African wild dog Lycaon pictus and other carnivores. Oryx 43, 67–72.

Hazzah, L. N. 2006. Living among lions (Panthera leo): Coexistence or killing? Community attitudes towards conservation initiatives and the motivations behind lion killing in Kenyan Maasailand. University of Wisconsin-Madison, Madison.

Hayward, M. W., Somers, M. (eds). 2009. Reintroduction of top-order predators (No. 5). Wiley-Blackwell.

Helldin, J. O., Liberg, O., Glöersen, G. 2006. Lynx (*Lynx lynx*) killing red foxes (*Vulpes vulpes*) in boreal Sweden–frequency and population effects. Journal of Zoology, 270(4), 657-663.

Hemson, G., Macdonald, D. W. 2002. Cattle predation by lions in the Makgadikgadi—some patterns and parameters. Pages 10–12 in A. J. Loveridge, T. Lynam, and D. W. Macdonald, editors. Lion conservation research: Workshop 2: modelling conflict. Wildlife Conservation Research Unit, Oxford, United Kingdom.

Hemson, G. 2003. The Ecology and conservation of lions: Human-wildlife conflict in semi-arid Botswana. Ph.D. Thesis, University of Oxford, Oxford, U. K., 213 pp.

Hemson, G., Maclennan, S., Mills, G., Johnson, P., Macdonald, D. 2009. Community, lions, livestock and money: A spatial and social analysis of attitudes to wildlife and the conservation value of tourism in a human-carnivore conflict in Botswana. Biological Conservation 142, 2718-2725.

Hermann, E. 2002. The conflict between lions and cattle in the southern Kalahari. Pages 9–10 in A. J. Loveridge, T. Lynam, and D. W. Macdonald, editors. Lion conservation research: Workshop 2: modelling conflict. Wildlife Conservation Research Unit, Oxford, United Kingdom.

Herremans, M. 2000. Land use and the conservation status of raptors in Botswana. Biological Conservation. Volume 94, Issue 1, June 2000, Pages 31–41

Herremans. M. 2006. Case in sustainable tourism: an experiential approach to making decisions. The Haworth Hospitality Press. 10 Alice Street. Binghamton, NY.

Hill, C. M. 1998. Conflicting attitudes towards elephants around Budongo Forest Reserve, Uganda. Environmental Conservation 25, 244-250.

Holmern, T., Mkama, S., Muya, J. 2006. Intraspecific prey choice of bush meat hunters outside the Serengeti National Park, Tanzania: a preliminary analysis. African Zoology 41(1), 81-87

Holmern, T., Nyahongo, J. W., Røskaft, E. 2007. Livestock loss caused by predators outside the Serengeti National Park, Tanzania. Biological Conservation, 135, 518-542.

Homewood, K., Brockington, D. 1999. Biodiversity, conservation and development in Mkomazi Game Reserve, Tanzania. Global Ecology and Biogeography 8, 301-313.

Hoogesteijn, R. 2002. Manual on the problem of depredation caused by jaguars and pumas on cattle ranches. Wildlife Conservation Society. New York.

Hoogesteijn, R., Hoogesteijn, A., Mondolfi, E. 1993. Jaguar predation vs. conservation: cattle mortality by felines on three ranches in the Venezuelan Llanos. In: (eds Dunstone, N., Gorman, M.L.), Mammals as Predators, Proceeding Symposium Zoological Society of London, vol. 65, pp. 391–407. Hudson, P. J., A. Rizzoli, B. T. Grenfell, H. Heesterbeek, and A. P. Dobson 2002. The Ecology of Wildlife Diseases. Oxford University Press, Oxford, U.K.

Houser, A. M., Somers, M. J., Boast, L. K. 2009a. Home range use of free-ranging cheetah on farm and conservation land in Botswana. South African Journal of Wildlife Research 39, 11-22.

Hussain, S. 2003. The status of the snow leopard in Pakistan and its conflict with local farmers. Oryx 37, 26-33.

Hutton, J. M., N. Leader-Williams. 2003. Sustainable use and incentive-driven conservation: realigning human and conservation interests. Oryx 37, 215-226.

Ikeda, N. 2004. Economic impacts of livestock depredation by snow leopard (Uncia uncia) in the Kanchenjunga Conservation Area, Nepal Himalaya. Environmental Conservation 31, 322–330.

Infield, M. 1988. Attitudes of a rural community towards conservation and a local conservation area in Natal, South Africa. Biological Conservation 45, 21–46.

Infield, M. 2001. Cultural values: a forgotten strategy for building community support for protected areas in Africa. *Conservation Biology*, 800-805.

Inskip, C., Zimmerman, A. 2009. Human-felid conflict: a review of patterns and priorities worldwide. Oryx 43, 18–34.

IUCN, 2002. The IUCN Red List of Threatened Species. Available at www.redlist.org.

IUCN, 2007. Regional conservation strategy for the cheetah and African wild dog in Southern Africa, IUCN, Gland, Switzerland

Jackson, R.M., Ahlborn, G.G., Gurung, M. 1996. Reducing livestock depredation losses in the Nepalese Himalaya. In: (eds Timm, R.M., Crabb, A.C.), Proceedings of the 17th vertebrate pest conference. University of California, Davis, pp. 241-247.

Johnsingh, A., Negi, A. 2003. Status of tiger and leopard in Rajaji–Corbett Conservation Unit, northern India. Biological Conservation 111 (2003) 385–393

Johnson, A., Vongkhamheng, C., Hedemark, M., Saithongdam, T. 2006, Effects of human–carnivore conflict on tiger (*Panthera tigris*) and prey populations in Lao PDR. Animal Conservation, 9, 421–430.

Jones, B. 1999. Community-based natural resource management in Botswana and Namibia. Evaluating Eden Series Discussion Paper No.6. IIED. International Institute for Environment and Development, London.

Kabaija, S. 2005. Wildlife Statistics 2004. Central Statistics Office. Department of Printing and Publishing Services. P/Bag 0081, Gaborone.

KCS. 2002. Kalahari Conservation Society. National predator strategy, Botswana. Pages 1-67. Department of Wildlife and National Parks, Kalahari Conservation Society, Gaborone.

Karani, I.W., Dublin, H.T., Koehler, G.M. 1995. Livestock depredation by predators in pastoral areas adjacent to Masai Mara National Reserve, Kenya.

Kellert, S.R. 1985. Public perceptions of predators, particularly the wolf and coyote. Biological Conservation 31(2), 167-189.

Kellert, S.R., Berry, J.K. 1987. Attitudes, knowledge and behaviours toward wildlife as affected by gender. Wildlife Society Bulletin 15, 363-371.

Kellert, S.R., Black, M., Rush, C.R., Bath, A.J. 1996. Human culture and large carnivore conservation in North America. Conservation Biology, 10, 977-990.

Kideghesho, J. R. 2006. Wildlife conservation and local land use conflicts in Western Serengeti Corridor, Tanzania. Faculty of Natural Sciences and Technology, Department of Biology. Norwegian University of Science and Technology, Trondheim, Norway.

Kiss, A. 1990. Living with wildlife: Wildlife Resource Management with Local Participation in Africa. World Bank, Washington DC.

Kissui, B.M. 2008. Livestock predation by lions, leopards, spotted hyenas, and their vulnerability to retaliatory killing in the Maasai steppe, Tanzania. Animal Conservation 11, 422–432.

Klein, R. 2007. Status report for the cheetah in Botswana. Cat News Special Issue No 3 2007.

Klein, R. 2008. An Assessment of human wildlife conflict in the Western Kalahari Conservation Corridor Project Area. Conservation International Report.

Knight, R., Maestas, J., Gilgert W. 2001. Biodiversity across a rural land-use gradient. Conservation Biology Volume 17, Issue 5, pages 1425–1434.

Knight, J. 2000. Introduction. Pages 1-35 in J. Knight, editor. Natural enemies: people wildlife conflict an anthropological perspective. Routledge, London.

Kolowski, J. M., Holekamp, K. E. 2006. Spatial, temporal, and physical characteristics of livestock depredations by large carnivores along a Kenyan Reserve Border. Biological Conservation 128, 529-541.

KPMG, 2007. Threatened species management policy, implementation strategy and action plan. November 2007. United Nations Development Programme Botswana.

Krebs, C.J., Boutin, S., Boonstra, R., Sinclair, A.R.E., Smith, J.N.M., Dale, M.R.T., Martin, K., Turkington, R. 1995. Impact of food and predation on the snowshoe hare cycle. Science, 269, 1112-1118.

Kreuter, U. P., Workman, J. P. 1997. Comparative profitability of cattle and wildlife ranches in semi-arid Zimbabwe. Journal of Arid Environments, 35(1), 171-187.

Kruuk, H. 2002. Hunter and Hunted: Relationships between carnivores and people. Cambridge University Press, Cambridge, U. K.

Kruuk, H. 1980. The effect of large carnivores on livestock and animal husbandry in Marsabit District, Kenya. IPAL Technical Report E - 4. Integrated Project on Arid Lands. UNEP and MAB (Man and Biosphere Program).

Kruuk, H. 2002. Hunter and hunted: relationships between carnivores and people. Cambridge University Press.

Lamarque, F., Anderson, J., Chardonnet, P., Fergusson, R., Lagrange, M., Osei-Owusu, Y., Bakker, L., Belemsobgo, U., Beytell, B., Boulet, H., Soto, B., Tabi Tako-Eta, P. 2008. Human-wildlife conflict in Africa. An overview of causes, consequences and management strategies. Working Paper. Food and Agriculture Organisation of the United Nations, Rome, February 2008.

Lagendijk, D.D.G., Gusset, M. 2008. Human-carnivore coexistence on communal land bordering the Greater Kruger Area, South Africa. Environmental Management 42, 971-976.

Landry, J.-M. 1999. The use of guard dogs in the Swiss Alps: A first analysis, KORA, Muri, Switzerland.

Lewis, D.M., Alpert, P. 1996. Trophy hunting and wildlife conservation in Zambia. Conservation Biology, 11, 59-68.

Lindsey, P., Du Toit, J.T., Mills, M.G.L. 2004. The distribution and population status of African wild dogs Lycaon pictus outside protected areas in South Africa. South African Journal of Wildlife Research 34, 143–151.

Lindsey, P.A., Du Toit, J.T., Mills, M.G.L. 2005a. Attitudes of ranchers towards African wild dogs Lycaon pictus: Conservation implications on private land. Biological Conservation 125, 113–121. 119

Lindsey, P.A., Alexander, R.R., Du Toit, J.T., Mills, M.G.L. 2005b. The potential contribution of ecotourism to African wild dog Lycaon pictus conservation in South Africa. Biological Conservation 123, 339–348.

Lindsey, P. A., Roulet, P. A., & Romanach, S. S. 2007. Economic and conservation significance of the trophy hunting industry in sub-Saharan Africa. Biological Conservation, 134(4), 455-469

Linnell, J. D. C., Swenson, J. E., Anderson, R. 2001. Predators and people: Conservation of large carnivores is possible at high human densities if management policy is favourable. Animal Conservation 4, 345-349.

Loveridge, A. J., Lynam, T, Macdonald, D. W. 2001. Lion conservation research in W. C. R. Unit, editor. Conflict with people, Oxford, UK.

Loveridge, A. J., Reynolds, J. C., Milner-Gulland, E. J. 2006. Does sport hunting benefit conservation? Key Topics in Conservation Biology, 1, 222.

Lugton, I.W. 1993. Diet of red foxes (*Vulpes vulpes*) in south-west New South Wales, with relevance to lamb predation. Rangeland Journal, 15, 39-47.

Macdonald, D.W., Sillero-Zubiri, C. 2002. Large carnivores and conflict: lion conservation in context. In Lion Conservation Research. Workshop 2: Modelling Conflict (eds Loveridge, A.J., Lynam, T., Macdonald, D.W.). Wildlife Conservation Research Unit, Oxford.

Maddox, T. 2003. The ecology of cheetahs and other large carnivores in a pastoralist dominated buffer zone. Ph.D. thesis, University of London, London, U. K.

Madzwamuse, M., Schuster, B., Nherera, B. 2007. The real jewels of the Kalahari: drylands ecosystem goods and services in Kgalagadi South District, Botswana. IUCN, Gland, Switzerland.

Makepe, P. M. 2006. The evolution of institutions and rules governing communal grazing lands in Botswana. Eastern Africa social science research review, 22(1), 39-61.

Marker-Kraus, L., Daniel, K. 1997 Conservation strategies for the long-term survival of the cheetah. International Zoo Yearbook 35, 59-66.

Marker, L. 1998. Current status of the cheetah (Acinonyx jubatus). In: Penzhorn, B.L. (Ed.), A Symposium on Cheetahs as Game Ranch Animals. Wildlife Group of South African Veterinary Association, Onderstepoort, South Africa, pp. 1-17.

Marker, L. 2002. Aspects of cheetah (Acinonyx jubatus) biology, ecology and conservation strategies on Namibian farmlands. Department of Zoology. University of Oxford, Oxford, U.K.

Marker, L. Dickman, A. 2003. Conserving cheetahs outside Protected Areas: An example from Namibian Farmlands. Cat News 38, 24-25.

Marker, L. 2002. Aspects of cheetah (Acinonyx jubatus) biology, ecology and conservation strategies on Namibian farmlands. D. Phil. thesis, University of Oxford, Oxford, U.K., 476 pp.

Marker, L.L., Dickman, A.J., Mills, M.G.L., Macdonald, D.W. 2003a. Aspects of the management of cheetahs, Acinonyx jubatus, trapped on Namibian farmlands. Biological Conservation, 114, 401-412.

Marker, L.L., Mills, M.G.L., Macdonald, D.W. 2003c. Factors Influencing Perceptions and Tolerance toward Cheetahs (Acinonyx jubatus) on Namibian Farmlands. Conservation Biology, 17, 1-9.

Marker, L., Dickman, A. 2004. Human aspects of cheetah conservation: Lessons learned from Namibian Farmlands. Human Dimensions of Wildlife, 9, 1-9.

Marker, L., Dickman, A. J., Mills, M. G. L., and Macdonald, D. M. 2010. Cheetahs and Ranchers in Namibia: A Case Study. Pages 353-372 in Macdonald, D. M., and Loveridge, A., editors. Biology and Conservation of Wild Felids. Oxford University Press: Oxford.

Mazzolli, M., Graipel, K., Dunstone, N. 2002. Mountain lion depredation in southern Brazil. Biological Conservation 105, 43-51.

Mbaiwa, J.E., Mbaiwa, O.I. 2006. The effects of veterinary fences on wildlife populations in Okavango Delta, Botswana. International Journal of Wilderness, 12(3), 17-41

Mbaiwa, J. E., Ngwenya, B. N., Kgathi, D. L. 2008. Contending with unequal and privileged access to natural resources and land in the Okavango Delta, Botswana. Singapore Journal of Tropical Geography, 29(2), 155-172.

McGahey, D. 2011. Livestock mobility and animal health policy in southern Africa: the impact of veterinary cordon fences on pastoralists. Pastoralism: Research, Policy and Practice 2011, 1, 14

McNutt, J. W., Boggs, L. 1996. Running Wild: dispelling the myths of the African wild dog. Southern Book Publishers.

McShane, T. O., Grettenberger, J. F. 1984. Food of the golden jackal (*Canis aureus*) in central Niger. African Journal of Ecology 22, 49-53.

Mech, L. D., Fritts, S. H., Paul, W. J. 1988. Relationship between winter severity and wolf depredations on domestic animals in Minnesota. Wildlife Society Bulletin 16, 269-272.

Mehta, J. N., Kellert, S. R. 1998. Local attitudes towards community-based conservation policy and programmes in Nepal: a case study in the Makalu-Barun Conservation Area. Environmental Conservation 25, 320-333.

Meyer, T., Bourquin, S. 2010. Consultancy to Identify Important Habitats for Key Wildlife in the Western Kgalagadi Conservation Corridor (WKCC). Report for Conservation International. Green Mamba Operations (Pty) Ltd. P/Bag 114; Suite 37, Maun, Botswana.

Michalski, F., Cullen, L., De Oliveira, T.G., Crawshaw, P.G. 2001. Felid cryptorchidism in Atlantic forest fragments: evidence of inbreeding in free ranging populations? Mammalia, 65, 548-550.

Michalski, F., Boulhosa, R. L. P., Faria, A., Peres, C. A. 2006. Human–wildlife conflicts in a fragmented Amazonian forest landscape: determinants of large felid depredation on livestock. *Animal Conservation*, *9*(2), 179-188.

Miquelle, D.G., Smirnov, E.N., Merrill, T.W., Myslenkov, A.E., Quigley, H.B., Hornocker, M.G., Schleyer, B. 1999. Hierarchical spatial analysis of Amur tiger relationships to habitat and prey. In: Seidensticker, J., Christie, S., Jackson, P. (Editors), Riding the Tiger: Tiger conservation in human-dominated landscapes. Cambridge University Press, Cambridge, U. K., pp. 71-99.

Miquelle, D. 2005. Searching for the coexistence recipe: a case study of conflict between people and tigers in the Russian Far East. in People and Wildlife: Conflict or Coexistence? (eds Woodroffe, R., Thirgood, S., Rabinowitz, A.). Cambridge University Press, Cambridge, UK, pp 305–322.

Mishra, C. 1997. Livestock depredation by large carnivores in the Indian trans-Himalaya: conflict perceptions and conservation prospects. Environmental Conservation, 24, 338-343.

Mishra, C., Allen, P., McCarthy, T., Madhusudan, M.D., Bayarjargal, A., Prins, H.H.T. 2003. The role of incentive programs in conserving the snow leopard. Conservation Biology, 17, 1512-1520.

Mittermeier R., Mittermeier C., Robles Gil P., Fonseca G., Brooks T., Pilgrim J. Et Konstant R. 2002. Wilderness: Earth's last wild places. Conservation International. 573 pp.

Mizutani, F. 1993 Home range of leopards and their impact on livestock on Kenyan ranches. In Mammals as predators (ed. N. Dunstone and M. L. Gorman). Zoological Society of London: Claranden Press, Oxford.

Motlopi, K. 2006. Privatisation of rangelands, ranch Development, management and equity: The case of Area 4B, Botswana. Master Thesis. Faculty of Natural Sciences and Technology, Department of Biology. Norwegian University of Science and Technology, Trondheim, Norway.

Muir, M. J. 2010. Human-predator conflict and livestock depredations: Methodological challenges for wildlife research and policy in Botswana. Journal of International Wildlife Law and Policy 13, 293 - 310.

Muntifering, J. R., Dickman, A. J., Perlow, L. M., Hruska, T., Marker, L. L., Ryan, P. G., Jeo, R. M. 2006. Managing the matrix for large carnivores: a novel approach and perspective from cheetah (Acinonyx jubatus) habitat suitability modelling. Animal Conservation 9, 103-112.

Muruthi, P. 2005. Human wildlife conflict: Lessons learned from AWF's African Heartlands. AWF Working Papers. publications@awfke.org

Musiani, M., Mamo, C., Boitani, L., Callaghan, C., Gates, C. C., Mattei, L. Volpi, G. 2003. Wolf depredation trends and the use of fladry barriers to protect livestock in western North America. Conservation Biology, 17(6), 1538-1547.

Mwangi, N. S. 1997. A cost-benefit analysis of livestock predation on the group ranches in the dispersal areas of Maasai Mara National Reserve, Kenya. Moi University.

Myers, N. 1975. The cheetah, Acinonyx jubatus, in Africa. IUCN Monograph. Morges, Switzerland. 4.

Nabane, N. 1995. In Wildlife and Development Series International. Institute for Environment and Development, London, UK.

Nagafela, N., Kalikawe, M.C. 1993. Results of livestock predation study. Botswana Department of Wildlife and National Parks, Gaborone.

Naughton-Treves, L. 1997. Farming the forest edge: vulnerable places and people around Kibale National Park, Uganda. The Geographical Review 87, 27-46.

Naughton-Treves, L. 1998. Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. Conservation Biology, 12, 156-168.

Naughton-Treves, L., Treves, A. 2005. Socio-ecological factors shaping local support for wildlife: crop raiding by elephants and other wildlife in Africa in R. Woodroffe, S.

Naughton-Treves, L., Grossberg, R., Treves, A. 2003. Paying for tolerance: rural citizens' attitudes toward wolf depredation and compensation. Conservation Biology 17, 1500–1511. Thirgood, and A. Rabinowitz, editors. People and Wildlife: Conflict or Coexistence. Cambridge University Press, Cambridge.

Ndhlukula, K., Du Plessis, P., Montgomery, S. 2009. Green labelling, eco-certification and fair trade: Threats and opportunities for Namibia. (S. Montgomery, Ed.). Windhoek: Polytechnic of Namibia, REEEI.

Nepal, S. K., Weber, K. E. 1995b The quandary of local people-park relations in Nepal's Royal-Chitwan- National-Park. Environmental Management 19, 853-866.

Nelson, F. 2009. Developing payments for ecosystem service approaches to carnivore conservation. Human Dimensions of Wildlife, 14:381–392.

Newmark, W. D., Leonard, N. I. 1993. Conservation attitudes of local people living adjacent to give protected areas in Tanzania. Biological Conservation 63, 177-183.

Newmark, W.D., Manyanza, D.N., Gamassa, D.-G.M., Sariko, H.I., 1994. The Conflict between wildlife and local people living adjacent to Protected Areas in Tanzania: Human Density as a Predictor. Conservation Biology, 8, 249-255.

Nijhawan, S., 2008. Understanding human large carnivore conflict in the Chobe, Botswana. Master's Thesis. Nicholas Scool of the Environment and Earth Sciences. Duke University. USA.

Nowell, K., Jackson, P. 1996. Wild cats: status survey and conservation action plan. Cambridge, Burlington Press.

Nyayhongo, J., Roskaft, R. 2007. Perception of people towards lions and other wildlife killing humans, around Selous Game Reserve, Tanzania. International Journal of Biodiversity and Conservation Vol. 3(4), pp. 110-115,

Nyhus, P., Fischer, H., Madden, F., Osofsky, S. 2003. Taking the bite out of wildlife damage: The challenges of wildlife compensation schemes. Conservation in Practice 4, 37-43.

Nyhus, P., Osofsky, S.A., Ferraro, P., Madden, F., Fischer, F. 2005. Bearing the costs of human-wildlife conflict: the challenges of compensation schemes. In: Woodroffe, R., Thirgood, S., Rabinowitz, A. (Editors), People and Wildlife: Conflict or Coexistence? Cambridge University Press, Cambridge, U. K., pp. 107-121.

O'Connell-Rodwell, C.E., Rodwell, T., Rice, M., Hart, L.A. 2000. Living with the modern conservation paradigm: can agricultural communities co-exist with elephants? A five-year case study in East Caprivi, Namibia. Biological Conservation, 93, 381-391.

Ogada, M.O., Woodroffe, R., Oguge, N.O., Frank, L.G. 2003. Limiting depredation by African Carnivores: the role of livestock husbandry. Conservation Biology, 17, 1521-1530.

Ogada, O.O., Ogada, D.L. 2004. Factors influencing levels of carnivore-livestock conflicts in Samburu Heartland and proposed mitigation measures. Unpublished consultancy report to African Wildlife

Ogra, M. 2008. Human–wildlife conflict and gender in protected area borderlands: A case study of costs, perceptions, and vulnerabilities from Uttarakhand (Uttaranchal), India. Geoforum 39 (2008) 1408–1422.

Oli, M.K., Taylor, I.R., Rogers, M.E. 1994. Snow leopard (*Panthera uncia)* predation of livestock: An assessment of local perceptions in the Annapurna Conservation Area, Nepal. Biological Conservation, 68, 63-68.

Packer, C., Ikanda, D., Kissui, B., Kushnir, H. 2005. Lion attacks on humans in Tanzania. Nature 436, 927-928.

Packer, C., Kosmala, M., Cooley, H. S., Brink, H., Pintea, L., Garshelis, D., Nowell, K. 2009. Sport hunting, predator control and conservation of large carnivores. Plos One, 4(6), e5941.

Palmeira, F. B. L., Crawshaw Jr., P. G., Haddad, C. M., Ferraz, K. M. P., Verdade. M.P., Luciano M. 2008. Cattle depredation by puma (*Puma concolor*) and jaguar (*Panthera onca*) in south-western Brazil. Biological Conservation 141, 118-125.

Parks, S. A., Harcourt, A. H., Tobler, W., Deichmann, U., Gottsegen, J., Maloy, K. 2002 Reserve size, local human density, and mammalian extinctions in US protected areas. Conservation Biology 16, 800-808.

Patterson, B. D., S. M. Kasiki, E. Selempo, R. W. Kays. 2004. Livestock predation by lions (Panthera leo) and other carnivores on ranches neighbouring Tsavo National Park, Kenya. Biological Conservation 119, 507-516.

Parry D., Campbell B. 1992. Attitude of rural communities to animal wildlife and its utilization in Chobe enclave and Mababe depression, Botswana. Environ Conservation 19(3), 245–252.

Parsons, D. R. 1998. 'Green fire' returns to the Southwest: reintroduction of the Mexican wolf. Wildlife Society Bulletin 26, 799-807.

Perkins, J. S., Thomas, D. S. G. 1993. Spreading deserts or spatially confined environmental impacts? Land degradation and cattle ranching in the Kalahari desert of Botswana. Land Degradation and Rehabilitation 4, 179-194.

Perkins, J. S., Ringrose, S. M. 1996. Development cooperation objectives and the Beef Protocol: The case of Botswana: A study of livestock/ wildlife/ tourism/degradation linkages. For Metroeconomica Ltd. Contract B-7-504094. University of Botswana, Gaborone.

Perkins, J. S. 1996. Botswana: fencing out the equity issue. Cattleposts and cattle ranching in the Kalahari. Journal of Arid Environments 33, 503-517. Perkins, 1998

Perkins, J. S., Stuart-Hill G., Kgabung B. 2002. The impact of cattle-keeping on the wildlife, vegetation, and veldt products of the Kalahari. In Sustainable Livelihoods in Kalahari Environments, (eds Sporton, D., Thomas, D.). Oxford University Press: Oxford; 66–79.

Polisar, J., Maxit, I., Scognamillo, D., Farrell, L.E., Sunquist, M.E., and Eisenberg, J.F., 2003. Jaguars, pumas, their prey base, and cattle ranching: ecological interpretations of a management problem. Biological Conservation, 109, 297-310.

Prugh, L. R., Stoner, C. J., Epps, C. W., Bean, W. T., Ripple, W. J., Laliberte, A. S., Brashares, J. S. 2009. The rise of the mesopredator. Bioscience, 59(9), 779-791.

Purvis, A., Mace, G. M., Gittleman, J. L. 2001. Past and future carnivore extinctions: a phylogenetic perspective. Pages 11-34 in J. L. Gittleman, S. M. Funk, D. Macdonald, and R. K. Wayne, editors. Carnivore Conservation. Cambridge University Press, Cambridge, U. K.

Quammen, D. 2003. Monster of god: The man-eating predator in the jungles of history and the mind. W. W. Norton, New York.

Rabinowitz, A. 2005. Jaguars and livestock: living with the world's third largest cat. Pages 278-285 in R. Woodroffe, S. Thirgood, and A. Rabinowitz, editors. People and Wildlife: Conflict or Coexistence? Cambridge University Press, Cambridge, U.K.

Rao, K. S., Maikhuri, R. K., Nautiyal, S., Saxena, K. G. (2002). Crop damage and livestock depredation by wildlife: a case study from Nanda Devi Biosphere Reserve, India. *Journal of Environmental Management*, *66*(3), 317-327.

Rasmussen, G.S.A. 1999. Livestock predation by the painted hunting dog Lycaon pictus in a cattle ranching region of Zimbabwe: a case study. Biological Conservation, 88, 133-139.

Reed, M., Dougill, A. 2002. Participatory selection process for indicators of rangeland condition in the Kalahari. The Geographical Journal, Vol. 168, No. 3, September 2002,

Reed, M. 2007. Integrating local and scientific knowledge for adaptation to land degradation: Kalahari rangeland management options. Land Degradation and Development. 18, 249-268.

Ricklefs, R. E. 1990. Ecology. New York, W. H. Freeman and Co.

Ripple, W. J., Rooney, T. P., Beschta, R. L. 2010. Large predators, deer and trophic cascades in boreal and temperate ecosystems. Trophic cascades: predators, prey, and the changing dynamics of nature. Island Press, Washington, DC, USA, 141-161.

Ritchie, E. G., Johnson, C. N. 2009. Predator interactions, mesopredator release and biodiversity conservation. Ecology letters, 12(9), 982-998.

Romanach, S.S., Lindsey, P.A., Woodroffe, R. 2007. Determinants of attitudes towards predators in central Kenya and suggestions for increasing tolerance in livestock dominated landscapes. Oryx 41, 185–195.

Roskaft, E., Bjerke, T., Kaltenborn, B. P., Linnell, J. D. C., Andersen, R. 2003. Patterns of self-reported fear towards large carnivores among the Norwegian Public.
Evolution and Human Behaviour, 24, 184-198.

Roskaft, E., Händel, B., Bjerke, T., Kaltenborn, B. P. 2007. Human attitudes towards large carnivores in Norway. Wildlife Biology, 13, 172-185.

Rozemeijer, N., 2003. CBNRM in Botswana today. SNV/IUCN, Gaborone.

Sagor, J. T., Swenson, J. E., Roskaft, E. 1997. Compatibility of brown bear Ursus arctos and free-ranging sheep in Norway. Biological Conservation 81, 91-95.

Sangay, T., Vernes, K. 2008. Human–wildlife conflict in the Kingdom of Bhutan: Patterns of livestock predation by large mammalian carnivores. Biological Conservation, 141(5), 1272-1282.

Schiess-Meier, M., Ramsauer, S., Gabanapelo, T., König, B. 2007. Livestock predation-insights from problem animal control registers in Botswana. Journal of Wildlife Management 71(4), 1267-1274.

Schumann, M. (Ed.), 2003. Guide to Integrated Livestock and Predator Management:
CCF RISE Namibia Communal Conservancy Shepherd Training Course Proceedings. Cheetah Conservation Fund, Windhoek, Namibia.

Sebele, L. S. 2010. Community-based tourism ventures, benefits and challenges: Khama Rhino Sanctuary Trust, Central District, Botswana. Tourism Management, 31(1), 136-146.

Sechele, M.L., Nzehengwa, D.M. 2002. Human predator conflicts and control measures in North-west district, Botswana. In Lion Conservation Research: Workshop 2: Modelling Conflict (eds Loveridge, A.J., Lynam, T., Macdonald, D.W.), Vol. 2. Wild CRU, Oxford.

Sekhar, N.U. 1998. Crop and livestock depredation caused by wild animals in protected areas: the case of Sariska Tiger Reserve, Rajasthan, India. Environmental Conservation, 25, 160-171.

Selebatso, M. 2006. Livestock losses and farmers' perceptions towards cheetah conservation in Ghanzi District, Botswana. MSc Thesis, Norwegian University of Life Sciences.

Selebatso, M., Moe, S.R., Swenson, J.E. 2008. Do farmers support cheetah Acinonyx jubatus conservation in Botswana despite livestock depredation? Oryx 42(3), 230-436.

Sillero-Zubiri, C., Laurenson, M. K. 2001. Interactions between carnivores and local communities: conflict or co-existence? Carnivore Conservation. J. L. Gittleman, S. M. Funk, D. W. Macdonald and R. K. Wayne. Cambridge, Cambridge University Press: 282-312.

Sinclair, A. R. E., Mduma, S. A., Hopcraft, J. G. C., Fryxell, J. M., Hilborn, R. A. Y., Thirgood, S. 2007. Long-term ecosystem dynamics in the Serengeti: Lessons for conservation. Conservation Biology, 21(3), 580-590.

Siphambe, H., Bakwena, M. 2001. The wage gap between men and women in Botswana's formal labour market. Journal of African economies, 10:2, pp127-142.

Songorwa, A. N., 1999. Community-based wildlife management (CWM) in Tanzania: are the communities interested? World Dev. 27(12), 2061–2079.

Spinage, C.A., Matlhare, J.M. 1992. Is the Kalahari cornucopia fact or fiction? A predictive model. Journal of Applied Ecology, 29, 605–610.

Stahl, P., Vandel, J.M., Herrenschmidt, V., Migot, P. 2001. The effect of removing lynx in reducing attacks on sheep in the French Jura Mountains. Biological Conservation, 101, 15-22.

Stahl, P., J. M. Vandel, S. Ruette, L. Coat, Y. Coat, L. Balestra. 2002. Factors affecting lynx predation on sheep in the French Jura. Journal of Applied Ecology 39, 204-216.

Stander, P.E. 1997. The ecology of lions and conflict with people in north-eastern Namibia. In: Penzhorn, B.L. (Ed.), A Symposium of Lions and Leopards as Game Ranch Animals. Wildlife Group of the South African Veterinary Association, Onderstepoort, South Africa, pp. 10-17.

Stein, A. B., Fuller, T. K., Damery, D. T., Sievert, L., Marker, L. L. 2010. Farm management and economic analyses of leopard conservation in north-central Namibia. Animal Conservation, 13(4), 419-427.

Stoddart, L. C., Griffiths, R. E., Knowlton, F. F. 2001. Coyote responses to changing jackrabbit abundance affect sheep predation. Journal of Range Management, 15-20.

Stringer, L.C., Reed, M.S. 2007. Land degradation assessment in Southern Africa: integrating local and scientific knowledge bases. To be submitted to Land Degradation and Development.

Swarner, M. 2004. Human-carnivore conflict over livestock: The African wild dog in central Botswana. Centre for African Studies Breslauer Symposium on Natural Resource Issues in Africa (University of California)

Taylor, D. 2004. Conservation education and its relevance to wild canids. In: (eds Sillero- Zubiri, C., Hoffmann, M., Macdonald, D.) Canids: foxes, wolves, jackals and dogs: status survey and conservation action plan. IUCN, Gland, pp 298–305.

Terborgh, J., Lopez, L., Nunez, P., Rao, M., Shahabudin, G., Orihuela, G., Riveros, M., Ascanio, R., Adler, G.H., Lambert, T.D., Balbas, L. 2002. Ecological meltdown in predator-free forest fragments. Science, 294, 1923.

Terborgh, J., & Estes, J. A. (eds). 2010. Trophic cascades: predators, prey, and the changing dynamics of nature. Island Press.

Thirgood, S., Redpath, S., Rothery, P., Aebischer, N. 2000. Raptor predation and population limitation in red grouse. Journal of Animal Ecology, 69, 504-516.

Thirgood, S., Woodroffe, R., Rabinowitz, A. 2005. The impact of human-wildlife conflict on human lives and livelihoods. In: Woodroffe, R., Thirgood, S., Rabinowitz, A. (Editors), People and Wildlife: Conflict or Coexistence? Cambridge University Press, Cambridge, U. K., pp. 13-26.

Thomas, D. S. G., Shaw, P. A. 1991. The Kalahari environment. Cambridge University Press, Cambridge.

Thomas D. S. G, Sporton D, Perkins J. S. 2000. The environmental impact of livestock ranches in the Kalahari, Botswana: Natural resource use, ecological change and human response in a dynamic dryland system. Land Degradation and Development 11, 327–341.

Thomas, D. S. G., Sporton, D. 2002. Introduction. Pages 1-20 in Sporton, D., and Thomas, D. S. G., editors. Sustainable Livelihoods in Kalahari Environments: A Contribution to Global Debates. Oxford University Press: Oxford.

Thomas, D.S. 2002. Sand, grass and cattle: The modern Kalahari environment. In Sustainable livelihoods in Kalahari environment: Contributions to global debates (eds Sporton, D., Thomas, D. 2002), pp. 21-38. Oxford University Press, New York.

Thouless, C. 1997. The current status of wildlife in Botswana. Proceedings of a National Conference on Conservation and Management of Wildlife in Botswana. Pp 32.

Thouless, C. 1998. Large mammals inside and outside protected areas in the Kalahari. Transactions of the Royal Society of South Africa, 53, 245-255.

Tjibae, M. 2001. Overview of problem animal control. In National Technical Predator Management and Conservation Workshop in Botswana (pp. 25-34).

Treves, A., Jurewicz, R., Naughton-Treves, L., Rose, R., Wydeven, A. 2002. Wolf depredation on domestic animals in Wisconsin 1997-2000. Wildlife Society Bulletin 30, 231-241.

Treves, A., Karanth, U. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. Conservation Biology, 17, 1491-1499.

Treves, A., Naughton-Treves, L., Harper, E.L., Mladenoff, D.J., Rose, R.A., Sickley, T.A., Wydeven, A.P., 2004. Predicting human-carnivore conflict: a spatial model based on 25 years of wolf predation on livestock. Conservation Biology, 18, 114-125.

Treves, A., Naughton-Treves, L. 2005. Evaluating lethal control in the management of human-wildlife conflict. In: Woodroffe, R., Thirgood, S., Rabinowitz, A. (Editors), People and Wildlife: Conflict or Coexistence? Cambridge University Press, Cambridge, U. K., pp. 86-106.

Treves, A., R. Wallace, L. Naughton-Treves, A. Morales. 2006. Co-managing human wildlife conflict. Human Dimensions of Wildlife 11,383-396.

Treves, A., Jones, S. M. 2010. Strategic trade-offs for wildlife-friendly eco-labels. Frontiers in Ecology and the Environment, 8(9), 491-498

Twyman, C. 2001. Natural resource use and livelihoods in Botswana's Wildlife Management Areas. Applied Geography 21, 45–68.

Twyman, C. 2000 Participatory conservation? Community-based Natural Resource Management in Botswana. The Geographical Journal, 166, 323-335.

Twyman, C. 2002. Entitled to a living: Opportunity and diversity in the Wildlife Management Areas. In Sustainable livelihoods in Kalahari environment: Contributions to global debates (eds Sporton, D., Thomas, D. 2002), pp. 130-159. Oxford University Press, New York.

Van Bommel, l., de Vaate, M., de Boer, W., de Jongh, H. 2007. Factors affecting livestock predation by lions. The Authors. Journal compilation. Blackwell Publishing Ltd, Afr. J. Ecol., 45, 490–498

Verlinden, A. 1997 Human settlements and wildlife distribution in the southern Kalahari of Botswana. Biological Conservation 82, 129-136.

Verlinden, A., Perkins, J. S., Murray, M., Masunga, G. 1998 How are people affecting the distribution of less migratory wildlife in the southern Kalahari of Botswana? A spatial analysis. Journal of Arid Environments 38, 129-141.

Vos, J. 2000. Food habits and livestock depredation of two Iberian wolf packs (Canis lupus signatus) in the north of Portugal. Journal of Zoology 251, 457-462.

Wagner, F. 1988. American wildlife management at the crossroads. Wildlife Society Bulletin, Vol. 17, No. 3 (Autumn, 1989), pp. 354-360

Walgren, M., Skarpe, C., Bergstrom, R., Danell, K., Bergstrom, A., Jakobsson, T., Karlsson, K., Strand, T. 2009. Influence of land use on the abundance of wildlife and livestock in the Kalahari, Botswana. Journal of Arid Environments. Volume 73, Issue 3, March 2009, Pages 314–321

Walpole, M. J., Goodwin, H. J. 2001. Local attitudes towards conservation and tourism around Komodo National Park, Indonesia. Environmental Conservation 28, 160-166.

Wang, S. W., Macdonald, D. W. 2006. Livestock predation by carnivores in Jigme Singye Wangchuck National Park, Bhutan. Biological Conservation, 129(4), 558-565.

White, R. 1993. Livestock development and pastoral production on communal rangeland in Botswana. The Botswana Society: Gaborone.

White, R. 1998a. Livestock and land tenure in Botswana. Land reforms in Southern Africa: Review of land reform strategies and community-based natural resource management ZERO-Regional Environment Organisation, Harare.

White, P.C.L., Jennings, V.N., Renwick, A.R., Barker, N.H.L., 2005. Questionnaires in ecology: a review of past use and recommendations for best practice. Journal of Applied Ecology 42, 421–430.

Whittington-Jones, B. M. 2011. The dispersal of African Wild Dogs (Lycaon pictus) from protected areas in the Northern KwaZulu-Natal province, South Africa. Master's thesis, Rhodes University.

WKCC Project Document, 2007. Wildlife conservation, rural community and tourism development in the Kalahari. Botswana. Conservation International.

Williams, C., Ericsson, G., Heberlein, T. 2003. A quantitative summary of attitudes toward wolves and their reintroduction (1972-2000). Wildlife Society Bulletin 2002, 30(2), 575-584

Wilson, S. 2002. Environmental appraisal for the construction of a game fence around Makgadikgadi Pans National Park. Scott Wilson and Ecosurve. Box201306. Gaborone.

Winterbach C. 2001. Draft predator management strategy. Department of Wildlife and National Parks.

Woodroffe, R., Ginsberg, J.R. 1998. Edge effects and the extinction of populations inside protected areas. Science, 280, 2126-2128.

Woodroffe, R. 2000. Predators and people: using human densities to interpret declines of large carnivores. Animal Conservation 3, 165-173.

Woodroffe, R., Ginsberg, J. R. 2000 Ranging behaviour and vulnerability to extinction in carnivores. In Behaviour and conservation (ed. M. L. Gosling and
W. J. Sutherland). Cambridge: Cambridge University Press.

Woodroffe, R. 2002. African wild dogs and African people: conservation through coexistence. 2nd annual report. Samburu-Laikipia Wild Dog Project, University of California. Davis.

Woodroffe, R., Thirgood, S., Rabinowitz, A., 2005. The impact of human-wildlife conflict on natural systems. In: Woodroffe, R., Thirgood, S., Rabinowitz, A. (Editors), People and Wildlife: Conflict or Coexistence? Cambridge University Press, Cambridge, U. K., pp. 1-12.

Woodroffe, R. and Frank, L.G. 2005. Lethal control of African lions (Panthera leo): Local and regional population impacts. Animal Conservation, 8, 91-98.

Woodroffe, R., Lindsey, P., Romanach, S., Stein, A., Ranah, S. 2005b. Livestock predation by endangered African wild dogs (Lycaon pictus) in northern Kenya. Biological Conservation 125, 225-234.

Woodroffe, R., Thirgood, S. and Rabinowitz, A. 2005. The future of co-existence: resolving human-wildlife conflicts in a changing world. In People and wildlife: conflict or coexistence (eds Woodroffe, R., Thirgood, S., Rabinowitz, A.), pp. 388-405. Conservation Biology 9, Cambridge.

Woodroffe, R., Frank, L.G., Lindsey, P.A., Symon, M.K., Ranah, S. M. K. O., Romanach, S. 2007. Livestock husbandry as a tool for carnivore conservation in Africa's community rangelands: A case-control study. Biodiversity and Conservation 16, 1245–1260.

Zabel, A., Holm-Müller, K. 2008. Conservation performance payments for carnivore conservation in Sweden. Conservation Biology 22(2), 247–251.

Zimmermann, B., Wabakken, P., Dötterer, M. 2001. Human-carnivore interactions in Norway: How does the re-appearance of large carnivores affect people's attitude. Forest Snow and Landscape Research 76(1/2), 137–153.

Zimmermann, A., Walpole, M. J., Leader-Williams, N. 2005. Cattle ranchers' attitudes to conflicts with jaguar (Panthera onca) in the Pantanal of Brazil. Oryx 39, 406-412.

Date	**Interviewer**		**Qu.No:**
Coordinates	**S:**	**E:**	

Section A: General Details

Name:	Anonymous
How long have you been on the farm?	
Ranch: Farm name and number	
Cattlepost: Name of the tribal lands:	

Section B: Socio-Economic Details

How many people in your family?	Adults:	Children:	
Year of birth?	School level?		
What is the main source of family income?	Livestock	Wildlife	Veld Products
	Employment	Own business	Mixed
	Other……		
What role do livestock play, if it is not the main source of income?			

Section C: Farm Details

How many persons live on the farm?			
Have there been changes in the habitat over time?	yes	no	don't know
Specify (how / over what time period)			
How many boreholes and water points on your farm?			
Distance from kraals?			

How many animals do you keep?		
Species	**Number**	Notes:
Cattle		
Sheep		
Goats		
Horses		
Donkeys		

What are the main problems encountered by livestock farmers? ***Rank importance: max 3***		
diseases	insufficient grazing	few extension visits
drought	poor quality grazing	theft
infertility	low yields	other……..
losses due to predators	unreliable market	other……..

Section D: Farm Management

Please explain how your stock are tended to at **night**? Cattle:

Goats and sheep:
During the **day**? Cattle:
Goats and sheep:

What is the your kraal design? Cattle:
Goats and sheep:

Do you have a calving season?				
All year	1st quarter	2nd quarter	3rd quarter	4th quarter

Do you have a lambing season?				
All year	1st quarter	2nd quarter	3rd quarter	4th quarter

During calving / lambing, do you:		
bring calving animals closer to homestead?	yes	no
check on livestock more often than before?	yes	no
keep careful records?	yes	no
kraal all livestock at night?	yes	no
kraal young calves / kids?	yes	no
use a maternity / calving kraal?	yes	no
other?		

Do you have a herder with livestock? (Specify cattle/goats/sheep)	yes	no

Are they effective?

Do you have a dog with livestock? (Specify goats/sheep)	yes	no
How many do you have per number of goats and sheep?		
Are they effective?		

Section E **Wildlife Details**

What are the trends in large game species in your area?	increase, decrease, stable	don't know
What are the trends in small game species in your area?	increase, decrease, stable	don't know
Do you have explanations for any changes in the numbers?		don't know

Section F **Predator Details**

How often do you see this predator? every day, every week; every month; every few months; a few times a year; once a year; once every few years; never		**Sighting details:** *date,time,group composition,location,activity*
Lion		
Cheetah		
Leopard		
Brown Hyena		
Wild dog		
Caracal		
Jackal		

During the time you have spent here, have predators number been?				
	decreasing	**stable**	**increasing**	**don't know**
Lion				
Cheetah				
Leopard				
Brown Hyena				
Wild dog				
Caracal				
Jackal				
Do you have explanations for any changes in the numbers?				don't know

Section G: Predation and conflicts

Do you lose livestock to predators	yes	no	don't know

Classify the predators, according to level of problem:			**Rank**: 1: biggest problem; 8: least problem		
Lion		Brown hyena		Jackal	
Cheetah		Spotted hyena		Caracal	
Leopard		Wild dog		Other…….	

If you had problem with predators in the last 12 months, describe:					don't know
Date or season	Animals killed or injured (no, spc,age, sex)	Predators Responsible (number,spcs,age)	How it was identified (visual (by who), spoor carcass, heard calls)	Time of day of incident	Location

What do you do protect cattle from predators?				
Kraal	at night	in day	don't know	
Herders		yes	no	
Guard animals		yes	no	
Calving season		yes	no	

Other (explain)

What do you do to protect goats/sheep from predators?

Kraal	at night	in day	
Herders	yes		no
Guard animals	yes		no
Lambing season	yes		no
Other (explain)			

What are the common circumstances of attacks?					
Day	Night	Inside kraal	Outside kraal	Herder	No herder
Are losses to predators seasonal?			yes	no	don't know
Which season?					

Have you lost animals in the past 12 months, due to other causes than predators? **Specify: number / species**					
If no numbers: rank importance: max 3					
Disease	Calving	Accidents	Starvation	Theft	Other…….
Can you give an approximate value for all losses in the last 12 months?					
During your time on the farm is the problem with predators:		increasing	decreasing	stable	
Can you give reasons why?					

What do you do when you have a loss to a predator?		
Did you ever have to remove predator? How? When? (live trap, shoot, poison)	yes	no
Details:		don't know
Have you contacted National Park office for assistance?		don't know
Details?		

Section H: Attitudes

What do you think about sharing the land with predators?					don't know
Benefit to farm	Like them	Dislike them	Kill when see	Other…….	
Why?					
Do you think wildlife is a national resource to be protected?				yes	no

Whose responsibility do you think predator/livestock conflict belongs to?					don't know
Farmers	Herders	Government	Conservation Organisations	Other…….	

Do you see any solutions for the survival of predators on farmlands?			
Improve farm management	Translocate	Decrease numbers	Other…….
Trophy hunting	Compensate	Tourism	

Appendix 3 – Scoring of Indices

Conflict Index

Do you lose livestock to predators	**Yes** 1	**No** 0				
Proportion of livestock lost %	**0** 0	**0.1-1** 1	**1-10** 2	**11-20** 3	**21-30** 4	**31-40** 5
	41-50 6	**51-60** 7	**61-70** 8	**71-80** 9	**81-90** 10	**91-100** 11
Predators problem dec/sta/ inc	**decrease** 0	**stable** 1	**increase** 2			
Action when loss to predator	**manage** 0	**nothing** 1	**report** 2	**trans** 3	**shoot** 4	

Maximum score: 18. yes (1), +91% lost (11), increase (2), shoot (4); Minimum score: 0

Cattle Management Index

Method	**free**	**kraal**	**patrols**	**kraal, dogs**	**herders**	**donkeys**
Cattle at night	0	2	2	3	na	2
Cattle in day	0	1	2	na	3	2
	acacia	**wood**	**wood, wire**	**acacia, wood, wire**	**metal poles, wire**	
Kraal design: cattle	2	1	1	2	1	

Kraal night	0	1
Herders	0	1
Guard animals	0	1
Calving season	0	1

During Breeding	**no**	**yes**
calving season	0	1
homestead	0	1
check	0	1
records	0	1
kraal night	0	1
kraal young	0	1
maternity kraal	0	1
herder	0	1

Maximum score: 24. Night: patrol (2); kraal, dogs (3), donkeys (2). Day: herders (3). boma design (2) and remaining factors (12). Minimum score: 0

Smallstock Management Index

Method	free	kraal	patrols	kraal, dogs	dogs	herders	herders, dogs	kraal, herders, dogs
Smallstock at night	0	2	na	3	1	2	3	4
Smallstock in day	0	1	na	3	2	2	3	4

	acacia	wood	wood, wire	acacia, wood, wire	metal poles, wire
Kraal design: smallstock	2	1	1	2	1

Kraal night	0	1
Herders	0	1
Guard animals	0	1
Calving season	0	1

During Breeding	no	yes
calving season	0	1
homestead	0	1
check	0	1
records	0	1
kraal night	0	1
kraal young	0	1
maternity kraal	0	1
herder	0	1

Maximum score: 22. Night: kraal herders dogs (4), Day: kraal herders dogs (4), boma design (2) and remaining factors (12). Minimum score: 0

Tolerance Index

Attitude to predators	**Kill** 0	**Dislike** 0	**Like** 1	**Benefit** 2				
National resource	**No** 0	**Yes** 1						
Responsibility	**Con** 0	**Gov** 0	**Gov&Con** 0	**Far,Gov&Con** 1	**Far&Gov** 1	**Far,Her,Gov,Con** 2		
	Far&Con 1	**Her&Con** 1	**Far,Her,Gov** 1	**Far, Her, Con** 1	**Far** 2	**Herders** 2	**Far&Her** 2	
Solutions	**Dec No** 0	**Trans** 0	**Compensn** 1	**Sus Utilisatn** 1	**Tourism** 2	**Imp FarmMangnt** 2	**Educatn** 2	**Consn** 3

Maximum score: 8. benefit (2), national resource (1), responsibility (2), solutions (3); Minimum score: 0

Responsibility - Conservation groups, Government, Farmers, Herders
Solutions - Decrease numbers, Translocate, Compensation, Sustainable utilisation, Tourism, Improve farm management, Education, Conservation

Carnivore Index

Every day	Every week	Every month	Every few months	Few times a year	Once a year	Every few years	Never
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**

Maximum score: All carnivores seen daily (56); Minimum score: 0