# Assessing the drivers and impact of illegal hunting for bushmeat and trade on serval (*Leptailurus serval*, Schreber 1776) and oribi (*Ourebia ourebi*, Zimmermann 1783) in South Africa.

**Nomthandazo Samantha Manqele**

**A thesis submitted in fulfilment of the academic requirements**

**for the degree of Master of Science in Geography**

**College of Agriculture, Science and Engineering**

**University of KwaZulu-Natal**

**Pietermaritzburg, South Africa**

**May 2017**

## ABSTRACT

Bushmeat contributes significantly to food security of rural people in developing countries. In regions where animal husbandry is not viable and access to domestic sources of protein is limited, bushmeat represents a primary source of animal protein. In rural marginalised communities where income opportunities are inadequate and livelihoods are prone to stresses and shocks, bushmeat is the cheapest food source, a primary source of direct income and plays a vital role as a safety net. However, in most regions where bushmeat is consumed, this is undertaken illegally. The results have been the decline in many of the world's large sized fauna. This effect is cascading down to medium and small sized bushmeat species. This represents one of the biggest challenges to conservation worldwide.

This study assesses the drivers and impact of the illegal use of wildlife resources in South Africa, with specific reference to serval (*Leptailurus serval*) and oribi (*Ourebia ourebi*). Questionnaire surveys were conducted between October 2015 and March 2016 in the Midlands, KwaZulu-Natal, South Africa. In addition, two population viability analyses were performed. It was found that illegal hunting is prevalent in the Midlands, with hunters comprising 27% of the respondents. Most of the illegal hunting was concentrated around farmlands as compared to protected areas. Illegal hunters reported hunting primarily to obtain meat for household consumption, because of their preference for bushmeat. Little commercial use of hunted animals was reported. Most illegal hunters had encountered serval (27%) and oribi (68%) during their hunting expeditions. The population viability analyses revealed that oribi populations are highly vulnerable to illegal hunting while the serval are relatively resilient.

In conclusion, illegal hunting in the region was not a result of limited access to alternative sources of protein, and bushmeat did not represent a significant source of livelihood security. Hunting for recreation was important to young males who claimed they had no alternative activities. Conservation initiatives aimed at curbing the illegal utilisation of wildlife resources should thus encompass inclusive education while promoting the sustainable utilisation of resilient species for bushmeat and traditional purposes.

## Preface

This study was conducted in Pietermaritzburg, South Africa from July 2015 to April 2017. Associated work was carried out while registered at the School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, under the supervision of Prof. T. R. Hill and co-supervision of Prof. C.T Downs and Dr. S. A. J Selier.

This thesis, represents original work by the author and has not otherwise been submitted in any form for any degree or diploma to any University. Where use has been made of the work of others, due acknowledgements are made.

…….

Nomthandazo Samantha Manqele

May 2017

I certify that the above statement is correct and as the candidate's supervisor I have approved this thesis for submission.

……..

Professor T. R. Hill

May 2017

## College of Agriculture, Engineering and Science

## Declaration 1- Plagiarism

I, Nomthandazo Samantha Manqele, declare that

1. The research reported in this thesis, except where otherwise indicated, is my original research.

2. This thesis has not been submitted for any degree or examination at any other university.

3. This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.

4. This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:
   a. Their words have been re-written but the general information attributed to them has been referenced
   b. Where their exact words have been used, then their writing has been placed inside quotation marks, italicised and referenced.

5. This thesis does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source being detailed in the thesis and in the references section.

Signed: … ……

Nomthandazo Samantha Manqele

May 2017

## College of Agriculture, Engineering and Science

## Declaration 2- Publications

DETAILS OF CONTRIBUTION TO PUBLICATIONS that form part and/or include research presented in this thesis.

Publication one

**NS Manqele, JA Selier, CT Downs and TR. Hill**

**Evaluating the drivers of illegal hunting and its implications for serval (*Leptailurus serval*) and oribi (*Ourebia ourebi*) conservation in South Africa: A case of the KwaZulu-Natal Midlands region.**

*Author contributions:*

NSM conceived paper with JAS, CTD and TRH. NSM collected and analysed data, and wrote the paper. JAS, CTD & TRH contributed valuable comments to the manuscript.

Publication two

**NS Manqele, JA Selier, CT Downs and TR. Hill**

**Assessing the impact of illegal hunting on the population viability of serval (*Leptailurus serval*) and oribi (*Ourebia ourebi*).**

*Author contributions:*

NSM conceived paper with JAS, CTD and TRH. NSM collected and analysed data, and wrote the paper. JAS, CTD & TRH contributed valuable comments to the manuscript.

Signed: …….

Nomthandazo Samantha Manqele

May 2017

## Acknowledgements

*And let us not be weary in well doing: for in due season we shall reap, if we faint not (Galatians 6:9, KJV).*

- I would like to extend my sincere gratitude to all my supervisors, Dr. JA Selier, Prof. CT Downs and Prof. TR Hill for steering me toward the right direction whenever I went off-track and for all their support.
- This research project would not have been a success without the financial support from the South African National Biodiversity Institute (SANBI), thank you for funding my studies.
- I'm grateful to Dr. Ramesh and Dr. Kalle for dedicating their precious time providing their insights and sharing data.
- A big thank you to T. Lephoto for helping me with R and for always willing to help when I encountered difficulties.
- To Mr. Brent Coverdale from EKZNW, your time and insights are greatly appreciated.
- I also like to thank Mr. S. Kubheka for being the best mentor, and always willing to offer assistance.
- I thank my mother N.V. Manqele for allowing me to study further, being away from home and for all her support.
- The Midlands community and Durban *muthi* traders, thank you for agreeing to working with me on this project.
- To all the UKZN students, from the School of Life Sciences and Geography discipline who helped with data collection, I appreciate your assistance. Thank you for your sacrifices.
- The UKZN PMB campus RMS staff, thank you for escorting me home from campus in the middle of the night and never complaining. The world needs more people like you.
- To all my friends, you have been incredibly supportive and motivating and for that I am forever grateful.

## Table of Contents

## List of Tables



## List of Figures

## List of Appendices

## List of Abbreviations

| | |
|---|---|
| AOO | Area of Occupancy |
| CAMPFIRE | Communal Areas Management Programme for Indigenous Resources |
| CBD | Central Business District |
| CBD | Convention on Biological Diversity |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| CSIR | Council for Scientific and Industrial Research |
| EKZNW | Ezemvelo KZN Wildlife |
| FAO | Food and Agriculture Organisation |
| IUCN | International Union for Conservation of Nature |
| KZN | KwaZulu-Natal |
| NEMA | National Environmental Management Act |
| NEM: BA | National Environmental Management: Biodiversity Act |
| NGOs | Non-Governmental Organisations |
| PHVA | Population and Habitat Viability Analysis |
| PVA | Population Viability Analysis |
| SADC | Southern African Development Community |
| SANBI | South African National Biodiversity Institute |
| SAPS | South African Police Service |
| ToPS | Threatened or Protected Species |
| US$ | United States of America Dollar |
| ZAR | South African Rand |

# CHAPTER ONE
# Introduction

## 1.1 Introduction

Meat derived from wild animals is referred to as bushmeat, it is harvested from a diverse range of species including insects, reptiles, birds and most commonly, mammals, particularly ungulates (Fa *et al.* 2005; Kaschula & Shackleton 2009; Ripple *et al.* 2016). For the majority of rural people residing in remote and marginalised regions, access to domestic sources of protein is often limited. As a result the readily available, accessible and affordable bushmeat represents a primary source of their protein intake (Fitzgibbon *et al.* 1995; Martin *et al.* 2012). For example in the Congo Basin, Central and West Africa, approximately 5 million tons of bushmeat are harvested annually (Fa *et al.* 2002). Similarly, in East Africa, a single hunter harvests an estimated 1077kg of bushmeat per annum of which the majority (80%) is for household consumption (Robinson & Bennett 2013). However, bushmeat consumption is not restricted to rural areas. A growing body of evidence highlights urban environments as markets for large quantities of bushmeat, harvested particularly from inside and around protected areas (Martin & Caro 2013).

The recent increase in bushmeat consumption is in accordance with the growing commercialisation of the resource (Kaltenborn *et al.* 2005). Villagers, often unemployed, generate income by selling bushmeat to city dwellers, which in most cases is illegally obtained, (van Vliet *et al.* 2014). Hughes (2017) argues that the global illegal wildlife trade, which includes bushmeat, accounts for approximately US$20 billion annually. For the marginalised, bushmeat is consumed to fulfil protein requirements. However, for the wealthy, bushmeat has become a delicacy, served in restaurants and consumed during ceremonies and festivals (Sandalj *et al.* 2016). The inclusion of people with adequate access to alternative sources of protein in the consumption of bushmeat has increased its demand, and generally beyond its productive capacity (Bennett *et al.* 2002). Furthermore, bushmeat commercialisation has been exacerbated by trade in wild animal body parts for use in traditional medicine (Mainka & Mills 1995; Whiting *et al.* 2013). Traditional medicine involving wildlife, has led to the endangerment of a number of iconic species including tigers (*Panthera tigris*), lions (*Panthera leo*), rhinos (*Rhinoceros spp*.)

and the Asiatic black bear (*Ursus thibetanus*) inter alia (Mills & Servheen 1994; Ngwenya 2001 unpubl. data).

Conservationists are disturbed by the rate at which wildlife is declining (Di Marco *et al.* 2014; Cronin *et al.* 2015) and the continued rate of extinction of wildlife species (Carruthers 1995). Although extinction is a complex result of a combination of threats acting together at the same time or alternating (Armstrong *et al.* 1998), over-hunting for human consumption is one of the primary threats that could lead to wildlife extirpation (Townsend 2008). Currently, many mammalian species are threatened with extinction due to illegal hunting (Ripple *et al.* 2016). Their failure to withstand illegal hunting pressures is exacerbated by factors such as habitat loss and degradation (Cullen 2000). Nonetheless, this crisis can be addressed and reversed. One of the first steps is the evaluation of the drivers behind such bushmeat practices which can be achieved through constructive engagement with hunters and consumers alike (Gavin *et al.* 2010; Nuno *et al.* 2013). However, due to the illicit nature of the activity, undertaking assessments remains difficult, as illegal hunters are challenging to identify and may be reluctant to participate in studies due to fear of persecution (John *et al.* 2010). As a mitigation measure, ways of engagement may be manipulated to achieve positive outcomes. Moreover, due to the complexity of the issue and the scarcity in financial resources, priority should be given to vulnerable mammalian species including rare, specialist and slow reproducing species. Priority should also be given to keystone and indicator species, as saving these could result in the protection of many other species.

In the fight against biodiversity loss, conservation managers and researchers have grown to appreciate the importance of private lands and the role they can play in the conservation of species occurring outside protected areas. Formally protected areas remain a backbone of biodiversity conservation (Rands *et al*. 2010), as they provide formal systematic protection to a diversity of plant and animal species along with their associated habitats (Newmark 2008). Terrestrial Protected areas today cover approximately 12.7% of the earth's surface (Craigie *et al*. 2010; Geldmann *et al*. 2013). Their importance is highlighted by a wealth of success stories, including those of populations recovering following PA establishments and records of species now only occurring within the boundaries of PAs (Caro & Scholte 2007). Such positive outcomes may be limited and erratically distributed owing to the diversity of challenges facing

protected areas today including limited financial and personnel resources, environmental irregularities and socio-economic issues inherent to various PAs (Kaltenborn *et al.* 2005; Western *et al.* 2009; Laurence *et al*. 2012; Geldmann *et al*. 2013; Selier *et al.* 2016). Factors in particular that hinder the expansion of protected areas have a greater effect on their viability to protect certain species. Some species' geographic ranges may extend beyond PA boundaries, while most PAs do not cover migration routes (Western *et al.* 2009; Craigie *et al.* 2010; Selier *et al*. 2014). As a result, a variety of species, including those of high conservation concern is found occupying private and communal lands (Newmark 2008; Humphries *et al.* 2016), where they are susceptible to retaliatory killings, illegal utilisation and habitat loss (Grey-Ross *et al*. 2012; Laurance *et al*. 2012; Ramesh & Downs 2013; Selier *et al*. 2014). For lands outside PAs to contribute significantly in conserving biodiversity, strong partnerships are to be established and incentives provided (Ezemvelo KZN Wildlife 2012a; Clements *et al.* 2016).

## 1.2 Study rationale

The rapid decline in the oribi (*Ourebia ourebi*, Zimmermann 1783) populations in South Africa is of concern. This decline is largely attributed to illegal hunting (Grey-Ross *et al.* 2010; Magwaza 2015), although habitat loss and fragmentation appear to be as detrimental. Oribi are specialist grassland species and represent an ideal indicator species for this threatened ecosystem (Coverdale *at al*. 2006). Their local extinction, like that of any other species, could have severe ramifications for regional biodiversity. Understanding the drivers of illegal hunting of oribi through hunter and relevant stakeholder engagement, could assist decision makers in the rehabilitation and management of oribi populations in the country.

Although, fairly resilient to habitat transformation in most of its national range, the serval (*Leptailurus serval*, Schreber 1776) is a wetland specialist, and a potential keystone species for montane wetland conservation (Ramesh & Downs 2013). Servals face a myriad of human induced threats including illicit hunting for trade and traditional medicine purposes. Due to the illegality of these activities and limited research in this regard, there is a poor understanding of the drivers and impact of these activities on the viability of oribi and serval populations in South Africa.

## 1.3 Aim and objectives

The aim of this study was to assess the drivers and impact of illegal hunting for bushmeat and *muthi* on serval and oribi in South Africa. In light of this aim, the following objectives were set:

- To determine cultural and socio-economic aspects of the illegal hunting and use of serval and oribi.
- To evaluate the severity of the illegal hunting of serval and oribi.
- To undertake a quantitative assessment of the impact of illegal hunting and use on serval and oribi populations.

## 1.4 Thesis structure

This thesis is composed of five chapters. Chapter one provides an introduction to the study and chapter two the literature review. The literature review concentrates on the primary factors driving illegal wildlife resource use, for meat and traditional medicine in developing countries and the associated impacts. It further evaluates the conservation, governance and use of wildlife in a South African context. Chapters three and four are data chapters presented as independent research papers, formatted for submission to the South African Journal of Wildlife Research. Chapter three incorporates an evaluation of the cultural and socio-economic factors responsible for the illegal exploitation of oribi and serval, in South Africa. Chapter four encompasses a quantitative population viability assessment of the two species, under varying illegal hunting pressures, using Vortex. The conclusions and synthesis are presented in chapter five. In this chapter, study objectives are revisited and the main findings are incorporated. It aggregates chapters two, three and four. To avoid multiple overlaps, all references were combined into a single list provided after chapter five.

# CHAPTER TWO

# Bushmeat and traditional medicine use in developing countries: a review of drivers and impacts.

## 2.1 Introduction

Poverty remains one of the greatest challenges facing developing countries (FAO 2015). Urban-biased development policies have left the rural areas of these nations severely lacking in social and economic capital and levels of inequality are high (Sporton & Thomas 2002). Poverty is further perpetuated by continued rapid population growth (Bennett *et al.* 2002; Brashares *et al.* 2004). This growth is often concentrated around protected areas with an annual increase of 3% around the Serengeti National Park in Tanzania, for example (Kaltenborn *et al.* 2005). In these areas, food insecurity and the levels of malnutrition generally remain high (Sylvester *et al.* 2016). Natural resources have always been a support system from nature and have thus been utilised to meet daily and seasonal needs of many marginalised and intermediate rural households (Shackleton & Shackleton 2006; Golden *et al.* 2011; Atuo & O'Connell 2015; Diop & Scheren 2016; Smith *et al.* 2017). The resources include; firewood, charcoal, fish, edible herbs, medicinal herbs, honey and bushmeat among others (Njovu 1993; Aziz 2017; Smith *et al.* 2017).

Bushmeat is one of the main products harvested from the wild that rural households from developing countries of Africa, Asia and Latin America depend upon. Although definitions may vary, for instance, Lindsey *et al.* (2013: 18) defines bushmeat as "*meat from wildlife that has been acquired via illegal hunting*". For the purpose of this review, bushmeat will be defined as meat derived from wild animals, either through legal or illegal means (Ebewore *et al.* 2015). It is considered illegal when it includes one or more of the following; violates regulations and ownership rights, exceeds established limits, is conducted out of season, or beyond demarcated areas, it involves the use of prohibited methods, is conducted without required permits, and involves endangered and/or protected species (Gavin *et al.* 2010). de Azevedo Chagas *et al.* (2015) argue that illegal hunting practices are a reflection of the local socio-economic, and ecological characteristics of the regions in which they occur. However, these factors are not enough to elucidate the drivers of illegal bushmeat hunting and the increase in this activity, due to its complexity (Cronin *et al.* 2015). This chapter reviews the primary drivers of illegal wildlife

use and the associated impacts. Further, wildlife resource governance and utilisation in South Africa are evaluated.

## 2.2 Bushmeat utilisation

Although agriculture is one of the primary livelihood strategies for the majority of people living in rural areas, these people are vulnerable to shocks and stresses arising from environmental and climatic changes, such as drought and diseases (Mazibuko 2013). Livelihoods are thus maintained through diversification (Shackleton *et al.* 2002), a phenomenon where people base their livelihoods on mixed strategies, for instance, wage employment and natural resource use (Berkes 2004). In areas where wildlife is readily available, subsistence and commercial bushmeat utilisation is one of the main ways in which rural marginalised communities broaden their livelihoods. The activity is illegal in many regions, however its increase has been due to factors that incentivise the need to consume bushmeat including; protein shortages, limited income sources, cultural requirements and poor law enforcement.

### 2.2.1 Bushmeat for household consumption

There is generally a high protein deficiency in rural areas of developing countries, particularly in Africa (White & Belant 2015). Although vegetal sources of protein may be available, access to animal protein is often limited. Bushmeat is a readily available and affordable resource, thus protein deprived households often exploit this resource for their needs. Today it represents a vital source of animal protein in many parts of the world (Fa *et al.* 2003). For example, in Kenya, 80% of the rural population consumes approximately 169.2kg of bushmeat per household annually (Barnett 2000). Rural livelihoods are prone to various stresses such as sudden job losses, crop failure, fish stock reductions and disease outbreaks (Brashares *et al.* 2004; Mazibuko 2013; Smith *et al.* 2017). When such stresses are experienced, bushmeat plays a vital role as a safety net and a supplement, in particular when stresses involve unanticipated reductions in agricultural output (Lindsey *et al.* 2013). Bushmeat consumption further compensates for crop losses due to wildlife crop raiders and/or livestock losses to predators (Fitzgibbon 1995; Barnett 2000; Loibooki *et al.* 2002; Kaltenborn *et al.* 2005; Kroos 2016). Such incidents often result from human encroachment onto wildlife reserves and the elimination of buffer zones surrounding national parks through agricultural expansion (Kroos 2016; Selier *et al.* 2016).

Bushmeat consumption predominantly escalates during the dry and early wet seasons (Fitzgibbon 1995; Kaltenborn *et al.* 2005; Lindsey *et al.* 2011), when wildlife visits the few water sources, agricultural activities are reduced and livestock mortality is increased (Barnett 2000; Lindsey *et al.* 2011; Lindsey & Bento 2012). This seasonal variation in hunting activities is legitimate, however in some villages in Gabon and Tanzania, hunting prevails during the wet season, for this is when the economic crisis is more severe due to reduced labour as most temporary jobs are available only during the dry season (Coad 2007). The wet season is also when wildlife is not restricted to a few water sources and is more wide ranging (Coad 2007; Martin *et al.* 2012). However, for Tanzanian illegal hunters, the rainy season generally presents greater hunting opportunities as roads are unusable and thus game patrols are restricted (Martin *et al.* 2012).

The consumption of bushmeat is dependent on species availability and accessibility (Martin *et al.* 2013). Livelihood activities and seasonal availability of other resources are significant in determining temporal differences in illegal hunting patterns. It remains unclear as to how much of the illegal bushmeat hunting is a necessity for food security, as there has been an increase in hunting and consumption of bushmeat by villagers with sufficient livelihood alternatives. In these cases, bushmeat consumption is driven by personal preference for reasons that include; it tastes better, it is healthy and entertaining to pursue (Hansel 2004). Therefore, solutions to bushmeat overconsumption are mostly site-specific. Nonetheless, economic and livelihoods improvements are still effective in reducing extensive bushmeat consumption when it is subsistence driven (Vasco & Sirén 2016), but it is more complex when it has extended beyond the rural areas into cities, through commercialisation.

### 2.2.2 Bushmeat as a source of income

Bushmeat is a source of income for households with limited income channels (Shackleton & Shackleton 2006; Coad *et al.* 2007; Pangau-Adam *et al.* 2012) and its importance in rural economies can be significant (Hansel 2004; Schlesinger *et al.* 2015). Commercially driven bushmeat hunting is practiced primarily by males with limited access to formal employment (i.e. unemployed and partially employed) in their late 20s and early 30s (Lindsey & Bento 2012). Although some of the meat may be sold locally (Martin *et al.* 2012), the biggest target markets are the cities (Fa *et al.* 1995), where alternative sources of protein are generally available. In

these areas bushmeat is served in restaurants and consumed as a delicacy during festivals and ceremonies (Barnett 2000; van Vliet *et al.* 2014; Sandalj *et al.* 2016). It is sold fresh, smoked, salted or frozen (van Vliet *et al.* 2014). Buyers are usually business people, teachers, government officials (Lindsey & Bento 2012), students (Sandalj *et al.* 2016) and field workers (van Vliet *et al.* 2014). Despite the abundance of domestic sources of protein in cities, access may be limited for a significant proportion of the population, including the unemployed and low income groups.

City dwellers with limited access to domestic meat can resort to bushmeat as it is generally cheaper than domestic meat. For instance, van Vliet *et al.* (2014) argue that in the Amazon, bushmeat is four times cheaper than domestic meat such as chicken and beef. Furthermore, a large income is generated from the sales and it can make a significant contribution to the hunters' monthly income. This money is used to pay for various services, purchase non-farm goods and in some cases, purchase fertilisers and pesticides to improve agricultural productivity (Shackleton *et al.* 2000). It is sometimes used to pay for school fees, with an increase in illegal bushmeat hunting for trade purposes coinciding with the end of school holidays (Warchol & Johnson 2009).

The commercial bushmeat trade has become so lucrative that most species are now harvested more for trade than for subsistence household consumption (Corlett 2007), sometimes leaving households' malnourished (Fa *et al.* 1995). In addition, hunting methods have advanced and are more effective in obtaining bushmeat. In most cases these hunting methods are illegal, and they include guns such as muzzleloaders and automatic rifles (van Vliet & Nasi 2008). These improvements in hunting methods are in accordance with the shift from a more subsistence based harvesting to a more commercial motivated extraction. These methods aid in taking large to medium sized and arboreal species which are often associated with substantial profits (Lindsey *et al.* 2011; Cronin *et al.* 2015). Large to medium sized species such as primates in Central Africa (Cronin *et al.* 2016) and ungulates in East Africa (Martin *et al.* 2013) are taken because of their high profitability. However, small to medium-sized species now dominate the informal bushmeat markets as a result of the dramatic reductions in large sized species. This is also attributed to the difficulty in extracting and transporting large species to markets (Fa *et al.* 1995), which in some cases are transported by bicycles (Lindsey *et al.* 2013). Commercially driven illegal bushmeat hunting has adverse implications, as large quantities of meat are required. Preferred and

generally hunted species are likely to include endemic (Fa *et al.* 1995) and endangered species (van Vliet *et al.* 2014; de Azevedo Chagas *et al.* 2015). The selling of other wildlife body parts such as skins, to be used in traditional medicine, increases the viability of trade driven illegal bushmeat harvesting.

#### 2.2.2.1 Traditional medicine

It is believed that wildlife possesses properties that play an important role in healing practices, rituals and religions of many people (Costa-Neto 1999). In China, over 1 500 wild animal species have been recorded to possess medicinal qualities and more than 180 animals are used for traditional medicine in Brazil (Alves & Rosa 2005). Animal based remedies and their utilisation remain under-represented in literature in comparison with plant based traditional remedies and their uses (Williams & Whiting 2016; Yohannes & Chane 2014). The use of wild animals in traditional medicine differs from that of plants, in that the historical discovery of traditional medicine was through the use of herbs. Plants are used in more remedies than animals. Moreover, some plant extracts (e.g. grapple tubers) are exported from rural Africa to be used in the making of western medicine while other animal derived medicines are supplemented with plant extracts to improve their effectiveness (Hunter *et al.* 1990; Mainka & Mills 1995; Van & Tap 2008). The medicinal resources derived from wildlife may be the only available source of healthcare for the majority of the human population with limited access to primary healthcare (Costa-Neto 2005; Alves & Rosa 2007; Atuo & O'Connell 2015). These are the marginalised communities living in distant rural areas with limited access to hospitals or community healthcare centres (Van & Tap 2008). Furthermore, the infrastructure in these areas is generally inadequate and this hampers access to the sick by healthcare representatives. Recently there has been an increase in the number of people residing in urban areas utilising this type of medicine and expanding its scope of demand (Whiting *et al.* 2013), despite numerous critics questioning its effectiveness (Swan & Conrad 2014).

The use of animal derived traditional medicine remains highly controversial as it is considered to be based on superstitions, rather than on evidence of efficacy and is thus predominantly dismissed by western-trained medical professionals (Still 2003; Swan & Conrad 2014). The safety of this practice is often questioned (Van Niekerk 2012) since it exposes patients and practitioners to risks of contracting zoonotic diseases (Nunkoo & Mahomoodally

2012; Yohannes & Chane 2014) such as Ebola. There is direct conflict between the two medical systems. Nonetheless, some studies have confirmed the pertinence of traditional medicine use (Costa-Neto 1999). Today it continues to gain popularity and is becoming a recognised livelihood strategy for traders and practitioners.

There are a large number of animal taxa used in traditional medicine, including mammals, birds, reptiles, arthropods and fish. For example, use of salmon, which has valuable medicinal properties that include OMEGA 3 commonly used to treat and prevent arthritis (Costa-Neto 2005). Echinoderms (Costa-Neto 1999), crustaceans, mollusks (Costa-Neto 2005) and annelids are popular in traditional medicine (Solavan *et al.* 2004). The most commonly treated ailments are respiratory diseases such as asthma (Costa-Neto 1999), impotency and infertility (Dedeke *et al.* 2006). Other uses related to medicine derived from wildlife resources include the use of body parts such as horns as instruments for the purposes of blood-letting and surgeries (Costa-Neto 2005). Animals with magical and superstitious associations are sold in traditional medicine markets and used for various purposes including protection against bad spirits, as good luck charms (Costa-Neto 2005; Alves & Rosa 2007) and for sacrifices (Lev 2003).

The majority of animal species recorded at South African markets are harvested locally, while the rest may be obtained from distant regions or neighbouring countries. For instance, most of the invertebrates sold at the Durban *muthi* market are harvested locally (Herbert *et al.* 2003) while others are sourced from the coast of Mozambique. This suggests a well-established cross-border trade between neighbouring countries that is most likely linked to the growing demand for traditional medicine in the region (Dedeke *et al.* 2006). To accommodate this demand without compromising the integrity of biodiversity, in some Asian regions wildlife farms have been established to supply body parts for the traditional medicine market (Swan & Conrad 2014). This practice has been recommended for countries experiencing similar pressures (Ngwenya 2001. unpubl. data), to reduce the over-exploitation of wildlife species including those of conservation concern, for example lion, leopard (*Panthera pardus*) and black rhino (*Diceros bicornis*) among others.

### 2.2.3 Bushmeat and culture

People attach values and exhibit certain attitudes to wildlife (Kaltenborn *et al.* 2005). Bushmeat hunting and consumption represent cultural norms for some rural communities (Wilkie &

Carpenter 1999; Milner-Gulland & Bennett 2003; Ebewore *et al.* 2015), even for some urban individuals who are still in touch with their cultural heritage (Effiom *et al.* 2013). Various rituals, such as the passage of young men into adulthood and circumcision, often involve ceremonies that are associated with a high consumption of bushmeat (van Vliet & Nasi 2008; van Vliet & Mbazza 2011; van Vliet *et al.* 2014). Accompanying the cultural significance of hunting is its social importance. In Tanzania, hunting men receive respect in their neighbourhoods compared with those that do not hunt (Lowassa *et al.* 2012). Cultural importance can have a greater influence on illegal hunting and bushmeat consumption than generally perceived (Tieguhong & Zwolinski 2008).

Moreover, in regions where illegal bushmeat activities are driven by unemployment with a cultural attachment, the emergence of alternative livelihood strategies may fail to curtail illegal hunting. Consequently, it is important for conservation strategies aimed at alleviating illegal bushmeat hunting to consider the influence of cultural factors. With these cultural practices come taboos which prohibit hunting and consumption of certain species perceived sacred or impure (Cullen *et al.* 2000; Nasi *et al.* 2011; van Vliet *et al.* 2014). Although these may reduce the trade value of these taboo species they are unlikely to reduce their harvesting (van Vliet & Mbazza 2011). Moreover, such association are highly localised and are being abandoned due to the increasing demand for bushmeat.

### 2.2.4 Law enforcement

As a result of the unsustainable use of biodiversity resources including wildlife, legislative bodies exist that control the use of these resources. These vary in their coverage from international to local institutions. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an example of an international convention regulating the trade in natural resources. CITES was drafted in 1963 and established in 1975, today 183 parties are signatories to the convention. CITES regulates international commercial and non-commercial trade in species of flora and fauna by placing them in one of three appendices (i.e. categories). Appendix I lists species that are at risk of extinction in the wild. No commercial trade is permitted, while any exports and imports require a permit. Appendix II lists species that are not necessarily threatened but for which trade needs to be controlled. A Party (country) that has already established protection instruments for a species but requires support from other parties to

enforce its sustainable utilisation may request for the inclusion of the species in Appendix III. Trading parties must ensure that trade will not have any detrimental effects on species involved and their populations in the wild. The notion behind CITES trade restrictions is that prohibitions will diminish the demand and force the use of alternatives (Swan & Conrad 2014). The Convention on Biological Diversity (CBD) is a further example of an international alliance concerned with the sustainable use of biodiversity resources, including wildlife, and a fair and equitable distribution of benefits derived from the use of biodiversity resources (Morgera 2010).

Regional bodies established to conserve wildlife are of great importance for they are often based on attributes that capture the uniqueness of these regions. The Protocol on Wildlife Conservation and Law Enforcement as part of the Southern African Development Community (SADC) Treaty was passed in 1999 and entered into force in 2003. It acknowledges the state's sovereign rights in the management of wildlife resources which is accompanied by the responsibility to use and conserve these resources. Its main objective lies in establishing a common set of approaches to conserve and use wildlife resources sustainably (Morgera 2010). National legislature governs the use of wildlife resources on a national level through a set of laws and regulations. These laws vary per country, although similarities may be drawn, particularly in countries of the same regions.

Countries have adopted various measures in an attempt to regulate hunting at a national level. In Gabon and Brazil, the use of wildlife by indigenous people is permitted on communal lands or on demarcated hunting grounds however, trade is strictly prohibited (van Vliet & Mbazza 2011; Vasco & Sirén 2016). In other countries the use of wildlife is regulated through quota and permit systems, strict prohibitions are established for species of high conservation concern (i.e. threatened and/or protected species) (Martin *et al.* 2012; Robinson & Bennett 2013; Lindsey *et al.* 2013). In addition, the use of certain hunting methods may be prohibited, for example, fire, snaring, trapping and hunting with dogs (Molewa 2010; Lindsey *et al.* 2013). Also prohibited is hunting in certain seasons commonly referred to as closed seasons, which may coincide with breeding times and thus prohibiting hunting allows time for breeding processes and juvenile growth.

Law enforcement is the pillar of all these regulations and it is inadequate in most developing countries, hence the high prevalence of illegal hunting and trade in endangered and

protected species (Fa *et al.* 2002; Townsend 2008; Terborgh *et al.* 2008; Martin *et al.* 2012; Lindsey *et al.* 2013; Cronin *et al.* 2015). The inadequacy in law enforcement increases the level of bushmeat hunting, consumption and trade (Lindsey *et al.* 2013). Strong conservation frameworks exist, however their application remains poor (Hughes 2017). Moreover, laws governing the use of wildlife resources are not well communicated to the local people, whose livelihoods have been based on these resources for decades (Pangau-Adam *et al.* 2012). Local people believe that the resources belong to them and thus prohibitions are perceived as a method of control and deprivation. Traditional land-uses suddenly became illegal (Sporton & Thomas 2002), this can be confusing and raise a number of questions accompanied by negative attitudes toward conservation (Warchol & Johnson 2009). In addition, while provisions for other wildlife uses are available such as trophy hunting in some countries, opportunities for subsistence or traditional hunting are limited (Booth 2010).

Various factors hinder the effectiveness of law enforcement in developing countries. Most protected areas operate under scarce financial resources (Terborgh *et al.* 2008), as a result staff are demotivated and may overlook illegal activities. Shortages in financial resources deter effective protection as few game rangers can be employed, in large reserves this may lead to some sites being left unguarded and illegal hunters taking advantage of this (Aziz 2017). Insufficient wages encourage corruption, where game guards cooperate with illegal wildlife users for better financial gains (Warchol & Johnson 2009). When local authorities are involved in illegal hunting activities either in buying, selling or transporting (Terborgh *et al.* 2008), local hunters will seldom comply with the law (Bouché *et al.* 2012) and this is the case in most illegal hunting stricken regions. Moreover, wildlife criminals are seldom prosecuted (Terborgh *et al.* 2008) and penalties may be weak (Slobodian *et al.* 2016) and this diminishes the gravity of the offence while encouraging further law breaking. The lack of cohesion in wildlife laws across national borders undermines adequate law enforcement (Slobodian *et al.* 2016). Law may exist and offenders be aware of it, however if not applied systematically its value diminishes and this may further escalate non-poverty related illegal uses of wildlife such as sport hunting (Shanee 2012).

## 2.3 The impacts of illegal bushmeat hunting

The impacts of the illegal hunting and utilisation of wildlife resources are far-reaching. Currently, 301 terrestrial mammals from developing countries are threatened with extinction as a result of illicit hunting and use (Ripple *et al.* 2016). Illegal hunting extends beyond undermining biodiversity integrity to affecting economic prosperity of developing countries. Ecosystem disturbances arising from wildlife over-harvesting have ramifications for communities that depend on these ecosystems. Subsistence hunting in many cases is considered sustainable however, this has been largely replaced with hunting for income which is demand driven and unlikely to be sustainable (Pangau-Adam *et al.* 2012). This shift from 'hunting for the pot' to 'hunting for economic gains' is the principal driver of the bushmeat crisis (Redford 1992; Fitzgibbon *et al.* 1995; van Vliet *et al.* 2014). The effects of illegal hunting are heightened by indirect factors such as habitat fragmentation and loss, the building of roads and the establishment of logging concessions in previously inaccessible wildlife reserves (Effiom *et al.* 2013; Kroos 2016).

### 2.3.1 The impacts of illegal bushmeat hunting on hunted species

Species respond differently to hunting pressures. Reproduction rate, abundance, dispersal ability, rarity and whether the species is a generalist or a specialist are some of the factors that influence the way in which individual species are affected by illegal hunting (Fitzgibbon *et al.* 1995; Ndibalema & Songorwa 2009; Linder & Oates 2011; Martin & Caro 2013). Hunters are attracted to large sized species of birds and mammals, with mammals being the most affected taxa (de Azevedo Chagas *et al.* 2015; Ripple *et al.* 2016). Their harvest is rewarding due to the quantity of meat they provide (Milner-Gulland & Bennett 2003). The advances in hunting technologies from traditional bows to muzzleloaders and shotguns accompanied by their wide availability, eased extraction and thus increased the number of off-takes while reducing the amount of time spent hunting (Dounias 2016). As a result, large species are the first ones to experience declines in heavily hunted sites. As, unlike the majority of small to medium sized species, large sized species are characterised by low reproductive rates, their capacity to withstand illegal hunting pressures is fairly limited. Illegal hunting is often unselective, and thus may lead to off-takes of breeding members of a population. This affects their population viability. The ramifications of this are indicated by the increase in dominance of small to medium sized species in bushmeat markets (Martin *et al.* 2013). Although these species may act as efficient economic substitutes

for large sized mammals, their long-term persistence is not guaranteed. Moreover, they are unlikely to adequately perform the ecosystem duties of their large counterparts. (Rovero *et al.* 2012; Cronin *et al.* 2016). In response to high pressures of illegal hunting, species may exhibit behavioural changes which in turn impair their ecological interactions.

### 2.3.2 The impacts of illegal bushmeat hunting on non-hunted species

The impacts of illegal hunting are not restricted to hunted species alone. The role played by each species is irreplaceable in a given ecosystem (Still 2003). The assessment of biological impacts of illegal hunting has been mainly restricted to tropical forest ecosystems (Cullen 2000; Wright 2003; Fa *et al.* 2005; Effiom *et al.* 2013). Tropical forests are highly productive (Malhi & Grace 2000; Lewis *et al.* 2009) and accommodate over half of the world's species (Wright 2005). They play a significant role in controlling the rate of climate change and in facilitating the global carbon cycle (Malhi & Grace 2000; Lewis 2006; Lewis *et al.* 2009). Although deforestation has been a major factor threatening the viability of these ecosystems (Lewis 2006), over-hunting of wildlife has increased significantly (Bennett *et al.* 2002). Comparative analyses of sites associated with active illegal hunting and sites with no illegal hunting activities, have found that defaunation changes the structure of tropical forests (Wright 2003; Wright *et al.* 2007; Effiom *et al.* 2013).

Most large and medium sized mammals and birds susceptible to illegal hunting are important in forest development. These include: granivores which consume large seeds, frugivores which disperse seeds and set the spatial organisation for plant recruitment, in particular large seeded plants and browsers which feed on leaves (Wright 2003; Wright 2005). Their reduction in abundance represents a major effect on the overall composition of forests while supporting the dominance of small seeded tree species, often dispersed by other agents including wind, bats and smaller birds (Wright *et al.* 2007; Effiom *et al.* 2013). Moreover, reductions in forest fauna result in disturbances in evolutionary processes (Nasi *et al.* 2011). Although indirect and often taking time to unveil, the consequences of defaunation on forest ecosystems are significant. The world's tropics are not inoculated against the empty forest syndrome, as predicted by Redford (1992), a phenomenon where fauna has been severely depleted in forest ecosystems and the long-term preservation of forest vegetation is compromised, unless rigorous approaches to moderating human's over reliance on wildlife

resources are adopted. Fauna-flora interactions are not the only relationships impaired by illegal hunting as evidence shows that over-hunting negatively interferes with predation through prey depletion (Redford 1992; Lindsey *et al.* 2013).

Most (93%) of the animal species illegally hunted in the Congo Basin are ungulates (Fa *et al.* 2002) and they comprise the largest proportion of the harvest in the world (van Vliet & Nasi 2008; Lindsey & Bento 2012; van Vliet *et al.* 2014). The preferred species are often the ideal diet for carnivores and these are the medium to large sized mammals (Karanth & Sunquist 1995; Henschel *et al.* 2011). Over-hunting of these species, for both subsistence and commercial purposes, reduces their abundance. Predators such as leopards, which are also persecuted, snared and hunted for their skins, resort to small and medium, poor quality prey to survive (Henschel *et al.* 2011; Linsey *et al.* 2013). This dietary niche overlap is prevalent in villages with high human densities and intensive consumption of bushmeat (Henschel *et al.* 2011). Non-selective intake of small mammals by large predators is an indicator of the reduction in preferred prey availability (Karanth & Sunquist 1995). For example, a study conducted in Gabon, found that in sites further away from human settlements where hunting was absent, leopard prey off-take was comprised of large sized ungulate prey, while in sites associated with high illegal hunting activities leopards capitalised on small prey and a diverse diet composed of porcupines, various primates and rodents (Henschel *et al.* 2011). Since over-hunting of preferred species eventually leads to declines, when this happens, hunters are forced to encroach upon sites further away from villages where wildlife is more abundant. The building of roads facilitates their access (Ziegler *et al.* 2016). This poses a potential continuous threat to predators.

### 2.3.3 The socio-economic impacts of illegal bushmeat hunting

In many African countries, wildlife-based land uses contribute significantly to national economies (Kaltenborn *et al.* 2005; Lindsey *et al.* 2009). One such use is trophy hunting. In Africa, 23 countries benefit from trophy hunting (Lindsey *et al.* 2007) and it is characterised by a high involvement of local rural communities (Bouché *et al.* 2012). Trophy hunting is the commercial based legal hunting of wildlife by clients or tourists to obtain a trophy. It is considered the most viable wildlife based land use activity, contributing approximately 89% to 95% of the total Communal Areas Management Programme for Indigenous Resources (CAMPIRE) revenue in Zimbabwe. While ecotourism contributes approximately 2% (Lindsey *et*

*al.* 2007; Frost & Bond 2008). Trophy hunting is less demanding and can be lucrative in areas where ecotourism is not a viable option, these include areas stricken by political unrest and associated with poor infrastructure (Lindsey *et al.* 2007). It is often regulated through a quota system approach and involves low off-takes of approximately 2-3 % of the male populations (Lindsey *et al.* 2007; Lindsey *et al.* 2009). From a conservation standpoint, well managed trophy hunting is preferable to other consumptive uses of wildlife (Loveridge *et al.* 2007). However, this use of wildlife has been criticised and blamed for the decline of key species, unethical practises and genetic losses. These critics have led to restrictions being imposed and the industry losing some of its vigour. Nonetheless, researchers argue that it remains a vital conservation and rural development tool (Loveridge *et al.* 2007; Lindsey *et al.* 2007; Muposhi *et al.* 2016).

Biodiversity conservation is costly (Adams 2013) and yet it is less funded compared with other forms of development (Muposhi *et al.* 2016). Revenue generated through trophy hunting can contribute significantly to improving and maintaining biodiversity integrity. Moreover, through tangible financial benefits channelled to local communities, the concessions provide incentives to safeguard wildlife (Frost & Bond 2008). Consequently, southern Africa has seen a steady increase and stability in elephant (*Loxodonta africana*) populations attributed in part to trophy hunting, while populations from other regions such as West Africa experienced declines (Muposhi *et al.* 2016). Moreover, trophy hunting helps keep in-check populations of problem animals while generating an income (Lindsey *et al.* 2007). However, illegal hunting is one of the biggest threats to trophy hunting (Muposhi *et al.* 2016), as species depletion reduces the trophy hunting potential and ecotourism value of affected areas.

There are many regions where bushmeat is one of the few sources of animal protein available (Robinson & Bennett 2013). The role played by this resource in ensuring food security and resilience is of great importance (Brashares *et al.* 2011). However, it is only in a few regions where bushmeat exploitation is subsistence based, sustainable and contained. Commercially driven hunting has grown significantly over the years, in spite of its illegal nature (De Merode *et al.* 2004; Fa & Yuste 2001; Bouché *et al.* 2012). This represents one of the greatest challenges for conservation (Fa *et al.* 1995). Prohibitions on access to bushmeat have been implemented on a larger scale (Golden *et al.* 2011). However, the ramifications of this negate subsistence users of wildlife resources. Access restrictions to certain areas adopted to control unsustainable bushmeat

harvesting, unintentionally limit access to other open resources such as medicinal and edible herbs (Rovero *et al.* 2012; Sylvester *et al.* 2016). This compromises food security and in turn fuels poverty (Barnett 2000; De Merode *et al.* 2004), while affecting local communities that consume bushmeat to improve health and alleviate malnutrition (Borgeson *et al.* 2016; Sylvester *et al.* 2016). Golden *et al.* (2011) argue that bushmeat consumption reduces anaemia occurrences by approximately 30% in rural Madagascar. Moreover, wildlife resource use prohibitions impinge on local people's ability to enjoy a sense of cultural pride (Sylvester *et al.* 2016). However, these restrictions and prohibitions may be necessary as without them, biodiversity will be lost (Golden *et al.* 2011).

## 2.4 The use of wildlife resources in South Africa

Historically, South Africans sustainably utilised a wide range of naturally occurring resources to meet their daily and long-term needs such as health, food and shelter (Carruthers 1995). It was not long before the use of natural resources became politicised, with the dawn of the agro-pastoral lifestyle. A period characterised by tribal forms of ownership over land and animals, particularly those with symbolic attributes. Due to the abundance of wildlife this shift did not have any pronounced effects on biodiversity (Carruthers 1995). However, it was followed by a greater shift that could not have been anticipated. It was accompanied by radical changes in the exploitation of natural resources, in particular wildlife. The arrival of European settlers led to hunting of wild animals for subsistence, sport, trade and the collection of specimens by artists and explorers for European Museums (Carruthers 1995). All these activities were made efficient by the increase in the use of firearms. The decline in wildlife was the outcome, accompanied by extinctions. As a response to this plight, conservation was adopted through the establishment of game reserves such as the Kruger National Park and the Phongola Nature Reserve (Carruthers 1995; Cock & Fig 2000; Grobler 2005).

The establishment of game reserves resulted in a large social destruction, as hundreds of indigenous villagers were evicted from their land to make way for reserve expansions (Tapela & Omara-Ojungu 1999). This was followed by impoverishment as these indigenous people were banned from hunting wild animals and accessing other vital resources such as water and grazing land. Moreover, conservation laws favoured the white minority, for example, white farmers were

allowed to kill problem animals on the spot while indigenous people had to pay for a licence to do so (Carruthers 1995). Tourism benefits were not shared with the indigenous people residing outside protected areas, instead these people were considered potential poachers, competitors for resources while their poverty was seen as an embarrassment to tourism (Cock & Fig 2000). "*Rather than being a means of nation building, the parks worked against national unity to reflect and maintain the privileges of white minority*" (Cock & Fig 2000: 23). However, with the involvement of Non-Governmental Organisations (NGOs) in the mid-1990 and the arrival of the new South Africa, new policies were adopted. These policies integrated conservation with the socio-economic and cultural needs of the local communities (Tapela & Omara-Ojungu 1999). These changes were characterised by the employment of indigenous local people in game reserves and an improved access to natural resouces and benefits derived from ecotourism (Tapela & Omara-Ojungu 1999; Cock & Fig 2000). Furthermore, previously evicted communities were given back their land (Carruthers 1995).

Cock & Fig (2000) argue that the restructuring has been shallow, rural dwellers adjacent to protected areas are still largerly marginalised. This corroborates the position that biodiversity conservation and community development are conflicting independent goals (Stoll-Kleemann & O'Riordan 2002), particularly in developing countries. They involve different sectors of policy concern, as they can be accomplished independently (Adams *et al.* 2004). Nonetheless, attempts to implement strategies that combine these two objectives should not be abandoned (Adams *et al.* 2004; Adams & Hutton 2007). Reliance on wildlife resources for subsistence and commercial purposes remains high (King 2007; Shackleton 2009). The resources provide a safety net and reduce income disparities (Shackleton *et al.* 2002; Shackleton & Shackleton 2006). However, the magnitude of their significance in rural livelihoods is uncertain and contested.

Today, South Africa is one of the leading biodiversity hotspots (Weis *et al.* 2002), a home to a wide range of natural resources (Shackleton 2009) and the third most biologically diverse country in the world (Wynberg 2002). However, terrestrial protected areas cover approximately 8.85% of the land (The World Bank 2014) and most of the country's wildlife is threatened, in particular mammals (Weis *et al.* 2002). Biodiversity is subjected to continuous and irreversible anthropogenic pressures, the greatest threat being the transformation of natural habitats (Wynberg 2002) for various development activities including agricultural expansion.

Commercial forestry, although viewed as one of the sectors that contribute to employment and economic prosperity of the country, is a common anthropogenic activity that leads to the loss, conversion and fragmentation of natural habitats (Grobler 2005; King 2007). Other threats facing biodiversity include, the increase in invasions by exotic species of which most local people have built their livelihoods around (Pietersen *et al.* 2011) and the unsustainable use of natural resources in the form of illegal harvesting and trade of various species (Shackleton *et al.* 2002; Weis *et al.* 2002; Grobler 2005; Warchol & Jonson 2009). As a result of these threats and their tendency to act synergistically (Armstrong *et al.* 1998) the country has experienced extinctions of some of its species including the blue antelope (*Hippotragus leucophaeus*) and the quagga (*Equus quagga quagga*), the endangerment of endemic species for example the riverine rabbit (*Bunolagus monticularis*), rare species such as the African Wild dog (*Lycaon pictus*) and iconic species such as the black rhino (Carruthers 1995; Kerley *et al.* 2009; Emslie 2012; Collins & Toit 2016; Davies-Mostert *et al.* 2016).

### 2.4.1 Conservation governance and wildlife use in South Africa

Wildlife in South Africa occurs on both state (national or provincial) and private land. At present, a significant proportion of the country's wildlife is under private ownership (Cloete *et al.* 2015). The National Environmental Management Act 10 of 2004 (NEMA) primarily manages the country's natural resource base. This body provides the legal basis for the conservation of biodiversity, the protection of species and ecosystems requiring national protection and the sustainable utilisation of biological resources, through the National Environmental Biodiversity Act (NEM: BA). The Threatened or Protected Species (ToPS) regulations facilitate the NEM: BA permit system for the undertaking of restricted activities involving threatened, and protected species. These restricted activities include, but are not limited to hunting, owning and selling of ToPS listed species. Species not included in the ToPS list may be protected through provincial statutes (Molewa 2010). Furthermore, South Africa is a member state of the CITES, which assists in regulating trade in wildlife species to curtail detrimental impacts. Both the CITES and ToPS regulations are underpinned by a national body, known as the Scientific Authority. The objective of the Scientific Authority is to support the regulation of trade involving ToPS and CITES listed species, through providing recommendations, insights and making non-detrimental findings (SANBI 2016). The country's strong legislative system is what ensures the long-term persistence of biodiversity resources in spite of the existing anthropogenic pressures.

Like elsewhere in southern Africa, bushmeat consumption in South Africa is not considered a crisis and has thus received minimal attention (Lindsey *et al.* 2011). Tanzania however, has seen a growing body of literature based on bushmeat consumption and its various dynamics (Loibooki *et al.* 2002; Martin & Caro 2013; Martin *et al.* 2012; Martin *et al.* 2013). Other southern African countries such as Zimbabwe (Lindsey *et al.* 2011) and Mozambique (Lindsey & Bento 2012) are also receiving some attention as far as the illegal use of wildlife resources is concerned. Studies conducted in different provinces of South Africa show that illegal bushmeat hunting is prevalent in the country, particularly in communal areas, farmlands and protected areas (Hayward 2009; Kaschula & Shackleton 2009; Warchol & Johnson 2009; Grey-Ross *et al.* 2010).

Illegal trade in bushmeat is minimal and restricted to areas where wildlife is relatively abundant, such as northern KwaZulu-Natal and around the Kruger National Park (Warchol & Johnson 2009). In these areas, there is an establishment of informal roadside bushmeat stalls which indicates a lucrative and substantial commercialisation, a situation similar to the one experienced in Western and Central Africa where illegal bushmeat trade is extensive. In other parts of the country, bushmeat is combined with other products such as fuel wood, wild herbs and traditional beer for a profitable trade and this contributes approximately 20% to the incomes of the poor (Shackleton & Shackleton 2006). The contribution from the selling of bushmeat is vital for most of the traders, as they have limited income sources at their disposal and thus thrive through opportunistic, low-skill and low-return activities (Shackleton & Shackleton 2006). Wildlife has been dramatically depleted outside protected areas and this is one of the factors affecting the viability of its trade in some parts of the country. However, lucrative and benefiting a large proportion of the population including people from both rural areas and cities, is the use of traditional medicine derived from wildlife.

The use of traditional medicine is widespread in South Africa (McKean & Mander 2007; Shackleton 2009). There are more than 25 000 traditional healers in the country (Richter 2003), with approximately 75% of the population using medicine derived from various species of plants and animals (Shackleton 2009). This can be attributed to: i) traditional medicine being considered more effective in treating certain conditions and ii) rural people having limited access to adequate primary healthcare while, traditional medicine is an affordable alternative (Alves &

Rosa 2007; McKean & Mander 2007). Its importance is advancing in urban populations. Furthermore, traditional medicine contributes significantly to the livelihoods of traders and practitioners (Grobler 2005).

A variety of vertebrates and invertebrates are used in traditional medicine, including species with declining populations (Simelane & Kerley 1998). Illegal hunting of mammals, reptiles and birds for *muthi* is high (Warchol *et al.* 2003). Studies have been conducted to shed light on some aspects of the trade (Simelane & Kerley 1998; Herbert *et al.* 2003; Ashforth 2005; Whiting *et al.* 2013). Some studies focused on specific taxa such as birds (Botha 2004; Simelane 2011; William *et al.* 2014), while others focused on specific species including vulture species (McKean *et al.* 2004; Mander *et al.* 2007; McKean *et al.* 2013). Plant species dominate the *muthi* markets in comparison to their animal counterparts. The majority of animal taxa found in the markets are mammals followed by birds, reptiles and then amphibians (Simelane & Kerley 1998; Whiting *et al.* 2013). The most traded birds being large avifauna such as vultures, hornbills, bustards and eagles (McKean *et al.* 2013; Williams *et al.* 2014). There is also a wide variety of invertebrates including cuttlebone (*Sepia sp.*) and millipedes (*sphaerotherium spp.*) (Herbert *et al.* 2003). Not all traditional medicine is for the treatment of diseases as some uses include, but are not limited to, power attainment, good fortune, relationship strengthening and the driving away of impure spirits (Simelane & Kerley 1998; Williams & Whiting 2016). Traders are not involved in the harvesting per se, but they have suppliers from rural areas (Ngwenya 2001 unpubl. data) and from neighbouring countries (Wynberg 2002). However, traders are often reluctant to reveal their sources (Whiting *et al.* 2013).

Two South African popular *muthi* markets are the Durban Warwick Triangle (Herbert *et al.* 2003) in KwaZulu-Natal Province and the Faraday market in Gauteng Province (Whiting *et al.* 2013). Species of conservation concern are sold in these markets (Simelane & Kerley 1998; Ngwenya 2001 unpubl. data). This is a challenge for conservation since most traders do not go through the required legal procedure to trade in these species. Other related traditional uses include the use of wildlife skins for religious/traditional regalia (Ramesh *et al.* 2016). In some cases the uses overlap, for instance one species may be used for consumption and traditional purposes. Many species are affected by hunting for bushmeat and traditional medicine, evaluating the level at which a single species of conservation concern is used and the impact of

such uses on its population viability is vital for its conservation. Some of the species used illegally, especially the small to medium sized ones are difficult to monitor and thus receive minimal conservation effort.

## 2.5 The ecology of oribi

Oribi (*Ourebia ourebi*) (Zimmermann 1783) are a small to medium sized African antelope (Tekalign & Bekele 2015). They occur in most savannas and grasslands of Africa, from Senegal toward the central regions, moving further to the eastern most part and then down to the southern tip of the continent (East 1999). Although widely distributed throughout the African landscape, oribi populations are severely fractured. In South Africa, oribi are currently restricted to KwaZulu-Natal, Eastern Cape and Mpumalanga provinces (East 1999; Shrader *et al.* 2016) where they thrive predominantly outside protected areas (East 1999; Coverdale *et al.* 2006). Grasslands constitute the main habitat for oribi while wooded areas may be avoided (Stears 2015). These grassland specialists require habitats with a mosaic of short and tall grasses for feeding and cover against predators respectively (Patel 2015). There have been limitations in the accurate estimation of the oribi population size in the country, stemming partly from inconsistencies by participants, landowners in particular (Magwaza 2015). However, available data and literature suggest a decline in the population. Factors limiting oribi population growth include, habitat loss and fragmentation, poor grassland management, competition from livestock and illegal hunting for bushmeat (East 1999; Perrin & Everret 1999; Grey-Ross *et al.* 2010). Being a small to medium sized ungulate, oribi make an ideal bushmeat species (Lindsey & Bento 2012), as they are easy to handle, hide and transport. Unlike the other small ungulates utilised for bushmeat, such as bushbuck (*Tragelaphus sylvaticus*) and duiker (*Cephalophinae spp.*), the capacity of oribi to withstand illegal hunting pressures is limited (East 1999). However, quantifying the effect of this activity remains a challenge due to its illicit nature (Patel 2015). Currently, oribi are listed as Least Concern by the International Union for Conservation of Nature (IUCN), although the regional assessment considers them Endangered (Shrader *et al.* 2016) and they are thus protected by the ToPS regulations where they are currently listed as Vulnerable.

## 2.6 The ecology of serval

The serval (*Leptailurus serval*) (Schreber 1776) is a medium sized, rare carnivore (Smithers 1986; Nowell & Jackson 1996; Thorn *et al.* 2011), restricted to high rainfall regions of Africa (Nowell & Jackson 1996). In South Africa, servals are found in the eastern most part of the country, abundant in the Drakensberg region (Bowland 1990; Ramesh & Downs 2013) and are believed to have recently recolonised the Free State Province (Herrmann *et al.* 2008). This solitary carnivore is an inhabitant of well-watered grasslands (Nowell & Jackson 1996; Thiel 2011) and its residence is primarily contingent upon food availability. Although servals have a broad diet, ranging from fish to birds (Nowell & Jackson 1996), they primarily feed on small mammals, in particular rodents (Ramesh & Downs 2015). For this reason they spend most of their time in wetlands as these habitats house a relatively high volume of their main diet component (Bowland & Perrin 1993). Although the serval is currently recovering from historical threats and expanding into new areas (Herrmann *et al.* 2008; Thorn *et al.* 2011), it remains vulnerable to a number of human induced threats. The main threats to its persistence include: i) habitat degradation, as wetlands are subjected to pressures from agriculture; ii) snaring, serval's nocturnal behaviour renders it vulnerable to snares set for other wild animals; iii) retaliatory killing, the species is considered a problem animal by both subsistence and commercial farmers, as is alleged to prey on poultry; iv) road kills, road mortalities involving mammals have increased over the past decade, servals are one of the species that are susceptible to road collisions due in part to their nocturnal behaviour (Bullock *et al.* 2011); and v) trade driven hunting, the serval skin is popular in the skin trade industry, where it is used to make traditional and religious regalia. In traditional medicine, certain serval body parts are used to treat urinary problems and epilepsy. As a result, servals are illegally killed when encountered. (Breitenmoser-Wursten 2008; Herrmann *et al.* 2008; Whiting *et al.* 2013; Ramesh *et al.* 2016). At present little is known with regards to the number of serval used for traditional purposes annually and the potential impact this may have on populations. The serval is currently listed as Near-Threatened by the regional IUCN red list assessment (Ramesh *et al.* 2016) and listed as a protected species under ToPS regulations, however, it remains a Least Concern species according to the IUCN global listing (Thiel 2015).

## 2.7 Summary

This review highlights the main drivers and impacts of human illegal consumption of wildlife resources. Protein shortages appear to be the main driver of bushmeat consumption for many rural villagers. Bushmeat is cheaper and easily accessible compared with its domestic alternatives. Rural people are further susceptible to stresses over which they have little or no control, when these are experienced, bushmeat acts as a safety net. While in some regions bushmeat consumption is associated with cultural practices. Since cultural practices are passed down from generation to generation, culturally related bushmeat consumption may represent a continuous threat to wildlife if not regulated and incorporated into policies. Moreover, there has been a shift from subsistence hunting to commercially driven hunting, which can be attributed to the rise in bushmeat demand stemming from cities. The need for income to pay for goods and services, support subsistence agriculture and purchase non-farm goods, plays a role. The profitability of bushmeat trade is enhanced by the demand for wild animal body parts for use in traditional medicine.

The challenge is that most bushmeat uses are carried out illegally. Law enforcement is failing in most regions where illegal bushmeat consumption is high. Limited funding allocated for the conservation of biological resources is one of the main reason for this outcome, as it hinders the ability to procure effective technological instruments that may help in detecting illicit activities and the adequate employment of staff. As a result of the bushmeat crisis, the pressure exerted on wildlife populations is high, with the greatest burden resting upon the vulnerable species, for they lack the capacity to withstand the increasing pressure. This phenomenon, not only affects the target species but also impairs ecosystem interactions. In addition, unsustainable use of wildlife resources has negative implications for the livelihoods of subsistence consumers and communities that benefit from legal wildlife-based uses such as trophy hunting. To effectively resolve the illegal use of wildlife resources, more investment in conservation is required. Cooperation between conservation and socio-economic sectors is vital if the utilisation of wildlife resources is to be sustainable.

## CHAPTER THREE

# Evaluating the drivers of illegal hunting and its implications for serval (*Leptailurus serval*) and oribi (*Ourebia ourebi*) conservation in South Africa: A case of the KwaZulu-Natal Midlands region.

**Nomthandazo S. Manqele [1], Jeanetta A. Selier [3], Colleen T. Downs [2] and Trevor R. Hill [1.]**

*1. School of Agricultural Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg, KwaZulu-Natal, 3209, South Africa*

*2. School of Life Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg, KwaZulu-Natal, 3209, South Africa*

*3. South African National Biodiversity Institute, Pretoria National Botanical Garden 2 Cussonia Avenue, Brummeria, Pretoria, 0184 Private Bag x101, Silverton, 0184*

Formatted for the South African Journal of Wildlife Research

## Abstract

Bushmeat serves as a vital source of animal protein for people with limited access to domestic alternatives. In rural areas where employment opportunities are few and income channels are scarce, bushmeat may be utilised for income generation purposes. The increase in demand, stemming partly from cities where bushmeat has become a popular delicacy, has resulted in unsustainable illegal harvesting. As a result, most mammalian species are threatened with extinction. Using questionnaire surveys, we investigated the drivers of illegal wildlife utilisation in the Midlands region of KwaZulu-Natal, South Africa. The assessment was based on two habitat specialists and keystone species namely, oribi (*Ourebia ourebi*) and serval (*Leptailurus serval*), of which the effect of illegal human use remains uncertain. The results suggested that illegal hunting in the KwaZulu-Natal Midlands was predominantly subsistence based. The majority of the respondents hunted to acquire meat (82%), as bushmeat is perceived to taste better than its domestic counterparts (46%) and access to domestic sources of protein was limited (32%). Although the region was characterised by a high rate of unemployment, and an inadequate subsistence agricultural potential, the results showed that Illegal hunting in the Midlands region was not a result of protein deprivation for the majority of respondents and thus did not represent a significant source of livelihood, as elsewhere in rural Africa. Oribi were

susceptible to illegal bushmeat hunting while the serval was highly sought after for purposes of traditional medicine and skin trade. In the formulation of conservation policies, the incorporation of site- specific socio-economic drivers of illegal hunting is vital. These results can serve as a guideline for wildlife conservation initiatives in the Midlands and in South Africa, not just for serval and oribi but for other small to medium sized species.

**Keywords**: Bushmeat, traditional medicine, illegal hunting, trade.

To whom correspondence should be addressed
E-mail: Hillt@ukzn.ac.za
E-mail: Downs@ukzn.ac.za

## 3.1 Introduction

The natural environment has always been a direct provider of basic human needs (Baudot & Moomaw 2016) including inter alia, shelter, medicine and food (Tsinda *et al.* 2016). In light of the ever-changing development approaches, some reliance on natural resources has been reduced by the emergence of diverse livelihood options and technological innovations (Ellis & Biggs 2001). However, due to cultural factors and the uneven distribution of capital assets including infrastructure, employment, education, and healthcare, a significant proportion of rural dwellers remain everyday consumers and users of natural resources including bushmeat (Rovero *et al.* 2012; Schlesinger *et al.* 2015).

Bushmeat, herein defined as meat obtained from wild animals (Ebewore *et al.* 2015) can be collected through legal or illegal means depending on the local legislative framework. Bushmeat is a significant source of animal protein in developing countries of Africa, Asia and Latin America, particularly in regions where opportunities for animal husbandry are limited (Fa & Yuste 2001; Corlett 2007; Schlesinger *et al.* 2015; de Azevado Chagas *et al.* 2015). It is utilised for household consumption, income generation or for both purposes depending on the harvest quantity and household needs (Gibson & Marks 1995; Barnet 2000) and is considered by some as a cultural product (Gibson & Marks 1995). Further, socio-economic factors such as rapid population growth, food insecurity, malnutrition and the lack of formal employment opportunities are the leading causes behind the increase in illegal use of wildlife resources (Simasiku *et al.* 2008; Lindsey *et al.* 2011; Lindsey & Bento 2012).

There has been an increase in demand for wildlife products for purposes other than the fulfilment of protein requirements, including skins, bones and fat used for medicinal purposes, which has led to increasing illegal harvesting and trade of many species (Fa *et al.* 1995; Ngwenya 2001 unpubl. data). Animal derived traditional medicine has been used to treat a diversity of conditions, including common respiratory diseases such as asthma (Costa-Neto 1999). Traditional medicine is relatively versatile, other than treating illness, it has been known to help users in other aspects of life. For example, lion (*Panthera leo*) fat is used to attain power and prestige (Masango, *muthi* trader, Durban pers. comm. 2016). At the same time traditional medicine trade represents a significant livelihood source in the face of limited employment opportunities.

The unsustainable collection and use of wildlife resources will have negative impacts on wildlife populations (Simelane & Kerley 1998; Alves & Rosa 2007; Williams & Whiting 2016). Preferred or frequently used animals in bushmeat and traditional medicine are highly vulnerable, as they are often large sized species with low reproductive rates. At the same time these species play vital roles in maintaining the quality of ecosystems in which they exist (Effiom *et al.* 2013). As far as livelihoods are concerned, illegal consumption of wildlife resources by some members of the community may result in prohibitions which may affect access to open resources for marginalised community members (Golden *et al*. 2011).

The oribi (*Ourebia ourebi*) (Zimmermann 1783) are an African small to medium sized diurnal antelope, inhabitant of open grasslands made up of a mosaic of short and long grasses for feeding and cover from predators respectively (Perrin & Everett 1999; Patel 2015). Oribi seem to be independent of water as they obtain most of their moisture from grass. The oribi are a selective feeder and thus reliant on decreaser grasses (i.e. grasses that are sensitive to degradation) such as *Themeda triandra* which dominates the grassland biome (Everett *et al.* 1992; Cowling *et al.* 2004). The oribi can serve as indicator species of grassland quality and facilitate the detection of grassland areas requiring urgent conservation intervention. They prefer recently burnt or mowed grass which is known to be high in protein, phosphate and calcium (Everett *et al.* 1991). The species is extensively distributed across the African landscape, although, with fragmented populations. This is accompanied by records of local extinctions within the oribi natural distribution range, such as Burundi and Tunisia (IUCN 2016). In South Africa, oribi are considered the most endangered antelope (Grey-Ross *et al.* 2009a; Stuart & Stuart 2015), as a result of habitat loss, fragmentation, poor veld management and illegal subsistence hunting, particularly on farmlands (Coverdale *et al.* 2006; Grey-Ross *et al.* 2010; Patel 2015). The International Union for Conservation of Nature (IUCN) lists the oribi as Least Concern due to their wide continental distribution however, in South Africa they are listed as Endangered (Shrader *et al.* 2016) and managed by the Threatened or Protected Species (ToPS) regulations.

The serval (*Leptailurus serval*) (Schreber 1776) is a small to medium sized carnivore with a fairly restricted population (Ramesh *et al.* 2015). Servals are nocturnal and sometimes crepuscular in nature (Perrin 2002; Ramesh *et al.* 2015). They are a specialist and a keystone

species of well-watered grasslands where small mammals such as *Otomys* species, which are a significant component of their diet, occur in abundance (Bowland & Perrin 1993; Perrin 2002; Thiel 2011; Ramesh *et al.* 2015). According to the IUCN, serval is listed globally as Least Concern which is a status that requires revision, due in part to the consequences of habitat loss and fragmentation that are not yet entirely understood (Thiel 2011; Thiel 2015). In South Africa, this species occurs in protected areas and on farmlands and was not protected until 2008 (Coverdale pers. comm. 2016). Currently the serval is regionally listed as Near-Threatened (Ramesh *et al.* 2016) and protected under the ToPS regulations. According to the KwaZulu-Natal Nature Conservation Management Amendment Act no. 5 of 1999, serval is listed as a specially protected indigenous mammal. The serval remains subjected to various threats including habitat degradation and illegal hunting (Ramesh *et al.* 2015). Illegal hunting, particularly in the form of snaring. The snares are often set for other carnivores, perceived as problem animals such as the black-backed jackal (*Canis mesomelas*) and bushmeat species. Due to serval's nocturnal nature, and the unselective nature of snares, servals fall victim to these. Human activities threatening the serval require evaluation so that their potential effect on serval populations and serval's ability to assist in the conservation of endangered ecosystems is understood.

Considering the illegal nature of these activities, accurately quantifying their effects on specific species can be challenging (Patel 2015). However, questionnaire surveys have been widely used to quantify and assess the dynamics of illegal wildlife activities including the contribution of these practices to food security of rural communities in developing countries (Nielsen 2006; Gavin *et al.* 2010; Ceppi & Nielsen 2014; Sandalj *et al.* 2016). Following this approach, this study assessed the drivers of illegal hunting and use of serval and oribi species. The study evaluated the implications for the conservation of these two species that occupy highly threatened grassland and wetland ecosystems (CSIR 2011; Egoh *et al.* 2011) and have a noteworthy potential to serve as effective keystone and indicator species for these ecosystems. We hypothesised that these two species would be heavily hunted in rural areas of the Midlands for subsistence and commercial purposes.

## 3.2 Methods

### 3.2.1 Study sites and population

The Midlands region of KwaZulu-Natal, South Africa lies between Pietermaritzburg and the Drakensberg, it is rich in biodiversity with wildlife occurring on farmlands, in protected areas and conservancies.

The vegetation of the region is predominantly grassland and includes the KwaZulu-Natal Highland thornveld, the Mooi River Highland grassland, the Midlands Mistbelt grassland and the Drakensberg Foothill moist grassland (Scott-Shaw & Escott 2011). Although much of the area has been transformed to support commercial agricultural based activities (Carbutt *et al.* 2011) some areas of pristine wetland and grassland ecosystems still remain (Haynes *et al.* 2003). The elevation of the region ranges from 1400-3000m above sea level (Nel 2009). The mean annual rainfall is approximately 856mm and falls predominantly in summer (Ramesh & Downs 2015). The mean annual temperature is $14.1^0$ C with cold winters that are associated with frost and snow (Uys *et al.* 2004; Carbutt *et al.* 2011).

The Midlands community engages in agriculture, both commercial and subsistence (Mkhabela & Materechera 2003). The former is extensive and involves dairy, meat, pasture, crop and timber production. The region is popular for its tourism operations. Population density is up to 678 people per $km^2$ and most of the human population is found in rural settlements practicing subsistence farming and diversifying through wage employment and informal trading. The majority of the population is black South Africans (*c.* 93%), with the majority of households headed by females. The number of people with higher education remains low (7.1%), although matric possession is high (24.8%). In addition, there is a high level of inequality with regards to the distribution of income, a significant proportion of households have no income sources while the majority falls in the range of ZAR1- 4.800 (US$0.072- US$347.63) (Stats South Africa 2011).

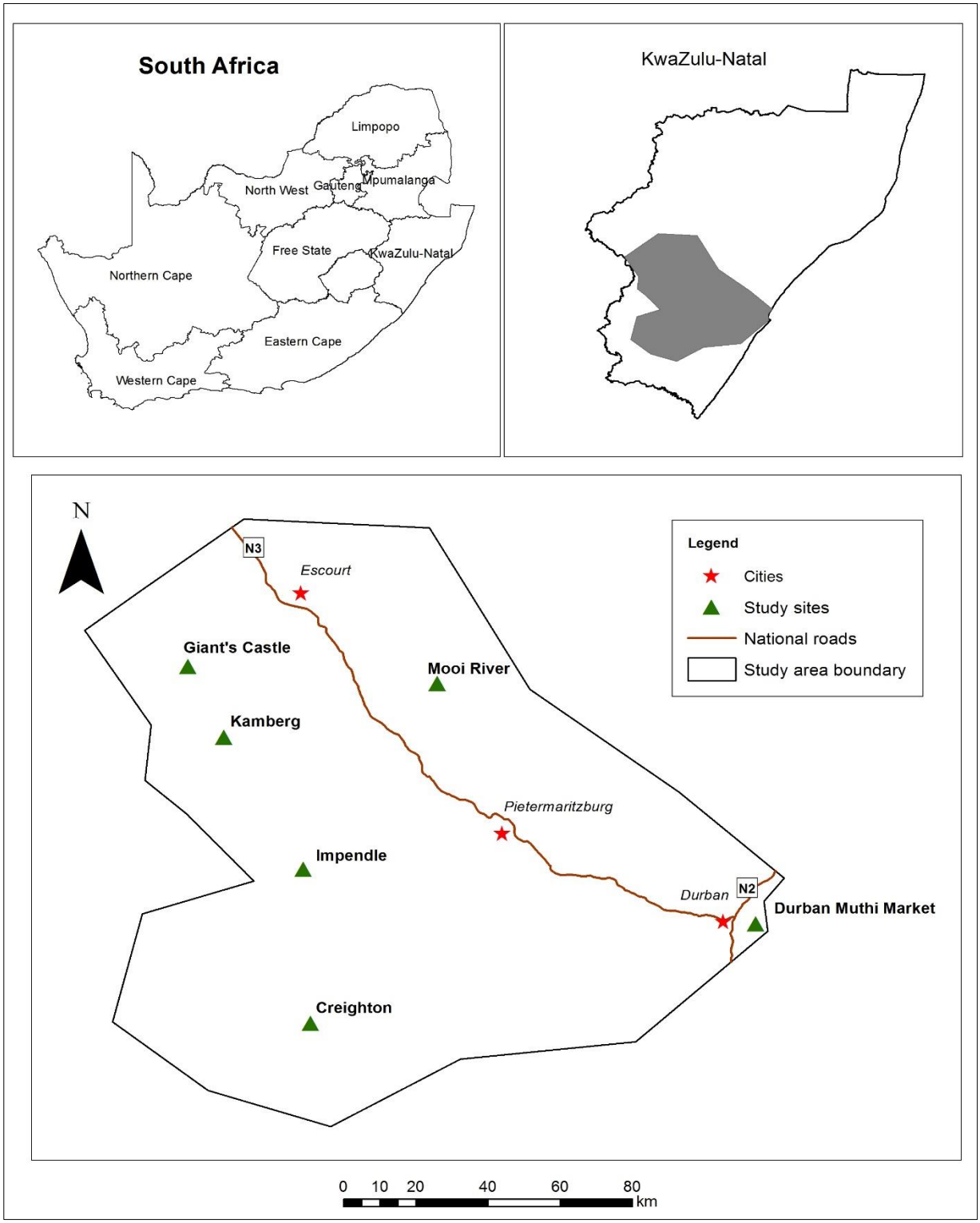



**Figure 3.1:** Map showing the location of study sites in the Midlands and Durban KwaZulu-Natal, South Africa.

### 3.2.2 Data collection

Data were collected between October 2015 and March 2016, in study sites selected based on the knowledge of occurrence of serval and oribi (Grey-Ross *et al.* 2010; Ramesh & Downs 2013). A mixed sampling method that incorporated random and targeted (i.e. purposive and snowball) techniques was used, due to the diversity of respondents. In each area, members of the community were randomly sampled by considering every second household whereas landowners together with farmworkers, illegal hunters and *muthi* traders were sampled purposively and a snowball method was applied. This is where respondents refer interviewers to other potential respondents belonging to the same category as them (Martin & Caro 2012). Prior to data collection, a pilot study was conducted and meetings were held with the relevant traditional and municipal authorities to obtain permissions. Images of the study species were used to avoid confusion, specifically as local names for these species tend to differ between localities.

Two hundred and seventy-one interviews were conducted using a semi-structured questionnaire comprised of open and closed ended questions (Appendix I). Due to the illicit nature of the activity studied (Lindsey *et al.* 2013) and the likelihood of obtaining biased data (John *et al.* 2010), general questions such as the demographics, presence of, and encounters with, wild animals in the area were asked at the beginning to establish an amicable environment. Overly sensitive questions which are often relevant to such studies were omitted including questions relating to household monthly incomes. Designing semi-structured questionnaires assisted in converting the interviews into conversations. In addition, data from relevant stakeholders were incorporated into the study. The questions were based on the regularity of sightings of the study species to understand their occurrence and density from the community's perspective. Moreover, questions regarding the use of these species and their threats were asked.

The Durban *Muthi* Market, located in the Central Business District (CBD) of Durban, KwaZulu-Natal, South Africa was visited to assess the level of traditional *muthi* trade involving serval and oribi. This was achieved through a questionnaire survey. Fifteen potential interviewees were approached out of which nine consented to participate in the study.

### 3.2.3 Data analyses

Statistical analyses were performed using R version 3.3.0 (R Core Team 2016). A binary logistic regression model was fitted to examine the relationship between hunting as a response variable

and the explanatory variables which included livelihood options (i.e. employed, trader, scholar and unemployed), property ownership as a measure of wealth, area type (this variable was divided into three categories namely: rural, farmland and protected area) and age. This was conducted to test the influence of the above-mentioned explanatory variables in the likelihood of one being an illegal hunter. The selection of explanatory variables was based on socio-economic factors that often influence the illegal utilisation of natural resources in developing countries based on published literature (Table 3.1).

**Table 3.1:** Explanatory variables used for data analyses.

| **Explanatory variable** | **Rationale** |
|---|---|
| Livelihood options | Illegal hunting is driven by the lack of employment opportunities, alternative sources of income and food insecurity (Loibooki *et al.* 2002; Lindsey & Bento 2012). |
| Property ownership | Property ownership particularly livestock and land is an indicator of wealth and households without these resources tend to engage in illegal hunting activities (Lindsey *et al.* 2011; Mgawe *et al.* 2012). |
| Area type | Illegal hunting prevalence is closely associated with the proximity to a protected area (Mgawe *et al.* 2012; Ceppi & Nielsen 2014). |
| Age and gender | There are explicit gender and age group associations with illicit hunting (Lindsey *et al.* 2011; Lindsey & Bento 2012). These are vital in outlining the drivers of illegal hunting. |

Chi-squared tests were performed to test the significance of gender discrepancies with regards to knowledge of conservation laws and to discern if the observed differences between hunter and farmworker/hunter harvest size were of any significance. Microsoft Excel (2010 & 2013) was used to perform descriptive statistics. The data obtained from *muthi* markets were sparse due to a

high rate of unwillingness from respondents. As a result they could not be analysed statistically. Data were thus tabulated and presented without any manipulation (Appendix II).

## 3.3 Results

### 3.3.1 Hunting

In total, 271 interviews were conducted with a non-response rate of 3.3% (n = 9) from 15 traditional *muthi* traders who were approached. Community members were respondents who did not fall under the categories of hunters, farm owners or farm workers. These were residents, predominantly older women and they constituted 59% (n = 161) of the survey. From this group, 60.3% (n = 9) were aware of illicit hunting activities taking place in their respective areas, 12.4% (n = 20) had hunters in their households and 27.3% (n = 44) were unaware of any hunting activities in their neighbourhoods.

Hunters comprised 27% (n = 73) of the study, while farm owners and farmworkers made up 6% each (n = 16 and 15 respectively). Some of the farmworkers were hunters (54%, n = 9). Traditional medicine traders, practitioners and skin traders contributed 2% (n = 6) of the respondents.

### 3.3.2 Socio- economic and demographic characteristics of hunters

Information on hunter profiles is summarised in table 3.2. The majority of hunters in the Midlands were males (92%), aged between 18 and 25 (40%, n = 33), while 14% (n = 11) were younger boys between the ages of 9 and 17. Older males aged 50 and above hunted to a lesser extent (10%, n = 8). The majority of hunters were from the town, Creighton (35%). Hunters reported being employed (48%) and in ownership of land and livestock (45%).

**Table 3.2:** Summary information on hunter profiles.

| Variables | Categories | % respondents | Total as % |
|---|---|---|---|
| Gender | Male | 92 | 100 |
| | Female | 8 | |
| Age | 9-17 | 14 | 100 |
| | 18-25 | 40 | |
| | 26-33 | 17 | |
| | 34-41 | 13 | |
| | 42-49 | 6 | |
| | 50 and above | 10 | |
| Area | Giant's Castle | 7 | 100 |
| | Kamberg | 11 | |
| | Mooi River | 21 | |
| | Impendle | 26 | |
| | Creighton | 35 | |
| Occupation | Employed | 48 | 100 |
| | Trader | 6 | |
| | Unemployed | 17 | |
| | Scholar | 29 | |
| Property | Land | 21 | 100 |
| | Livestock | 16 | |
| | Livestock & land | 45 | |
| | None | 18 | |
| Farmworker | Yes | 11 | 100 |
| | No | 89 | |

Age was a significant factor in hunting, according to the binary logistic model. With men over the age of 41 less likely to engage in hunting activities. In addition, young boys from the first age class (i.e. 9-17) had a high likelihood of being regular hunters (Table 3.3).

**Table 3.3:** Binary logistic regression of a demographic characteristic with hunter and non-hunter respondent (n = 142).

| Variable | Class | Coefficient | Standard error | Pr (>\|z\|) | Odds ratio | 95%CI |
|---|---|---|---|---|---|---|
| Age ref: 50 and above | 9-17 | 3.321 | 1.34 | 0.01315 * | 27.69 | 2.73 - 723.5 |
| | 18-25 | 1.444 | 0.647 | 0.02576 * | 4.24 | 1.24 - 16.04 |
| | 26-33 | 1.811 | 0.794 | 0.02257 * | 6.11 | 1.35 - 31.16 |
| | 34-41 | 1.592 | 0.782 | 0.04220 * | 4.91 | 1.10 - 24.38 |
| | 42-49 | -0.841 | 0.979 | 0.38968 | 0.43 | 0.06 - 2.87 |

**Note:** Significance codes: 0 (***) 0.001 (**) 0.01 (*).

A number of communities from five areas were visited and grouped into three classes based on area type: settlements adjacent to farmlands, settlements surrounding nature reserves and residential areas away from protected areas or farmlands. Hunter presence was strongly correlated with area type; settlements in close proximity to farmlands were likely to have a higher number of illegal hunters in comparison with settlements adjacent to nature reserves (Table 3.4).

Property ownership and occupation were used as indicators of economic status. Most hunters were employed (48%, n = 69), some reported being unemployed (17%, n = 14), while others were traders (6%, n = 5) who owned small enterprises. Scholars (i.e. respondents who attended either primary, secondary or high school at the time of the study) comprised 29% (n = 24) of the regular illegal hunters in the region. Occupation had a significant influence on the decision to hunt. Scholars and employed respondents were more likely to engage in illegal hunting activities compared with unemployed and self-employed males (Table 3.4).

Property ownership was divided into four classes (i.e. land, livestock, land and livestock and none). Most illegal hunters (45%, n = 37) owned land and livestock, while 21%, (n = 17) owned only land, 16% (n = 13) only livestock and 18% (n = 15) had acquired no assets. The relationship between the need to hunt and property ownership was not significant (Table 3.4).

**Table 3.4:** Binary logistic regression of indicators of wealth and residential area type with hunter and non-hunter respondent (n = 142).

| Variables | Class | Coefficient | Standard error | Pr (>\|z\|) | Odds ratio | 95% CI |
|---|---|---|---|---|---|---|
| Occupation. Ref: Unemployed | Employed | 1.628 | 0.523 | 0.00185 ** | 5.09 | 1.89 - 14.93 |
| | Scholar | 1.96 | 0.711 | 0.00582 ** | 7.1 | 1.85 - 30.95 |
| | Trader | 1.28 | 0.856 | 0.13442 | 3.6 | 0.68 - 20.45 |
| Property. Ref: None | Land | 1.55 | 0.915 | 0.09023 . | 4.71 | 0.82 - 30.91 |
| | Livestock and land | -0.189 | 0.626 | 0.76278 | 0.83 | 0.24 - 2.82 |
| | Livestock | -0.23 | 0.739 | 0.75486 | 0.79 | 0.18 - 3.39 |
| Area. Ref: Rural areas | Protected areas | 0.426 | 0.559 | 0.44527 | 1.53 | 0.51 - 4.63 |
| | Farmlands | 2.176 | 0.556 | >0.001 *** | 8.81 | 3.11 - 27.87 |

**Note:** Significance codes: 0 (***) 0.001 (**) 0.01 (*).

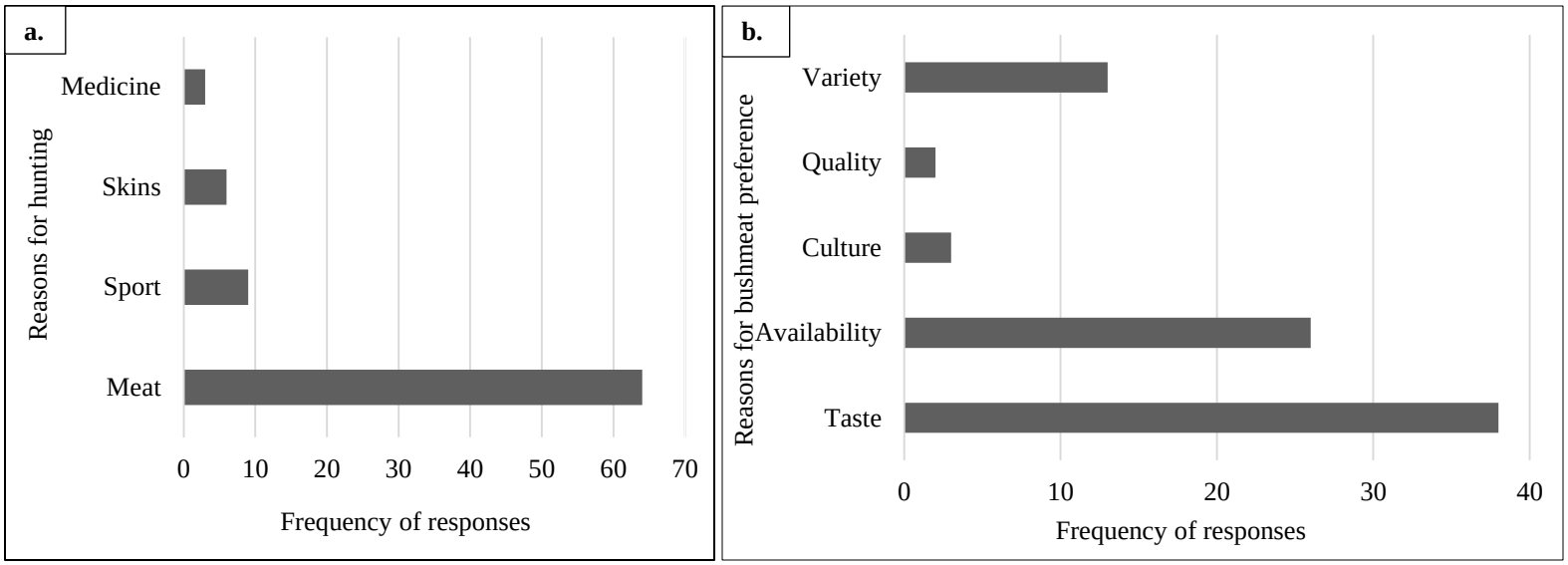
### 3.3.3 The dynamics of illegal hunting

Most of the illegal hunting in the region was subsistence based (97%, n = 80), with a few hunters hunting for both subsistence and commercial purposes (3%, n = 2). The use of dogs was the predominant method of hunting (93%, n = 76), followed by snares (6%, n = 5) and rifles (1%, n = 1). Spears and sticks served as backup when hunting with dogs. The number of dogs each hunter kept for hunting ranged from 2-20. All hunters, including those who were farmworkers, collected between 0-6 wild animals on their most recent hunting trip. Hunters who were farmworkers acquired larger harvests (5-6) more frequently compared with hunters who were not farmworkers (0-2), this variation was significant ($X^2$ = 25.946: df = 2: P <0.001). Hunters in the Midlands practiced collective hunting (86%, n = 71). This is a phenomenon where hunters in a village, particularly those who hunt with dogs, meet and hunt as a group. This increases the number of dogs and the hunter's chance of being successful.

The regularity of hunting was measured on weekly, monthly and yearly basis and the results showed a slight difference between the number of hunters hunting weekly (47%, n = 39) and monthly (43%, n = 35).

### 3.3.4 Reasons for illegal hunting

Most of the hunting in the region was practiced to acquire meat (82%, n = 67), although there were some who hunted for sport (18%, n = 15), to obtain skins (9%, n = 6) and medicinal materials (4%, n = 3) (Figure 3.2a). For those who hunted primarily for meat, did so because they believe bushmeat tastes better than domestic meat (46%), they cannot always afford domestic meat (32%), they consume bushmeat to diversify their diets (16%), it is a cultural requirement for them to eat bushmeat (4%) and meat from wild animals is healthier and it makes them strong (2%) (Figure 3.2b).




**Figures 3.2: a**. Reasons for hunting and **b**. bushmeat preference in the Midlands, KZN (n = 82).

### 3.3.5 Hunter contact with serval and oribi

Most hunters had encountered oribi (68%, n = 56), while some had come across serval (27% = 22) and 5% (n = 4) had not seen either of these species on their hunting expeditions (Figure 3.3). Other mammals that hunters encountered in the region (Figure 3.4) include reedbuck (*Redunca arundinum*), warthog (*Phacochoerus africanus*) , baboon (*Papio sp.*), caracal (*Caracal caracal*), rock hyrax (*Procavia capensis*) and wildebeest (*Connochaetes sp.*).

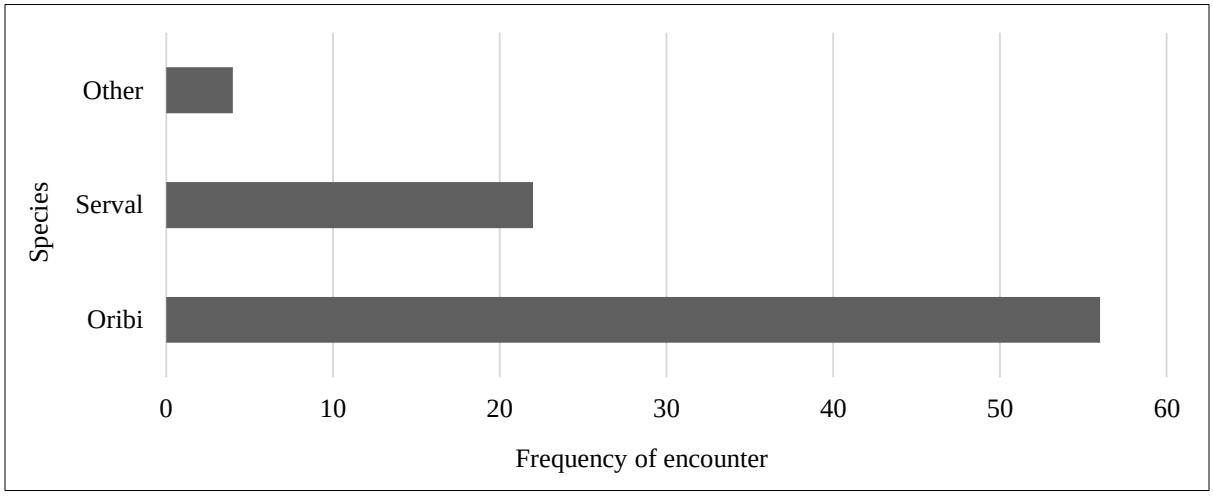



**Figure 3.3:** Hunter's encounter with serval and oribi, ("Other" herein means neither of the species but other wild animals).

### 3.3.6 Other threats faced by the serval and oribi

Respondents (54%, n = 31) reported that the serval is a problem animal that feeds on their poultry. When encountered, servals were chased and killed with dogs. The species had been a victim of disease outbreaks, specifically rabies according to the respondents (86%, n = 6) (Figure 3.5).


**Figure 3.4:** Other mammals hunted in the Midlands, name size represents the number of times an animal was mentioned (William & Whiting 2016).

A significant proportion of respondents reported seeing both species killed on the roads (oribi = 55%, serval = 26%). Drowning was another common cause of mortality for both species according to farm owners. Oribi are a prey for black-backed jackal and other small carnivores such as caracal in the region, respondents report.

### 3.3.6.1 The use of serval in traditional medicine and skin trade.

Servals are popular for their medicinal properties (Appendix II). Traditional *muthi* practitioners and traders who were interviewed, reported using serval body parts to treat epilepsy, headaches, urinary problems and arthritis. They stated that its bones are crushed and mixed with bones from other carnivore species to chase away bad spirits. In addition, parts of serval were used to strengthen relationships. Serval skin was popular as Zulu traditional attire, although other small to medium sized species with spotted pelts such as genet (*Genetta sp*.), were also used. Respondents reported obtaining their stocks from local wildlife traders, from Zululand or as far afield as Mozambique, however, they were not explicit on the origin of the stocks acquired through the traders. Most respondents bought their material (83%, n = 5) with the exception of one respondent who hunted to obtain his material (17%, n = 1). "*Servals are rare and hard to find*" according to one of the traditional healers.

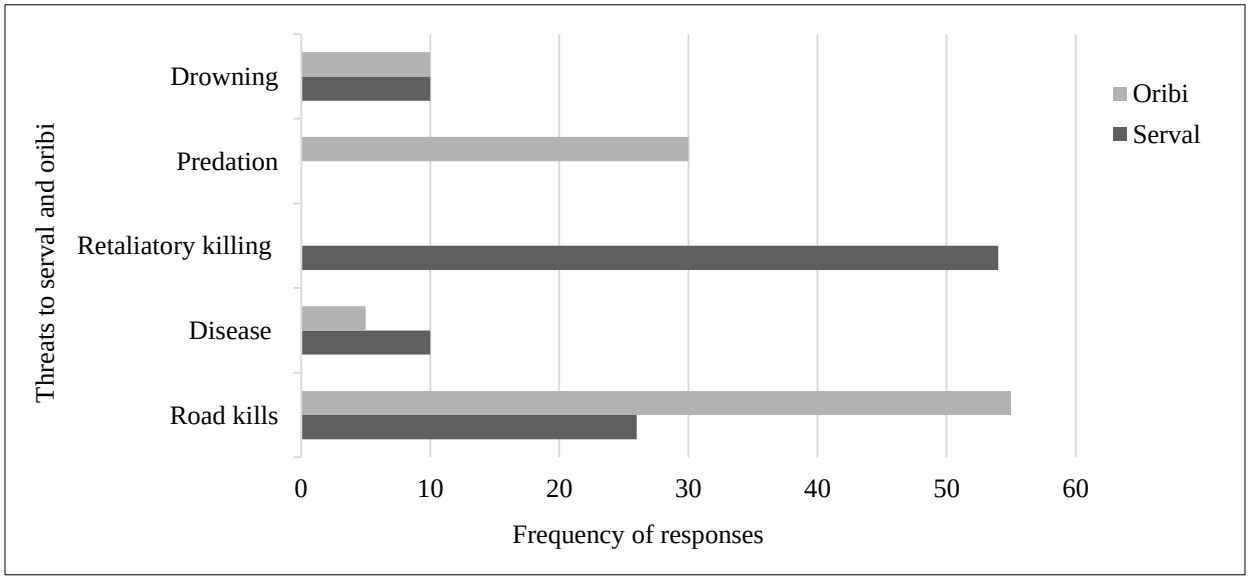



**Figure 3.5:** Threats faced by serval and oribi in the Midlands other than illegal hunting.

### 3.3.7 Knowledge of conservation laws

The majority of respondents were aware of the laws governing the use of wildlife resources (80.4%, n = 213). Moreover, most of the *muthi* and skin traders interviewed were registered to operate in the market, although none had a permit to use threatened and protected species. When asked if they were doing anything to ensure that their utilisation of wildlife resources was sustainable, they all answered no. According to one of the traders "*animals reproduce just like humans, so there is no way that their populations can decrease*".

## 3.4 Discussion

### 3.4.1 Hunting

According to Ziegler *et al*. (2016), the extent of hunting in a given area is determined by the number of hunters in that area. There was a large number of hunters in the Midlands (Grey-Ross *et al.* 2010), considering that in addition to the hunters interviewed some of the community members reported having hunters in their households although they themselves did not practice hunting as most of them were women (Kaschula & Shackleton 2012). Hunting was mainly subsistence based, with a few hunters selling parts of their harvest, such as bones and teeth, to local traditional healers. The overall commercial potential was negligible.

There was a high involvement of young males aged between 9 and 25 in illegal hunting activities. This finding was in conjunction with the results of a study conducted in Latin America (Marsh & Mittermeier 1987), which discovered that children frequently hunted for sport in forests close to their villages. Pfeiffer *et al.* (2015) found that young boys were using slingshots and stones to hunt vultures in the Eastern Cape Province of South Africa. Hunting is labour intensive and time consuming (Kaschula & Shackleton 2009), young people are relatively energetic and have ample time after school, during weekends and school holidays. As males grow older they lose interest and/or strength since hunting is laborious and presumably more so when it is illegal. Moreover, younger hunters were more willing to participate in the study and were more forthcoming on the subject in comparison with older hunters which could be attributed to young hunter's ignorance with regards to consequences associated with illegal hunting (Ceppi & Nielsen 2014).

### 3.4.2 Socio-economic and demographic characteristics of hunters

The relationship between illegal hunting and lack of employment opportunities, access to land and domestic sources of animal protein is well documented in Sub-Saharan Africa (Ndibalema & Songorwa 2008; Lindsey & Bento 2012; Lindsey *et al.* 2013). Improved access to, and ownership of these assets as a measure of relative wealth is expected to discourage illicit utilisation of natural resources (Loibooki *et al.* 2002). Contrary, this study revealed that the majority of illegal hunters were employed and the ownership of land and livestock was widely distributed amongst them.

The influence of occupation on illegal hunting was significant. The level of unemployment in rural South Africa is typically high. Most of the jobs that the few manage to secure are often local temporary jobs in supermarkets, neighbouring farms and other low skill jobs. This is in accordance with the fact that only a small portion of the population advances to tertiary level (Stats South Africa 2011). Although hunters were employed, these could have been non-permanent low wage opportunities. Vasco & Siren (2016) argue that people with stable jobs do not have time to hunt. Moreover, people with jobs worth preserving are unlikely to engage in activities that might lead to imprisonment such as illegal hunting.

On the other hand, employment may fund hunting by providing a means to purchase advanced hunting material (De Merode *et al.* 2004; Nuno *et al.* 2013). Hunters in the Midlands owned up to *c*. 20 dogs per person regardless of the costs associated with obtaining and keeping a hunting dog. In addition, some of the employed hunters were farmworkers. Farmworkers had significantly larger harvests than hunters who were not employed on commercial farms. This is likely attributed to their increased access to wild animals, as they may be relatively abundant on farmlands (Bowland & Perrin 1993) and the low level of law enforcement.

The relationship between illegal hunting and property ownership was not significant. However, the likelihood of hunting by people who owned land was higher compared with people who owned livestock or both livestock and land. The increased involvement of people with land in illegal hunting activities often indicates a deteriorating subsistence agricultural system (Mfunda & Roslash 2010), which is a result of the increase in unfavourable and erratic climatic conditions among other factors. Such conditions are associated with reductions in productivity, as a result subsistence farmers become discouraged. Moreover, in rural areas, males and females

of the household equally engage in subsistence farming activities as a result, when this practice is curtailed, ample time afforded may be used for illegal hunting activities.

### 3.4.3 The dynamics of illegal hunting

The use of dogs was widespread in the Midlands as in most regions across the country (Kaschula & Shackleton 2009), while only a few hunters admitted to using snares. Both these methods are prohibited in South Africa, although dogs are permitted under exceptional circumstances (Beinart 1990; Molewa 2010). Snaring is highly detrimental due to its unselective and thus wasteful nature (Nielsen 2006; Pangau-Adam *et al.* 2012). None of the interviewed hunters were registered or owned a hunting permit. In addition to some hunters being too young to obtain permits, other reasons were; hunting regulations being ambiguous and permits being too expensive to obtain. A hunting permit fee is ZAR100 (US$7.28) (Molewa 2010), which is 0.1% of the fine associated with hunting illegally.

Hunting was carried out on a weekly to monthly basis with no seasonal patterns evident. However, it escalated during timber harvesting, an activity often associated with migrant labour. Cronin *et al.* (2015) argue that the immigration of people with bushmeat preference often increases illegal hunting activities in host areas. Moreover, when hunters with dogs were caught hunting on private properties, they used these plantations as refuges. This relationship between illegal hunting and logging concessions was reported in other studies, where the concessions provided access to remote wildlife areas through roads built primarily for log transportation. Moreover, they assisted in secretively transporting hunted animals to markets by hiding the carcasses between logs (Mainka & Trivedi 2002; Wright 2003; Effiom *et al.* 2013).

### 3.4.4 Reasons for illegal hunting

The primary reason for hunting was to obtain meat. Most hunters who preferred bushmeat claimed that it tastes better than its domestic counterparts (Mfunda & Roslash 2010; Borgerson *et al.* 2016), while others argued that for them, bushmeat was a more accessible source of protein (i.e. it was a cheaper option than purchasing domestic meat). Food prices are high in rural areas (Jacobs *et al.* 2010) and accessing the nearest CBD can be challenging. The inequality in the distribution of protein is common across the African landscape (Obasanjo 2013) and is one of the main drivers of illegal bushmeat harvesting, which is a readily available resource. Even when bushmeat is traded, it is often cheaper than its domestic alternatives (Warchol & Johnson 2009).

Illegal hunting in the Midlands region was not a result of protein deprivation for the majority of respondents and thus did not represent a significant source of livelihood. Bushmeat was not commercialised, only particular body parts were traded irregularly to local users at a modest scale. Nonetheless, in light of the widespread protein deficiency and malnutrition in Africa (FAO 2015; White & Belant 2015), the role of bushmeat in food security of those with limited access to alternative resources cannot be dismissed. Furthermore, wildlife outside protected areas has been severely depleted in the region, to this end there may not be substantial wildlife for households to base their livelihoods around. This may also be intensified by the fact that it is obtained illegally from farmlands and protected areas, retaliation from farm owners and protected area managers may discourage continuous use of the resource.

Contrary to the situation in the current study region, Warchol & Johnson (2009) learnt that commercially driven hunting is prevalent in the north-eastern part of South Africa, this activity showed a significant level of viability in areas studied. This was indicated by the presence of informal roadside bushmeat markets and a border market between Mozambique and South Africa which offered bushmeat and other wildlife products. This study concluded that bushmeat was a significant means of livelihood for the majority of households, although obtained illegally. Local people circumvent law enforcement by establishing a fund to pay for bails and fines sustained by their members for hunting illegally (Warchol & Johnson 2009).

There was a relatively high prevalence of sport hunting in the current study area. According to the youth, this is due to a lack of alternative hobbies. Moreover, there was another form of sport hunting that was associated with monetary gains, locally known as taxi hunting, which involved hunting with dogs and betting on the first dog to catch an animal (Grey-Ross *et al.* 2010). The value of gains from this type of wildlife utilisation was not assessed as it was practiced mainly by people from neighbouring and remote areas and not the locals. This threatens the availability of bushmeat, in particular for the local people and is likely to persist in areas of inadequate law enforcement and monitoring (Pietersen *et al.* 2011; Ceppi & Nielsen 2014).

### 3.4.5 Hunter contact with serval and oribi

Most hunters have had encounters with both serval and oribi although the most sought after species was oribi. As an ungulate this is expected considering the number of hunters who

practiced hunting to procure meat. Ungulates are ideal sources of bushmeat (Corlett 2007; Kaschula & Shackleton 2009), the small and medium sized ones such as oribi are often targeted, as they are easy to hide and transport (Oliver 1978; Fitzgibbon *et al.* 1995). Other ungulates such as reedbuck, duiker (*Philantomba monticola*) and impala (*Aepyceros melampus*) were also commonly hunted for meat. These ungulates are likely to release pressure on species of high conservation concern such as oribi, as they are highly prolific and relatively resilient to hunting pressures (East 1999; Kaschula & Shackleton 2009). The high frequency of encounters with oribi is not necessarily representative of its density. Most respondents reported a sharp decline in the oribi population over the years as a result of habitat loss and illegal hunting. In addition, oribi are a prey to jackal and caracal (Grey-Ross *et al.* 2009b; Stuart & Stuart 2015). The abundance of the black-backed jackals in the region as a result of their high tolerance of agricultural activities, (Humphries *et al.* 2016) may be the cause of the escalating predation. Furthermore, the vulnerability of oribi to predators may increase in the Midlands due to poor veld management (Stears 2015).

Serval was seldom actively hunted for meat, with only two hunters reported having eaten serval meat. The use of wild animals in traditional medicine has grown extensively in the country (Whiting *et al.* 2013). Serval bones are vital in treating epilepsy, urinary problems and headaches. The bones are crushed and mixed with bones from other species for a mixture used to chase away bad spirits and strengthen relationships. In traditional medicine, different species can be used for the same purpose (Mootoosamy & Mahomoodally 2014), the respondents indicated that due to the rarity of serval, they often make use of substitutes. This may help release some pressure on this already threatened species. The serval is currently sold for ZAR200 (US$14.57) to ZAR250 (US$18.21) depending on carcass size and quality. However, a great deal remains unknown regarding other uses of serval in traditional medicine, as respondents were reluctant to provide further information, arguing that the information was too sensitive to provide and they needed to protect their intellectual property. *Muthi* traders asserted that in the past, researchers have used their traditional knowledge for their own benefit.

The skin trade industry had a market for serval skin which was used to tailor traditional Zulu attire. Leopard *(Panthera pardus*) skin is mainly used, but very expensive, for example, an *imbatha,* made of leopard skin, ranges from ZAR4000 (US$291.24) - ZAR7000 (US$509.67) in

price. Those who cannot afford it resort to other spotted skins such as the serval's. However, according to the respondents, the serval has become rare and as a result it was being replaced with genet skin. If traditional medicine and skins for traditional attire were the by-products of bushmeat hunting, the impacts on the serval population would be significantly reduced (Marsh & Mittermeirer 1987). However, the serval is not a common bushmeat species. In traditional medicine, it is believed that only specimens from the wild are effective (Liu *et al.* 2016) however, respondents in the current study showed a willingness to use products from farmed specimens if these were made available.

Other threats to serval included persecution for preying on poultry. This has a long history and is quite common, it however, does not necessarily indicate natural food shortages as serval would choose a chicken over its natural prey (Bowland 1990; Perrin 2002), the possibility should however not be dismissed. Servals tend to extend their range in light of reduced food availability (Ramesh *et al.* 2015), thus encounters with domestic animals in such cases are highly probable. In the absence of proper management and control, livestock owners often hunt predators illegally in protection of their livestock (Næss & Bårdsen 2016).

Moreover, the serval has been a victim of the rabies outbreak in the region. A similar case was reported for the black-backed jackal and this could be a result of contact with domestic animals while in search of food, as Kingdon (1971) argues that most wild animals are vulnerable to, and often contract diseases common to domestic animals. Snaring was the second most popular method of hunting, servals are nocturnal and this exposes them to high risks of being caught in snares. The technique seems to be used more by farmworkers and the prevalence of servals on farmlands renders them highly vulnerable to snares.

Conservation management outside protected areas is often not approached with the same regard as management inside protected areas (Infield 1988). The results of this study showed that wildlife populations that thrive outside protected areas were significantly more vulnerable to illegal hunting and other anthropogenic threats compared with populations inside protected areas. Communities adjacent to protected areas hunted significantly less, while private lands away from protected areas experienced increased cases of illegal hunting. This could be related to rapid population growth which cannot be adequately regulated (Milner-Gulland & Bennett 2003). Moreover, the lack of incentives associated with conservation and compensations for livestock

and crop losses to wild animals may develop negative attitudes toward conservation management outside protected areas (Lindsey *et al.* 2013). During data collection, a respondent referred us to a settlement where his friend who happened to be a well-known illegal hunter lived. As we approached, the residents started shouting "*we want houses*". There could be a possibility of a relationship between unresolved social issues and illegal natural resource use. However, this could also support many studies (Kaltenborn *et al*. 2005; Bouché *et al.* 2012; Martin *et al.* 2012; Ceppi & Nielsen 2014) that highlight the influence of poverty on illegal wildlife use. The relationship between the local communities and conservation custodians outside protected areas seemed inadequate.

Illegal hunting is likely to be prevalent around protected areas, due to the fact that wildlife has been depleted outside and away from protected areas (Phakathi pers. comm. 2016). There is a high possibility that the respondents may have downplayed the real situation (Gavin *et al.* 2010; John *et al.* 2010) due to their awareness of penalties associated with illegal hunting. Therefore, illegal hunting could be high in both nature reserves and private lands depending on the strength of law enforcement. Nevertheless, with the conservation management extending its jurisdiction through the stewardship programme with the aim of legally protecting biodiversity of high value outside formally protected areas, through partnerships between conservation agencies and landowners (Ezemvelo KZN Wildlife 2012a), there is a positive prospect for wildlife outside protected areas.

## 3.5 Conclusions

The aim of this study was to assess the drivers of illegal hunting and the implications of this activity for serval and oribi populations. These species are particularly important due to their potential role in the conservation and management of the ecosystems they occupy; which will in turn improve the well-being of other species that depend on these ecosystems. Illegal hunting in the Midlands was high and predominantly for subsistence purposes. Unemployment accompanied by limited access to productive land and domestic sources of protein are some of the main attributes of the communities studied. However, these factors were not the main drivers of illegal wildlife utilisation. Bushmeat procurement was the main reason for illegal hunting. Bushmeat preference over domestic meat was due to its distinctive flavour. Illegal hunting by young boys from the ages of 9 to 17 was unexpectedly high. These young men were hunting

primarily for sport, although the meat obtained was consumed, it did not represent a significant source of animal protein.

Wildlife has been depleted in the region, in particular outside protected areas, as a result bushmeat hunting in this region cannot be a viable safety net. Prohibited methods of hunting including dogs and snares were used. The ambiguous nature of hunting regulations accompanied by the cost of obtaining a permit were cited as primary reasons for hunting illegally. The two species investigated were vulnerable to illegal hunting. Oribi were primarily hunted for meat. Natural predation seemed to be high, as a natural phenomenon, it is not expected to be detrimental however, to a vulnerable species such as the oribi it may pose some threat. Servals were highly susceptible to retaliatory killing for preying on poultry. Moreover, snaring and road kills of servals were high in the region, their nocturnal nature renders them more susceptible to these threats. Servals were used in the making of traditional medicine and attires. However, due to their rarity, the majority of users have found substitutes, although this does not entirely release pressure on this species.

Information about the demographic and socio-economic characteristics of illegal hunters, the spatial distribution of the activity, additional threats and the implications for individual species may be incorporated in selecting priority areas for conservation initiatives. The study sheds light on the well-being of serval and oribi populations. The consideration of their role as indicator and keystone species could enhance their conservation inside and outside protected areas. This can effectively support the conservation of a wide diversity of small and medium sized animals in the wild together with the wetland and grassland ecosystems.

## 3.6 Recommendations

There is no panacea to the issue of illegal wildlife utilisation. However, understanding the site-specific drivers could be the first step in an attempt to remedy the situation. More investments into biodiversity conservation may enhance law enforcement both inside and outside protected areas and thus reduce the vulnerability of species, in particular on private properties.

The consideration of the needs of rural people living adjacent to biodiversity refuges whether protected or private is vital, to reduce the adverse impacts of poverty on biodiversity conservation. The creation of employment opportunities and the promotion of entrepreneurship

may help curb illegal hunting by increasing access to domestic sources of protein and reducing available time that can be utilised to engage in illegal hunting activities.

Extensive and inclusive environmental education is essential. Although most hunters were aware of the illegality of the activity, they were not fully aware of the ecological consequences of unsustainable utilisation on biodiversity. Most illegal hunters did not know how to go about obtaining a hunting permit. During the survey, contact details of those who needed assistance obtaining a permit were taken. Ezemvelo KZN wildlife was contacted to enquire about the subsistence hunting permit process and this information will be shared with the illegal hunters.

Productive hobbies for the youth in rural areas may reduce illegal hunting, as many children hunted because they had nothing else to do. There is an initiative called Indigo Skate Camp which is a movement aimed at nurturing sustainable skateboarding environments for rural and vulnerable young people, which involves competitions, where skaters go and compete with others from across the country. Initiatives similar to this one, the establishment of educational centres and conventional sporting activity facilities can be effective in curbing youth engagement in illegal hunting activities.

The development of sustainable human-wildlife conflict management approaches is essential. These conflicts differ with localities and therefore site-specific solutions should be sought. In the Midlands, strengthening the relationships between local communities, land owners and protected area managers may be a first step in conflict management.

## Acknowledgements

The South African National Biodiversity Institute and the University of KwaZulu-Natal are thanked for their financial support. We thank the Midlands authorities for welcoming us and the participants for their time. The assistance received from UKZN students with data collection is highly appreciated. Skhumbuzo Kubheka, Brent Coverdale, Mr. Ngwenya, Simon Phakathi and Thabo Lephoto are thanked for their insights and assistance in various parts of this research study.

## CHAPTER FOUR

# Assessing the impact of illegal hunting on the population viability of serval (*Leptailurus serval*) and oribi (*Ourebia ourebi*).

**Nomthandazo S. Manqele [1], Jeanetta A. Selier [3], Colleen T. Downs [2] and Trevor R. Hill [1.]**

*1. School of Agricultural Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg, KwaZulu-Natal, 3209, South Africa*

*2. School of Life Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg, KwaZulu-Natal, 3209, South Africa*

*3. South African National Biodiversity Institute, Pretoria National Botanical Garden 2 Cussonia Avenue, Brummeria, Pretoria, 0184 Private Bag x101, Silverton, 0184*

Formatted for the South African Journal of Wildlife Research

## Abstract

The increase in the illegal harvesting and use of wildlife resources can have far-reaching effects on their long-term persistence. Although there are other direct threats such as fragmentation and loss of natural habitats, the illegal harvesting of wildlife resources remains difficult to quantify due to its illicit nature. As a result, its impacts on certain species of conservation concern remain less understood. Using a Vortex simulation model to carry out population viability analyses of serval (*Leptailurus serval*) and oribi (*Ourebia ourebi*), this study evaluated the impact of hunting on the long-term survival of these two ecosystem indicator and potential keystone species in South Africa. Population estimates of the KwaZulu-Natal Province sub-populations were used. Life history parameters were obtained from secondary data sources. Models were run for 100 iterations over 50 and 100 years for oribi and serval respectively. Multiple scenarios were run for each species representing varying illegal hunting levels. The model predicted that an increase in hunting by 22% will drive the oribi population to extinction within 42 years, if the initial population size is 1583. The serval was resilient to hunting, with its population declining insignificantly, from 25 individuals until the mortality rate was multiplied by 4.2. This increase resulted in an extinction probability of 0.01% within 91 years. PVAs are effective conservation tools, however, their strength is reliant on data availability and quality. The results of this

assessment can help support the establishment of regulations and the initiation of conservation measures for serval and oribi in South Africa.

**Keywords**: PVA, Vortex, illegal hunting, population, extinction

To whom correspondence should be addressed
E-mail: Hillt@ukzn.ac.za
E-mail: Downs@ukzn.ac.za

## 4.1 Introduction

The last three decades have seen an exponential decline in the world's large mammals (De Marco *et al.* 2014). In response, there has been a heightened global focus on these species (Ripple *et al.* 2016). Small to medium sized mammals, including both carnivores and ungulates, have flooded the bushmeat, traditional medicine and skin trade markets and subsequently replaced their large counterparts (Fa *et al.* 2014). Due to their relatively small sizes they are harvested in large quantities to ensure profitable sales in these markets. Moreover, for bushmeat hunters these species have always been the centre of focus accompanied by avian fauna (Kaschula & Shackleton 2009; Booth 2010). The sustainability of their extraction from the wild is diminishing. Rural poverty associated with limited sources of livelihood and perpetuated by the failure of traditional systems to cope with changing climatic conditions is one of the main drivers. Furthermore, this predicament is in part attributed to limited legal provisions available to subsistence hunters (Booth 2010), accompanied by an inadequacy in law enforcement (Bouché *et al.* 2012). The associated outcomes are far-reaching, since most of the species exploited play vital roles in the functioning of their respective ecosystems (Wright 2003; Effiom *et al.* 2013; Ripple *et al.* 2016) and the scale at which they are harvested could affect the whole biotic community (Bennett *et al.* 2002). The effects of such activities are dependent on the species resilience or lack thereof.

Opportunists and generalists have an improved chance of maintaining viable populations for longer periods of time in light of anthropogenic threats. Attributes such as high reproductive rates render species resilient to human induced pressures, including illegal hunting (Kaschula & Shackleton 2009). Inferential information is needed to account for the level of resilience of different species to human induced threats. Consistent population monitoring enables detection of changes in population trends. The lack thereof can hinder effective conservation management, particularly in the case of naturally rare species, as this may result in late detection, if any, of extinction risks. Rare and specialist species, those with small and fragmented populations and species with most of their preferred habitats occurring outside protected areas, require close monitoring due to their high vulnerability to anthropogenic pressures (Karanth & Sunquist 1995; Chapron *et al.* 2008; Linder & Oates 2011). Extinction is a result of a synergy between various threats, some of which may be indirect and thus undetectable (Armstrong *et al.* 1998). More often, the results of a threat may render the species highly vulnerable to other threats. For

example, habitat fragmentation may aggravate the effects of illegal hunting by hindering recolonisation of over-hunted sites (Wright 2005). Early detection is key, and can be achieved through continuous monitoring of population trends. There are various ways of achieving this, including the use of correlational data, algebraic formulae (Keesen *et al.* 2017) and population viability analyses (Townsend 2008).

A population viability analysis is a quantitative tool commonly utilised to predict the capacity of a population to maintain sustainability in the face of various threats for a given period of time. Studies on the assessment of populations have evaluated minimum long-term viable population sizes, demographic parameters responsible for species persistence, threats with the greatest impact, and most effective conservation strategies (Morris *et al.* 1999; Bach *et al.* 2010; Volampeno *et al.* 2015) and in some cases, all of the above (Desbiez *et al.* 2011). This tool is not without its limitations, however it plays a significant role in supporting conservation decisions and informing policy (Morris *et al.* 1999; Ebenhard 2000).

Oribi (*Ourebia ourebi*, Zimmermann 1783) are diurnal inhabitants of grassland and savanna habitats away from densely populated areas (East 1999). In South Africa, they are currently restricted to KwaZulu-Natal, Eastern Cape and Mpumalanga Provinces (East 1999; Shrader *et al.* 2016) where they are mostly found outside protected areas (East 1999; Coverdale *et al.* 2006). Oribi are a grassland specialist and selectively forage predominantly on grasses. They present a potential keystone species for the threatened grassland biome. However, like elsewhere in Africa (Lindsey & Bento 2012), oribi are utilised as bushmeat species, sometimes illegally (Grey-Ross *et al.* 2010) and this poses a threat to their population viability (Magwaza 2015). To this end, the oribi are reportedly declining in KwaZulu-Natal (Patel 2015). Other major threats facing oribi include habitat fragmentation and loss accompanied by poor veld management (Coverdale *et al.* 2006; Stears 2015). Currently they are listed as Least Concern by the International Union on Conservation of Nature (IUCN), whereas the regional assessment considers the species Endangered (Shrader *et al.* 2016) and are thus protected by the Threatened or Protected Species (ToPS) regulations. The effect of illegal hunting on oribi populations is not well understood.

Serval (*Leptailurus serval*, Schreber 1776) is an African medium sized carnivore, from the felidae family. This solitary cat is found widely distributed across the African continent. Due to its specialised habitat requirements, it is inherently restricted to areas with suitable habitat, which include well-watered and adequately covered landscapes (Kingdon 1971), both natural and man-made (Herrmann *et al.* 2008). Like most wild cats, the serval is nocturnal and crepuscular in nature, which is in accordance with the time when rodents, its main prey species are active (Bowland 1990; Ramesh & Downs 2015). In South Africa, the serval is found on the eastern part of the country, particularly in the Drakensberg region (Bowland 1990), and are well-adapted to farmland environments (Ramesh & Downs 2013). However, various anthropogenic activities remain a threat to serval and they include habitat fragmentation, illegal hunting for trade and subsistence, snaring, persecution and road mortalities. Although threats to serval may be known, their consequences to its population remain uncertain. Currently, the serval is listed as Least Concern by the IUCN (Thiel 2015). However, according to the regional red list assessment, serval is Near-Threatened (Ramesh *et al.* 2016), protected under the ToPS regulations and listed as a specially protected indigenous mammal in the Province of KwaZulu-Natal.

The aim of this study was to assess the impact of illegal hunting for meat, and trade on the populations of oribi and serval in South Africa, using KwaZulu-Natal sub-population estimates. We used various scenarios to model the persistence of these two species and highlight their vulnerability to illegal hunting pressures.

## 4.2 Methods

### 4.2.1 Vortex simulation model

Vortex is an open source software (Lacy *et al.* 2015) that models species population changes and their associated outcomes, in light of various interactive deterministic (e.g. over-harvesting, habitat fragmentation and predation) and stochastic (e.g. migration, gender determination, disease, breeding and migration) events (Lacy 1993; Lindenmayer *et al.* 2000). The program is predominantly applied to species characterised by low reproductive rates and long life spans such as mammals, birds and reptiles (Lacy 1993; Bach *et al.* 2010; Andersen *et al.* 2015). It is an individual- based population viability simulation model (Lacy 2000), which simulates birth and death processes and the transmission of genes through generations, by producing random

numbers to determine the survival, and number of progeny by each female per year (Lacy 1993). The status of each individual is closely monitored as this influences the entire population (Lacy 2000). Vortex produces results in the form of a summary table that incorporates statistical predictions on population growth rate, mean population size, genetic variation, probability of extinction and time to extinction (Lacy 1993).

### 4.2.2 Study area, data sources and life history parameters

The current population assessment was restricted to populations in the KwaZulu-Natal Province of South Africa. In this province, population strongholds of the two species in question are found. Data used for the assessments were obtained from secondary data sources, primarily published literature. Data include, life history parameters, estimates on population size and mortality rates. An oribi population and habitat viability model was conducted in 2006 (Coverdale *et al.* 2006). This national study played a vital role in shedding light on the population and habitat status of this species and was used as a baseline in the current study. The majority of life history parameters for oribi were extracted from this assessment including data on annual mortality rates (Table 4.1).

**Table 4.1:** Life history parameters used for the oribi PVA.

| **Parameters** | **Value** | **Source (s)** |
|---|---|---|
| Group size | 3 | Rowe-Rowe 1983 |
| Home range size | 60 ha | Ezemvelo KZN Wildlife 2012b |
| Diet | herbivorous | Everett *et al.* 1992 |
| Habitat | grasslands and savannas | Adamczak & Dunbar 2008 |
| Mating system | long-term monogyny | Coverdale *et al.* 2006 |
| Fecundity rate | 75% | Coverdale *et al.* 2006 |
| Adult sex ratio | 50:50 | Ezemvelo KZN Wildlife 2012b |
| Infant sex ratio | 50:50 | Coverdale *et al.* 2006 |
| Sexual maturity male | 4 years | Coverdale *et al.* 2006 |
| Sexual maturity female | 3 years | Coverdale *et al.* 2006 |
| Gestation period | 210 days | Stears 2015 |
| No of offspring | 1 | Coverdale *et al.* 2006 |
| Annual mortality infant (1st year) Juvenile female | 0.1 | Coverdale *et al.* 2006 |
| Annual mortality infant (1st year) Juvenile male | 0.1 | Coverdale *et al.* 2006 |

| | | |
|---|---|---|
| Annual mortality sub-adult female | 0.04 | Coverdale *et al.* 2006 |
| Annual mortality sub-adult male | 0.02 | Coverdale *et al.* 2006 |
| Annual mortality adult female | 0.05 | Coverdale *et al.* 2016 |
| Annual mortality rate male | 0.05 | Coverdale *et al.* 2006 |
| Population size | 1583 | Magwaza 2015; Patel 2015 |
| Longevity | 13 | Coverdale *et al.* 2006 |
| Carrying capacity | 3166 | Rija 2009 |
| Maximum age of male reproduction | 13 | Coverdale *et al.* 2006 |
| Maximum age of female reproduction | 13 | Coverdale *et al.* 2006 |

While oribi data are available, the same cannot be said for a medium sized carnivore, serval. Life history data for the species are sparse, however in such cases a surrogate species may be used. The caracal (*Caracal caracal*) is a close relative of the serval and as a result missing data for serval were complemented with caracal data. However, population estimates cannot be transferred and there has not been any annual comprehensive collection of serval population data in the country. This outcome could be in relation to the fact that the serval were not a protected species until recently (2008) and challenges associated with population counts owing to the predominantly nocturnal behaviour of serval. Life history parameters used for serval PVA are incorporated in table 4.2.

**Table 4.2:** Life history parameters for the serval PVA.

| **Parameter** | **Value** | **Reference(s)** |
|---|---|---|
| Group size | 4 | Smithers 1987 |
| Home range size | 60 | Ramesh *et al.* 2015 |
| Diet | small mammals | Smithers 1978; Thiel 2011 |
| Habitat | riverine grasslands | Smithers 1987 |
| Mating system | polygynous | http://animaldiversity.org |
| Fecundity rate | 90% | Bernard & Stuart 1987; Kingdon 1971 |
| Adult sex ratio | 1:1 | Skinner & Chimimba 2005 |
| Infant sex ratio | 1:1 | Skinner & Chimimba 2005 |
| Sexual maturity male | 13 months | Bernard & Stuart 1987 |
| Sexual maturity female | 14 months | Bernard & Stuart 1987 |

| | | |
|---|---|---|
| Gestation period | 70 days | Estes 1999 in Thiel 2011 |
| No of offspring (s) | 3 kittens | Smithers 1978 |
| Annual mortality from 0-1 male | 6.4 % | |
| Annual mortality from 0-1 female | 3.2 % | |
| Annual mortality after age 1 male | 30 % | |
| Annual mortality after age 1 female | 15 % | |
| Population size | 25.3 individuals | |
| Longevity | 12 years | Gutler 2006 in Theil 2011 |
| Carrying capacity | 51 | Rija 2009 |
| Maximum age of male reproduction | 12 years | Gutler 2006 cited in Theil 2011 |
| Maximum age of female reproduction | 12 years | Gutler 2006 cited in Theil 2011 |

### 4.2.3 Oribi PVA scenarios

The aim of the PVA model was to assess the impact of illegal hunting on the oribi population. The model was run as a population based model with a single population and the initial population size was set at 1583 individuals (Magwaza 2015). Due to lack of data on age structure, a stable age distribution was assumed. One catastrophe was included in the model, as oribi are known to suffer in extreme weather conditions, particularly during winter (Oliver 1987). In the western part of the KwaZulu-Natal Province, the core of the oribi population in South Africa, winter temperatures can be extremely low, accompanied by frost. The effect of this catastrophe was set at 10% and 0% on the survival and reproduction rates respectively (Coverdale *et al.* 2006). The carrying capacity was set at double the initial population size (Rija 2009), one hundred iterations were run for 50 years (Coverdale *et al.* 2006). No annual removal (harvest) and addition of individuals (supplementation) were included in the model.

Multiple scenarios were run to determine the effect of illegal hunting (Table 4.3). Illegal hunting was excluded in the first scenario, in all scenarios that followed, it was introduced. The proportion of off-takes was increased from 0.5% to 22%. Data on annual mortality, which excluded illegal hunting, were extracted from the oribi PHVA of Coverdale *et al.* (2006). Illegal hunting was included from age 2-3 years for both male and female up to adults. According to Mostert & Hoffman (2007) gender has no impact on the quality of bushmeat and as a result, it

was assumed that both males and females are hunted equally, however, hunters tend to avoid visibly pregnant females. Age is a significant factor in determining the quality of meat, juveniles are avoided while sub-adults and adults are sought after equally (Xaba, subsistence hunter, Creighton pers. comm. 2017).

### 4.2.4 Serval PVA scenarios

Life history information is a basic requirement for population viability analyses. Such data requires intensive field work, over a lengthy period of time and are thus not always available (Bernard & Stuart 1987). The issue is inherently compounded for illusive and small to medium sized mammals by challenges that are associated with studying them. However, data scarcity may be mitigated by using data from studies of closely related species (Rija 2009), the caracal in the case of serval.

To estimate the current population of serval in KwaZulu-Natal, a population density estimate of 6.9 individuals per 100km$^2$ (Ramesh & Downs 2013), and an Area of Occupancy (AOO) equalling 367.196km$^2$ derived from a 60km buffer of South African wetlands (clipped with a KZN boundary) resulted in an estimated population size of 25.3 servals in the province. Reproductive rate was set at 90% with a 10% environmental variation. Similar to other small to medium sized wild cats, the serval was assumed to be highly prolific. Breeding can take place throughout the year with significant peaks during the summer season (Bernard & Stuart 1987; Kingdon 1971). Gestation period is short (70 days) and offspring mature rapidly. These conditions may provide females the opportunity to breed twice a year (Kingdon 1971), rendering breeding opportunities adequate.

Various scenarios were run for serval (Table 4.4). In the absence of annual mortality rate data, estimates were determined. These were based on personal communications and the severity of known threats to serval, which include; road kills, snaring, retaliatory killing and hunting with dogs and rifles (Friedmann & Daly 2004; Ramesh *et al.* 2016). The serval is a rare mesocarnivore, this is reinforced by its nocturnal and sometimes crepuscular behaviour (Ramesh & Downs 2013). As a result it was assumed that hunting with dogs and rifles is opportunistic and therefore modest.

The use of roads and established tracks by servals is common (Smithers 1978; Thiel 2011) and this increases their chances of being killed on roads particularly at night. Retaliatory killing

may be moderate as serval seldom prey on poultry (Ramesh & Downs 2015), although they tend to return to where they have killed poultry (Henley 1997) increasing their chances of being persecuted, they are illusive and often challenging to catch. Snaring, however, has a significant contribution to serval mortality (Sollmann *et al.* 2016) because of its prevalence on farmlands (Ramesh *et al.* 2015) and the fact that it is unselective in terms of age and gender. Female and male mortality rates varied. For males, the rates were higher which was attributed to their wide ranging habits (Ramesh *et al.* 2015). Hunting, accompanied by other causes of mortality, were introduced from the first scenario, intensity increased subsequently up to the last scenario. In total, nine scenarios were incorporated into the model (Table 4.4).

## 4.3 Results

### 4.3.1 Oribi population viability analysis

The initial oribi population size was 1583 individuals with a randomly distributed age structure. In the absence of illegal hunting the population exhibited a healthy growth rate of 0.08%, no extinction was experienced within the 50 year period, while the final population size was almost double the initial population size (3144). The introduction of illegal hunting into the model was accompanied by significant changes. Off-take of 0.5% (n = 8) of the population resulted in a reduction in population growth rate to 0.074 and the final mean population size to 3117 individuals.

The subsequent increase in off-takes as a result of illegal hunting steadily reduced the population. At 9% (n = 142) extraction, the population ceased to grow, resulting in a mean final population size of 1699 ± 73.3 individuals. A steady increase in off-takes affected the growth rate and the final mean population size. Significant changes occurred with an increase in mortality of 16.5% (n = 261), and resulted in a 0.01% probability of extinction at 50 years. When the illegal hunting intensity was increased to 20% (n = 317), it resulted in an extinction probability of 0.42% that occurred within 45 years. Moreover, a further increase by 2% (n = 348) in illegal hunting yielded an extinction probability of 0.8% within 42 years, while reducing the mean final population to less than two individuals (Table 4.3).

**Table 4.3:** Results of the oribi vortex simulation model under 15 scenarios with different illegal hunting effects.

| Input | | Results | | | |
|---|---|---|---|---|---|
| Scenario | Illegal hunting effect (%) | Mean population growth rate (r) | Probability of extinction P[E] | Mean time to extinction (years) | Mean final population |
| 1 | None | 0.081 ± 0.001 | 0 | 0 | 3144 ± 8.85 |
| 2 | 0.5 | 0.074 ± 0.001 | 0 | 0 | 3117 ± 12.8 |
| 3 | 1.5 | 0.067 ± 0.001 | 0 | 0 | 3114 ± 11.8 |
| 4 | 3.5 | 0.049 ± 0.001 | 0 | 0 | 3089 ± 14.9 |
| 5 | 5.5 | 0.032 ± 0.001 | 0 | 0 | 2980 ± 27.8 |
| 6 | 7.5 | 0.013 ± 0.001 | 0 | 0 | 2558 ± 59.3 |
| **7** | **9** | **0.000 ± 0.001** | **0** | **0** | **1699 ± 73.3** |
| 8 | 11 | -0.019 ± 0.001 | 0 | 0 | 732 ± 49.4 |
| 9 | 11.5 | -0.022 ± 0.001 | 0 | 0 | 556 ± 27 |
| 10 | 13.5 | -0.048 ± 0.001 | 0 | 0 | 165 ± 9 |
| 11 | 15.5 | -0.065 ± 0.001 | 0 | 0 | 77 ± 4.7 |
| 12 | 16 | -0.069 ± 0.001 | 0 | 0 | 60 ± 3 |
| **13** | **16.5** | **-0.074** ± 0.001 | **0.01** | **50** | **45 ± 2** |
| 14 | 20 | -0.1148 ± 0.002 | 0.42 | 45 | 7 ± 0.7 |
| 15 | 22 | -0.1391 ± 0.002 | 0.81 | 42 | 1.4 ± 0.3 |

**Note:** Bold formatted values indicate significant changes.

### 4.3.2 Serval population viability analysis

The initial population size of serval was estimated at 25.3 individuals, modelled as a single population with randomly distributed age classes. The rate of mortality used as a baseline was estimated at 13.8 (55%) individuals per annum.

After the first scenario, a mean population growth rate of 0.627 was attained while the final population size was double the initial population size, suggesting a healthy population trend. In the following scenario, when the rate of mortality was doubled, the population exhibited no significant changes. However, a steady reduction in the growth rate was apparent when mortality was further increased. When the initial rate of mortality was multiplied by 4.2, a 0.001

probability of extinction was experienced at year 91. From this point, imposed further increases in mortality rate, rapidly reduced the population and the multiplication of the rate of mortality by 5 resulted in extinction of the remainder of the population (100%) within 24 years.

**Table 4.4:** Results of the serval vortex simulation model under 9 scenarios with different illegal hunting effects.

| **Input** | | **Results** | | | |
|---|---|---|---|---|---|
| Scenario | Description | Mean population growth rate (r) | Probability of extinction P[E] | Mean time to extinction (years) | Mean final population |
| 1 | Initial mortality rate (13.8) | 0.627 ± 0.001 | 0 | 0 | 51.1 ± 0.13 |
| 2 | Initial *2 | 0.486 ± 0.002 | 0 | 0 | 51 ± 0.15 |
| 3 | Initial *2.5 | 0.407 ± 0.002 | 0 | 0 | 50.9 ± 0.11 |
| 4 | Initial *3 | 0.320 ± 0.002 | 0 | 0 | 50.7 ± 0.2 |
| 5 | Initial *3.5 | 0.225 ± 0.002 | 0 | 0 | 49.8 ± 0.4 |
| 6 | Initial *4 | 0.341 ± 0.005 | 0 | 0 | 44.6 ± 1 |
| 7 | Initial *4.2 | 0.076 ± 0.002 | 0.001 | 91 | 40.9 ± 1.3 |
| 8 | Initial *4.4 | 0.024 ± 0.002 | 29 | 48 | 23.12 ± 1.9 |
| 9 | Initial *5 | -0.096 ± 0.006 | 100 | 24 | 0.00 ± 0.00 |

Across all scenarios, the population showed a fluctuating trend throughout the 100 year time period (Figure 4.1). The decline observed as a result of increased off-takes was supplemented through reproduction and maturity of juveniles. However, as the population declined further and rapidly, the trend began to follow a single trajectory.

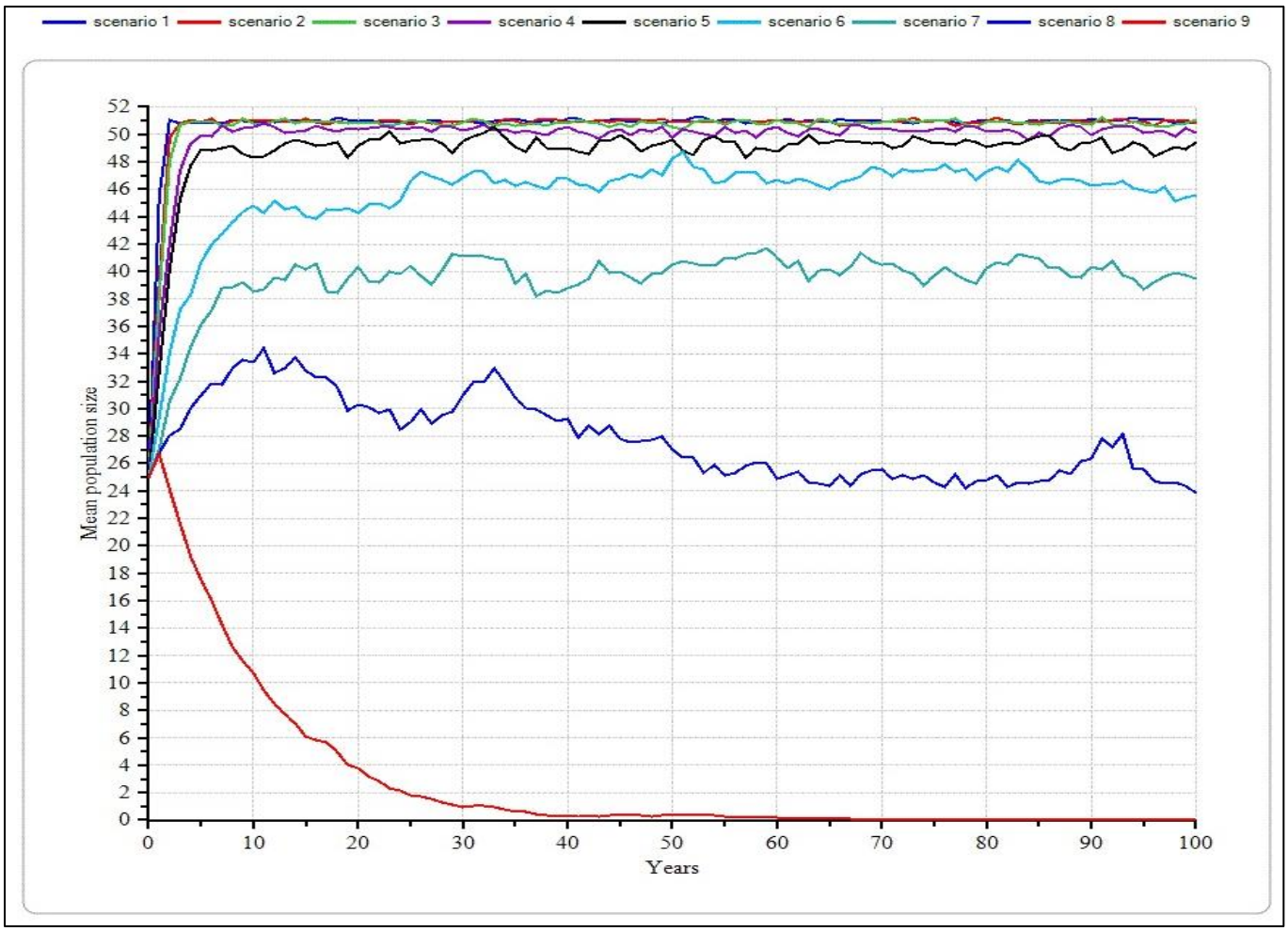



**Figure 4.1:** Predicted serval population trends over a 100 year period for 9 scenarios.

## 4.4 Discussion

### 4.4.1 Oribi population viability analysis

The model elucidated the levels at which illegal hunting becomes unsustainable and detrimental to the current oribi population. It showed that at an annual off-take greater than 9% (142 individuals), the population becomes static and begins to decline steadily. Further increases in off-takes of up to a 16.5 % (261 individuals) result in a 0.01 % probability of extinction within 50 years. The only scenario where oribi exhibited a healthy population was when illegal hunting was absent and the only threat imposed was a single catastrophic event with a 10% effect on survival.

However, it is likely that on average, over 142 oribi are illegally hunted in the KZN Province each year. Grey-Ross *et al.* (2010) reported a 39% proportion of hunters in the Midlands that admitted to hunting the species while in Chapter two, we showed that 68% of illegal hunters in the same region have had encounters with oribi during their recent hunting expeditions. It is noteworthy that these figures may be an underestimate of the actual situation in the Midlands region considering that the activity being assessed is illegal and not all respondents will reveal accurate information due to fear of potential persecution (John *et al.* 2010).

Oribi have a low reproductive rate, this is exacerbated by their specialist nature which renders them highly susceptible to habitat degradation (Coverdale *et al.* 2006; Stears 2015). Illegal hunting alone has a pronounced negative impact on oribi populations, this activity is accompanied by a range of other anthropogenic threats and as a result the current population size is unable to support hunting. Oribi are hunted legally in the province, quotas are based on the current population size, and therefore illegal hunting interferes with this activity by reducing the number of specimens available for legal off-takes. The main outcome of this may include reductions in revenue generated through legal hunting.

### 4.4.2 Serval population viability analysis

Healthy and high reproductive rates create a buffer against hunting induced mortality (Chapron *et al.* 2008). The serval population used in this model appeared to be resilient to human induced mortality. This can be attributed to its high reproductive rate accompanied by rapid maturity of juveniles and the polygynous mating system. These characteristics were not affected by any other factor except mortality. Most of the threats that resulted in mortality were severe on adults and thus provided the juveniles a chance to mature and reproduce. The model shows that serval can withstand hunting and other causes of mortality included in the model, provided there are no external forces interfering with breeding. Due to data scarcities, the model was run as a single population, which is one of the limitations of this assessment for there is likely more than one populations in the province. The contribution of dispersal to population growth was not included and it could have sustained the population under higher off-takes for a long period of time.

Being a rare and a nocturnal species, is likely advantageous for the serval population. Most of the hunting is opportunistic, as a result most traders have replaced serval skin with genet's skin. However, this trait could lead to unnoticed significant changes in the population and by the

time they are noticed, it is too late to reverse. Therefore it is imperative to consistently monitor such species even when they exhibit healthy population trends. Although a sensitivity analysis was beyond the scope of this assessment, it is assumed that the most influential parameter was reproduction, for the population was relatively small and such populations are susceptible to extinction risks (Desbiez *et al.* 2012). Its ability to rehabilitate itself after high off-takes helped keep the population at a viable state.

The ability of the serval to adapt to diverse landscapes and to utilise semi-natural and man-made habitats (Herrmann *et al*. 2008; Ramesh & Downs 2013) increases its chances of survival. However, further reductions in its preferred habitat, which may be companied by food shortages, forces the species to extend its range and increases the risks of human contact which often leads to conflict.

## 4.5 PVA limitation

A population viability analysis is a valuable quantitative conservation tool from which meaningful insights can be drawn and robust support for biodiversity management initiatives can be obtained however, its strength is highly dependent on the availability and quality of data. Large amounts of accurate data collected over a long period of time are needed for the analyses to produce robust results (Morris *et al*. 2002). In light of limited financial resources and shortages in personnel, common factors in biodiversity conservation (Terborgh *et al.* 2008), accumulating adequate data can be challenging. This is more pronounced in endangered species with small populations (Andersen *et al.* 2015).

## 4.6 Conclusions and recommendations

A PVA can raise awareness on the need of species specific research and identify research priority areas. Both the analyses focused mainly on illegal hunting, which is one of the major threats to biodiversity. The concern with regards to illegal hunting is that it is difficult to quantify due to it illicit nature which means, in most cases, it goes unnoticed. Although a PVA is unlikely to provide a solution, it can shed light on the vulnerability of certain species to unsustainable off-takes and provide corroboration for their protection.

Oribi are vulnerable to illegal hunting and the current population of KwaZulu-Natal may not be able to support unregulated off-takes. Other anthropogenic threats such as habitat fragmentation and poor veld management increases oribi risk of extinction, as a result other bushmeat species with stable population trends such as the reedbuck (*Redunca arundinum)*, duiker (*Philantomba monticola*) and impala (*Aepyceros melampus*) should be made available to subsistence bushmeat hunters to assist in the recovery of oribi populations.

Although not commonly used for bushmeat purposes, servals are important to local people for various purposes including traditional medicine and regalia. The model revealed that the species is resilient to illegal hunting accompanied by other sources of mortality such as road kills and persecution. The serval's high reproductive rate is a significant contributor to this outcome and is one of its strongest attributes. However, since figures used in the model were based on estimates, they are likely to be an underestimate of the real situation. Close monitoring and research on the population dynamics of the species may assist in its long-term survival. In-depth research on the life history of the species is required to support conservation initiatives.

Eradication and degradation of natural habitat should be addressed, for this is one of the main human-induced threats that often work synergistically with illegal hunting to increase the risk of extinction. Inadequacies in law enforcement accompanied by poor trade regulations should be countered to ensure viable populations which will in turn enable the species to withstand various anthropogenic threats.

## Acknowledgements

We are most grateful for the financial assistance received from the South African National Biodiversity Institute (SANBI) and the University of KwaZulu-Natal. The assistance and insights received from Brent Coverdale are greatly appreciated.

# CHAPTER FIVE
# Synthesis

## 5.1 Introduction

The purpose of this study was to assess the drivers and impact of illegal hunting on oribi (*Ourebia ourebi*) and serval (*Leptailurus serval*) in South Africa. The issue of illegal hunting for subsistence and trade purposes has not received much attention in South Africa. This is an outcome attributed to the notion that the illegal use of wildlife resources is negligible in the country (Lindsey *et al.* 2011). The bushmeat crisis is a global challenge to conservation (Ripple *et al*. 2016) and socio-economic development (Frost & Bond 2008). The conditions under which it takes place and its driving forces may well be country and/or site-specific but the outcomes are often comparable and their effect extends beyond national borders.

From previous South African studies, we have learnt that the contribution of wildlife resources to the livelihoods of rural dwellers with limited employment opportunities and channels of income is modest, but plays a significant role (Shackleton & Shackleton 2006; Kaschula & Shackleton 2009). Fuelwood and wild herbs appear to be the predominantly used and consumed natural resources by most rural households (Shackleton & Shackleton 2006). This may be due to the scarcity of harvestable wildlife resources outside protected areas accompanied by the level of law enforcement inside protected areas. This state of protection cannot be said to occur for all the protected areas. In north eastern parts of the country, illegally obtained bushmeat is found traded on street corners (Warchol & Johnson 2009) which suggests a viable local market, while elsewhere in the country wildlife is hunted for recreational purposes (Kaschula & Shackleton 2009). There are uncertainties surrounding the use of wildlife resources, particularly with regards to its dynamics and magnitude. Declining population trends exhibited by some species of conservation concern in areas prone to illegal hunting activities (Grey-Ross *et al.* 2010; Ramesh & Downs 2013), present an opportunity to evaluate the drivers and impacts of illegal use on these species.

This chapter is a retrospection of the current research and provides a direction for conservation efforts for oribi and serval. The findings and conclusions resulting from Chapter two, a review of literature, and Chapter three which addresses the first and second objectives of

this treatise will be incorporated in this chapter together with those of Chapter four which is a discourse of the third objective.

## 5.2 Bushmeat and traditional medicine use in developing countries: a review of drivers and impacts.

Journal articles, books, book chapters and reports were collected. Published literature addressing the issues linked to bushmeat consumption, trade and the use of wild animals in traditional medicine in developing countries of Africa, Asia and Latin America was reviewed. The focus was on the drivers behind the use of these resources which is mostly illegal and its associated impacts.

Bushmeat is a significant source of animal protein and income for the majority of rural households in developing countries. In regions where access to domestic sources of protein is limited, households resort to bushmeat for it is readily available and affordable. In times of low agricultural productivity, shocks and stresses the consumption of wildmeat escalates, which means it is a vital buffer against food insecurity and uncertainties that rural livelihoods are often prone to. The commercialisation of bushmeat is replacing subsistence hunting, with the growing demand from cities. Large quantities of meat are harvested and transported to cities where bushmeat is consumed primarily as a delicacy (Sandalj *et al.* 2016). The increase in harvests is detrimental to the long-term persistence of wildlife, as evidence shows that a wide range of large mammalian fauna is endangered (Ripple *et al.* 2016). The species illegally hunted for bushmeat are prey to wild carnivores and their decline in abundance as a result of this activity, negates predation. Furthermore, other biological interactions such as seed dispersal are disrupted owing to heavy off-takes of fauna for human consumption. The impacts extend to interfere with socio-economic development in developing counties. Concessions such as trophy hunting, which is a significant conservation and rural development tool are undermined by illegal hunting. Subsistence consumers of bushmeat and other natural resources find themselves losing access to these resources as a result of illegal use by other members of the community and in some cases by people from outside the community.

## 5.3 Evaluating the drivers of illegal hunting and its implications for serval (*Leptailurus serval*) and oribi (*Ourebia ourebi*) conservation in South Africa.

A questionnaire based survey was conducted between October 2015 and March 2016 in the Midlands region of KwaZulu-Natal, South Africa, to evaluate the drivers of illegal hunting for bushmeat and trade, and its implications for serval and oribi species. The questionnaires were semi- structured while the study population was sampled using a mixed sampling method. This method comprised of random, purposive and snowball techniques. Two hundred and seventy-one interviews were conducted.

The severity of illegal hunting in a given area is dependent upon the number of hunters present. Out of 271 interviews conducted, with a non-response rate of 3.3%, 71 (27%) of the respondents were illegal hunters. This is a significant proportion considering that the activity evaluated is predominantly illegal. Hunters were aged between 9 and 25 and age came up as a significant factor. Most of the illegal hunting was concentrated around farmlands compared with protected areas. Although most hunters hunted for subsistence purposes, hunting in the Midlands was not driven by limited access to alternative sources of protein. Hunters had a certain preference for bushmeat because of its distinctive taste while others seemed to enjoy hunting as a recreational activity. There was no commercialisation except for the sporadic trade in by-products such as skins and other body parts for use in traditional medicine. Moreover, the focal species, namely serval and oribi, had been encountered by 27% and 68% of illegal hunters respectively. Which is in accordance with the finding that most of the hunting in the region was practiced to obtain meat and serval is not a common bushmeat species, above being naturally rare. Although not a common bushmeat species, serval was popular in traditional medicine, the respondents reported that they used serval body parts to treat various ailments and conditions including epilepsy, urinary system problems and headaches. Its bones were crushed and used to chase away bad spirits.

The results of this study shed light on the dynamics of illegal hunting activities in the Midlands region. However, due to the illegal nature of the activity, the results of this study should be approached with caution. Further research may assess the willingness of illegal hunters to adopt alternative activities for recreation and assess the viability of these activities in curbing sport related illegal hunting of endangered and protected species. In the case of traditional

medicine, effective ways to engage traditional *muthi* traders should be explored. Some of these users were willing to use alternative resources if these were available.

## 5.4 Assessing the impact of illegal hunting on the population viability of serval and oribi.

To assess the impact of illegal hunting on serval and oribi populations, a Vortex simulation model was used. Both the species occur in most provinces across the country, however for this study only the KwaZulu-Natal population estimates were used in the model. For oribi, a previous PHVA conducted in 2006 was used as a baseline. For serval, life history parameters were extracted from the literature. All models were run for 100 iterations over 50 and 100 years for oribi and serval respectively. Different scenarios representing varying illegal hunting intensities were executed.

With an initial population size of 1583, the model results showed that oribi are vulnerable to illegal hunting. This is probably due to their relatively low rate of reproduction. The model predicted that the species would become extinct in 42 years of 50, with the increase in illegal hunting of 22% (n = 348). The population started to lose its viability with an increase of 9% (142) in illegal hunting intensity, the population ceased to grow and started to decline rapidly. Drawing from the results of this study, subsistence hunting of oribi should be closely monitored, through adequate law enforcement until the population attains stability.

According to the model, the serval is resilient to illegal hunting in the Midlands. This may be attributed to its relatively high reproductive rate and the rapid rate at which the offspring reach sexual maturity. As a result the population is able to withstand elevated hunting pressures. However, once the population reaches a threshold and starts declining the rate of extinction may be rapid. Due to serval's rarity, it may be easy for conservation managers to miss this turning point.

This study was limited by the availability of data, particularly for serval and the strength of a PVA is dependent on this. However, this study also indicates further research needs as far as the focal species are concerned.

## 5.5 Conclusion

Illegal exploitation of biological resources is one of the global primary challenges to conservation (Redford 1992; Ripple *et al*. 2016). Rapid population growth accompanied by increasing levels of poverty are often cited as the main drivers behind this phenomenon. Strict laws have been established to regulate utilisation and ensure the long-term persistence of these resources, which could effectively contribute to socio-economic development of marginalised communities. However, the ongoing illegal activities upon resources such as bushmeat, could negate this effort. Understanding the leading causes of such activities and their associated impacts may be the first step to tackling them.

The aim of this study was to assess the drivers and the impact of illegal hunting activities in the Midlands region of KwaZulu-Natal, South Africa with specific reference to serval and oribi, indicator and potential keystone species for the wetland and grassland ecosystems. These ecosystems are under increasing pressure from anthropogenic activities including agriculture. The results of this study showed that the prevalence of illegal bushmeat hunting in the Midlands region of South Africa was not driven mainly by limited access to alternative resources. Although the study region is characterised by marginalisation, bushmeat exploitation was not a primary livelihood option. Bushmeat was consumed predominantly out of preference. The results also revealed that oribi remain susceptible to uncontrolled hunting, contrary to the serval which appears relatively resilient. The study findings presented herein can be utilised to inform and corroborate conservation initiatives aimed at protecting these species for their long–term persistence and that of other grassland and wetland dependent species.

## References


Adamczak, V. G., and R. Dunbar. 2008. Variation in the mating system of oribi and its ecological determinants. *African Journal of Ecology* 46:197-206.

Adams, W. M. 2013. Against extinction: the story of conservation. Earthscan. London.

Adams, W. M., R. Aveling, D. Brockington, B. Dickson, J. Elliott, J. Hutton, D. Roe, B. Vira, and W. Wolmer. 2004. Biodiversity conservation and the eradication of poverty. *Science* 306:1146-1149.

Adams, W. M., and J. Hutton. 2007. People, parks and poverty: political ecology and biodiversity conservation. *Conservation and Society* 5:147-183.

Alves, R. R., and I. L. Rosa. 2005. Why study the use of animal products in traditional medicines? *Journal of Ethnobiology and Ethnomedicine* 1:5 doi: 10.1186/1746-4269-1-5.

Alves, R. R., and I. L. Rosa. 2007. Zootherapy goes to town: The use of animal-based remedies in urban areas of NE and N Brazil. *Journal of Ethnopharmacology* 113: 541-555.

Andersen, L. H., P. Sunde, V. Loeschcke, and C. Pertoldi. 2015. A population viability analysis on the declining population of Little Owl (*Athene noctua*) in Denmark using the stochastic simulation program VORTEX. *Ornis Fennica* 92:1-21.

Armstrong, A., G. Benn, A. Bowland, P. Goodman, D. Johnson, A. Maddock, and R. Scott-Shaw. 1998. Plantation forestry in South Africa and its impact on biodiversity. *Southern African Forestry Journal* 182:59-65.

Ashforth, A. 2005. Muthi, medicine and witchcraft: regulating 'African science'in post-apartheid South Africa? *Social Dynamics* 31:211-242.

Atuo, F. A., and T. J. O'Connell. 2015. An assessment of socio-economic drivers of avian body parts trade in West African rainforests. *Biological Conservation* 191:614-622.

Aziz, M. A., S. Tollington, A. Barlow, J. Goodrich, M. Shamsuddoha, M. A. Islam, and J. J. Groombridge. 2017. Investigating patterns of tiger and prey poaching in the Bangladesh Sundarbans: Implications for improved management. *Global Ecology and Conservation* 9:70-81.

Bach, L. A., R. B. Pedersen, M. Hayward, J. Stagegaard, V. Loeschcke, and C. Pertoldi. 2010. Assessing re-introductions of the African wild dog (*Lycaon pictus*) in the Limpopo Valley Conservancy, South Africa, using the stochastic simulation program Vortex. *Journal for Nature Conservation* 18:237-246.

Barnett, R. 2000. Food for thought: the utilization of wild meat in eastern and southern Africa. TRAFFIC East/Southern Africa. Nairobi, Kenya. Available from

https://portals.iucn.org/library/sites/library/files/documents/Traf-066.pdf (Accessed: February 2016).

Baudot, B. S., and W. R. Moomaw 2016. People and their planet: searching for balance. Springer, Berlin.

Beinart, W. 1990. Empire, hunting and ecological change in southern and central Africa. *Past and Present Society* 128:162-186.

Bennett, E. L., E. Milner-Gulland, M. Bakarr, H. E. Eves, J. G. Robinson, and D. S. Wilkie. 2002. Hunting the world's wildlife to extinction. *Oryx* 36:328-329.

Berkes, F. 2004. Rethinking community-based conservation. *Conservation Biology* 18:621-630.

Bernard, R., and C. Stuart. 1987. Reproduction of the caracal (*Felis caracal)* from the Cape Province of South Africa. *African Zoology* 22:177-182.

Booth, V. 2010. Contribution of wildlife to national economies. FAO and CIC Technical Series Publication 8. Budapest, Hungary. Available from www.wildlife-baldus.com/download/8_.pdf (accessed July 2015).

Borgerson, C., M. A. McKean, M. R. Sutherland, and L. R. Godfrey. 2016. Who hunts lemurs and why they hunt them. *Biological Conservation* 197:124-130.

Botha, J., T. Witkowski, C. M. Shackleton, and H. Fairbanks. 2004. Socio-economic differentiation in the trade of wildlife species for traditional medicines in the Lowveld, South Africa: implications for resource management initiatives. *International Journal of Sustainable Development and World Ecology* 11:280-297.

Bouché, P., R. N. M. Mange, F. Tankalet, F. Zowoya, P. Lejeune, and C. Vermeulen. 2012. Game over! Wildlife collapse in northern Central African Republic. *Environmental Monitoring and Assessment* 184:7001-7011.

Bowland, J. M. 1990. Diet, home range and movement patterns of serval on farmland in Natal. University of Natal. MSc thesis, University of Natal, Pietermaritzburg, South Africa.

Bowland, J. M., and M. Perrin. 1993. Wetlands as reservoirs of small-mammal populations in the Natal Drakensberg. *South African Journal of Wildlife Research* 23:39-43.

Brashares, J. S., P. Arcese, M. K. Sam, P. B. Coppolillo, A. R. Sinclair, and A. Balmford. 2004. Bushmeat hunting, wildlife declines, and fish supply in West Africa. *Science* 306:1180-1183.

Brashares, J. S., C. D. Golden, K. Z. Weinbaum, C. B. Barrett, and G. V. Okello. 2011. Economic and geographic drivers of wildlife consumption in rural Africa. *Proceedings of the National Academy of Sciences* 108:13931-13936.

Breitenmoser-Wursten C, Henschel P and Sogbohossou E. 2008. *Leptailurus serval*. The IUCN Red List of Threatened Species. Version 2014.3. Available from www.iucnredlist.org. (Accessed March 2015).

Bullock, K., G. Malan, and M. Pretorius. 2011. Mammal and bird road mortalities on the Upington to Twee Rivieren main road in the southern Kalahari, South Africa. *African Zoology* 46:60-71.

Carbutt, C., M. Tau, A. Stephens, and B. Escott. 2011. The conservation status of temperate grasslands in southern Africa. *Grassroots* 11:17-23.

Caro, T. and P. Scholte. 2007. When protection falters. *African Journal of Ecology* 45:233-235.

Carruthers, J. 1995. The Kruger National Park: a social and political history. University of Natal Press, Pietermaritzburg.

Ceppi, S. L. and M. R. Nielsen. 2014. A comparative study on bushmeat consumption patterns in ten tribes in Tanzania. *Tropical Conservation Science* 7:272-287.

Chapron, G., D. G. Miquelle, A. Lambert, J. M. Goodrich, S. Legendre, and J. Clobert. 2008. The impact on tigers of poaching versus prey depletion. *Journal of Applied Ecology* 45:1667-1674.

Clements, H., G. Cumming and G. Kerley. 2016. Predators on private land: Broad-scale socioeconomic interactions influence large predator management. *Ecology and Society* 21:45-53.

Cloete, P. C., van der Merwe, P., Saayman, M. 2015. Game ranch profitability in South Africa. Oxlynn Centre, Pretoria.

Coad, L. M. 2007. Bushmeat hunting in Gabon: socio-economics and hunter behaviour. Ph.D. thesis, University of Cambridge and Imperial College, London.

Cock, J., and D. Fig. 2000. From colonial to community based conservation: environmental justice and the national parks of South Africa. *Society in Transition* 31:22-35.

Collins, K., and J. T. Toit. 2016. Population status and distribution modelling of the critically endangered riverine rabbit (*Bunolagus monticularis*). *African Journal of Ecology* 54:195-206.

Corlett, R. T. 2007. The impact of hunting on the mammalian fauna of tropical Asian forests. *Biotropica* 39:292-303.

Costa-Neto, E. M. 1999. Healing with animals in Feira de Santana city, Bahia, Brazil. *Journal of Ethnopharmacology* 65:225-230.

Costa-Neto, E. M. 2005. Animal-based medicines: biological prospection and the sustainable use of zootherapeutic resources. *Annals of the Brazilian Academy of Sciences* 77:33-43.

Coverdale, B., B. Daly, Y. Friedmann, F. Lemmer, A. Marchant, K. McCann, I. Rushworth, and J. Wakelin. 2006. Oribi antelope (*Ourebia ourebi*) population and habitat viability assessment workshop report. Conservation Breeding Specialist Group (SSC/IUCN)/CBSG Southern Africa, Endangered Wildlife Trust, Johannesburg.

Cowling, R. M., D. M. Richardson, and S. M. Pierce 2004. Vegetation of southern Africa. Cambridge University Press, Cape Town.

Craigie, I. D., J. E. Baillie, A. Balmford, C. Carbone, B. Collen, R. E. Green and J. M. Hutton. 2010. Large mammal population declines in Africa's protected areas. *Biological Conservation* 143:2221-2228.

Cronin, D. T., S. Woloszynek, W. A. Morra, S. Honarvar, J. M. Linder, M. K. Gonder, M. P. O'Connor, and G. W. Hearn. 2015. Long-term urban market dynamics reveal increased bushmeat carcass volume despite economic growth and proactive environmental legislation on Bioko Island, Equatorial Guinea. *PloS one* 10:e0134464.

Cronin, D. T., C. Riaco, J. M. Linder, R. A. Bergl, M. K. Gonder, M. P. O'Connor, and G. W. Hearn. 2016. Impact of gun-hunting on monkey species and implications for primate conservation on Bioko Island, Equatorial Guinea. *Biological Conservation* 197:180-189.

CSIR. 2011. Atlas of freshwater ecosystem priority areas in South Africa. Available from http://www.csir.co.za/impact/docs/Final_Freshwater_Atlas_Article.pdf (Accessed: 12 September 2016).

Cullen, L., R. E. Bodmer, and C. V. Pádua. 2000. Effects of hunting in habitat fragments of the Atlantic forests, Brazil. *Biological Conservation* 95:49-56.

Cummes, D. 2013. South African indigenous healing: how it works. *Journal of Science and Healing* 9:58-65.

Davies-Mostert, H. T., Page-Nicholson, S. K., Morwewick, D. G., Morwewick, K. A., Cillers, D., Whittington-Jones, B., Killian, H., Mills, M. G., Parker, D., Power, R. J., Rehset, T. and Child, M. F. 2016. A conservation assessment of *Lycaon pictus*. In Child, M. F., Roxburgh,

L., Do, L., San, E., Raimondo, D. and Davies-Mostert, H. T. eds. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

de Azevedo Chagas, A. T., M. A. da Costa, A. P. V. Martins, L. C. Resende, and E. Kalapothakis. 2015. Illegal hunting and fishing in Brazil: a study based on data provided by environmental military police. *Brazilian Journal for Nature Conservation* 13:183-189.

De Merode, E., K. Homewood, and G. Cowlishaw. 2004. The value of bushmeat and other wild foods to rural households living in extreme poverty in Democratic Republic of Congo. *Biological Conservation* 118:573-581.

Dedeke, G. A., D. A. Soewu, O. A. Lawal, and M. Ola. 2006. Pilot survey of ethnozoological utilisation of vertebrates in southwestern Nigeria. *Indilinga African Journal of Indigenous Knowledge Systems* 5:87-96.

Desbiez, A. L. J., A. Keuroghlian, U. Piovezan, and R. E. Bodmer. 2011. Invasive species and bushmeat hunting contributing to wildlife conservation: the case of feral pigs in a Neotropical wetland. *Oryx* 45:78-83.

Desbiez, A. L., K. Traylor-Holzer, B. Lacy, B. M. Beisiegel, C. Breitenmoser-Würsten, D. A. Sana, E. Moraes Jr, E. Carvalho Jr, F. Lima, and R. de Paula. 2012. Population Viability Analysis of jaguar populations in Brazil. *Cat News* 7:35-37.

Di Marco, M., L. Boitani, D. Mallon, M. Hoffmann, A. Iacucci, E. Meijaard, P. Visconti, J. Schipper, and C. Rondinini. 2014. A retrospective evaluation of the global decline of carnivores and ungulates. *Conservation Biology* 28:1109-1118.

Diop, S., and P. Scheren. 2016. Sustainable oceans and coasts: Lessons learnt from Eastern and Western Africa. *Estuarine, Coastal and Shelf Science* doi: 10.1016/ j.ecss.2016.03.032.

Dounias, E. 2016. From subsistence to commercial hunting: Technical shift in cynegetic practices among southern Cameroon forest dwellers during the 20th Century. *Ecology and Society* 21:23- 35.

East, R. 1999. African antelope database 1998. IUCN/SSC Antelope Specialist Group. (pp. 434) IUCN Gland, Switzerland and Cambridge, United Kingdom.

Ebenhard, T. 2000. Population viability analyses in endangered species management: the wolf, otter and peregrine falcon in Sweden. *Ecological Bulletins* 48:143-163.

Ebewore, S., O. Ovharhe, and P. Emaziye. 2015. Acceptability of Bush Meat as a Source of Animal Protein in Delta State, Nigeria: Implication for Extension Services. *Journal of Northeast Agricultural University* 22:67-78.

Effiom, E. O., G. Nuñez-Iturri, H. G. Smith, U. Ottosson, and O. Olsson. 2013. Bushmeat hunting changes regeneration of African rainforests. *Proceedings of the Royal Society of London* B: 280: 20130246.

Egoh, B. N., B. Reyers, M. Rouget, and D. M. Richardson. 2011. Identifying priority areas for ecosystem service management in South African grasslands. *Journal of Environmental Managemen*t 92:1642-1650.

Ellis, F., and S. Biggs. 2001. Evolving themes in rural development 1950s-2000s. *Development Policy Review* 19:437-448.

Emslie, R. 2012. *Diceros bicornis*. The IUCN Red List of Threatened Species 2012: Available from http://www.iucnredlist.org/details/6557/0 (Accessed 11 October 2015).

Everett, P., M. Perrin, and D. Rowe-Rowe. 1991. Responses by oribi to different range management practices in Natal. *South African Journal of Wildlife Research* 21:114-118.

Everett, P., M. Perrin, and D. Rowe-Rowe. 1992. Diet of oribi on farmland in Natal. *South African Journal of Wildlife Research* 22:7-10.

Ezemvelo KZN Wildlife. 2012a. About Stewardship. Available from http://www.kznwildlife.com/about-stewardship.html (Accessed: 18 August 2016).

Ezemvelo KZN Wildlife. 2012b. *Ourebia ourebi*-oribi. Available from http://www.kznwildlife.com/ourebia-ourebi-oribi.html (Accessed: 23 November 2016).

Fa, J. E., J. Juste, J. P. Del Val, and J. Castroviejo. 1995. Impact of market hunting on mammal species in Equatorial Guinea. *Conservation Biology* 9:1107-1115.

Fa, J. E., and J. G. Yuste. 2001. Commercial bushmeat hunting in the Monte Mitra forests, Equatorial Guinea: extent and impact. *Animal Biodiversity and Conservation* 24:31-52.

Fa, C. A. Peres, and J. Meeuwig. 2002. Bushmeat exploitation in tropical forests: an intercontinental comparison. *Conservation Biology* 16:232-237.

Fa, J. E., D. Currie, and J. Meeuwig. 2003. Bushmeat and food security in the Congo Basin: linkages between wildlife and people's future. *Environmental Conservation* 30:71-78.

Fa, S. F. Ryan, and D. J. Bell. 2005. Hunting vulnerability, ecological characteristics and harvest rates of bushmeat species in afrotropical forests. *Biological Conservation* 121:167-176.

FAO. 2015. The state of food insecurity in the world 2015—Meeting the 2015 international hunger targets: taking stock of uneven progress (pp.56). FAO, Rome.

Fitzgibbon, C. D., H. Mogaka, and J. H. Fanshawe. 1995. Subsistence Hunting in Arabuko-Sokoke Forest, Kenya, and Its Effects on Mammal Populations. *Conservation Biology* 9:1116-1126.

Friedmann, Y., and B. Daly. 2004. Red data book of the mammals of South Africa: a conservation assessment. CBSG Southern Africa, Conservation Breeding Specialist Group (SSC/IUCN), Endangered Wildlife Trust. South Africa.

Frost, P. G., and I. Bond. 2008. The CAMPFIRE programme in Zimbabwe: payments for wildlife services. *Ecological Economics* 65:776-787.

Gavin, M. C., J. N. Solomon, and S. G. Blank. 2010. Measuring and monitoring illegal use of natural resources. *Conservation Biology* 24:89-100.

Geldmann, J., M. Barnes, L. Coad, I. D. Craigie, M. Hockings and N. D. Burgess. 2013. Effectiveness of terrestrial protected areas in reducing habitat loss and population declines. *Biological Conservation* 161:230-238.

Gibson, C. C. and S. A. Marks. 1995. Transforming rural hunters into conservationists: an assessment of community-based wildlife management programs in Africa. *World Development* 23:941-957.

Golden, C. D., L. C. Fernald, J. S. Brashares, B. R. Rasolofoniaina, and C. Kremen. 2011. Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. *Proceedings of the National Academy of Sciences* 108:19653-19656.

Grey-Ross, R., C. T. Downs, and K. Kirkman. 2009a. Is use of translocation for the conservation of subpopulations of oribi *Ourebia ourebi* (Zimmermann) effective? A case study. *African Journal of Ecology* 47:409-415.

Grey-Ross, R., C. T. Downs, and K. Kirkman. 2009b. Reintroduction failure of captive-bred oribi (*Ourebia ourebi*). *South African Journal of Wildlife Research* 39:34-38.

Grey-Ross, R., C. T. Downs, and K. Kirkman. 2010. An assessment of illegal hunting on farmland in KwaZulu-Natal, South Africa: implications for oribi (*Ourebia ourebi*). *South African Journal of Wildlife Research* 40:43-52.

Grobler, L. 2005. Conservation in South Africa: An Orchidist's Perspective. *Selbyana* 26:81-84.

Hansel, T. 2004. Observations on subsistence hunting along the Phu Yai mountain range, Xanakham district, Vientiane province, Lao PDR. *Natural History Bulletin of the Siam Society* 52:195-200.

Haynes, R., C. Dominy, and M. Graham. 2003. Effect of agricultural land use on soil organic matter status and the composition of earthworm communities in KwaZulu-Natal, South Africa. *Agriculture, Ecosystems and Environment* 95:453-464.

Hayward, M. W. 2009. Bushmeat hunting in Dwesa and Cwebe Nature Reserves, Eastern Cape, South Africa. *South African Journal of Wildlife Research* 39:70-84.

Henley, S. 1997. On the proposed reintroduction of serval (*Felis serval*) into the Great Fish River Reserve, Eastern Cape. Unpublished Report no. 16. University of Port Elizabeth, Port Elizabeth.

Henschel, P., L. T. Hunter, L. Coad, K. Abernethy, and M. Mühlenberg. 2011. Leopard prey choice in the Congo Basin rainforest suggests exploitative competition with human bushmeat hunters. *Journal of Zoology* 285:11-20.

Herbert, D., M. Hamer, M. Mander, N. Mkhize, and F. Prins. 2003. Invertebrate animals as a component of the traditional medicine trade in KwaZulu-Natal, South Africa. *African Invertebrates* 44:1-18.

Herrmann, E., J. F. Kamler, and N. L. Avenant. 2008. New records of servals (*Leptailurus serval)* in central South Africa: short communications. *South African Journal of Wildlife Research* 38:185-188.

Hughes, A. 2017. Understanding the drivers of southeast Asian biodiversity loss. *Ecosphere* 8:e01624.

Humphries, B. D., Ramesh, T., Hill, T. R., and Downs, C. T. 2016. Habitat use and home range of black-backed jackals (*Canis mesomelas*) on farmlands in the Midlands of KwaZulu-Natal, South Africa. *African Zoology* 51:37-45.

Hunter, M. L., R. K. Hitchcock, and B. Wyckoff-Baird. 1990. Women and wildlife in Southern Africa. *Conservation Biology* 4:448-451.

IUCN SSC Antelope Specialist Group. 2016. *Ourebia ourebi*. The IUCN Red List of Threatened Species 2016. Available from http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T15730A50192202.en (Accessed 22 March 2017).

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

Jacobs, P., N. Ngcobo, T. Hart, and M. Baipheti. 2010. Developmental social policies for the poor in South Africa: Exploring options to enhance impacts? Overcoming Inequality and Structural Poverty in South Africa: Towards Inclusive Growth and Development. HSRC and Free State University, Johannesburg.

John, F. A. S., G. Edwards-Jones, J. M. Gibbons, and J. P. Jones. 2010. Testing novel methods for assessing rule breaking in conservation. *Biological Conservation* 143:1025-1030.

Karanth, K. U., and M. E. Sunquist. 1995. Prey selection by tiger, leopard and dhole in tropical forests. *Journal of Animal Ecology* 64:439-450.

Kaltenborn, B. P., J. W. Nyahongo, and K. M. Tingstad. 2005. The nature of hunting around the western corridor of Serengeti National Park, Tanzania. *European Journal of Wildlife Research* 51:213-222.

Kaschula, S. A., & Shackleton, C. M. 2009. Quantity and significance of wild meat off-take by a rural community in the Eastern Cape, South Africa. *Environmental Conservation* 36:192-200.

Kaschula, S. A., & Shackleton, C. M. 2012. How do HIV and AIDS impact the use of natural resources by poor rural populations? The case of wild animal products. *South African Journal of Science* 108:01-09.

Keesen, F. E., A. C. Silva, E. Arashiro, and C. Pinheiro. 2017. Simulations of populations of *Sapajus robustus* in a fragmented landscape. *Ecological Modelling* 344:38-47.

Kerley, G. I., R. Sims-Castley, A. F. Boshoff, and R. M. Cowling. 2009. Extinction of the blue antelope (*Hippotragus leucophaeus*): modelling predicts non-viable global population size as the primary driver. *Biodiversity and Conservation* 18:3235-3242.

King, B. H. 2007. Conservation and community in the new South Africa: A case study of the Mahushe Shongwe Game Reserve. *Geoforum* 38:207-219.

Kingdon, J. 1971. East African Mammals: An Atlas of Evolution in Africa, Volume 3, Part A: Carnivores. University of Chicago Press, Chicago.

Kroos, A. 2016. Bushmeat Consumption and Prediction of Ebola Risk Factors in Senegal. MSc thesis, University of Washington, Washington.

Lacy, R. C. 1993. VORTEX: a computer simulation model for population viability analysis. *Wildlife Research* 20:45-65.

Lacy, R. C. 2000. Structure of the VORTEX simulation model for population viability analysis. *Ecological Bulletins* 48:191-203.

Lacy, R.C., P.S. Miller, and K. Traylor-Holzer. 2015. Vortex 10 User's Manual. 19 January 2015 update. IUCN SSC Conservation Breeding Specialist Group, and Chicago Zoological Society, Minnesota.

Laurance, M. Campbell, K. Abernethy and P. Alvarez. 2012. Averting biodiversity collapse in tropical forest protected areas. *Nature* 489:290-294.

Lev, E. 2003. Traditional healing with animals (zootherapy): medieval to present-day Levantine practice. *Journal of Ethnopharmacology* 85:107-118.

Lewis, S. L. 2006. Tropical forests and the changing earth system. *Philosophical Transactions of the Royal Society of London* B: 361:195-210.

Lewis, S. L., G. Lopez-Gonzalez, B. Sonké, K. Affum-Baffoe, T. R. Baker, L. O. Ojo, O. L. Phillips, J. M. Reitsma, L. White, and J. A. Comiskey. 2009. Increasing carbon storage in intact African tropical forests. *Nature* 457:1003-1006.

Lindenmayer, D. B., R. C. Lacy, and M. L. Pope. 2000. Testing a simulation model for population viability analysis. *Ecological Applications* 10:580-597.

Linder, J. M., and J. F. Oates. 2011. Differential impact of bushmeat hunting on monkey species and implications for primate conservation in Korup National Park, Cameroon. *Biological Conservation* 144:738-745.

Lindsey, P., P. Roulet, and S. Romanach. 2007. Economic and conservation significance of the trophy hunting industry in sub-Saharan Africa. *Biological Conservation* 134:455-469.

Lindsey, P., S. Romanach, and H. Davies-Mostert. 2009. The importance of conservancies for enhancing the value of game ranch land for large mammal conservation in southern Africa. *Journal of Zoology* 277:99-105.

Lindsey, P. A., S. Romanach, S. Matema, C. Matema, I. Mupamhadzi, and J. Muvengwi. 2011. Dynamics and underlying causes of illegal bushmeat trade in Zimbabwe. *Oryx* 45:84-95.

Lindsey, P., and C. Bento. 2012. Illegal hunting and the bushmeat trade in Central Mozambique. A case-study from Coutada 9, Manica Province. TRAFFIC East/Southern Africa, Harare, Zimbabwe.

Lindsey, P. A., G. Balme, M. Becker, C. Begg, C. Bento, C. Bocchino, A. Dickman, R. W. Diggle, H. Eves, and P. Henschel. 2013. The bushmeat trade in African savannas: Impacts, drivers, and possible solutions. *Biological Conservation* 160:80-96.

Liu, Z., Z. Jiang, H. Fang, C. Li, A. Mi, J. Chen, X. Zhang, S. Cui, D. Chen, and X. Ping. 2016. Perception, Price and Preference: Consumption and Protection of Wild Animals Used in Traditional Medicine. *PloS one* 11:e0145901.

Loibooki, M., H. Hofer, K. L. Campbell, and M. L. East. 2002. Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. *Environmental Conservation* 29:391-398.

Loveridge, A., A. Searle, F. Murindagomo, and D. Macdonald. 2007. The impact of sport-hunting on the population dynamics of an African lion population in a protected area. *Biological Conservation* 134:548-558.

Lowassa, A., D. Tadie, and A. Fischer. 2012. On the role of women in bushmeat hunting–Insights from Tanzania and Ethiopia. *Journal of Rural Studies* 28:622-630.

Magwaza, J. F. 2015. Making sense of oribi census. Midlands Conservancies Forum. Available from https://midlandsconservanciesforum.wordpress.com/2015/05/18/making-sense-of-oribi-census/ (Accessed: 23 November 2016).

Mainka, S. A., and J. A. Mills. 1995. Wildlife and traditional Chinese medicine: supply and demand for wildlife species. *Journal of Zoo and Wildlife Medicine* 1:193-200.

Mainka, S., and M. Trivedi 2002. Links between Biodiversity Conservation, Livelihoods and Food Security: The sustainable use of wild species for meat. IUCN Gland, Switzerland and Cambridge, United Kingdom.

Malhi, Y., and J. Grace. 2000. Tropical forests and atmospheric carbon dioxide. *Trends in Ecology and Evolution* 15:332-337.

Marsh, C. W., and R. A. Mittermeier 1987. Primate conservation in the tropical rain forest. Monographs in Primatology. Liss Inc., New York.

Martin, A., T. Caro, and M. Borgerhoff. 2012. Bushmeat consumption in western Tanzania: a comparative analysis from the same ecosystem. *Tropical Conservation Science* 5:352-364.

Martin, A., and T. Caro. 2013. Illegal hunting in the Katavi-Rukwa ecosystem. *African Journal of Ecology* 51:172-175.

Martin, A., T. Caro, and C. Kiffner. 2013. Prey preferences of bushmeat hunters in an East African savannah ecosystem. *European Journal of Wildlife Research* 59:137-145.

Mazibuko, S. 2013. Understanding underdevelopment through the sustainable livelihoods approach, *Community Development* 44:173-187.

McKean, S. 2004. Traditional use of vultures: some perspectives. In: Monadjem, A., Anderson, M.D., Piper, S.E. & Boshoff, A.F. (Eds). Vultures in the Vultures of Southern Africa – Quo Vadis? Proceedings of a workshop on vulture research and conservation in southern Africa. Birds of Prey Working Group, Johannesburg.

McKean, S. and M. Mander. 2007. Traditional medicine and the vulture trade. *South African Health Review* 21:197–199.

McKean, S., M. Mander, N. Diederichs, L. Ntuli, K. Mavundla, V. Williams, and J. Wakelin. 2013. The impact of traditional use on vultures in South Africa. *Vulture News* 65:15-36.

Mfunda, I. M., and E. Roslash. 2010. Bushmeat hunting in Serengeti, Tanzania: an important economic activity to local people. *International Journal of Biodiversity and Conservation* 2:263-272.

Mgawe, P., M. Borgerhoff Mulder, T. Caro, A. Martin, and C. Kiffner. 2012. Factors affecting bushmeat consumption in the Katavi-Rukwa ecosystem of Tanzania. *Tropical Conservation Science* 5:446-462.

Mills, J., and C. Servheen. 1994. The Asian trade in bears and bear parts: impacts and conservation recommendations. *International Conference on Bear Research and Management* 9: 161-167.

Milner-Gulland, E. J., and E. L. Bennett. 2003. Wild meat: the bigger picture. *Trends in Ecology and Evolution* 18:351-357.

Mkhabela, T., and S. Materechera. 2003. Factors influencing the utilization of cattle and chicken manure for soil fertility management by emergent farmers in the moist Midlands of KwaZulu-Natal Province, South Africa. *Nutrient Cycling in Agroecosystems* 65:151-162.

Molewa, B. 2010. National Environmental Management: Biodiversity Act, 2004: Act 10 of 2004. Affairs, Doe (Ed.), Draft Norms and Standards for the Management of Damage-Causing Animals in South Africa, Government Gazette, Pretoria.

Mootoosamy, A., and M. F. Mahomoodally. 2014. A quantitative ethnozoological assessment of traditionally used animal-based therapies in the tropical island of Mauritius. *Journal of Ethnopharmacology* 154:847-857.

Morgera, E. 2010. Wildlife law in the southern African development community (pp.136). FAO and CIC, Budapest.

Morris, W., D. Doak, M. Groom, P. Kareiva, J. Fieberg, L. Gerber, P. Murphy, and D. Thomson. 1999. A practical handbook for population viability analysis. The Nature Conservancy, Arlington.

Morris, W. F., P. L. Bloch, B. R. Hudgens, L. C. Moyle and J. R. Stinchcombe. 2002. Population viability analysis in endangered species recovery plans: past use and future improvements. *Ecological Applications* 12:708-712.

Mostert, R., and L. Hoffman. 2007. Effect of gender on the meat quality characteristics and chemical composition of kudu (*Tragelaphus strepsiceros*), an African antelope species. *Food Chemistry* 104:565-570.

Muposhi, V. K., E. Gandiwa, P. Bartels, and S. M. Makuza. 2016. Trophy hunting, conservation, and rural development in Zimbabwe: Issues, options, and implications. *International Journal of Biodiversity* 2016: ID 8763980, http://dx.doi.org/10.1155/2016/8763980.

Næss, M. W., and B.-J. Bårdsen. 2016. Why do Tibetan pastoralists hunt? *Land Use Policy* 54:116-128.

Nasi, R., A. Taber, and N. V. Vliet. 2011. Empty forests, empty stomachs? Bushmeat and livelihoods in the Congo and Amazon Basins. *International Forestry Review* 13:355-368.

Nel, W. 2009. Rainfall trends in the KwaZulu-Natal Drakensberg region of South Africa during the twentieth century. *International Journal of Climatology* 29:1634-1641.

Newmark, W. D. 2008. Isolation of African protected areas. *Frontiers in Ecology and the Environment* 6:321-328.

Ndibalema, V. G., and A. N. Songorwa. 2008. Illegal meat hunting in Serengeti: Dynamics in consumption and preferences. *African Journal of Ecology* 46:311-319.

Ngwenya, M. 2001. Implications for the medicinal animal trade for nature conservation in KwaZulu-Natal. Unpublished report no. NA/124/04. Ezemvelo KZN wildlife, Pietermaritzburg.

Nielsen, M. R. 2006. Importance, cause and effect of bushmeat hunting in the Udzungwa Mountains, Tanzania: Implications for community based wildlife management. *Biological Conservation* 128:509-516.

Njovu, F. C. 1993. Non-wood forest products in South Africa. Non-wood forest products: A regional expert consultation for English-speaking African countries (Pp.17-22). Annex IV. FAO and the Commonwealth Science Council, Rome and London.

Nowell, K., and P. Jackson 1996. Wild cats: status survey and conservation action plan. IUCN Gland, Switzerland and Cambridge, United Kingdom.

Nunkoo, D. H., and M. F. Mahomoodally. 2012. Ethnopharmacological survey of native remedies commonly used against infectious diseases in the tropical island of Mauritius. *Journal of Ethnopharmacology* 143:548-564.

Nuno, A., N. Bunnefeld, L. C. Naiman, and E. J. Milner-Gulland. 2013. A novel approach to assessing the prevalence and drivers of illegal bushmeat hunting in the Serengeti. *Conservation Biology* 27:1355-1365.

Obasanjo, O. 2013. The challenges of agricultural production and food security in Africa. Routledge, Abingdon.

Oliver, M. 1978. Population ecology of oribi, grey rhebuck and mountain reedbuck in Highmoor State Forest Land. *South African Journal of Wildlife Research* 8, 95-105.

Pangau-Adam, M., R. Noske, and M. Muehlenberg. 2012. Wildmeat or bushmeat? Subsistence hunting and commercial harvesting in Papua (West New Guinea), Indonesia. *Human Ecology* 40:611-621.

Patel, T. 2015. Population dynamics and relocation success of the oribi antelope (*Ourebia ourebi*) in KwaZulu-Natal, South Africa. MSc thesis. University of KwaZulu-Natal, Pietermaritzburg.

Perrin, M. R., and P. S. Everett. 1999. Habitat use by oribi at midlands elevations in KwaZulu-Natal, South Africa. *South African Journal of Wildlife Research* 29:10-14.

Perrin, M. J. 2002. Space use by a reintroduced serval in Mount Currie Nature Reserve. *South African Journal of Wildlife Research* 32: 79-86.

Pfeiffer, M. B., J. A. Venter, and C. T. Downs. 2015. Identifying anthropogenic threats to Cape Vultures *Gyps coprotheres* using community perceptions in communal farmland, Eastern Cape Province, South Africa. *Bird Conservation International* 25:353-365.

Pietersen, D. W., A. E. McKechnie, and R. Jansen. 2011. A review of the anthropogenic threats faced by Temminck's ground pangolin, Smutsia temminckii, in southern Africa. *South African Journal of Wildlife Research* 44:167-178.

R Core Team .2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available from https://www.R-project.org/

Ramesh, T., and C. T. Downs. 2013. Impact of farmland use on population density and activity patterns of serval in South Africa. *Journal of Mammalogy* 94:1460-1470.

Ramesh, T., and C. T. Downs. 2015. Diet of serval (*Leptailurus serval*) on farmlands in the Drakensberg Midlands, South Africa. *Mammalia* 79:399-407.

Ramesh, T., R. Kalle, and C. T. Downs. 2015. Spatiotemporal variation in resource selection of servals: insights from a landscape under heavy land-use transformation. *Journal of Mammalogy* 97:554-567.

Ramesh T, Downs C. T., Power J. R, Avenant, N., Laurence, S., Matthews, W., Child F. M. 2016. A conservation assessment of *Leptailurus serval*. In Child F. M., Roxburgh L., Do, Linh. San, E., Raimondo, D., Davies-Mostert H. T, eds. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Rands, M. R., W. M. Adams, L. Bennun, S. H. Butchart, A. Clements, D. Coomes, A. Entwistle, I. Hodge, V. Kapos and J. P. Scharlemann. 2010. Biodiversity conservation: challenges beyond 2010. *Science* 329:1298-1303.

Redford, K. H. 1992. The empty forest. *BioScience* 42:412-422.

Richter, M. 2003. Traditional medicines and traditional healers in South Africa. *Treatment Action Campaign and AIDS Law Project* 17:4-29.

Rija, A. A. 2009. The long-term impacts of hunting on population viability of wild ungulates in Tarangire, northern Tanzania. MSc thesis, Victoria University of Wellington, Wellington.

Ripple, W. J., K. Abernethy, M. G. Betts, G. Chapron, R. Dirzo, M. Galetti, T. Levi, P. A. Lindsey, D. W. Macdonald, and B. Machovina. 2016. Bushmeat hunting and extinction risk to the world's mammals. *Royal Society Open Science* 3:160498.

Robinson, J. G., and E. L. Bennett 2013. Hunting for sustainability in tropical forests. Columbia University Press, New York.

Rovero, F., A. S. Mtui, A. S. Kitegile, and M. R. Nielsen. 2012. Hunting or habitat degradation? Decline of primate populations in Udzungwa Mountains, Tanzania: An analysis of threats. *Biological Conservation* 146:89-96.

Rowe-Rowe, D. 1983. Habitat preferences of five Drakensberg antelopes. *South African Journal of Wildlife Research* 13:1-8.

SANBI. 2016. The Scientific Authority. Available from https://www.sanbi.org/biodiversity-science/science-policyaction/scientific-authority (Accessed: 21 March 2017).

Sandalj, M., A. C. Treydte, and S. Ziegler. 2016. Is wild meat luxury? Quantifying wild meat demand and availability in Hue, Vietnam. *Biological Conservation* 194:105-112.

Schlesinger, J., A. Drescher, and C. Shackleton. 2015. Socio-spatial dynamics in the use of wild natural resources: Evidence from six rapidly growing medium-sized cities in Africa. *Applied Geography* 56:107-115.

Scott-Shaw, C. R. and Escott, B. 2011. KwaZulu-Natal Vegetation Type Description Document for Vegetation Map 2011. Available from http://bgis.sanbi.org/kzn/KZN_vegetationtypes_descriptionsVer2_1.pdf (Accessed: 25 March 2015).

Selier, S. A. J., B. R. Page, A. T. Vanak and R. Slotow. 2014. Sustainability of elephant hunting across international borders in southern Africa: A case study of the greater Mapungubwe Transfrontier Conservation Area. *The Journal of Wildlife Management* 78:122-132.

Selier, S. A. J., R. Slotow, and E. Di Minin. 2016. The influence of socioeconomic factors on the densities of high-value cross-border species, the African elephant. *PeerJ* 4:e2581.

Shackleton, C. M., S. Shackleton, and B. Cousin. 2000. Re- Evaluating the communal lands of southern Africa: New understandings of rural livelihoods. *Natural Resource Perspectives* 62:1-4.

Shackleton, S., C. Shackleton, T. Netshiluvhi, B. Geach, A. Ballance, and D. Fairbanks. 2002. Use patterns and value of savanna resources in three rural villages in South Africa. *Economic Botany* 56:130-146.

Shackleton, C. M., and S. E. Shackleton. 2006. Household wealth status and natural resource use in the Kat River valley, South Africa. *Ecological Economics* 57:306-317.

Shackleton, C. 2009. Will the real custodian of natural resource management please stand up. *South African Journal of Science* 105:91-93.

Shanee, N. 2012. Trends in local wildlife hunting, trade and control in the Tropical Andes Biodiversity Hotspot, north-eastern Peru. *Endangered Species Research* 19:177-186.

Shrader, A. M., Little, I., Coverdale, B., Patel, T. 2016. A conservation assessment of *Ourebia ourebi ourebi*. In Child, F. M, Roxburgh, L., Do, Linh, San, E., Raimondo, D., Selier, J., Davies-Mostert H. T, eds. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Simasiku, P., Simwanza, H. I., Tembo, G., Bandyopadhyay, S. and Pavy, J. 2008. Game Management Areas in Crisis. The impact of wildlife management policies on communities and conservation. Natural Resources Consultative Forum, University of Zambia, Lusaka.

Simelane, T., and G. Kerley. 1998. Conservation implications of the use of vertebrates by Xhosa traditional healers in South Africa. *South African Journal of Wildlife Research 28*:121-126.

Simelane, T. 2011. Are traditionally used resources within conservation areas a function of their sizes? *Natural Resources* 2:130-139.

Skinner, J. D., and C. T. Chimimba 2005. The mammals of the southern African sub-region. Cambridge University Press, Cape Town.

Slobodian, L., Escot, L., Majamba, H., Bakari, G., Kweka, G., Lema, D., Luambuano, T. and Rwechungura, E. 2016. Wildlife cases in Tanzanian courts. Bonn, Germany.

Smith, E. H., D. M. Hudson and K. Schreckenberg. 2017. Livelihood diversification: The role of charcoal production in southern Malawi. *Energy for Sustainable Development* 36:22-36.

Smithers, R. H. 1986. Red data book–terrestrial mammals. South African National Scientific Programmes Report 125. CSIR, Pretoria.

Smithers, R. H. 1978. The serval *Felis serval* Schreber, 1776. *South African Journal of Wildlife Research* 8:29-37.

Sollmann, R., L. T. Hunter, R. Slotow, D. W. Macdonald, and P. Henschel. 2016. Effects of human land-use on Africa's only forest-dependent felid: The African golden cat (*Caracal aurata*). *Biological Conservation* 199:1-9.

Sporton, D., and D. S. Thomas. 2002. Sustainable livelihoods in Kalahari environments: a contribution to global debates. Oxford University Press, New York.

Statistics South Africa. 2011. Available from http://www.statssa.gov.za (Accessed 11 November 2016).

Stears, K. 2015. Key factors driving the foraging ecology of oribi; fear, cattle and the quality and quantity of food. Ph.D. thesis, University of KwaZulu-Natal, Pietermaritzburg.

Still, J. 2003. Use of animal products in traditional Chinese medicine: environmental impact and health hazards. *Complementary Therapies in Medicine* 11:118-122.

Stoll-Kleemann, S., and T. O'Riordan. 2002. From participation to partnership in biodiversity protection: experience from Germany and South Africa. *Society and Natural Resources* 15:161-177.

Stuart, C and Stuart, M. 2015. Stuarts' Field Guide to Mammals of Southern Africa, including Angola, Zambia and Malawi. 5th ed. Struik, Cape Town.

Swan, K., and K. Conrad. 2014. The conflict between Chinese cultural and environmental values in wildlife consumption. Routledge Handbook of Environment and Society in Asia. Routledge, Abingdon.

Sylvester, O., A. G. Segura, and I. J. Davidson-Hunt. 2016. The protection of forest biodiversity can conflict with food access for indigenous people. *Conservation and Society* in-press.

Tapela, B., and P. Omara-Ojungu. 1999. Towards bridging the gap between wildlife conservation and rural development in post-apartheid South Africa: the case of the Makuleke community and the Kruger National Park. *South African Geographical Journal* 81:148-155.

Tekalign, W., and A. Bekele. 2015. Population status of oribi (*Ourebia ourebi* Zimmermann, 1783) in Maze National Park, southern Ethiopia. *Bangladesh Journal of Zoology* 41:145-151.

Terborgh, J., G. Nuñez-Iturri, N. C. Pitman, F. H. C. Valverde, P. Alvarez, V. Swamy, E. G. Pringle, and C. Paine. 2008. Tree recruitment in an empty forest. *Ecology* 89:1757-1768.

The World Bank. 2014. Available from http://data.worldbank.org/indicator/ER.LND.PTLD.ZS?end=2014&locations=ZA&start=2014&view=bar. (Accessed: 02 February 2017).

Thiel, C. 2011. Ecology and population status of the serval (*Leptailurus serval*) Schreber, 1776 in Zambia. Ph.D. thesis, Bonn University, Germany.

Thiel, C. 2015. *Leptailurus serval*. The IUCN Red List of Threatened Species 2015: Available from http://dx.doi.org/10.2305/IUCN.UK.20152.RLTS.T11638A50654625.en. (Accessed 06 October 2016).

Thorn, M., M. Green, M. Keith, K. Marnewick, P. W. Bateman, E. Z. Cameron, and D. M. Scott. 2011. Large-scale distribution patterns of carnivores in northern South Africa: implications for conservation and monitoring. *Oryx* 45:579-586.

Tieguhong, J. C., and J. Zwolinski. 2008. Unrevealed economic benefits from forests in Cameroon. IuFRO International Symposium on emerging needs of society from forest

ecosystems: Towards the opportunities and dilemmas in forest managerial economics and accounting. Ljubljana, Slovenia.

Townsend, C. R. C. R. 2008. Ecological applications toward a sustainable world. Blackwell, United Kingdom.

Tsinda, A., R. Mugisha, L. Mutesi, A. Bizoza, E. Kayitesi, and P. Abbott. 2016. Biodiversity informatics in Eastern Africa: Status, drivers and barriers. *Journal for Nature Conservation* 32:67-80.

Uys, R. G., W. J. Bond, and T. M. Everson. 2004. The effect of different fire regimes on plant diversity in southern African grasslands. *Biological Conservation* 118:489-499.

Van, N. D. N., and N. Tap. 2008. An overview of the use of plants and animals in traditional medicine systems in Vietnam. TRAFFIC Southeast Asia, Greater Mekong Programme, Ha Noi.

Van Niekerk, J. d. V. 2012. Traditional healers formalised? *South African Medical Journal* 102:105-106.

van Vliet, N., and R. Nasi. 2008. Hunting for livelihood in North East Gabon: patterns, evolution and sustainability. *Ecology and Society* 13:3 http://www.ecologyandsociety.org/vol13/iss2/art33/

van Vliet, N., and P. Mbazza. 2011. Recognizing the multiple reasons for bushmeat consumption in urban areas: a necessary step toward the sustainable use of wildlife for food in Central Africa. *Human Dimensions of Wildlife* 16:45-54.

van Vliet, N., M. P. Quiceno Mesa, D. Cruz-Antia, L. J. Neves de Aquino, J. Moreno, and R. Nasi. 2014. The uncovered volumes of bushmeat commercialized in the Amazonian trifrontier between Colombia, Peru & Brazil. *Ethnobiology and Conservation* 3:1-11.

Vasco, C., and A. Sirén. 2016. Correlates of wildlife hunting in indigenous communities in the Pastaza province, Ecuadorian Amazonia. *Animal Conservation* 19:244-429.

Volampeno, M. S., G. H. Randriatahina, R. Kalle, A. L. Wilson, and C. T. Downs. 2015. A preliminary population viability analysis of the critically endangered blue-eyed black lemur (*Eulemur flavifrons*). *African Journal of Ecology* 53:419-427.

Warchol, G., L. L. Zupan, and W. Clack. 2003. Transitional criminality an analysis of the illegal wildlife market in southern Africa. *International Criminal Justice Review* 13:1-27.

Warchol, G., and B. Johnson. 2009. Wildlife crime in the game reserves of South Africa: A research note. *International Journal of Comparative and Applied Criminal Justice* 33:143-154.

Weis, J. S., J. Edwards, E. D. Enger, G. A. Gall, H. J. Jarrar, D. D. Lauritsen, E. Y. Pixley, T. L. Poulson, E. Samuels, and C. L. Shafer. 2002. Biology, environment, and conservation in South Africa: A delegation of biologists from the United States visited South Africa to learn about ecology, conservation biology, and environmental policy from South African biologists and resource managers. *BioScience* 52:781-789.

Western, D., S. Russell and I. Cuthill. 2009. The status of wildlife in protected areas compared to non-protected areas of Kenya. *PloS one* 4: e6140.

White, P. A., and J. L. Belant. 2015. Provisioning of Game Meat to Rural Communities as a Benefit of Sport Hunting in Zambia. *PloS one* 10:e0117237.

Whiting, M. J., V. L. Williams, and T. J. Hibbitts. 2013. Animals traded for traditional medicine at the Faraday market in South Africa: species diversity and conservation implications. Animals in Traditional Folk Medicine (pp. 421- 473). Springer, New York.

Wilkie, D. S., and J. F. Carpenter. 1999. Bushmeat hunting in the Congo Basin: an assessment of impacts and options for mitigation. *Biodiversity and Conservation* 8:927-955.

Williams, V. L., A. B. Cunningham, A. C. Kemp, and R. K. Bruyns. 2014. Risks to birds traded for African traditional medicine: A quantitative assessment. *PLoS one* 9: e105397.

Williams, V. L., and M. J. Whiting. 2016. A picture of health? Animal use and the Faraday traditional medicine market, South Africa. *Journal of Ethnopharmacology* 179:265-273.

Wright, S. J. 2003. The myriad consequences of hunting for vertebrates and plants in tropical forests. Perspectives in Plant Ecology. *Evolution and Systematics* 6:73-86.

Wright, S. J. 2005. Tropical forests in a changing environment. *Trends in Ecology and Evolution* 20:553-560.

Wright, S. J., A. Hernandéz, and R. Condit. 2007. The bushmeat harvest alters seedling banks by favouring lianas, large seeds, and seeds dispersed by bats, birds, and wind. *Biotropica* 39: 363-371.

Wynberg, R. 2002. A decade of biodiversity conservation and use in South Africa: Tracking progress from the Rio Earth Summit to the Johannesburg World Summit on Sustainable Development: *South African Journal of Science* 98:233–243.

Yohannes, D. W., and M. Chane. 2014. Ethnozoological study of traditional medicinal animals used by the Kore people in Amaro Woreda, southern Ethiopia. *International Journal of Molecular Evolution and Biodiversity* 4:1-8.

Ziegler, S., J. E. Fa, C. Wohlfart, B. Streit, S. Jacob, and M. Wegmann. 2016. Mapping bushmeat hunting pressure in Central Africa. *Biotropic*a 48:405-412.

## Appendices

### Appendix I:

The questionnaire used to assess the drivers and extent of illegal hunting and trade of serval (*Leptailurus serval*) and oribi (*Ourebia ourebi*) species in the Midlands and Durban *muthi* market, South Africa.

**Assessing the drivers and extent of hunting and trade in serval and oribi in South Africa**.

Common names: serval (E) indlozi (Z) tierboskat (A) Ingwenkala (X)

: oribi (E) oorbiegie (A) insinza (N)

*NB//* Respondents may remain anonymous.

| | |
|---|---|
| Name of Interviewer: | Date: |
| Location/indawo: | Survey assistant name: |
| Sub-area/isigodi: | Questionnaire No.: |

*NB// Sections with 3 stars to be completed by all respondents.*

*****A) Demographic Profile**

1. Age

| | | | | |
|---|---|---|---|---|
| 1. 18-25 | 2. 26-32 | 3. 33-40 | 4. 47-54 | 50 and above (please specify) |

2. Gender

| | |
|---|---|
| 1. Male | 2. Female |

3. Position in the family

| | | | | |
|---|---|---|---|---|
| 1. Head | 2. Daughter | 3. Son | 4. Close relative | 5. Other (please specify) |

4. Do you own livestock, land or both for farming?

| | | | |
|---|---|---|---|
| 1. Land | 2. Livestock | 3. Land and livestock | 4. None |

5. What are your livelihood options?

| | | | | |
|---|---|---|---|---|
| 1. Employed | 2. Trader | 3. Hunter | 4. Farmer | 5. Other (please specify) |

**B) The following section is to be completed by community members**

6. Are you aware of wild animals in your local area?

| | |
|---|---|
| 1.Yes | 2. No |

6.1 If yes, have you had any encounter with a wild animal in this area?

| | |
|---|---|
| 1.Yes | 2. No |

6.1.1 How, why, which species and how often? (Please see codes below).

| Activity | Animal | Reason | Regularity |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

Codes:

| | | | | |
|---|---|---|---|---|
| ***Reason*** | 1. Meat | 2. Sport | 3. Culture/ Tradition | 4. Muthi |
| ***Regularity*** | 1. Very frequent(weekly) | 2. Frequent(monthly) | 3. Sometimes (6months) | 4. Rare(yearly) |

6.1.2 If the selected activity above is hunting, do you hunt as a group or alone?

| | | |
|---|---|---|
| 1. As a group | 2. Alone | 3. As a group and alone sometimes |

7. What hunting methods do you use?

| | | | |
|---|---|---|---|
| 1. Snares | 2. Dogs | 3. Guns | 4. Other (please specify) |

7.1 If dogs, how many dogs do you have?

| | | | |
|---|---|---|---|
| 1. 1-2 | 2. 3-4 | 3. 5-6 | 4. More than 6 (please specify) |

8. Are you a subsistence or commercial hunter?

| | | |
|---|---|---|
| 1. Commercial | 2. Subsistence | 3. Both |

9. How long have you been hunting?

| | | |
|---|---|---|
| 1. Less than 5 years | 2. 5-10 years | 3. More than 10 years |

10. If the selected reason for hunting in 6.1.1 is tradition/culture, did your forefathers practice this?

**……..**

11. Have you taught your children to hunt or are you still going to teach them?

**……..**

12. If the selected reason in 6.1.1 is meat, do you prefer wild meat over domestic? If so why?

**……..**

**B (1) Contact with serval and oribi**

13. Have you had any encounter with serval or oribi?

| | | | |
|---|---|---|---|
| 1. Yes serval | 2. Yes oribi | 3. Yes Both | 4. No |

13.1 If yes, when was it?

| | | | |
|---|---|---|---|
| 1. Few days ago | 2. A week ago | 3. A month ago | 4. Other (please specify) |

13.2 Was it a random or a non-random encounter?

| | |
|---|---|
| 1. Random | 2. Non-random |

13.3 If encounter was with serval, are they problematic animals?

| | |
|---|---|
| 1. Yes | 2. No |

13.4 If yes, why and what mitigation measures are normally taken?

……

**C) The following section is to be completed by muthi traders**

14. Are you a muthi trader?

| | |
|---|---|
| 1. Yes | 2. No |

14.1 If yes, do you sell muthi derived from wild animals?

| | |
|---|---|
| 1. Yes | 2. No |

14.2. If yes, how long have you been trading here?

| | | | |
|---|---|---|---|
| 1. Less than 5 years | 2. 5 to 10 years | 3. 10-15 years | 4. More than 15 years |

14.3 Are you a registered trader with a permit to trade in protected species?

| | |
|---|---|
| 1. Yes | 2. No |

15. Do you know serval?

| | |
|---|---|
| 1. Yes | 2. No |

16. Do you sell any parts of it as traditional medicine or other uses?

| | |
|---|---|
| 1. Yes | 2. No |

16.1 If yes, how do you obtain it?

| | | |
|---|---|---|
| 1. Hunt/ Harvest | 2. Buy from supplier | 3. Other (please specify) |

17. What parts of serval are vital in muthi making or other uses?

……

18. What is this muthi used for? (E.g. ailments it heals)

……..

19. Have you noticed changes in the demand for this service?

| | |
|---|---|
| 1. Yes | 2. No |

20. If yes, where does the demand come from?

……...

21. If increased, what is causing this change?

…….

22. What other animals do you use more often?

…….

22.1. Would you accept products from game farmed animals or domestic alternatives (substitutes) if there were any?

| | |
|---|---|
| 1. Yes | 2. No |

22.2 If no, why?

.....

23. Do you have other livelihood options?

……

24. What measures do you take to ensure sustainability?

…….

**D) The following section is to be completed by farm workers.**

25. Do you hunt for meat?

| | |
|---|---|
| 1. Yes | 2. No |

25.1 If yes, why?

……

26. How long have you been hunting?

| | | |
|---|---|---|
| 1. Less than 5 years | 2. More than 5 years | 3. Grew up hunting |

27. How often do you hunt?

| | | | |
|---|---|---|---|
| 1. Once a week | 2. Once in two weeks | 3. Once a month | 4. Other (please specify) |

28. What animals do you hunt for meat?

……

29. What methods do you use when hunting and why?

……

30. How much was your last harvest?

| | | | |
|---|---|---|---|
| 1. One | 2. Two | 3. Three | 4. More than three (please specify) |

31. Do you know oribi and do you hunt for it?

| | |
|---|---|
| 1. Yes | 2. No |

32. Why do you prefer oribi (wildmeat) over Domestic meat?

| | | | |
|---|---|---|---|
| 1. Tastes better | 2. Easy to obtain | 3. Better source of protein | 4. other (please specify) |

33. Are you selective when hunting, gender and age wise?

| | |
|---|---|
| 1.Yes | 2. No |

33.1 If yes, what do you target for?

| 1. Males | 2. Females |
|---|---|
| A. Adult | B. Young |

34. Do you sell any derivatives of oribi?

**……**

**E) The following section is to be completed by hunters**

35. Are you a commercial or a subsistence hunter?

| 1. Commercial | 2. Subsistence |
|---|---|

36. How long have you been hunting?

| 1. less than 5 years | 2. 5 to 10 years | 3. More than 10 years |
|---|---|---|

37. Reasons for hunting

| 1. Meat | 2. Medicine | 3. Skins | 4. Sport | 5. Other (please specify) |
|---|---|---|---|---|

38. What methods do you use when hunting?

| 1. Snares | 2. Dogs | 3. Guns | 4. Other (please specify) |
|---|---|---|---|

38.1 If dogs, how many dogs do you have?

| 1. 1-2 | 2. 3-4 | 3. 5-6 | 4. More than 6 (please specify) |
|---|---|---|---|

39. How often do you go out to hunt?

| 1. Once a week | 2. Once in two weeks | 3. Once a month | 4. Other (please specify) |
|---|---|---|---|

40. Have you had contact with serval or oribi?

. ……

40.1 If yes, when was it?

| | | | |
|---|---|---|---|
| 1. This week | 2. Two weeks ago | 3. Three weeks ago | 4. More than 3 weeks ago |

41. Do you hunt for these animals and for what purposes?

……

42. How much was your last harvest?

| | | | |
|---|---|---|---|
| 1. One | 2. Two | 3. Three | 4. More than three (please specify) |

43. Has there been an increase in demand for these animals?
……

44. If yes, where is the demand coming from?

……

**F) Section to be completed by farmers**

45. Are you a farmer (commercial or subsistence)?

| | |
|---|---|
| 1. Yes | 2. No |

46. Are there servals or oribis in your property or in this area?

| | | | |
|---|---|---|---|
| 1. Yes servals | 2. Yes oribis | 3. Yes both | 4. No |

(Please indicate if they are in the area or in your property)

……....

46.1. If yes, how often do you see these animals or this animal?

| | | | |
|---|---|---|---|
| 1. Once a week | 2. Once in two weeks | 3. Once a month | 4. Other (please specify) |

47. How much land do you own (Square km or Hectares)?

**……..**

48. What kind of crops do you grow?

**……..**

49. How often do you burn grass or wetland vegetation?

| | | | |
|---|---|---|---|
| 1. Once a year | 2. Twice a year | 3. Three times a year | 4. Other (please specify) |

50. Have you ever found a dead oribi or serval in your property?

| | |
|---|---|
| 1. Yes | 2. No |

50.1 If yes, what was the cause of death?

**……**

*****G) Knowledge and consideration of laws and regulations (To be completed by all respondents)**

51. Do you know of any norms, regulations or laws governing the use of oribi or serval?

**……..**

52. If yes, do you understand and follow them, or have you ever tried following them?

**…….**

*****H) Changes (To be completed by all respondents)**

53. Have you noticed any changes in the population of serval or oribi?

| | |
|---|---|
| 1. Yes | 2. No |

54. If yes, are the changes positive or negative?

| | |
|---|---|
| 1. Positive | 2. Negative |

55. What could be the cause of such changes according to your understanding?

……

56. If negative, what can be done to solve the problem?

……

57. Has there been a disease outbreak involving oribi or serval?

……

58. Do you take any measures to ensure sustainable use of these resources (wild animals)?

……..

59. Do you know of any road accidents involving oribi or serval?

……..

**END**

**Appendix II:**

The results of the survey conducted in the Durban *muthi* market with *muthi* traders, skin traders and traditional healers.

| | | Parts used | | | | | | | Ailments & uses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Respondent | Procurement | Meat | Bones | Head | Feet | Fat | Body fluids | Skin | Headache | Epilepsy | Arthritis | bad spirits | urinary issues | Relationships | Traditional attire | Farmed Alternatives |
| MT | Buy | ✓ | ✓ | ✓ | | ✓ | | ✓ | | ✓ | | ✓ | | | | Yes |
| TH | Hunt | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | | | Yes |
| MT | Buy | | ✓ | | | | | ✓ | | | | ✓ | | ✓ | | Yes |
| TH | Buy | | ✓ | | | | | | | | ✓ | | | | | Yes |
| ST | Buy | | | | | | | ✓ | | | | | | | ✓ | Yes |
| ST | Buy | | | | | | | ✓ | | | | | | | ✓ | Yes |

Note: MT- *muthi* trader, TH- traditional healer, ST- skin trader.