Ownership and Poaching of Rhinos on Private Land in South Africa

Laura Chapman

PhD

University of York

Environment and Geography

July 2019

Abstract

South Africa contains almost 75% of Africa's rhino population, and around one-third of these rhinos are held on private land. This thesis focuses on the conservation contribution and challenges faced by private rhino owners. The work utilises historical surveys, a questionnaire of rhino owners and managers, and stakeholder interviews to assess the conservation value of private ownership of rhinos. Mainstream and social media reports of poaching events were combined with landowner reports to provide a database of poaching incidences. The questionnaires also provided information regarding the use and effectiveness of anti-poaching strategies employed by private rhino owners. Results indicate that private landowners have contributed significantly to the increase in numbers of rhinos in South Africa. Private rhino owners perceive that they make a valuable contribution to conservation, but this view is not always shared by wider stakeholders. Many challenges were identified by private owners, notably the continuing increase in security expenditure due to poaching. A wide range of anti-poaching strategies is employed by private rhino owners, with varying levels of success. Rhinos were more likely to be poached at night, under the light of a full moon, but there was no evidence of selective poaching with respect to species, sex or age. Private land located near to large urban areas, international airports and state or provincial parks holding rhinos was found to be most at risk of poaching, but the strength of these associations varied across the country. Rhinos were also found to be more at risk in areas of high unemployment and low engagement in formal education with Kwa-Zulu-Natal. There were no other associations found with any socio-economic factors. It is imperative that more detailed information relating to poaching of rhinos is recorded and released by the South African Government to assist with rhino conservation. Strategic deployment of anti-poaching strategies in areas known to be poaching hotspots may serve to reduce the impact of rhino poaching across the country, as may increased collaboration of private rhino owners with other stakeholders.

Contents

List of Tables

List of Figures

Acknowledgements

This research would not have been possible without the continued support of my supervisor Piran White. From initially taking a chance on an unfunded idea to continually pushing me through and providing insightful feedback on chapter drafts, I could not have done any of this without his help and support. As my only supervisor, I relied completely upon his guidance and expertise and I am truly thankful to him for believing in me.

I am also indebted to a number of other staff members at the University of York. As my TAP members, Andy Marshall and Julia Touza-Montero provided useful feedback and comments on my work throughout. With Julia in particular, continually driving me to produce better work. Colin McLean taught me how to map in R and helped develop much of the code used in Chapter 5 – without his assistance this chapter would not be anywhere near what it is now. I also thank Joana Cruz and Anna Riach for their assistance with statistical analysis and ideas for what else could be done. Thanks must also be offered to my internal examiner, Bryce Stewart, and my external examiner, Dawn Scott.

This work initially came about due to informal discussions with Lynne MacTavish, Dougal MacTavish, Charles Theron and James Huntingford. I am grateful to all of them for being the inspiration behind this work. Dougal and Lynne deserve special recognition for allowing me to be part of the Mankwe family and fostering my love of rhinos in the first place. Lynne further deserves thanks for taking part in the research, even though I know how difficult it is for her to discuss what has happened to her rhinos. I also thank Lynne for introducing me to Pelham Jones.

For the provision of the Private Rhino Owners Association data, and for valuable initial advice on working with private rhino owners, I thank Pelham Jones. I am forever thankful to all of those private rhino owners who contributed data to be used in Chapter 2 and details of their poached rhinos. As many remained anonymous, or did not want further involvement, I cannot thank them all individually, but I am eternally grateful for their willingness to supply delicate information without which this work could not have been undertaken.

For their engagement with the interviews undertaken for Chapter 3, and the provision of additional useful background information and advice, I am thankful to Hans Kooy,

Piet Warren, PC Ferreira, Stefran Broekman, Dex Kotze, Gabi Teren, Ian Hall, Elri Schaap, Pieter Kruger, Lozanne van Sittert, Patrick Minter, Eugene Fuhri and all those who opted to remain anonymous. Many of these people welcomed me to their properties and all shared their valuable time and wisdom without hesitation.

To conduct the fieldwork for Chapter 3, I required considerable assistance from my friend Dirk Boshoff. Without his help in translations and sharing the driving across much of South Africa during the first stage of fieldwork, this research would have been considerably more difficult. For their generous hospitality during this stage of fieldwork, I also wish to thank Wilhelmina Dorethea Boshoff, Paul Steyn and the Ferreira family.

Whilst the majority of this work was unfunded, I must thank the Scottish International Education Trust for two grants received which allowed me to undertake the second and third data collection visits to South Africa. I also thank my aunt and late uncle, Helen and Michael Gray, for their incredible generosity in supplementing my income to allow me to undertake this PhD in the first place. Similar thanks go to my mother, Aileen Chapman, for all her financial support. For my tuition fees, I must acknowledge the legacy of my late granny, Maureen Chapman. I hope she would agree that I have spent what she left me well.

The willingness of Operation Wallacea (notably Heather Gilbert) to allow me to collect data whilst working for their Balule project is gratefully acknowledged. I am also thankful for the opportunity I was given to share my work with the students. To be able to tell the story of the rhinos' plight to over 370 people, from 26 different countries on 6 continents, was truly special. I cannot mention Operation Wallacea without acknowledging the special friendship and support of the TWAM (those already acknowledged above, Sally Cave, Thilo Heinecke, Melissa van Rensburg and Andrew Clark). I am thankful not only for their support, but also for indulging my rhino obsession.

Finally, I cannot fully express my thanks for the love and support of my friends and family. My mother, aunt and wonderful boy Loki have borne the brunt of my stress and the inevitable emotional strain that comes with working on such a topic and have never wavered in their love and support for me. To all of my friends, those who have fully understood this process and those who have only a rough idea of what I've

been doing for the last four years, I am truly grateful for such friendship and love. A special note of thanks needs to go to the girls of office 128 (Polly, Sophie, Sarah, Karla, Maryam, Talia and Zakiya). They are all incredible women and I am so thankful for our friendship.

This thesis is dedicated to the memory of Cheeky Cow, Winnie, Charlie and Patrol. Their deaths at the hands of poachers inspired me to undertake this work and be “the voice of the voiceless”. I hope I have done justice to their memory.

Declaration

I declare that this thesis is a presentation of original work and I am the sole author, except where due acknowledgement is made. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

Publication of this work is as follows:

- Chapter 1: Parts of the literature review for this chapter have been published: Chapman, L. (2016). The past, present and future of private rhino conservation in South Africa. *Imprint. The Yorkshire Mammal Group Newsletter*, 43, 9-21. ISSN: 0264-6781
- Chapter 3: This chapter has been published: Chapman, L. A. and White, P. C. L. (2019). Stakeholder perspectives on the value and challenges of private rhinoceros ownership in South Africa. *Human Dimensions of Wildlife*, doi: 10.1080/10871209.2020.1697838

Piran White has been included as co-author on Chapters 2-5 due to his advice in editing the papers for publication. However, I have played the dominant role in all data collection, analysis and interpretation, and in writing this work.

Signed

Laura Aileen Chapman

Chapter 1:

Introduction

Structure of thesis

Aims and objectives

Literature review

Parts of the literature review for this chapter have been published: Chapman, L. (2016). The past, present and future of private rhino conservation in South Africa. *Imprint. The Yorkshire Mammal Group Newsletter*, 43, 9-21. ISSN: 0264-6781

Introduction

With concerns about the declining effectiveness of state-management of wildlife resources (Damania and Hatch, 2005), private landowners are likely to play an increasing role in achieving conservation objectives. It is therefore essential to understand the drivers behind private engagement in conservation and the effectiveness of private sector contributions to conservation. Throughout this work I use the definition of Sodhi et al. (2011) who define conservation as “any evidence of positive conservation outcomes, such as population increases of endangered species following targeted interventions” (pg. 585) and the specific private land conservation definition of any land “owned and administered by individuals, communities, NGOs, or corporations with a primary goal of protecting, managing and/or ensuring the persistence of biodiversity” (Selinske et al., 2015: pg. 282).

It is known that private lands host a considerable proportion of endangered terrestrial species including some which are absent or not appropriately represented within designated protected areas (Wilcove et al., 2004). Effective conservation policies therefore require contributions from private land (Figgis et al., 2005; Polasky and Doremus, 1998). Most land in western countries is privately owned (Bourke, 2011), including up to 70% of all land in the USA (Wilcove et al., 2004) and Australia (Figgis et al., 2005), but often conservation policies have focused on public land. Throughout the 19th century, the focus in France, Germany and the Netherlands was on government protection, whilst the UK and USA developed policies to encourage private land conservation (Bourke, 2011). This mix of private and state protection continued into the 20th century with Australia heavily developing conservation policies, for both public and private land, throughout the 1990s (Smith, 2006) and the USA starting to provide tax incentives and grants for conservation on private land (Mir and Dick, 2012). All levels of Australian government now have policies in place to enhance conservation on private land from voluntary agreements, through contractual agreements to binding covenants on land (Figgis et al., 2005). The New Zealand government has specifically recognised the importance of private land for conservation (Norton, 2000). Private landowners normally have a desire to derive economic gain from their land and so the management policies applied to public land may not be exactly replicable on private land (Norton, 2000), but collaboration between the public and private sector can mitigate these difficulties. In

the Northern Territory, Australia, 43% of land is held by indigenous peoples, with management plans in place combining modern science and land management techniques with the traditional understanding of ecology (Figgis et al., 2005). In South Africa in particular, the circumstances of the country's development have encouraged private conservation areas as a way for the government to absolve itself of the financial burden associated with conservation (Maciejewski et al., 2016).

In southern Africa, private ownership and use of wildlife resources has a long history, providing an ideal case study for research into private sector conservation. This thesis investigates the role of private ownership in the conservation of both black (*Diceros bicornis*) and white (*Ceratotherium simum*) rhinoceros (hereafter referred to by the more commonly used, shortened, term "rhino(s)") in South Africa. The variety of methods utilised by owners to manage and protect their stock will be discussed within the broader perspective of species conservation on private land. Rhinos have been chosen as the case study due to their position as charismatic mega-fauna and the increasing threat to them due to poaching, which has the potential to reduce the conservation value of private sector engagement in rhino protection. This work aims to explore the conservation value of private rhino ownership by considering the range of properties engaging in such actions and identifying any evidence of a move towards intensive management of rhinos on comparatively small areas of land. Conservation value is further explored by considering the growth of the private rhino industry over the last few decades and by considering the perceptions of both private rhino owners and the wider industry in relation to the conservation actions undertaken by private rhino owners both currently and in the future.

Poaching of wild rhino in South Africa is a problem that has grown significantly in the last few years. Prior to 2007, rhino poaching was at a very low level, averaging fourteen per year from 1990 to 2005 (Milliken and Shaw, 2012), but since then has increased to over 1,000 for every year between 2013 and 2017 (DEA, 2019). With white rhino currently classified by the International Union for the Conservation of Nature and Natural Resources (IUCN) as near threatened (Emslie, 2012a) and black rhino classified as critically endangered (Emslie, 2012b), any risks to the populations must be carefully monitored. Whilst the poaching of wild animals has been widely studied (e.g. Beale at al., 2018; Aziz et al., 2017; Becker et al., 2013; Gandiwa et al., 2013; Watson et al., 2013; Clements et al., 2010; Messer, 2010; Dobson and Lynes,

2008; Jachmann, 2008a; Jachmann, 2008b; Wato et al., 2006; Heltberg, 2001), very few studies have focused specifically on rhino (Barichievy et al., 2017; Lunstrum, 2017; Brook et al., 2014; Cheteni, 2014; Lopes, 2014; Milliken and Shaw, 2012) with even fewer (Barichievy et al., 2017; Lunstrum, 2017; Cheteni, 2014; Milliken and Shaw, 2012) based in southern Africa. Even those studies that have investigated poaching in general and rhino poaching across Africa and Asia have focused their attention on state owned national and provincial parks, with very little attention paid to the thousands of animals held on privately owned land. It must however be noted, that very recently, some researchers have focused their efforts on the conservation contribution and challenges faced by private rhino owners in South Africa (Rubino and Pienaar, 2018a; Rubino and Pienaar, 2018b; Rubino et al., 2018; Hayward et al., 2017; Pienaar et al., 2017; Ververs et al., 2017; Wright et al., 2016).

In 2008, there were 395 private farms in South Africa that kept rhino (Hall-Martin et al., 2009). Primarily these are southern white rhino, *Ceratotherium simum simum*. Recent population surveys suggest that South Africa currently holds 86.48% of all white rhino, of which around 45% are privately owned (Emslie et al., 2019). Of the 37.23% of the global population of black rhino found in South Africa (Emslie et al., 2019), around 33% are privately owned (Selier, 2019). These privately held animals therefore comprise an important part of the rhino population. Increased investment in rhinos by private rhino owners (Rubino and Pienaar, 2017) alongside increased populations, particularly on expansive areas of land (Rubino et al., 2018) lead to an increase in rhino conservation. Private farms incurred approximately 14% of the total rhino poaching incidences from 2004 to 2008, despite there being no confirmed rhino deaths by poaching on private land prior to 2007 (Hall-Martin et al., 2009). In 2017, 21.79% of rhinos poached were on private land (Rhino Alive, 2018). The poaching risk on private land is therefore increasing, yet what can be done to protect rhinos on private land has received little research attention and the real impact of rhino poaching on private land is not fully understood. This work explores the temporal and spatial factors related to rhino poaching as well as investigating factors which may make particular rhinos more likely to be poached than others. The work also looks at the range and effectiveness of anti-poaching strategies employed by private rhino owners to prevent such events from occurring on their properties.

Part of this work focuses on the relationships with local communities, as it has been well documented (e.g. Duffy and St. John, 2013; Lindsey et al., 2013; Rentsch and Damon, 2013; Kaltenborn et al., 2008; Johannesen and Skonhoft, 2005), that local communities are often involved in poaching. How this relates to rhino poaching on private land is however currently unknown. As well as exploring the socio-economic factors in areas around poaching hotspots which may entice people into rhino poaching, the work also considers the relationships between private rhino owners and their local communities.

Structure of the Thesis

The majority of this thesis (Chapters 2-5) is presented as scientific papers, with necessary crossover in methodology.

Chapter 1

This chapter outlines the aims of this study and presents a critical review of the literature surrounding this topic. Particular focus is given to the history and value of private conservation, both worldwide and in South Africa specifically. The review follows with a discussion of the status of rhino populations within South Africa, a wider discussion of the illegal trade in endangered species, how this demand for wildlife products drives poaching, and a review of anti-poaching options utilised to combat this issue. The review concludes with a discussion of the role local communities can play in conservation, thus widening the potential for private sector conservation contributions. Parts of the literature review for this chapter have been published: Chapman, L. (2016). The past, present and future of private rhino conservation in South Africa. *Imprint. The Yorkshire Mammal Group Newsletter*, 43, 9-21. ISSN: 0264-6781

Chapter 2

This chapter investigates the role of private rhino owners in the growth of southern white rhino populations, through the analysis of semi-regular studies conducted with these owners through time. Private rhino owners were then questioned to identify the range of properties engaging in private rhino ownership and whether they face similar challenges in their efforts to conserve rhinos into the future. This chapter also includes a small-scale investigation of the anti-poaching efforts deployed by private rhino owners and the effectiveness and economic impact of such measures.

Chapter 3

This chapter assesses the opinions of a variety of stakeholders associated with private rhino conservation. Their perceptions of private rhino ownership as a conservation tool and the associated challenges are investigated. This chapter also explores the potential future of rhinos in South Africa and includes a discussion of the potential for legal international trade in rhino horn. This chapter has been published: Chapman, L. A. and White, P. C. L. (2019). Stakeholder perspectives on the value and challenges of private rhinoceros ownership in South Africa. *Human Dimensions of Wildlife*, doi: 10.1080/10871209.2020.1697838

Chapter 4

This chapter investigates the temporal trends in rhino poaching on private land between 2003 and 2017 in an effort to determine when, with regards to specific months, days, times and moon phase, it may be most effective for private rhino owners to deploy their limited anti-poaching capabilities. This chapter also investigates whether specific categories of rhinos (in relation to their species, sex and age) are more at risk of being poached.

Chapter 5

This chapter identifies hotspots of in rhino poaching on private land between 2003 and 2017. Particular focus is given to spatial and socio-economic factors which may indicate areas where rhinos are more at risk of poaching. This may inform law enforcement agency activities in their efforts to deter and apprehend rhino poachers.

Chapter 6

This chapter concludes the work presented in the rest of the thesis in the wider context of private sector contributions to conservation. It includes a summary of the findings of this work in light of the initial aims and objectives and an evaluation of the methodology used. This is followed by wider discussion of the accuracy of the official

poaching statistics, how rhino poaching may change in the future, the wider role of private rhino owners in the conservation of rhinos in the future, legal international trade in rhino horn and the role local people can play in rhino conservation in the future. It concludes with suggestions for further work that could be carried out to further the collective knowledge on both the efficacy of private-sector animal conservation and the challenges faced by private rhino owners due to poaching, followed by final conclusions and recommendations.

Aims and Objectives

There were two main aims of the research. The first was to assess the conservation value of privately-owned rhino populations in South Africa and the challenges private rhino owners face. The second was to understand the spatial, temporal and socio-economic factors that have contributed to the substantial increase in rhino poaching that has occurred in the last decade – the major challenge faced by private rhino owners. The results of this work may encourage increased collaboration between rhino owners and the other stakeholders (notably governments and NGOs) in defining a future approach for rhino protection in South Africa. In the short term, the results of the second main aim may allow private rhino owners to more effectively direct their limited anti-poaching capabilities and may inform law enforcement actions in attempts to reduce rhino poaching on private land.

To achieve these two aims, the following specific objectives are identified:

1. To identify the role of private rhino owners in the resurgence of the southern white rhino from a species numbering less than 50 to one now numbering over 18,000.
2. To explore the range or properties engaging in private rhino conservation.
3. To explore the range of anti-poaching strategies employed by private rhino owners.
4. To explore the perspectives of different stakeholders involved in private rhino ownership.
5. To identify challenges to private rhino ownership that may impact on owners' decision to continue in their rhino conservation efforts.
6. To assess trends in rhino poaching on private land across South Africa between 2003 and 2017.
7. To identify hotspots of rhino poaching on private land across South Africa between 2003 and 2017 and identify socio-economic and spatial factors which may impact on these hotspots.

Literature Review

Private protection of public wildlife resources

Kamal et al. (2015) provide a broad overview of the ways in which private land conservation has been encouraged around the world considering both voluntary and involuntary strategies. They identify various voluntary strategies, including informal private reserves (such as those found in South Africa, Brazil and parts of Central America), voluntary but legally binding covenants and easements where the landowner will forgo certain activities in return for economic benefits, non-binding agreements, and conservation networks, where landowners work together to achieve conservation goals and share information and advice. These voluntary agreements are described as being directed by the landowners' desire to become involved in conservation work and may involve conservation organisations holding large parcels of land. They identify involuntary strategies as "prescriptions or prohibitions by government agencies or authorities that provide for minimal participation from landowners" (pg. 578) in either management or in decision making, which include total acquisition and/or compulsory displacement and imposed regulations. They state that whilst it is now rare for these to not include a compensatory aspect, there is still often little consultation with the landowner. A summary of conservation on private land globally is presented in Table 1.1.

Table 1.1: Summary of conservation on private land globally

Region/Country		Examples of private land conservation	References
Global		International Organization for Standardization (ISO) 1400 Environmental Management certification	Cashore et al., 2005
		Forest Stewardship Council certification	Cashore et al., 2005
Africa	Botswana	Community protected areas	Stone and Stone, 2011

	Kenya	Group ranches	Olivier, 2014; Carter et al., 2008
		Private conservancies	Olivier, 2014; Carter et al., 2008
	Namibia	Game farming	Muir-Leresche and Nelson, 2000
	South Africa	Biodiversity and Wine Initiative	Honig et al., 2015; von Hase et al., 2010
		Game farming	Carruthers, 2008; Muir-Leresche and Nelson, 2000
		Provincial Biodiversity Stewardship Programmes	Cumming and Daniels, 2014
	Tanzania	Payment for ecosystem service (PES)	Ingram et al., 2014
	Zimbabwe	Game farming	Muir-Leresche and Nelson, 2000
		Community lands	Duffy, 1997
		Freehold conservancies	Jones, 2014
Asia	China	Community/private nature reserves	Zhang, 2014
		Payment for ecosystem service (PES)	Zhang, 2014
	Japan	National Biodiversity Strategy includes private landowners	IUCN-WCPA, 2011
	Korea	National Trust	Heo, 2014
		National Nature Trust communal sites	Heo, 2014
		Biodiversity Management Contract Program	IUCN-WCPA, 2011
		Tax breaks for landowners	IUCN-WCPA, 2011

Australasia	Australia	Non-binding management agreements	Clough, 2000
		Permanent land covenants	Fitzsimons, 2014; Clough, 2000
		Permanent easements	Fitzsimons, 2014; Clough, 2000
		Federal Save the Bush Programme grants	Clough, 2000
		Biodiversity Banking/Biobanking	Smith, 2006
	New Zealand	Open space covenants	Clough, 2000
		Nature Heritage funded areas	Clough, 2000
Europe	Finland	Private nature reserves	Heinonen, 2014
		Habitat or Species Protection Areas	Heinonen, 2014
	Germany	Differential Land Use Tax	Clough, 2000
		Landcover Mitigation Scheme	Clough, 2000
	Spain	Land Stewardship schemes	Fornieles, 2014
	Switzerland	Ecological Compensation Programme	Clough, 2000
	United Kingdom	54% of Sites of Special Scientific Interest in England are privately owned	Kirby, 2003
		Land held by NGOS (e.g. National Trust, RSPB)	Langholz and Krug, 2004
		National Park system	Kirby, 2003
North America	Canada	Canadian Boreal Forest Agreement	Murray et al., 2015
		Conservation covenants with associated tax relief	Clough, 2000
		Natural Areas Conservation Program	Wilkinson, 2014
	Mexico	Voluntary Conservation Use Areas	Bezaury-Creel, 2014

	United States	Nature Conservancy conservation easements	Rissman et al., 2007
		Tax relief in individual states	Clough, 2000
		Conservation Reserve Program grants	Clough, 2000
		US Fish and Wildlife Service Safe Harbor agreements	Wilcove et al., 2004
South America	Brazil	Privately-owned Atlantic Forest reserves	Buckley and Vasconcellos Pegas, 2015
		Legal Reserves	Pellin and Valladares Pádua, 2014
		Areas of Permanent Preservation	Pellin and Valladares Pádua, 2014
		Forrest/environmental easements	Pellin and Valladares Pádua, 2014
		Private Reserves of Natural Heritage	Pellin and Valladares Pádua, 2014
	Chile	Voluntary protected areas	Núñez-Ávila, 2014
		Nature Sanctuaries	Núñez-Ávila, 2014

In the United States of America, most land is privately owned, but conservation is focused on public land, despite half of all threatened species being found exclusively on private land and almost all having some distribution on private land (Knight, 1999). There are however, a variety of schemes in place to encourage private land conservation in the US. Conservation easements, set up by the Nature Conservancy, are negotiated individually for a variety of purposes including contributing to connectivity of areas, protecting endangered species and restoration activities (Rissman et al., 2007). Individual states also have their own easement

policies in exchange for tax relief (Clough, 2000). Voluntary agreements exist which require land owners to sign up to a long-term contract in exchange for grants to replace lost income, such as the Conservation Reserve Program (CRP), which has ten year contracts (Clough, 2000), US Fish and Wildlife Service (FWS) Safe Harbor agreements, where grants are received in order to undertake activities consistent with biodiversity protection (Wilcove et al., 2004), and the Conservation Security Program (CSP), which pays landowners US$20,000-45,000 annually to sign up to 5-10 year contracts to adopt and maintain conservation practices on their land (Shogren et al., 2003). What defines all of these agreements is that the landowners must protect the species. The Endangered Species Act prevents any utilisation of the species under its protection (Clough, 2000) and so landowners are not able to exploit those resources. It assumes that preventing a species from becoming extinct is worthwhile regardless of the cost (Shogren et al., 2003) and so landowners face restrictions on their use of their land under this Act, which does not supply compensation for such actions (Clough, 2000).

In Canada, the policies are similar to those in the US. There are programmes offering annual payments to cover conservation costs and lost income for 15-21 year contracts (Permanent Prairie Cover Restoration Program), conservation covenants in exchange for tax relief (Clough, 2000) and the voluntary Canadian Boreal Forest Agreement (CBFA), which prevents logging over 29 million hectares of boreal forest (Murray et al., 2015). Private land conservation often takes place in forested environments, with many governments utilising economic incentives to encourage forest landowners to reduce activities that are harmful to the natural environment and encourage those which can restore habitats (Mayer and Tikka, 2006). In the US, which has a history of deforestation, incentives typically focus on increasing the area of forest cover, whilst in Europe, incentives typically focus on specific features of the forests related to quality and diversity, rather than just total area (Mayer and Tikka, 2006). Certification programmes exist to endorse private forest owners for acting in an environmentally compatible manner, such as the International Organization for Standardization (ISO) 1400 Environmental Management certification, which requires voluntary adherence to processes related to wood product production, and Forest Stewardship Council (FSC) certification, which is a form of private governance with the threat of social action if adherence is not forthcoming (Cashore et al., 2005). As

with the specific US examples, these schemes promote protection of habitats for species and so do not include rights to utilise the wildlife found within these areas.

Private conservation has a long history in the United Kingdom, with organisations such as the National Trust and the Royal Society for the Protection of Birds (RSPB) holding large areas of land (Langholz and Krug, 2004), and most of England's National Park system comprising private lands (Kirby, 2003). Historically, the Nature Conservancy Council (now Natural England) designated Sites of Special Scientific Interest (SSSIs) for protection. Around 54% of the SSSI woodlands in England are privately owned (Kirby, 2003). From 1949 to 1980, SSSI designation did not effectively prevent development, until the initiation of the Wildlife and Countryside Act 1981, which gave the Nature Conservancy Council more power and provided compensatory payments to landowners for lost income (Kirby, 2003). As with the North American examples discussed so far, conservation on private land in the UK aims to prevent utilisation of rare and threatened species. In some cases UK property rights can even create more conservation problems with the preference for salmon and trout (*Salmo sp.* and *Oncorhynchus mykiss*) fishing leading to the deliberate removal of other species, and the popularity of carp (*Cyprinus carpio*) fishing leading to over stocking of these fish, which can be destructive to habitats (Clough, 2000).

Australia has also long considered conservation of wildlife as the responsibility of the government, but the role that private lands play is becoming more recognised, with each state and territory implementing legislation for private land conservation (Byron et al., 2001). Again, there are a variety of schemes in place to encourage private land conservation (Clough, 2000), including non-binding management agreements (e.g. Land for Wildlife) where management information is provided, permanent covenants where landowners are compensated for lost income (e.g. Conservation Covenant Programme, Victoria), permanent easements in exchange for one-off payments (e.g. Heritage Agreements, South Australia), purchasing of leases in exchange for recurring payments (e.g. Conservation Area Scheme, South Australia) and grants for biodiversity enhancement work (e.g. Federal Save the Bush Programme). Another scheme across the whole of Australia is known as Biodiversity Banking (Biobanking); a market-based approach to encouraging development that offsets its biodiversity costs through tree planting or other forms of vegetation

management (Smith, 2006). Unlike the previous examples, Australia does not necessarily prevent the utilisation of the wildlife found on private land (Byron et al., 2001). Queensland legislation controls the “taking, keeping, use and trade of native wildlife by the private sector” (pg. 10), but there is uncertainty about ownership due to multiple licensing and permit regulations, whereas in South Australia it is possible to apply to keep any native wildlife. This difference makes the system in some Australian states much more comparable to the private reserve networks of southern Africa.

Chacon (2005) provides a discussion of private land conservation throughout Central America, highlighting that most lands are privately owned, either through land titles or by occupation, but there is little information available about how many there are or what form they take. Best estimates are that there are at least 350 landowners, protecting 350,000 ha in total across the region. How these private areas are managed for conservation is not overseen by government or NGOs. If landowners do not wish to be involved, they can have their land removed from the list of privately protected areas unless there is a permanent easement on the land. Historically, these private landowners have been seen as a threat to biodiversity conservation, but most form private protected areas because they feel it is important for intrinsic and economic reasons, and to access support available, such as tax breaks, which are not effective in all countries, payments for environmental services (PES) in the form of annual cash payments per protected hectare and access to legal procedures to evict squatters. The ability of these private landowners to manage their lands as they choose is much more comparable to the southern African system of private land management and wildlife utilisation than those of the more developed countries discussed so far.

In South Africa, vineyard owners have been targeted for involvement in voluntary conservation activities. The Biodiversity and Wine Initiative (BWI) gives landowners voluntary incentives, such as public recognition, to manage vineyards in such a way as to promote biodiversity (von Hase et al., 2010). Of those involved, one study (Honig et al., 2015) found that 86% were motivated by intrinsic values, by their own innate responsibility to conservation, with only three of the people interviewed identifying economic gains as the reason for their involvement. Whilst this is positive, such schemes are not necessarily effective. Only 11% of five-year conservation

goals were achieved and less than 9% of 20-year goals were met (von Hase et al., 2010). Whilst this strategy of voluntarily involving landowners in conservation activities aimed to protect habitats is common in the rest of the world, it is a relatively new idea in southern Africa. The countries in this region have historically managed private land conservation in a very different way. South Africa, Zimbabwe, Botswana and Namibia are unusual compared with much of the rest of the world, in that they have largely privatised the ownership of wildlife – so long as certain conditions (relating primarily to fencing) are met, then owners can utilise the wildlife on their land (Muir-Leresche and Nelson, 2000). This virtually unique situation in southern Africa, of permitting the commercial utilisation of wildlife resources, makes the game farming industry of South Africa an ideal case study for further exploration of the private protection of public wildlife resources.

History of game farming in South Africa

Game was abundant throughout Africa, except in the former Cape Province, throughout the nineteenth century, until the increased use of guns brought about significant declines in the early decades of the twentieth century (Pollock, 1969). This led to an increased interest in the preservation of native species, with the first game reserves being developed in the former Transvaal of South Africa in 1894 and 1898, followed by the former Zululand in 1897, and other African nations subsequently (Pollock, 1969). Demand for meat after World War 2 and drought creating challenging environments for raising cattle were both linked to increased interest in game farming in South Africa (Carruthers, 2008). By 1956-1959, wild game was generating revenue for more than 2,000 properties (Pollock, 1969). The first private game auction took place in 1965, followed by sales from provincial conservation departments (Carruthers, 2008). The Department of Agricultural Development recognised the legitimacy of game ranching as an agricultural activity in 1980, although implementation of the appropriate subsidies took considerably longer (Carruthers, 2008). The Certificate of Adequate Enclosure, issued by the provincial authorities, conferred full ownership rights over the animals on their land to private landowners (Carruthers, 2008). These developments in South Africa were replicated in Rhodesia (Muir-Leresche and Nelson, 2000) in 1961, with the implementation of the Conservation Act allowing farmers to harvest their wildlife

under permit, which led to the development of a safari industry throughout the 1960s. In 1975, this was extended to allow the management of all wildlife activity on private land under the Parks and Wildlife Act. After independence in 1980, the newly formed Zimbabwe also experienced rapid development in game ranching. Zimbabwean conservancies also developed, partially in co-operation with WWF's Rhino Conservancy Project. Namibia transferred management of wildlife to private landowners in 1967 (Muir-Leresche and Nelson, 2000).

The increasing number of game farms throughout South Africa led to the development of the Game Theft Act 105 of 1991, which gave private landowners legal rights over the animals on their land (Davies-Mostert, 2014; Burgener et al., 2001) and includes animals which have escaped or been deliberately lured away (Burgener et al., 2001). This legal protection for game farmers has led to the expansion of the game farming industry to include livestock auctions and the growth of trophy hunting and other commercial exploitation of wildlife (Davies-Mostert, 2014).

Private land dedicated to game farming covers an area more than three times that of all protected state and provincial land (Milliken and Shaw, 2012). However, one particularly potentially lucrative animal was, for a long time, missing from this industry, the rhino. Black and white rhinos are one of South Africa's "big five"; they are the most difficult to hunt on foot (Taylor et al., 2015a) and therefore the most valued by hunters. Whilst the rest of the big five (lions (*Panthera leo*), leopard (*Panthera pardus*), buffalo (*Syncerus caffer*) and elephant (*Loxodonta africana*)) were also heavily hunted (Caro and Riggio, 2014), rhinos faced additional problems due to land clearances (Leader-Williams, 2013). By 1900, the number of white rhinos had dropped to fewer than 50 (Knight et al., 2015; Brooks, 1999). At that point, all white rhinos were in one population under the ownership of the then Natal Parks Board (Emslie, 1999) and intensive breeding programmes were started, resulting in over 1,800 white rhinos by 1968 (Milliken and Shaw, 2012). The black rhino was historically much more numerous and may have numbered up to 850,000 across the whole of Africa at one stage (Emslie, 2012a). Black rhinos were also affected by the land clearances that reduced white rhino populations (Leader-Williams, 2013), with an estimated 100,000 remaining by 1960 (Emslie, 2012a).

Current status of rhinos in South Africa

By 1895, around 50 white rhinos made up a single population in the former Umfolozi Game Reserve (EWT, 2013), within what is now KwaZulu-Natal (KZN) Province (Carruthers, 2013). Throughout the 1940s and 1950s, interest in conservation grew and the development of more protected areas led to the population reaching 437 by the first aerial count in 1953 (EWT, 2013). The intensive breeding and conservation programme known as “Operation Rhino” was instigated in 1961 (EWT, 2013) to sell some of these animals to private owners in order to ensure the carrying capacity of the region was not exceeded (Knight, 2015; Carruthers, 2013; Leader-Williams, 2013; Milliken and Shaw, 2012; Leader-Williams et al., 2005; Spenceley and Barnes, 2005; Brooks, 1999). The first sales of white rhinos from Natal Parks Board to private owners occurred in 1986, allowing white rhinos to reach their commercial sales value (Knight, 2015). Black rhino sales followed in 1990 (‘t Sas-Rolfes, 1997; Walker, 1994), when the first breeding herd was sold to Lapalala Wilderness (Walker, 1994). Trophy hunting of white rhinos was legalised in 1968 (Knight, 2015; Brooks, 1999; Emslie, 1999), when the population was only 1,800 (Knight, 2015). The ability to now own white rhinos and offer them as hunting trophies once again allowed private white rhino owners to offer hunters a big five experience. By 2004, the white rhino population in South Africa had increased six-fold (Reilly et al., 2004), due to the now strong financial incentives to keep and breed these animals (Abensperg-Traun, 2013; ‘t Sas-Rolfes, 1997). These financial incentives, combined with the legal protection afforded by the Game Theft Act, 1991, promoted legal ownership and consumptive use of stock, and so the privately held white rhino population in South Africa grew to around 5,000, on 400 properties, by 2008 (Knight, 2015).

By the end of 2017, the South African population, of around 15,625 white rhinos, represented over 86% of the total wild population (Emslie et al., 2019). South Africa was also estimated to hold around 2,046 black rhinos (37% of the total population: Emslie et al., 2019). More than 42% of South Africa’s black and white rhino populations are held by private owners (Emslie et al., 2019). Private sector ownership of these animals therefore represents a sizeable proportion of the total population. Private owners regularly buy and sell stock, both from the private sector and from South African National Parks (SANParks) and provincial bodies, with the

South African government selling 581 rhinos between 2005 and 2008, generating ZAR98.3 million (Milliken and Shaw, 2012). The former Natal Parks Board sold white rhinos in 1980 for ZAR9,900 (extrapolated to 2004 prices) which was considerably less than the trophy price of ZAR64,350 (2004 equivalent), resulting in owners buying them to be hunted (Spenceley and Barnes, 2005). Opening the market to auctions rather than set pricing increased the value of the animals with average prices ranging from ZAR95,281 in 2005 to ZAR274,712 in 2008 (Hall-Martin et al., 2009). These auction prices include privately owned animals, with the prices fetched by SANParks and Ezemvelo KZN Wildlife (the former Natal Parks Board) only averaging ZAR230,000 in 2011 (DEA, 2013). Whilst the prices achieved by state and provincial animals are not as high as those from privately reared animals, this still represents a sizeable contribution to the income of these state conservation organisations.

The recovery of black rhino populations was managed in much the same way as that of white rhinos, primarily on state-owned land (Leader-Williams et al., 2005), with private sector ownership of black rhinos only heavily promoted since the 1990s (Leader-Williams et al., 2005). Black rhinos are currently listed on Appendix I of CITES (CITES, 2017), which may partially explain why there are far fewer black rhinos kept on private land.

Whilst the size of the privately-owned rhino population and the commercial benefits associated with keeping them are clear, what is less well understood is the range of properties engaging in private rhino ownership. The motivations of private owners in keeping these animals, beyond simple commercial value, are also poorly understood. This thesis explores the range of properties engaging in private rhino conservation and the effectiveness of such actions in Chapter 2. The motivations of owners are briefly considered in Chapter 2 when asked about the priorities of their properties, and further considered in Chapter 3. Chapter 3 also considers the wider industry perceptions of the value of private rhino owners to rhino conservation, both now and in the future.

International trade in wildlife products

All species of rhino were placed on the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix I (which restricts all commercial international trade in listed species and their parts; CITES, not dated; ‘t Sas Rolfes, 1997) in 1977 (Hume, 2013; Milliken and Shaw, 2012), which prevented international hunters from exporting trophies from South Africa. After this listing on Appendix I, the final end market price of rhino horn increased significantly (Abensperg-Traun, 2013; ‘t Sas-Rolfes, 1997); triggering poaching and stockpiling of rhino horn by producers (‘t Sas-Rolfes, 1997). In 1992, South Africa (along with Zimbabwe) proposed the downlisting of its white rhino populations to Appendix II, which permits trade so long as it is not detrimental to the future sustainability of the species and the required permits are obtained (Abensperg-Traun, 2009; ‘t Sas-Rolfes, 1997; CITES, not dated;), but this was rejected (Leader-Williams, 2003; ‘t Sas-Rolfes, 1997). In 1994, the exportation of live specimens to “appropriate and acceptable destinations” (CITES, not dated) and hunting trophies was legalised by downlisting to Appendix II for these purposes only (Leader-Williams et al., 2005; Leader-Williams, 2003; Brooks, 1999). Full Appendix II downlisting was again proposed and rejected in 1997 (Leader-Williams, 2003). Since the downlisting of live specimens and hunting trophies, the white rhino population of South Africa has increased by 50% (Reilly et al., 2004). The auction price of white rhinos, which had stabilised under Appendix I listing, also increased after downlisting (‘t Sas-Rolfes, 1997).

Throughout the 1970s to the mid-1990s (whilst international trade was prohibited), Africa’s rhinos suffered their first poaching crisis; primarily due to the demand for traditional medicine in Asia and dagger handles in Yemen (Knight, 2015; Emslie, 2012a; Emslie, 2012b; Milliken and Shaw, 2012; Spenceley and Barnes, 2005; ‘t Sas-Rolfes, 1997). This first major poaching crisis resulted in the loss of around 100,000 rhinos across the continent (Hume, 2013). Black rhinos in Kenya were particularly heavily persecuted throughout this time (Walpole et al., 2001; ‘t Sas-Rolfes, 1997; Western, 1982) and total black rhino numbers decreased by 96% across Africa between 1970 and 1992 (Spenceley and Barnes, 2005) and 98% when the time limit is expanded to 1960 to 1995 (Emslie, 2012a). Total numbers of black rhinos across Africa had dropped to only 2,410 by 1995 (Knight, 2015), although

South Africa (and Namibia) did not suffer as heavily from the poaching of black rhinos as other countries (Knight, 2015).

Alongside the international trade in white rhinos and their parts, South Africa also permitted national trade in rhino horn, until that was banned on the 13th February 2009 (High Court of South Africa, 2015a). This moratorium on the domestic trade in rhino horn was lifted on the 26th November 2015, by the High Court of South Africa, Gauteng Division, Pretoria, which deemed the ban illegal due to "substantial non-compliance with consultative and participatory process by the members of the public" (High Court of South Africa, 2015a: 37). The Department of Environmental Affairs (DEA) indicated it would appeal this ruling and filed an application to do so on the 7th December 2015 (DEA, 2015a; High Court of South Africa, 2015b). This appeal was dismissed on 20th January 2016 (DEA, 2016a). A further appeal was lodged against this ruling (DEA, 2016a), but dismissed by the Constitutional Court (Constitutional Court of South Africa, 2017) meaning that sales of rhino horn within South Africa are now legal.

There have been suggestions by some private rhino owners that trade restrictions are responsible for the increase in rhino poaching (Hume, 2013). Rhino Alive (an initiative of the Private Rhino Owners Association [PROA]) has also suggested that the CITES international ban on rhino horn was linked to the initial poaching crisis of the 1970s to mid-1990s (Rhino Alive, 2016). It has been claimed (Milliken and Shaw, 2012) that the national trade had previously, illegally, supplied international demand for rhino horn. In that case, the lifting of the national moratorium may lead to a decrease in rhino poaching, but that is, as yet, unknown.

The potential for legalisation of international trade in rhino horn had been considered by the Department of Environmental Affairs prior to the 17th CITES Conference of Parties (CoP), held in Johannesburg in September 2016 (DEA, 2015b; Duffy et al., 2013), with the 2016 DEA budget including this proposal (National Treasury, 2016). However, at the cabinet meeting of 13th April 2016, this proposal was rejected (Government Communication and Information System, 2016). The potential to submit a proposal for trade in rhino horn was considered again in 2018 (Parliamentary Monitoring Group, 2018), but no proposal from South Africa was submitted ahead of the 18th CITES CoP (CITES, 2019).

One outspoken private rhino owner, John Hume, published an open letter (Hume, 2013) which claims that the CITES ban is a “dismal failure” (pg. 15). He discusses the issues with trade bans driving trade underground and artificially inflating prices, for what is essentially a renewable/sustainable product, due to the fact that horn grows back (Biggs et al., 2013; Duffy et al., 2013; Hume, 2013). This idea that CITES does not work as a conservation tool has been considered by multiple authors (e.g., Weber et al., 2015; Abensperg-Traun, 2013; ‘t Sas-Rolfes, 1997), with most focusing on the trade in elephant ivory (Gao and Clark, 2014; van Kooten, 2008; Heltberg, 2001; Bulte and van Kooten, 1999; Burton, 1999; Khanna and Harford, 1996; Glennon, 1990).

CITES exists to restrict trade in order to try and protect vulnerable species and populations (Challender et al., 2015a; Weber et al., 2015), but trade bans will not eliminate all trade as long as economic gains can be made from an illegal product (van Kooten, 2008); without a reduction in demand the trade is simply driven underground (Challender et al., 2015b; Khanna and Harford, 1996). The total international trade in flora and fauna, in 2002, was in excess of US$20 billion, with about a quarter of this estimated to be illegal (Brack, 2002). By 2004, the trade was worth US$159 billion, involving more than 350 million plants and animals, with US$6 billion of this trade estimated to be illegal (Warchol, 2004). The species protected by CITES are scarce and, as with any rare product, high demand can drive high prices, making this an exceptionally lucrative trade. Wildlife crime is particularly lucrative due to the low costs involved in extraction, high value, ease of trafficking and difficulties in proving the illegality of the product (Douglas and Alie, 2014). CITES regulations are also often poorly enforced, due to lack of funding or political will (Brack, 2002), or not being considered a priority in the context of high-value resources (Douglas and Alie, 2014). There are also suggestions that such illegal products have been concealed in diplomatic baggage (Warchol, 2004; Brack, 2002), suggesting that the problem is as much a political issue as a law enforcement and environmental one. Tackling such corruption and ensuring regulation is effective is just as important as legislation in reducing environmental crime (Coppens, 2013), such as the poaching and smuggling of illegal rhino horn and elephant ivory.

The African elephant was placed on CITES Appendix II in 1976 (‘t Sas-Rolfes, 1997) then upgraded, in December 1989, to Appendix I (Burton, 1999; ‘t Sas-Rolfes, 1997).

The elephant population in South Africa was subsequently downlisted again to Appendix II in 1997 (Burton, 1999), after initial rejections to this proposal in 1992 and 1994 (‘t Sas-Rolfes, 1997). The impact of the Appendix I listing of elephants is disputed, with some authors (Abensperg-Traun, 2013) claiming that it has had no impact on the illegal ivory trade, whilst others have claimed that poaching did decline during this time (Bulte and van Kooten, 1999). ‘t Sas-Rolfes (1997) has claimed that the African elephant is the only species that has benefited from listing on Appendix I of CITES and even then conceding that this may not be economically viable in the long term. What is known is that during the Appendix II listing period (1976-1989), the population declined by 50% due to poaching (Abensperg-Traun, 2013; Fischer, 2004; Warchol, 2004), with some estimates equating this to around 100,000 elephants (Fischer, 2004) and others estimating up to 700,000 were lost during this time (Warchol, 2004).

The trade in ivory is complex, with white (licensed agencies, authorised by government), grey (live auctions of ivory artwork – the legality of which is unknown/ambiguous) and black (illegal) markets existing (Gao and Clark, 2014). All of these potentially contribute to the illegal trade in ivory as legal trade routes can be exploited to launder illegal product (van Kooten, 2008; Fischer, 2004; Bulte and van Kooten, 1999; Khanna and Harford, 1996). It is also virtually impossible to distinguish legal ivory from the illegal product (Khanna and Harford, 1996; Glennon, 1990) and so it is entirely possible that ivory purporting to be legal is in fact illegal. It is clear that the legal elephant ivory market is fed by poaching, with the volume of ivory traded in Chinese auctions positively correlating with poaching pressure (Gao and Clark, 2014). Even the increased enforcement of ivory trading laws in December 2011, which resulted in far less ivory being traded, did not create a respective decrease in elephant poaching (Gao and Clark, 2014), which suggests that the trade simply moved to the black market. When the price of a product is so high (ivory in China can sell for more than ten times the price it can achieve in producer countries in Africa; Gao and Clark, 2014) international trade restrictions, such as CITES, cannot diminish the attractiveness of exploiting that market (Glennon, 1990). The requirements to manage this trade put significant financial pressures on producer countries in the developing world (Challender et al., 2015a), which may not be able to shoulder that expenditure. It has been suggested (Glennon, 1990) that elephants

are a global commodity, whose attraction reaches far beyond that of just their native countries and so greater global input may be required to protect the elephant, rather than just enforcing all of the responsibility onto developing countries due to an "accident of geography" (pg. 34). It cannot be forgotten that conservation of biodiversity has global benefits, but local costs, and that those are often borne by the poorest countries and the poorest people within them; a lack of local incentives to develop local protected areas for conservation and the minimal regional benefits of increased tourism further increase the costs for these communities (Wells, 1992).

Legalising the trade in elephant ivory has been discussed several times in the literature (e.g. van Kooten, 2008; Heltberg, 2001; Glennon, 1990), with the general consensus being that banning the ivory trade does not prevent poaching (van Kooten, 2008) and costs the producer countries more by requiring more expenditure on conservation (Glennon, 1990). Tightly monitoring trade in ivory may reduce black market demand and raise funds for conservation (Heltberg, 2001) as well as allowing producer countries to control prices through the sale of stockpiles, which poachers cannot do (van Kooten, 2008).

Whilst the end market for most elephant ivory is Asia (Warchol, 2004), as is the case for rhino horn (Knight, 2015; Warchol, 2004), the use of the end product is very different, which some authors (Glennon, 1990) suggest means that the trade in ivory cannot be compared to the trade in rhino horn. Elephant ivory is considered a decorative item (Fischer, 2004; Warchol, 2004), rather than medicinal, as is the case for rhino horn. Therefore, it may be more relevant to consider the effectiveness of the CITES trade ban on rhino horn in light of its effectiveness on the trade of other species used for medicine, such as tigers (*Pathera tigris*), bears (*Ursus sp*., *Tremarctos ornatus, Melursus ursinus and Helarctos malayanus*) and pangolins (*Manis sp*.). The difficulties in controlling the trade in tiger products, which are used for multiple purposes in traditional medicine (Abbott and van Kooten, 2011), lie in the fact that many of their range countries are also end user countries and so international trade does not necessarily occur ('t Sas-Rolfes, 1997). China did enact a domestic ban on the trade in tiger bone and tiger bone medicine in 1993, but the existence of Chinese tiger farms indicates that this is not effectively enforced (Abbott and van Kooten, 2011).

CITES has also been ineffective in controlling the trade in bears, for the use of their bile, due to the split-listing and non-listing of some species, as well as the existence of look-alike products (‘t Sas-Rolfes, 1997). The pangolin trade issue is slightly different from the others discussed, in that since 2000, CITES has received very few reports on the poaching of pangolins yet seizure and trade records indicate that around 227,278 animals were traded from July 2000 to 2003 (Challender et al., 2015b). This indicates not only a sizeable illegal trade in these animals, but also a failure of CITES to acknowledge or monitor this trade. CITES has also been considered (Abensperg-Traun, 2013) as implicit in the persecution, and subsequent population declines, of leopard across Africa, as this increased after the Appendix I listing of the species as landowners could no longer see the value in these predators, which are known to kill livestock (Abensperg-Traun, 2013; Warchol, 2004; Stuart et al., 1985). This issue has clear parallels with the arguments by private rhino owners that restricting trade only makes rhinos less attractive to private owners and so will result in fewer being kept (Duffy et al., 2013; Hume, 2013).

From the examples discussed, it is clear that the capacity of CITES to impact on conservation is limited by its sole focus on international trade (Abensperg-Traun, 2013; ‘t Sas-Rolfes, 1997). A lack of monitoring, over-reliance on regulation and non-compliance have all been considered failures of CITES (Challender et al., 2015a), along with the lack of emphasis on reducing end market demand (Crookes and Blignaut, 2015), with some going so far as to say that CITES in fact completely fails to acknowledge market factors (Challender et al., 2015a). Trade bans have no impact on a pre-existing illegal market (Fischer, 2004) and so can only exert an influence if there is a concurrent decrease in demand (Burton, 1999). Even if CITES did expand its remit to consider end user market demand, it must be remembered that reduction in such demand is unlikely to occur quickly, and indeed may not occur at all (Knight, 2015). If it were possible to disrupt illegal markets by promoting use of legal products by law-abiding consumers who may not wish to partake in illegal activity, this may be more efficient in disrupting illegal trade than trade bans and may increase the willingness of consumers to pay a premium for legal goods (Fischer, 2004). Alternatively, it may create a price reduction, thereby making the product more appealing and increase demand even further (Duffy et al., 2013).

Rhino horn trade

Understanding market forces that drive the trade for rhino horn are (as with all the examples discussed previously) complicated by the illegality of the market. Rhino horn is made from compressed keratin (Biggs et al., 2013; Amin et al., 2003), the same material as human hair and finger/toenails and has no medicinal properties (Milliken and Shaw, 2012). However, rhino horn has been used in traditional Asian medicine since 2600 BCE (Brook et al., 2014) as a cure for everything from fevers (Milliken and Shaw, 2012; 't Sas-Rolfes, 1997; Pienaar et al., 1991) and headaches to measles and strokes (Milliken and Shaw, 2012). Whilst this traditional market has existed for a significant length of time, it has expanded in recent years with the newfound, previously mostly dormant, Vietnamese market (Knight, 2015; Milliken and Shaw, 2012). The Milliken and Shaw (2012) review of the trade in rhino horn between South Africa and Vietnam found that, alongside its traditional use as a general tonic, rhino horn has also been promoted as a cure for cancer and is commonly used, mixed with water, as a hangover cure. They also found that whilst it has long been the case that Western society linked rhino horn use in the East with its supposed aphrodisiac qualities (debunked by traditional exponents of Asian medicine; Jackson, 1982) it has now come full circle and men are now embracing horn for these reasons in "rhino wine". They also highlight that horn is being used in Vietnam as an expensive gift or partial payment for luxury items (sometimes involving political officials), as well as a way to conspicuously flaunt wealth. These exaggerated claims of the value of rhino horn will only continue to further drive demand (Amin et al., 2003), which is particularly concerning when coupled with the increasing wealth of much of Asia potentially allowing even more members of the population access to such luxury goods (Knight, 2015; Sutherland et al., 2014).

In 2015, rhino horn was trading for approximately US$60,000 per pound (Harper, 2015), which is around US$27,000 per kilogram; more than cocaine or gold (Massé and Lunstrum, 2016). Given that the average African rhino horn weighs 4 kg (Lunstrum, 2014), this would represent a substantial income for a rhino horn trader, or indeed a private owner, were horns legally allowed to be traded internationally. This figure is likely to be an underestimate, as the Lunstrum (2014) average mass was for all African rhinos, whereas Pienaar et al. (1991) investigated individual rhinos and found the average adult male white rhino carried 8.31 kg of horn (across

both anterior and posterior horns) and the average adult female white rhino had 5.23 kg of horn. Even the smaller black rhinos still carry enough horn to make them very valuable, with the average adult black rhino carrying 2.65 kg of horn. This substantial difference in horn size may go some way to explaining why white rhinos are poached much more heavily (discussed in more detail below) than black rhinos. Even the Indian one-horned rhinos (*Rhinoceros unicornis*), with a horn weighing only 750 g on average (Martin et al., 2009), is threatened by poaching for its horn. In the case of the Indian one-horned rhinos, the threat to them is not due to the size of their horn, but the fact that it is highly prized for being more potent for use in medicine (Martin et al., 2009).

In light of this demand and very high value, the calls from private owners (e.g. Rhino Alive, 2016; Hume, 2013) to legalise the trade in rhino horn, could be interpreted in two ways: the way in which they claim, which is in the interests of species preservation (Rhino Alive, 2016; Hume, 2013), or in the interest of their own financial situation (UNODC, 2012). Irrespective of their motives, it is noted that a lack of legal trade in rhino horn runs the risk of reducing incentives for private rhino owners and so may increase the rate of disinvestment in rhinos. Disinvestment is already occurring (Duffy et al., 2013; EWT, 2011), with more than 70 properties disinvesting in rhino by 2016 (DEA, 2016b). Disinvestment in private land conservation is not unique to private rhino owners in South Africa. A study in privately owned forests in Finland (Paloniemi and Tikka, 2008) found general disinterest in formal conservation on the land beyond protecting what was already present. Only 15% of the forest owners were willing to engage in conservation activities, which the authors related to a generally negative perception of nature conservation policy. This pattern is repeated in the United States, where the policies in place can themselves act as disincentives to conservation activity (Polasky and Doremus, 1998; Polasky et al., 1997). Because the presence of endangered or protected species on their land may create problems for landowners by restricting their activities, they may deny access to regulators and may even take actions to negate the conservation value of their land prior to any visit by a government agent (Polasky and Doremus, 1998; Polasky et al., 1997). Alternatively, they may undertake activities to overinflate the conservation value of their land in return for higher compensatory payments (Polasky and Doremus, 1998). What is clear is that conservation has an economic value and

rhinos are very valuable animals, both dead and alive. Whilst this idea of placing a price on an animal in order to conserve it may seem counterintuitive, it is the basis upon which the extensive trophy hunting industry in South Africa has thrived.

Unfortunately, it is the case that legal trophy hunting of white rhinos has been used as a cover for the illegal trading of rhino horn. Milliken and Shaw (2012) provide a detailed discussion of these issues, pertaining to illegal activity producing rhino horn for the Vietnamese markets. This report highlights the increase, since 2004, of non-traditional hunters buying permits to shoot rhinos (particularly from Vietnam), with five Vietnamese syndicates believed to have conducted 203 hunts between 2005 and 2007. From 2007 to 2009 Vietnamese hunters were second only to Americans in the number of rhino hunts conducted and in 2006 they were third behind Spanish hunters. Prices increased significantly during this time, suggesting that there was an attempt to price traditional hunters out of the market; Vietnamese rhino hunters paid a total of US$22 million between 2003 and 2010. Milliken and Shaw (2012) also highlight the use of pseudo-hunters; inexperienced or naïve hunters, including Thai prostitutes, with no interest in having their trophies mounted. The authors suggest that these pseudo-hunters were used in order to allow syndicates to continue to collect rhino horn without hunting themselves, after changes to the regulations pertaining to rhino hunting were brought in to prevent individuals conducting multiple hunts. In 2009, the Professional Hunters Association of South Africa (PHASA) advised its members against taking on Vietnamese hunters due to their concerns over the legality of such hunts (Milliken and Shaw, 2012). Further legislative changes in 2012 have largely controlled this issue of pseudo-hunting (Duffy et al., 2013).

Limited studies have been undertaken (Rubino and Pienaar, 2018b; Wright et al., 2016) to try and understand perceptions of trade in rhino horn amongst game farmers, but few have considered the perceptions of the wider industry. With the potentially powerful and widespread influence of NGOs on public perception and the localised influence of field guides and anti-poaching staff on people in local communities, it is important to consider the perspectives of the wider private rhino industry regarding trade, alongside the perceptions of private rhino owners themselves. These wider industry perceptions regarding horn trade are explored in Chapter 3 of this thesis.

Poaching

Poaching has been defined as the hunting of any animal not permitted by the state or private owner (Duffy, 2014) and in Africa ranges from the subsistence hunting of bushmeat to the deliberate targeting of large, valuable species, such as elephants and rhinos. Whilst bushmeat hunters may not be equipped to poach a rhino, were they to come across one they may well kill it if they can, or alert rhino poachers to its whereabouts (Metzger at al., 2007), so rhino poaching cannot be considered without also considering the factors that drive people to illegally hunt other species.

Bushmeat hunting has been defined (Lowassa et al., 2012: 623) as "the (usually illegal) act of hunting wild mammals, often for the purpose of obtaining meat" and is often considered by law enforcement to be a low priority subsistence activity (Milner-Gulland and Clayton, 2002; Barnett, 1997), practised by the poorest in the local community (Lindsey et al., 2013; Kühl et al., 2009). Subsistence hunters generally hunt small game species through the use of traps and snares (Duffy and St. John, 2013; Gandiwa et al., 2013; Kaltenborn et al., 2005), taking only what they can carry on short hunting trips into protected areas (Kaltenborn et al., 2005). One of the most significant problems caused by bushmeat poaching, lies in the non-selectivity of the methods utilised; namely snares (Watson et al., 2013; Lowassa et al., 2012). Snares are used because they are effective, can be set by people on foot, which is less noticeable to patrols (Jachmann, 2008a; Setsaas et al., 2007), are silent and so do not attract attention as a gunshot would (Watson et al., 2013) and are easily moved as required. For all of these reasons, snaring appears to be more common in areas where anti-poaching activity is high (Watson et al., 2013). Snares are also commonly placed along boundaries, such as fence lines (Watson et al., 2013; Wato et al., 2006) as well as along roads and near water bodies (Watson et al., 2013). They are less likely to be found as distance from the perimeter increases (Watson et al., 2013; Wato et al., 2006), likely due to the fact that they are set by hand and often collected again before dawn to avoid detection by anti-poaching patrols (pers. obs.). The unintentional snaring of non-target species is known as snaring by-catch and has had significant effects on wildlife populations in Zambia (Becker et al., 2013). By-catch has increased elephant poaching by 32%, caused the death of 11.5% of all adult and sub-adult lions and 20% of the deaths of adult male lions and has affected 67% of African wild dog (*Lycaon pictus*) packs (Becker et al., 2013).

Besides the non-selectivity of the methods utilised, bushmeat hunting also causes generalised wildlife declines, edge effects and has disproportionate effects on some species that are more commonly targeted (Lindsey et al., 2013). As bushmeat hunters do not own the animals they are exploiting, they do not have to consider the long-term viability of the populations they target in the way that the owners of the animals do (Bulte and van Kooten, 1999; Skonhoft and Solstad, 1998). They are able to exploit what is available and do so to supplement their diet (Rentsch and Damon, 2013; Barnett, 1997) or income, particularly at times when agricultural activity is low (Brashares et al., 2011; Skonhoft and Solstad, 1998). The impact of bushmeat hunting may also be underestimated as research does not often consider birds and reptiles, which are often hunted by women and children (Taylor et al., 2015b).

The issues caused by the hunting of bushmeat is likely to be amplified with the increasing commercialisation of the process (Duffy and St. John, 2013; Milner-Gulland and Clayton, 2002; Barnett, 1997). In areas isolated from where bushmeat can be sold, most is consumed and so the activity remains primarily traditional subsistence hunting, but in areas where there is a market, up to 80% of bushmeat is sold (Brashares et al., 2001). In some areas, bushmeat is seen as a superior product and so prices are higher, which then drives even more commercialisation with many individuals trading bushmeat as their sole source of income (Barnett, 1997). This means that not only do poorer rural households have high bushmeat consumption, but wealthier urban households also have high bushmeat consumption (Brashares et al., 2011). When poaching for commercial reasons, hunters may set up camps in the bush for a week or more and butcher and preserve what they hunt to then take to market in larger quantities (Kaltenborn et al., 2005). This then blurs the line between subsistence poachers and commercial traders, as poachers move towards working in small, organised groups and acting as traders themselves (Damania and Bulte, 2007). As bushmeat hunters move towards becoming traders, they need to develop trade routes, with illegal bars a popular place for trading (Barnett, 1997). They are also able to take advantage of the corruption of officials to exploit wildlife resources on a much larger scale than subsistence poaching. Field rangers are known to poach, or be complicit in poaching, and may allow poachers access to reserves in exchange for sharing profits or for supplying alcohol or bushmeat (Warchol and

Johnson, 2009). This collaboration with corrupt officials can allow former subsistence hunters to connect with more commercialised poaching operations to enable them to poach and then traffic much higher value products, such as elephant ivory and rhino horn, which they would not be able to do without those connections (Duffy and St. John, 2013).

Rhino poaching

It is not optimal for small scale operations to poach rhinos or elephants, but it does pay for larger groups (Milner-Gulland and Leader-Williams, 1992). Rhino poachers are unlikely to follow the same behaviour patterns as bushmeat poachers (Metzger et al., 2007), but the gangs are known to hire subsistence poachers; paying them US$42-1,042 to act as guides in India (Martin et al., 2009). The gangs can then be paid US$4,167-10,417 per kilogram for the horn by traders in India (Martin et al., 2009) and US$1,000-9,000 per kilogram in South Africa (Lunstrum, 2014). These huge financial rewards make it cost effective to use sophisticated technology, such as helicopters and immobilisation darts (Biggs et al., 2013) to target rhinos. The use of immobilisation drugs and rhinos being killed with well-placed bullets fired by skilled marksmen indicate the involvement of wildlife industry professionals in rhino poaching (Knight, 2015; Duffy et al., 2013; Milliken and Shaw, 2012; Warchol and Johnson, 2009; Warchol, 2004), with some suggestions indicating that these corrupt veterinarians, game farm owners, game capture professionals, professional hunters and pilots may be up to 3% of the industry (Milliken and Shaw, 2012). These professionals may act as local middlemen, whilst poachers may be from the local community, the wildlife industry or may be former police or military (Milliken and Shaw, 2012). Members of the military have also been implicated in rhino poaching in Nepal (Kock et al., 2008) and highly trained former civil war soldiers from Mozambique are known to be involved in rhino poaching in South Africa (Knight, 2015). Even considering only individuals who are not former civil war soldiers, poachers from Mozambique are known to be a significant factor in the poaching of rhinos in South Africa (Knight, 2015; Massé and Lunstrum, 2015; Chaderopa, 2013), particularly in Kruger National Park (KNP), where the open border is very close and

allows an escape route for poachers beyond which South African enforcement cannot follow (Massé and Lunstrum, 2015).

Once a rhino has been poached and its horn removed, which can be done in minutes (Kock et al., 2008; Western, 1982), the horn is usually passed to middlemen, of which there may be several levels (Warchol, 2004). The 2012 TRAFFIC study (Milliken and Shaw, 2012) found that in South Africa, these middlemen are usually South African nationals, often of Asian descent, who conduct a considerable amount of trade in horn; a single Thai man exported 300 kg in 2007 and 2008, 80% of which came from a businessman of Vietnamese descent based in Hartebeespoort Dam. These middlemen then use a series of cover mules, primarily air passengers including students and workers with the Vietnamese Embassy in Pretoria, to smuggle the horn out of South Africa (Milliken and Shaw, 2012). In the past, wildlife poachers were not usually associated with international crime syndicates, with the exception of abalone (any genus and species of the family Haliotidae) poaching, which was controlled by the triads (Warchol, 2004), but it is now recognised that organised crime syndicates are playing a role in rhino poaching and smuggling (Knight, 2015; Milliken and Shaw, 2012), including European groups, which indicates that the trade goes beyond eastern Asia (UNODC, 2012). There have even been suggestions that wildlife crime has played a role in funding terrorism, or indeed that poachers themselves can be considered as terrorists (Duffy, 2016).

As previously mentioned, rhinos suffered from heavy poaching through the 1970s to the mid-1990s, but this had mostly stabilised with an average of fourteen rhinos poached per year in South Africa between 1990 and 2005 (Milliken and Shaw, 2012). However, recently, this number has increased substantially, with over 1,000 poached per year from 2013 to 2017. Figure 1.1 shows the rhino poaching level in South Africa, from state, provincial and private land. The statistics from 1990 to 2009 and from 2018 are total figures from all land in South Africa.

Whilst it is important to understand the scale of rhino poaching at a national level, poaching statistics alone do not present the full picture. To fully understand rhino poaching, it is important to identify what factors determine when and where poaching will take place, and which individual rhinos are most at risk of poaching. Such

research has not been undertaken for private land but could help in directing anti-poaching activities most effectively. In Chapters 4 and 5 of this thesis the temporal and spatial factors which may influence rhino poaching are explored. Chapter 4 also identifies factors which may determine which individual rhinos are targeted by poachers.

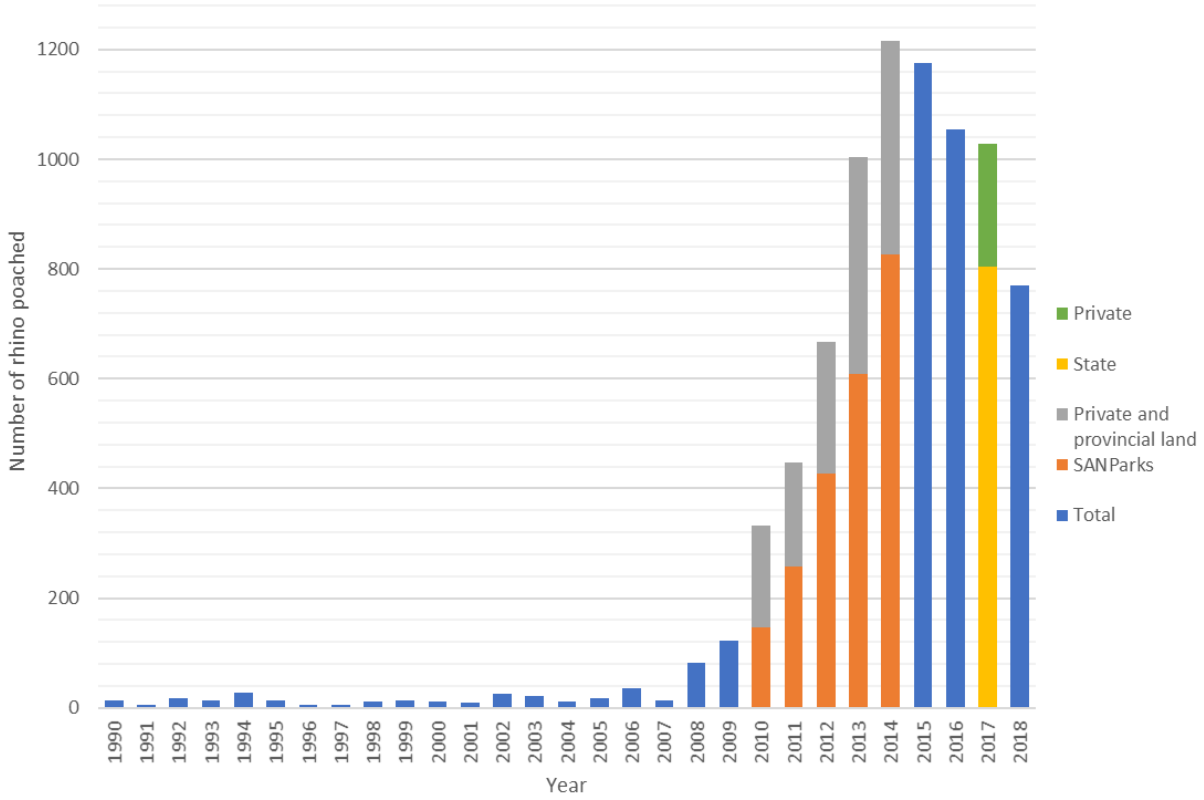

Figure 1.1: Official rhino poaching statistics (DEA, 2019; Rhino Alive, 2018; DEA, 2016a; DEA, 2014; Milliken and Shaw, 2012)

Anti-poaching measures

Protecting animals from poaching is an additional prohibitive expense on top of the already high cost of protecting endangered species (Damania and Bulte, 2007). In 2012, private rhino owners spent, on average, ZAR30,000 to ZAR40,000 per month on extra security (Milliken and Shaw, 2012) even though the average annual household expenditure in 2011 was only ZAR95,183 (Statistics South Africa, 2012).

In order to secure the animals on their land to comply with the Game Theft Act, 1991, private landowners must install game fencing to contain their animals. Cost of fencing varies significantly, but generally it is expensive and requires maintenance

(de Boer et al., 2007), with one report estimating that 38 km of solar-powered standard 2.5 m game fencing with three electric strands could cost up to US$41,000 per year for the first twenty years to install and maintain (de Boer et al, 2007). Maintenance of these fences, whilst expensive, is one of the first steps in making reserves less accessible to poachers and one that is undertaken by private reserves without too much difficulty (Pernetta, 2014).

One of the other ways that private owners have tried to protect their rhino stock is through dehorning (Lindsey and Taylor, 2011), and the injection of poison into the horns (Duffy et al., 2013; Milliken and Shaw, 2012). Dehorning has also been carried out in a few provincial parks but has not been practiced by other provincial parks or by SANParks (Lindsey and Taylor, 2011) until recently. In May 2019, SANParks authorities issued a media release (SANParks, 2019) indicating that they had started selective dehorning of rhino cows in the southern part of the Greater Kruger Protected Area. Dehorning is a simple process, using chainsaws or cross-cut wood saws to cut horizontally through the horn above the growth plate (Lindsey and Taylor, 2011). It can cost as little as US$20 per animal to shave the horn (Biggs et al., 2013), but a survey of rhino stakeholders (Lindsey and Taylor, 2011) found that dehorning usually costs around US$973 per rhino, with lows of US$125-250 if the animals can be darted from the ground, and highs of up to US$1,600 per rhino in difficult terrain or where populations are widely dispersed. Dehorning also needs to be repeated on a regular basis, with most recommendations suggesting that older animals and males are dehorned slightly more regularly than females and younger animals (Rachlow and Berger, 1997). Lindsey and Taylor (2011) suggest that rhinos under severe threat of poaching should be dehorned every 12 to 24 months and those under intermediate threat, every 24 to 36 months. Due to the expense involved and the risks of calf predation when a mother has been dehorned, they do not consider dehorning appropriate for rhinos under a lesser threat of poaching and recommend translocations of rhinos as preferable to dehorning. With very large populations, dehorning becomes impractical and unaffordable as a poaching deterrent (Duffy et al., 2013).

An alternative to dehorning rhino is to inject the horns with a poison which would make them unsuitable for consumption, but this is unlikely to work on a large scale (Milliken and Shaw, 2012). As with dehorning, poisoning horns is an ongoing

process as the horn grows, and the efficacy is unclear as yet (Duffy et al., 2013). Ferreira et al. (2014) have been particularly critical of this option, noting that the teams advocating it have not cut through a horn to assess the dispersal of the dye and stating that “all evidence indicates wide-scale failure of the application” (pg. 58). Regardless of the efficacy, poisoning horn also reduces the saleability of the product and so may actually drive prices even higher (Duffy et al., 2013), potentially making rhino poaching even more attractive. Both dehorning and poisoning horns require rhinos to be sedated regularly, which carries an immediate low risk of mortality (Duffy et al., 2013; Lindsey and Taylor, 2011; Rachlow and Berger, 1997) and has unknown long-term implications (Rachlow and Berger, 1997).

These strategies may not even actually act as deterrents to poachers, as the poison is not visible (Duffy et al., 2013) and in some areas, poaching is so profitable that removing the small pieces of horn left after dehorning is still worth the risks associated with poaching (Lindsey and Taylor, 2011; Milner-Gulland, 1999). Unfortunately, this small piece of horn cannot be removed without a high risk of adverse effects, since cutting too close to the germinal layer can cause damage to the underlying vascular tissue, introduce infections and lead to horn deformities (Lindsey and Taylor, 2011). Therefore, effective anti-poaching activity is still required in order for dehorning to be an effective deterrent to poachers (Lindsey and Taylor, 2011).

The Norms and Standards for the Marking of Rhinoceros and Rhinoceros Horn, and for the Hunting of Rhinoceros for Trophy Hunting Purposes (updated April 2012) require DNA samples to be taken from all dehorned rhinos, all trophy horns and indeed any rhinos that are sedated for any reason (Milliken and Shaw, 2012), which would include sedation for the purposes of injection of poison into their horns. This DNA information is then stored on the central Rhino DNA Index Database (RhoDIS) at the Veterinary Genetics Laboratory, University of Pretoria (rhodis.co.za). This database can keep the DNA of rhinos and allow confiscated horns to be tracked (Cress and Zommers, 2014; Harper et al., 2013; Kapur et al., 2003). For this process to work efficiently, the DNA samples must be collected correctly with incomplete profiles being produced if DNA is collected from the outer layers of horn (Harper et al., 2013). Only very small pieces of horn are required with 1-35 mg producing a full profile and even 0.1 mg still allowing matches of forty-one of forty-six alleles (Harper

et al., 2013). Due to the fact that it is made of compressed keratin, rhino horn reflects the diet of an animal in its chemical composition, which can allow identification down to the level of which park that animal came from (Amin et al., 2003), even if its full DNA profile is not in the RhoDIS database.

Whilst dehorning may act as a deterrent and the RhoDIS database can provide evidence in the event of a poaching incident, most reserves wish to prevent poachers from entering their land in the first place and so employ anti-poaching units (APUs), which may conduct regular foot patrols day and night, or may be deployed strategically in response to poaching threats (Gandiwa et al., 2013). These APUs may consist of trained, armed, paid staff, or may be made up of volunteers (Pernetta, 2014; Milliken and Shaw, 2012). Depending on the habitat within the reserve, the level of effectiveness and input into these patrols differs significantly; with increased foot patrols being found to decrease poaching in savannah habitats, but not in forested areas (Jachmann, 2008b). This is particularly concerning when it is considered that poaching can be ten to fifty times higher in forested areas than in savannahs (Jachmann, 2008b). Whilst state-backed reserves, such as the SANParks and provincial parks in South Africa, fund their APUs through their government funding as well as tourist generated income and donations from NGOs, private reserves must fund their anti-poaching activities from only the income they generate themselves. APUs with limited funding (as is the case on private reserves or those supported by NGOs) are under financial and manpower limitations which reduce their patrolling ability (Clements et al., 2010). Even in state-backed reserves, funding limitations can still apply (Gandiwa et al., 2013; Jachmann, 2008b; Johannesen, 2007) and result in inadequate staffing or staff who are not adequately trained in order to be effective (Martin et al., 2009). A lack of appropriately trained staff, or staff who not experienced enough to be fully effective, is one of the biggest hindrances to protected area management (Aung, 2007). Anti-poaching activities can be improved by the provision of adequate funding, appropriate training of staff, development of experienced staff and through building good working relationships with local communities and law enforcement (Lindsey et al., 2013). Private sector APUs do however face some more difficulties in dealing with poachers than those in state backed reserves as they are limited in the use of force they can apply due to restrictions on their use of semi-automatic weapons and some also fear murder

charges if they were to kill a poacher (Duffy et al., 2013). South Africa does permit the use of lethal force to deal with poachers, but private APUs and volunteers are unclear as to how this applies to them (J. Huntingford pers. comm.; C. Theron pers. comm.). Nevertheless, some private APUs are being trained in military techniques in the use of firearms, tracking, arrest procedures etc. by former military personnel (Lunstrum, 2014; Milliken and Shaw, 2012). Indeed, some former South African Defence Force (SADF) soldiers moved into the conservation field after the end of apartheid as their skills in survival, planning and tracking and their understanding of weapons are easily transferable to that field (Duffy, 2014).

An increasing move towards militarisation of anti-poaching exists in a background of poor understanding of the effectiveness and utilisation of non-militarised anti-poaching efforts. The range of anti-poaching strategies employed by private rhino owners is poorly explored beyond the regular owner surveys (Balfour et al., 2015) and so requires further exploration. Chapter 2 of this thesis explores the range of anti-poaching strategies employed by private rhino owners and also explores the effectiveness of such strategies in deterring future poaching events.

Militarisation of anti-poaching measures

Increased militarisation of anti-poaching units is not unique to the private sector and is widely applied in the protection of animals from poachers on state owned reserves also (Massé and Lunstrum, 2016; Duffy, 2014; Lunstrum, 2014); sometimes with support from private APUs (Humphreys and Smith, 2014). In fact, it is also not a new idea, with many African nations training their rangers in a military style to combat the threat of elephant and rhino poachers during the 1980s (Lunstrum, 2014). This increased militarisation can take the form of increased use of force as well as specialist training in military techniques (Duffy, 2014), but may inadvertently lead to an arms race with poachers that could have severe repercussions for both sides (Massé and Lunstrum, 2016; Cheteni, 2014; Duffy, 2014; Lunstrum, 2014). Indeed, it is already known that poachers are carrying weapons such as pistols and grenades, which are not intended for use on animals (Lunstrum, 2014). Management in KNP have been utilising military techniques for several years now, with the introduction of 57 South African National Defence Force (SANDF) soldiers into the park in August

2011, primarily to monitor the open border with Mozambique, followed by the training of another 150 in January 2012 to join the 500 SANParks anti-poaching staff (Milliken and Shaw, 2012). KNP also previously employed retired Army Major General Johan Joost to oversee the anti-poaching strategy (Lunstrum, 2014). As well as protecting the border with Mozambique, the army have trained KNP rangers in the use of military techniques to support anti-poaching and have actively participated in anti-poaching patrols (Massé and Lunstrum, 2016; Lunstrum, 2014).

As well as adopting military style techniques, reserves are also applying military technology in the fight against rhino poachers (Cress and Zommers, 2014; Duffy, 2014; Duffy et al., 2013). Drones are being deployed regularly to monitor animals and provide aerial surveillance (Cress and Zommers, 2014; Duffy, 2014; Duffy et al., 2013) as are helicopters, microlights (Duffy et al., 2013) and mikrokopters, which are similar to drones (Cress and Zommers, 2014). One author (Cheteni, 2014) even goes as far as to suggest that drones and other remotely operated aerial vehicles could be equipped with missiles to target poachers. Camera traps, GPS trackers and thermal imaging technology are also being increasingly used (Duffy, 2014; Duffy et al., 2013) and are slightly more affordable pieces of technology, which may make them more accessible to private rhino owners. Even more advanced technologies include the use of radio frequency identification (RFID) tags, which are microchips that can be attached or implanted into individuals to track their movements (Cress and Zommers, 2014; Duffy et al., 2013), acoustic traps that allow for the triangulation of noise sources (some are even able to deploy drones or other aerial equipment capable of recording video footage or still images) and military-style (mesh) networks that allow transmissions from chipped or radio tagged animals to be scrambled and then decoded preventing them from being picked up and interpreted by poachers (Cress and Zommers, 2014).

Military-style anti-poaching activities are inherently expensive but are increasingly deployed in efforts to deter poachers. It is essential to understand the effectiveness of such actions and the economic impact of increasing militarisation of anti-poaching in order to determine the potential benefits of such actions for private rhino owners. As noted above, Chapter 2 of this thesis explores the range and effectiveness of anti-poaching strategies employed by private rhino owners. Chapter 2 also includes an analysis of the economic impact of such activities on private rhino owners.

A team of militarised anti-poaching rangers, equipped with technology can only be effective in reducing poaching if they are managed and deployed effectively; it is not appropriate to simply instigate anti-poaching strategies without first considering which strategies work, why they work and when they should be utilised (Geldmann et al., 2013). Poor management, low accountability and an unwillingness to make decisions by management have all been linked to the extinction of the Javan rhino (*Rhinoceros sondaicus*) from Vietnam (Brook at al., 2014). Appropriate, regular supervision of APUs by senior staff is known to increase the effectiveness of anti-poaching measures (Jachmann, 2008b), and is particularly important on private farms which may have absentee owners and an on-site manager (Warchol and Johnson, 2009). Managers and anti-poaching teams must also be willing to regularly adapt their anti-poaching practices in order to prevent poachers from becoming familiar with them (Martin et al., 2008).

One suggested alternative to capturing and prosecuting poachers is to increase the use of shoot-on-sight policies (Messer, 2010). Messer found that including the risk of death in models (through the inclusion of shoot-on-sight policies) made poaching a less viable option in areas with very low wages. During the elephant poaching of the 1970s to 1990s, Botswana, South Africa, Tanzania and Zambia did not implement shoot-on-sight policies and their elephant populations decreased, whilst the populations in Kenya and Zimbabwe, which did employ shoot-on-sight policies, increased over the same time period (Messer, 2010). There is also generally public and NGO (including Born Free, International Federation for Animal Welfare (IFAW) and Care for Wildlife International) support for shoot-on-sight policies for anti-poaching, with WWF even funding anti-poaching efforts in Zimbabwe which has a shoot-on-site policy (Messer, 2010). South Africa permits lethal force in anti-poaching activities but does not endorse shoot-on-sight policies (Lunstrum, 2014), and there are no indications that such a move is forthcoming. What the South African government has done, is try to encourage local communities to work against rhino poachers in their areas, with cash rewards of ZAR100,000 available for information leading to the arrest of heads of poaching gangs and a further ZAR1 million for their subsequent conviction (Duffy, 2016; Duffy et al., 2013).

Local community engagement in conservation

This concept of involving local people in conservation action is not new (Nepal, 2002) and is widely considered to be important in protecting the wildlife in an area. Land for conservation has often been taken from local people; displacing them from their homes as well as restricting access for agriculture and natural and cultural resources (Skonhoft, 2007; Kaltenborn et al., 2005; Skonhoft, 1998; Gibson and Marks, 1995), which often results in people living around these areas demonstrating notably negative attitudes towards wildlife (Dobson and Lynes, 2008; Skonhoft, 2007; Mbaiwa, 2005). Most people living close to wildlife habitats do not believe that this proximity to wildlife has a role to play in poverty alleviation in their community at the household level and this lack of economic benefit negates any positive roles wildlife may play in their lives (Kangalawe and Noe, 2012). Several studies (Pienaar et al., 2014; Arjunan et al., 2006; Hackel, 1990; Infield, 1988) have found that local people usually have positive attitudes towards conservation in general, but are more negative, or less interested, when it directly impacts on their daily lives. The concern is then that these negative attitudes may lead to poaching (Dobson and Lynes, 2008) or other activities not consistent with conservation priorities. The increasing militarisation of APUs can further damage these relationships with local communities (Hackel, 1990), with the killing of poachers particularly destructive to community-reserve relationships (Lunstrum, 2014). In southern Africa in particular, this inability to access resources and unequal access to land, due to the fact that most private land is owned by whites and is therefore inaccessible to the majority black population (Humphreys and Smith, 2014), links back to the historical persecution of subsistence hunters in order to protect trophy species favoured by colonists (Duffy, 2014) and so reflects historical resentment as well as contemporary issues. The increasing number of absentee foreign owners of private conservation land in South Africa has further contributed to this idea of neocolonialism (Langholz and Krug, 2004).

As previously discussed, most poaching has links to local communities and so their assistance in tackling poaching at its source may reduce the need for continual funding of anti-poaching activities (Collier et al., 2001). More consultation with local people may encourage them to become part of the solution to conservation problems (Duffy et al., 2013), but local communities need to profit from these interactions and cannot simply just be part of the anti-poaching activities without additional benefits

(Maroney, 2005). One South African based study (Spenceley, 2005) found that informers within local communities or informal communication with tribal leaders can mitigate poaching problems, but in only one-quarter of the study sites was this a mutually beneficial arrangement. The study found that local people do appreciate the environmental education that some reserves offer but would prefer compensation for living so close to wildlife, or employment. People view conservation more favourably when they can directly benefit from it, especially if that benefit is economic, in the form of employment (Vodouhê et al., 2010). Direct payment schemes allow local communities to work in ways determined by themselves and so are less constraining than schemes which require local communities to carry out predetermined activities (Ferraro and Kiss, 2002; Nepal, 2002). It is possible that these types of community integration schemes may therefore be more successful in engaging local people with conservation.

Payment for ecosystem services (PES), provides landowners with payments for working in a manner that protects biodiversity (Ingram et al., 2014). PES can allow communities to benefit from biodiversity and can help them to develop new, transferable skills, but it does require outside funding (Ingram et al., 2014). In one example from Tanzania (Ingram et al., 2014), a tour operator who has operated in the area for a long time and is known to the local community, pays villagers a US$4,500 fee per year for them to refrain from hunting, making charcoal or raising crops in a designated area. The Wildlife Conservation Society (WCS) also pays the salaries (US$50 each per month) of four anti-poaching scouts recruited from the village. In an area where typical household expenditure is around US$10 per month and employment opportunities are limited, this project is an attractive option to the local community, but it is unsustainable without continued investment from the tour operator and WCS. A further example of PES operating with support from NGOs can be found in the privately-owned Atlantic Forest reserves in Brazil (Buckley and de Vasconcellos Pegas, 2015). In this instance, NGOs have helped private landowners to manage the financial costs of setting up private reserves to protect golden lion tamarins (*Leontopithecus rosalia*). Whilst the authors found NGOs had supported 21 of the 37 landowners asked, they also found that landowners did not feel they received any government support and had not received any payments, despite the PES system in this case being based upon taxation relief.

The ideal situation would be for local people to choose to become involved in conservation without involvement from outside agencies and investment from reserve managers. In some instances, that does occur. After incidences of rhino poaching in Nepal, a team of local youths, NGO staff and National Parks staff formed their own investigative unit and collected information about suspected poachers, ultimately catching four members of army personnel in possession of rhino horn, tiger bones and rifles (Kock et al., 2008). Similar incidences have occurred in India, where local communities have found out about poaching and forced community members to hand themselves in (Martin et al., 2009). Alternatively, rather than directly involving themselves in conservation, local communities may create their own businesses around the opportunities provided by proximity to wildlife, with some local people organising trekking parties in Morocco due to their proximity to a national park (Shafer, 1999).

Local people can be encouraged to engage in conservation and provide economically for themselves in a variety of manners, through Community Based Natural Resource Management (CBNRM) with integrated conservation and development projects (ICDPs) being one of the most widely utilised (Johannesen and Skonhoft, 2005). The concept of ICDPs is that when local communities have rights over the wildlife in their area, in the form of a share of the profits from it, then their interests in conservation will increase and poaching and other illegal practices will decrease (Johannesen and Skonhoft, 2005), although it must be noted that Loibooki et al (2002) found that participation in community conservation schemes had no impact on the level of bushmeat poaching by local people. Improvements to the welfare of local people are ambiguous and some may simply combine this new income stream with their existing activities, which may not be beneficial to conservation (Johannesen and Skonhoft, 2005). An assessment of community conservation schemes in the Serengeti area of Tanzania (Kaltenborn et al., 2008) found that whilst people did benefit in some aspects (supply of game meat, lowered taxes, wildlife education and help in tracking lost livestock) from being involved in such programmes, they still felt little impact at a personal level. One particular community involvement scheme in Botswana, the Khama Rhino Sanctuary Trust (KRST), provides an example of these schemes in action (Stone and Stone, 2011; Sebele, 2010). Whilst local people have benefited from some employment, rent from

workers and funding for the building of an orphanage in the community, they have lost access to natural resources, such as firewood and thatching grass, and are not represented sufficiently in the management of the KRST to feel any ownership of the programme (Stone and Stone, 2011; Sebele, 2010). That local residents are unequal stakeholders in such schemes has also been criticised elsewhere (Gibson and Marks, 1995). There is also the potential for such economic benefits to be viewed as bribes and further imposition of Western values (Ferraro and Kiss, 2002), with local people generally employed and having little engagement in the management and direction of such projects (Mbaiwa, 2004).

Alternatively, other ICDPs in Botswana, that encourage local people to be involved in the management of the wildlife resources, whilst permitting their consumptive utilisation of those resources, have been shown to decrease poaching and improve attitudes towards conservation (Mbaiwa, 2005). An ICDP project in northern Canada has had significant benefits to local Inuit communities (Freeman and Wenzel, 2006). A polar bear (*Ursus maritimus*) hunting system was set up so that local Inuit communities were allocated an appropriate number of tags, which they could then choose to use themselves or sell to trophy hunters. They were also provided with the training required to operate hunting businesses themselves. Inuit outfitters can receive C$19,300 per hunter directly or can operate through outfitters outside of the community who can annually pay C$186,700 to locals to act as guides, C$33,350 to locals for tags and C$12,670 for supplies. As well as the direct financial benefits of this scheme, the local community can sell souvenirs to tourists, are usually left the meat from the bear and can offer other products to visitors such as fishing trips and cultural tours.

ICDPs are becoming more prevalent in South Africa, but local conflicts exist with traditional uses of thatching grass, which is often burned for management practices, and traditional hunting practices (Leach et al., 1999). Leach and colleagues (1999) further discuss the inherent implications of these programmes with regards to local communities remaining static. They argue that these programmes often act on an inherent belief that local communities exist in harmony until they are disrupted by outside forces, but that does not necessarily accurately reflect the reality of most communities, which are subject to modernity, breakdown of traditional authority and immigration. Adams and Hume (2001) further discuss the potential pitfalls of ICDPs,

many of which are economic, but they also highlight the importance of communication and working effectively with local communities. They illustrate the difficulties that can arise when instigating these initiatives and expecting locals to work effectively with people who may have been foes for a significant period of time and the abiding resentment that may exist. Community conservation initiatives cannot be seen as sure-fire methods of protecting conservation and so require compromises in both community and biodiversity objectives (Wilshusen et al., 2002; Adams and Hume, 2001).

The conflicts that exist between local communities and conservation initiatives are likely to extend to private game farms, yet there is little understanding of the relationships between such properties and the people around them. Whilst it is widely claimed that most rhino poachers are local people (Warchol et al., 2003; Swanepoel, 1998; du Toit, 1998), little work has been undertaken to determine the factors which may drive local people to poach rhinos. Chapter 5 of this work explicitly considers the local socio-economic environment around poaching hotspots to identify factors which may lead local communities to poach. There is also very little evidence of rhino owners positively engaging with their local communities, which is further explored in Chapter 3 where rhino owners are asked about their relationships with the local communities.

Summary

Conservation of rare species on private land is becoming more prevalent worldwide. It has however long been established in Southern Africa. Whilst increases in numbers of game species in South Africa since private ownership was permitted have been well-studied, the impact that private ownership has had on rhino populations has not been analysed. This thesis utilises past surveys of private rhino owners (Chapter 2), alongside interviews with private rhino owners and other professionals working within the industry (Chapter 3) to assess the conservation value of private rhino ownership. In Chapter 2, the range of properties involved in private rhino ownership was explicitly considered to assess any move towards the large-scale farming of rhinos for their horns.

One of the most controversial aspects of private rhino ownership, is the discussion around trade in rhino horn. This topic is explicitly considered in Chapter 3, although it is also briefly touched upon in Chapter 2. The demand for horn is what has driven the substantial increase in poaching in recent years, which is consistently noted to be a challenge to private rhino ownership (Chapters 2 and 3). Identifying trends in rhino poaching (Chapters 4 and 5) may assist private rhino owners in directing their limited anti-poaching capabilities in the most effective manner and may also direct law enforcement actions in preventing poaching events and/or apprehending offenders.

The economic costs of anti-poaching activities are considerable and are examined in Chapter 2. Chapter 2 also explores the range of different anti-poaching strategies utilised on private properties and the associated expenditure.

Local community issues were considered with regards to poaching links in Chapters 2 and 3. To assess the true impact local communities may have on rhino poaching in an area (and not just the impact perceived by private rhino owners and other stakeholders), socio-economic factors of local municipalities are considered in the analysis of spatial trends in poaching in Chapter 5.

Chapter 6 draws all these threads together to produce final conclusions on the conservation value of private rhino ownership and the poaching challenges it faces, framed in the wider context of private sector conservation.

References

Abbot, B. and van Kooten, G. C. (2011). Can domestication of wildlife lead to conservation? The economics of tiger farming in China. *Ecological Economics*, 70, 721-728.

Abensperg-Traun, M. (2009). CITES, sustainable use of wild species and incentive-driven conservation in African countries, with an emphasis on southern Africa. *Biological Conservation*, 142, 948-963.

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

Amin, R., Bramer, M. and Emslie, R. (2003). Intelligent data analysis for conservation: experiments with rhino horn fingerprint identification. *Knowledge-Based Systems*, 16, 329-336.

Arjunan, M., Holmes, C., Puyravaud, J-P. and Davidar, P. (2006). Do developmental initiatives influence local attitudes toward conservation? A case study from the Kalakad-Mundanthurai Tiger Reserve, India. *Journal of Environmental Management*, 79, 188-197.

Aung, U. M. (2007). Policy and practice in Myanmar's protected area system. *Journal of Environmental Management*, 84, 188-203.

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

Balfour, D., Knight, M. and Jones, P. (2015). *Status of white rhino on private and communal land in South Africa: 2012 - 2014*. Pretoria: Department of Environmental Affairs.

Barichievy, C., Munro, L., Clinning, G., Whittington-Jones, B. and Masterson, G. (2017). Do armed field-rangers deter rhino poachers? An empirical analysis. *Biological Conservation*, 209, 554-560.

Barnett, R. (1997) *Food for thought: the utilization of wild meat in eastern and southern Africa*. Nairobi: TRAFFIC East/Southern Africa.

Beale, C. M., Hauenstein, S., Mduma, S., Frederick, H., Jones, T., Bracebridge, C., Maliti, H. and Kohi, E. M. (2018). Spatial analysis of aerial survey data reveals correlates of elephant carcasses within a heavily poached ecosystem. *Biological Conservation*, 218, 258-267.

Becker, M., McRobb, R., Watson, F., Droge, E., Kanyembo, B., Murdoch, J. and Kakumbi, C. (2013). Evaluating wire-snare poaching trends and the impacts of by-catch on elephants and large carnivores. *Biological Conservation*, 158, 26-36.

Bezaury-Creel, J. E. (2014). Mexico. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Biggs, D., Courchamp, F., Martin, R. and Possingham, H. P. (2013). Legal trade of Africa's rhino horns. *Science*, 339, 1038-1039.

Bourke, M. (2011). Private investment in biodiversity conservation. A growing trend in the western world? *Global Environment*, 7/8, 38-49.

Brack, D. (2002). Combatting international environment crime. *Global Environmental Change*, 12, 143-147.

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

Brook, S. M., Dudley, N., Mahood, S. P., Polet, G., Williams, A. C., Duckworth, J. W., Van Ngoc, T. and Long, B. (2014). Lessons learned from the loss of a flagship: The extinction of the Javan rhinoceros *Rhinoceros sondaicus annamiticus* from Vietnam. *Biological Conservation*, 174, 21-29.

Brooks, M. (1999). *A draft conservation strategy for white rhinos in South Africa within the context of a century of conservation endeavour.* In: *Proceedings of a workshop on conservation of African rhinos on private land through utilization*. Onderstepoort, South Africa, 8-9 October 1999. African Rhino Owners Association.

Buckley, R. G. and de Vasconcellos Pegas, F. (2015). Four hurdles for conservation on private land: the case of the golden lion tamarin in Brazil's Atlantic Forest. *Frontiers in Ecology and Evolution*, 3. doi: 10.3389/fevo.2015.00088

Bulte, E. H. and van Kooten, G. C. (1999). Economic efficiency, resource conservation and the ivory trade ban. *Ecological Economics*, 28, 171-181.

Bürgener, M., Snyman, N. and Hauck, M. (2001) *Towards a sustainable wildlife trade. An analysis of nature conservation legislation in South Africa with particular reference to the wildlife trade*. Cape Town: Institute of Criminology, University of Cape Town in association with TRAFFIC East/Southern Africa.

Burton, M. (1999). An assessment of alternative methods of estimating the effect of the ivory trade ban on poaching effort. *Ecological Economics*, 30, 93-106.

Byron, N., Holland, P. and Schuele, M. (2001). *Constraints on private conservation: Some challenges in managing Australia's tropical rainforests*. Annual Conference of the Rainforest Cooperative Research Centre. Cairns, 14-15 November 2015.

Caro, T. and Riggio, J. (2014). Conservation and behavior of Africa's "Big Five". *Current Zoology*, 60, 486-499.

Carruthers, J. (2008). 'Wilding the farm or farming the wild'? The evolution of scientific game ranching in South Africa from the 1960s to the present. *Transactions of the Royal Society of South Africa*, 63, 160-181.

Carruthers, J. (2013). "Operation Rhino" – KwaZulu-Natal South Africa 1961. *Global Environment: A Journal of History and Natural and Social Sciences*, 11, 195-196.

Carter, E., Adams, W. M. and Hutton, J. (2008). Private protected areas: management regimes, tenure arrangements and protected area categorization in East Africa. *Oryx*, 42, 177-186.

Cashore, B., van Kooten, G. C., Vertinsky, I., Auld, G. and Affolderbach, J. (2005). Private or self-regulation? A comparative study of forest certification choices in Canada, the United States and Germany. *Forest Policy and Economics*, 7, 53-69.

Chacon, C. M. (2005). Fostering conservation of key priority sites and rural development in Central America: the role of private protected areas. *Parks*, 15, 39-47.

Chaderopa, C. (2013). Crossborder cooperation in transboundary conservation-development initiatives in southern Africa: The role of borders of the mind. *Tourism Management*, 39, 50-61.

Challender, D. W. S., Harrop, S. R., and MacMillan, D. C. (2015a). Towards informed and multi-faceted wildlife trade interventions. *Global Ecology and Conservation*, 3, 129-148.

Challender, D. W. S., Harrop, S. R., and MacMillan, D. C. (2015b). Understanding markets to conserve trade-threatened species in CITES. *Biological Conservation*, 187, 249-259.

Cheteni, P. (2014). An analysis of anti-poaching techniques in Africa: a case of rhino poaching. *Environmental Economics*, 5, 63-70.

CITES (not dated) *The CITES Appendices* [Online] CITES. Available at: www.cites.org/eng/app/index.php [Accessed 20 February 2019].

CITES (2017) *Appendices I, II and III valid from 4 October 2017* [Online] CITES. Available at: www.cites.org/eng/app/appendices.php [Accessed 20 February 2019].

CITES (2019). *Proposals for amendment of Appendices I and II - CoP18.* [Online]. CITES. Available at: https://cites.org/eng/cop/18/prop/index.php [Accessed 23 February 2019].

Clements, R., Rayan, D. M., Zafir, A. W. A., Venkataraman, A., Alfred, R., Payne, J., Ambu, L. and Sharma, D. S. K. (2010). Trio under threat: can we secure the future of rhinos, elephants and tigers in Malaysia? *Biodiversity Conservation*, 19, 1115-1136.

Clough, P. (2000). *Encouraging private biodiversity - incentives for biodiversity conservation on private land*. *Treasury Working Paper 00/25*. Wellington: NZ Institute of Economic Research (INC.).

Collier, N., Campbell, B. M., Sandker, M., Garnett, S. T., Sayer, J. and Boedhihartono, A. K. (2011). Science for action: the use of scoping models in conservation and development. *Environmental Science and Policy*, 14, 628-638.

Constitutional Court of South Africa (2017). *Case CCT/121/16*. Order dated 30 March 2017

Coppens, L. (2013). Transnational environmental crime – A common crime in need of better reinforcement. Article reproduced from United Nations Environment Programme (UNEP) Global Environmental Alert Service (GEAS). *Environmental Development*, 6, 108-116.

Cress, D. and Zommers, Z. (2014). Emerging technologies: Smarter ways to fight wildlife crime. Article reproduced from United Nations Environment Programme (UNEP) Global Environmental Alert Service (GEAS). *Environmental Development*, 12, 92-27.

Crookes, D. J. and Blignaut, J. N. (2015). Debunking the myth that a legal trade will solve the rhino horn crisis: A system dynamics model for market demand. *Journal for Nature Conservation*, 28, 11-18.

Cumming, T. and Daniels, F. (2014). South Africa. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Damania, R. and Bulte, E. H. (2007). The economics of wildlife farming and endangered species conservation. *Ecological Economics*, 62, 461-472.

Damania, R., & Hatch, J. (2005). Protecting Eden: markets or government? *Ecological Economics*, 53, 339-351.

Davies-Mostert, H. T. (2014). Overcoming barriers to understanding the biodiversity contribution of private ranchlands. *Animal Conservation*, 17, 399-400.

de Boer, W. F., Stigter, J. D. and Ntumi, C. P. (2007). Optimising investments from elephant tourist revenues in the Maputo Elephant Reserve, Mozambique. *Journal for Nature Conservation*, 15, 225-236.

Department of Environmental Affairs (DEA) (2013). *Rhino issue management report 2013*. Pretoria: Department of Environmental Affairs.

Department of Environmental Affairs (DEA) (2014). *South African government is aware that ongoing scourge of rhino poaching is linked to worldwide Illicit wildlife trade* [Online]. DEA. Available at: www.environment.gov.za/mediarelease/rhinopoaching_wildlifetrade [Accessed 20 February 2019].

Department of Environmental Affairs (DEA) (2015a). *Department of Environmental Affairs appeals the rhino horn moratorium judgment* [Online]. DEA. Available at: www.environment.gov.za/mediarelease/dea_appeals_rhinohornmoratoriumjudgment [Accessed 20 February 2019].

Department of Environmental Affairs (DEA) (2015b). *Minister Edna Molewa highlights progress in the fight against rhino poaching* [Online]. DEA. Available at: www.environment.gov.za/mediarelease/molewa_highlightsprogress_onrhinopoaching [Accessed 20 February 2019].

Department of Environmental Affairs (DEA) (2016a). *Minister Edna Molewa highlights progress in the fight against rhino poaching* [Online]. DEA. Available at: www.environment.gov.za/mediarelease/molewa_highlightsprogress_againstrhinopoaching [Accessed 20 February 2019].

Department of Environmental Affairs (DEA) (2016b). *CITES CoP17 Conference in South Africa: Colloquium on preparations, with Minister in attendance. Committee meeting summary.* [Online] Parliamentary Monitoring Group. Available at: https://pmg.org.za/committee-meeting/23252 [Accessed 02 May 2019].

Department of Environmental Affairs (DEA) (2019). *Minister of Environmental Affairs highlights progress on the implementation of the integrated strategic management of rhinoceros* [Online] DEA. Available at: www.environment.gov.za/progressonimplementationofintegratedstrategicmanagementofrhinoceros [Accessed 21 February 2019].

Dobson, A. and Lynes, L. (2008). How does poaching affect the size of national parks? *Trends in Ecology and Evolution*, 23, 177-180.

Douglas, L. R. and Alie, K. (2014). High-value natural resources: Linking wildlife conservation to international conflict, insecurity and development concerns. *Biological Conservation*, 171, 270-277.

Duffy, R. (1997). The environmental challenge to the nation-state: Superparks and national parks policy in Zimbabwe. *Journal of Southern African Studies*, 23, 441-451.

Duffy, R. (2014). Waging a war to save biodiversity: the rise of militarized conservation. *International Affairs*, 90, 819-834.

Duffy, R. (2016). War, by conservation. *Geoforum*, 69, 238-248.

Duffy, R. and St. John, F. A. V. (2013). *Poverty, poaching and trafficking: What are the links? Evidence on Demand*. London: Department for International Development.

Duffy, R., Emslie, R. H. and Knight, M. H. (2013). *Rhino poaching: How do we respond? Evidence on Demand*. London: Department for International Development.

du Toit, J. G. (1998). *A Manual for Owners of White Rhinos*. Onderstepoort: South African Veterinary Foundation.

Emslie, R. H. (1999). *Strategic white rhino conservation in the private sector*. In: *Proceedings of a workshop on conservation of African rhinos on private land through utilization*, Onderstepoort, South Africa, 8-9 October 1999. African Rhino Owners Association.

Emslie, R. (2012a). *Diceros bicornis. The IUCN Red List of Threatened Species 2012: e.T6557A16980917.* [Online]. IUCN. Available at: www.iucnredlist.org/species/6557/16980917 [Accessed 20 February 2019].

Emslie, R. (2012b). *Ceratotherium simum. The IUCN Red List of Threatened Species 2012: e.T4185A16980466*. [Online]. IUCN. Available at: www.iucnredlist.org/species/4185/16980466 [Accessed 20 February 2019].

Emslie, R. H., Milliken, T., Talukdar, B., Burgess, G., Adcock, K., Balfour, D. and Knight, M. H. (2019). *African and Asian rhinoceroses - status, conservation and trade: A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to*

Resolution Conf. 9.14 (Rev. CoP17) (No. CoP18 Doc. 83.1 Annex 2). Geneva: CITES Secretariat.

Endangered Wildlife Trust (EWT) (2011). *A moratorium on rhino hunting - some thoughts and recommendations*. Johannesburg: Endangered Wildlife Trust.

Endangered Wildlife Trust (EWT) (2013). *Rhino Security Booklet*. Modderfontein: Endangered Wildlife Trust.

Ferraro, P. J. and Kiss, A. (2002). Direct payments to conserve biodiversity. *Science*, 289, 1717-1719.

Ferreira, S. M., Pfab, M. and Knight, M. (2014). Management strategies to curb rhino poaching: Alternative options using a cost-benefit approach. *South African Journal of Science*, 110, 1-8.

Figgis, P., Humann, D. and Looker, M. (2005). Conservation on private land in Australia. *Parks*, 15, 19-29.

Fischer, C. (2004). The complex interactions of the markets for endangered species products. *Journal of Environmental Economics and Management*, 48, 926-953.

Fitzsimons, J. (2014). Australia. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Fornieles, M. R. (2014). Spain. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Freeman, M. M. R. and Wenzel, G. W. (2000). The nature and significance of polar bear conservation hunting in the Canadian Arctic. *Arctic*, 59, 21-30.

Gandiwa, E., Heitkönig, I. M. A., Lokhorst, A. M., Prins, A. H. T. and Leeuwis, C. (2013). Illegal hunting and law enforcement during a period of economic decline in Zimbabwe: A case study of northern Gonarezhou National Park and adjacent areas. *Journal for Nature Conservation*, 21, 133-142.

Gao, Y. and Clark, S. G. (2014). Elephant ivory trade in China: Trends and drivers. *Biological Conservation*, 180, 23-30.

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

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

Glennon, M. T. (1990). Has international law failed the elephant? *The American Journal of International Law*, 84, 1-43.

Government Communication and Information System (2016). *Statement on the Cabinet Meeting of 13 April 2016* [Online]. Government Communication and Information System. Available at: www.gcis.gov.za/newsroom/media-releases/statement-cabinet-meeting-13-april-2016 [Accessed 20 February 2019].

Hackel, J. D. (1990). Conservation attitudes in southern Africa: A comparison between KwaZulu and Swaziland. *Human Ecology*, 18, 203-209.

Hall-Martin, A. J., du Toit, J. G., Hitchens, P. M. and Knight, M. H. (2009). *An exert of the 2008 survey of white rhinoceros, Ceratotherium simum simum, on private land in South Africa*. Cape Town: WWF-African Rhino Programme.

Harper, J. (2015). $60K a pound: Illegal rhino horn now declared more valuable than gold, diamonds and cocaine. *Washington Times* [Online]. Available at: www.washingtontimes.com/news/2015/may/17/rhino-horn-considered-cure-all-and-aphrodesiac-now/ [Accessed 20 February 2019].

Harper, C. K., Vermeulen, G. J., Clarke, A. B., de Wet, J. I. and Guthrie, A. J. (2013). Extraction of nuclear DNA from rhinoceros horn and characterization of DNA profiling systems for white (*Ceratotherium simum*) and black (*Diceros bicornis*) rhinoceros. *Forensic Science International: Genetics*, 7, 428-433.

Hayward, M. W., Ripple, W. J., Kerley, G. I. H., Landman, M., Plotz, R. D. and Garnett, S. T. (2017). Neocolonial conservation: Is moving rhinos to Australia conservation or intellectual property loss? *Conservation Letters*, 11, e12354 doi.org/10.1111/conl.12354

Heinonen, M. (2014). Finland. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Heltberg, R. (2001). Impact of the ivory trade ban on poaching incentives: a numerical approach. *Ecological Economics*, 36, 189-195.

Heo, H. Y. (2014). Korea. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

High Court of South Africa (2015a). *Case number 57221/12*. In the matter between Krüger Johan, Hume John and The Minister of Water and Environmental Affairs, Wildlife Ranching South Africa (WRSA), The Private Rhino Owners Association (PROA). Judgement.

High Court of South Africa (2015b). *Case number 57221/12*. The Minister of Water and Environmental Affairs and Johan Krüger, John Hume, Wildlife Ranching South Africa (WRSA), The Private Rhino Owners Association (PROA). Application for Leave to Appeal.

Honig, M., Peterson, S., Sheraing, C., Pintér, L. and Kotze, I. (2015). The conditions under which farmers are likely to adapt their behaviour: a case study of private land conservation in the Cape Winelands, South Africa. *Land Use Policy*, 48, 389-400.

Hume, J. (2013). Saving rhino from extinction. *African Indaba*, 11, 14-17.

Humphreys, J. and Smith, M. L. R. (2014). The 'rhinofication' of South African security. *International Affairs*, 4, 795-818.

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

Ingram, J. C., Wilkie, D., Clements, T., M, cNab, R. B., Nelson, F., Baur, E. H., Sachedina, H. T., Peterson, D. D. and Foley, C. A. H. (2014). Evidence of payments for ecosystem services as a mechanism for supporting biodiversity conservation and rural livelihoods. *Ecosystem Service*, 7, 10-21.

IUCN-WCPA (2011). *Protected areas in East Asia: Evaluating and strengthening implementation of the CBD Programme of Work on Protected Areas and the East Asian Regional Plan*. Gland: IUCN.

Jachmann, H. (2008a). Monitoring law-enforcement performance in nine protected areas in Ghana. *Biological Conservation*, 141, 89-99.

Jachmann, H. (2008b). Illegal wildlife use and protected area management in Ghana. *Biological Conservation*, 141, 1906-1918.

Jackson, P. (1982). The future of elephants and rhinos in Africa. *Ambio*, 11, 202-205.

Johannesen, A. B. (2007). Protected areas, wildlife conservation, and local welfare. *Ecological Economics*, 62, 126-135.

Johannesen, A. B. and Skonhoft, A. (2005). Tourism, poaching and wildlife conservation: what can integrated conservation and development projects accomplish? *Resource and Energy Economics*, 27, 208-226.

Jones, B. T. B. (2014). Namibia. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

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

Kaltenborn, B. P. Nyahongo, J. W., Kidegesho, J. R. and Haaland, H. (2008). Serengeti National Park and its neighbours – Do they interact? *Journal for Nature Conservation*, 16, 96-108.

Kamal, S., Grodzińska-Jurczak, M. and Broqn, G. (2015). Conservation on private land: a review of global strategies with a proposed classification system. *Journal of Environmental Planning and Management*, 58, 576-597.

Kangalawe, R. Y. M. and Noe, C. (2012). Biodiversity conservation and poverty alleviation in Namtumbo District, Tanzania. *Agriculture, Ecosystems and Environmen*t, 162, 90-100.

Kapur, V., Prasanth, S. G., O'Ryan, C., Azfer, M. A. and Ali, S. (2003). Development of a DNA marker by minisatellite associated sequence amplification (MASA) from the endangered Indian rhino (*Rhinoceros unicornis*). *Molecular and Cellular Probes*, 17, 1-4.

Khanna, J. and Harford, J. (1996). The ivory trade ban: Is it effective? *Ecological Economics*, 19, 147-155.

Kirby, K. J. (2003). Woodland conservation in privately-owned cultural landscapes: the English experience. *Environmental Science & Policy*, 6, 253-259.

Knight, M. (2015). Calling all rhino wwners: How can you, the private rhino owner, help to solve the rhino crisis? *Wildlife Ranching*, 4, Rhino Supplement, 9-13.

Knight, M. H., Emslie, R. H., Smart, R. and Balfour, D. (2015). *Biodiversity management plan for the white rhinoceros (Ceratotherium simum) in South Africa 2015-2020*. Pretoria: Department of Environmental Affairs.

Knight, R. (1999). Private lands: the neglected geography. *Conservation Biology*, 13, 223-224.

Kock, R., Amin, R. and Subedi, N. (2008). Postscript: Rogue Army staff involved in poaching in Bardia National Park, Nepal, 2007-2008. *Pachyderm*, 45, 115-116.

Kühl, A., Balinova, N., Bykova, E., Arylov, Y. N., Esipov, A., Lushchekina, A. A. and Milner-Gulland, E. J. (2009). The role of saiga poaching in rural communities: Linkages between attitudes, socio-economic circumstances and behaviour. *Biological Conservation*, 142, 1442-1449.

Langholz, J. A. and Krug, W. (2004). New forms of biodiversity governance: non-state actors and the private protected area action plan. *Journal of International Wildlife Law and Policy*, 7, 9-29.

Leach, M., Mearns, R. and Scoones, I. (1999). Environmental entitlements: dynamics and institutions in community-based natural resources management. *World Development*, 27, 225-247.

Leader-Williams, N. (2013). Fate riding on their horns - and genes. *Oryx*, 47, 311-312.

Leader-Williams, N. (2003). Regulation and protection: successes and failures in rhinoceros conservation. In Oldfield, S. (Ed). *The Trade in Wildlife: Regulation for Conservation*. London: Earthscan Publications Ltd., pp. 89-99.

Leader-Williams, N. Milledge, S., Adcock, K., Brooks, M., Conway, A., Knight, M., Mainka, S., Martin, E. B. and Teferi, T. (2005). Trophy hunting of black rhino *Diceros bicornis*: Proposals to ensure its future sustainability. *Journal of International Wildlife Law and Sustainability*, 8, 1-11.

Lindsey, P. A. and Taylor, A. (2011). *A study on dehorning of African rhinoceroses as a tool to reduce the risk of poaching*. Johannesburg: Endangered Wildlife Trust and the South African Department of Environmental Affairs.

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

Loibooki, M., Hofer, H., Campbell, K. L. I. and East, M. L. (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

Lopes, A. A. (2014). Civil unrest and the poaching of rhinos in Kaziranga National Park, India, *Ecological Economics*, 103, 20-28.

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

Lunstrum, E. (2014). Green militarization: Anti-poaching efforts and the spatial contours of Kruger National Park. *Annals of the Association of American Geographers*, 104, 816-832.

Lunstrum, E. (2017). Feed them to the lions: Conservation violence goes online. *Geoforum*, 79, 134-143.

Maciejewski, K., Baum, J. and Cumming, G. S. (2016). Integration of private land conservation areas in a network of statutory protected areas: Implications for sustainability. *Biological Conservation*, 2002, 200-206.

Maroney, R. L. (2005). Conservation of argali *Ovis ammon* in western Mongolia and the Altai-Sayan. *Biological Conservation*, 121, 231-241.

Martin, E., Martin, C. and Vigne, L. (2008). Recent political disturbances in Nepal threaten rhinos: lessons to be learned, *Pachyderm*, 45, 98-107.

Martin, E., Talukdar, B. K. and Vigne, L. (2009). Rhino poaching in Assam: challenges and opportunities. *Pachyderm*, 46, 25-34.

Massé, F. and Lunstrum, E. (2016). Accumulation by securitization: Commercial poaching, neoliberal conservation and the creation of new wildlife frontiers. *Geoforum*, 69, 227-237.

Mayer, A. L. and Tikka, P. M. (2006). Biodiversity conservation incentive programs for privately owned forests. *Environmental Science & Policy*, 9, 614-625.

Mbaiwa, J. E. (2004). Socio-economic benefits and challenges of a community-based safari hunting tourism in the Okavango delta, Botswana. *Journal of Tourism Studies*, 15, 37-50.

Mbaiwa, J. E. (2005). Wildlife resource utilisation at Moremi Game Reserve and Khwai community area in the Okavanga Delta, Botswana. *Journal of Environmental Management*, 77, 144-156.

Messer, K. D. (2010). Protecting endangered species: When are shoot-on-sight policies the only viable option to stop poaching? *Ecological Economics*, 69, 2334-2340.

Metzger, K. L., Sinclair, A. R. E., Campbell, K. L. I., Hilborn, R., Hopcraft, J. G. C., Mduma, S. A. R. and Reich, R. M. (2007). Using historical data to establish baselines for conservation: The black rhinoceros (*Diceros bicornis*) of the Serengeti as a case study. *Biological Conservation*, 139, 358-374.

Milliken, T. and Shaw, J. (2012). *The South Africa – Viet Nam rhino horn trade nexus: A deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates*. Johannesburg: TRAFFIC.

Milner-Gulland, E. J. (1999). How many to dehorn? A model for decision-making by rhino managers. *Animal Conservation*, 2, 137-147.

Milner-Gulland, E. J. and Clayton, L. (2002). The trade in barbirusas and wild pigs in North Sulawesi, Indonesia. *Ecological Economics*, 42, 165-183.

Milner-Gulland, E. J. and Leader-Williams, N. (1992). A model of incentives for the illegal exploitation of black rhinos and elephants: Poaching pays in Luangwa Valley, Zambia. *Journal of Applied Ecology*, 29, 388-401.

Mir, D. F. and Dick, K. (2012). Conservation approaches to protecting critical habitats and species on private property. *Natural Areas Journal*, 32, 190-198.

Muir-Leresche, K. and Nelson, R. H. (2000). *Private property rights to wildlife: The southern African experiment*. *ICER Working Paper 02-2000*. Torino: International Centre for Economic Research.

Murray, D. L., Majchrzak, Y. N., Peers, M. J. L., Wehtje, M., Ferreira, C., Pickles, R. S. A., Row, J. R. and Thornton, D. H. (2015). Potential pitfalls of private initiatives in conservation planning: A case study from Canada's boreal forest. *Biological Conservation*, 192, 174-180.

National Treasury (2016). *2016 Budget. Estimates of national expenditure. Environmental Affairs.* [Online]. Department of National Treasury. Available at: www.treasury.gov.za/documents/national%20budget/2016/enebooklets/Vote%2027%20Environmental%20Affairs.pdf [Accessed 20 February 2019].

Nepal, S. K. (2002). Involving indigenous peoples in protected area management: Comparative perspectives from Nepal, Thailand and China. *Environmental Management*, 30, 748-763.

Norton, D. A. (2000). Conservation biology and private land: shifting the focus. *Conservation Biology*, 14, 1221-1223.

Núñez-Ávila, M. C. (2014). Chile. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Olivier, R. (2014). Kenya. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Paloniemi, R. and Tikka, P. M. (2008). Ecological and social aspects of biodiversity conservation on private lands. *Environmental Science & Policy*, 11, 336-346.

Parliamentary Monitoring Group (2018). *Rhino horn demand management & CITES preparations: DEA briefing*. [Online]. Parliamentary Monitoring Group. Available at: https://pmg.org.za/committee-meeting/27322/ [Accessed 23 February 2019].

Pellin, A. and Valladares Pádua, C. (2014). Brazil. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Pernetta, A. P. (2014). A disappearing drylands icon? White rhinoceros conservation and the need for public-private partnerships. *Biodiversity*, 15, 231-232.

Pienaar, D. J., Hall-Martin, A. J. and Hitchens, P. M. (1991). Horn growth rates of free-ranging white and black rhinoceros. *Koedoe*, 34, 97-105.

Pienaar, E. F., Jarvis, L. S. and Larson, D. M. (2014). Using a choice framework to value conservation-contingent development programs: An application to Botswana. *Ecological Economics*, 98, 39-48.

Pienaar, E. F., Rubino, E. C., Saayman, M. and van der Merwe, P. (2017). Attaining sustainable use on private game ranching lands in South Africa. *Land Use Policy*, 65, 176-185.

Polasky, S. and Doremus, H. (1998). When the truth hurts: Endangered species policy on private land with imperfect information. *Journal of Environmental Economics and Management*, 35, 22-47.

Polasky, S., Doremus, H. and Rettig, B. (1997). Endangered species conservation on private land. *Contemporary Economic Policy*, 15, 66-76.

Pollock, N. C. (1969). Some observations on game ranching in southern Africa. *Biological Conservation*, 2, 18-24.

Rachlow, J. L. and Berger, J. (1997). Conservation implications of patterns of horn regeneration in dehorned white rhinos. *Conservation Biology*, 11, 84-91.

Reilly, T., Reilly, M. and Emslie, R. H. (2004). Transfer of Swaziland's southern white rhino from CITES Appendix I to Appendix II. *Pachyderm*, 37, 99-105.

Rentsch, D. and Damon, A. (2013). Prices, poaching, and protein alternatives: An analysis of bushmeat consumption around Serengeti National Park, Tanzania. *Ecological Economics*, 91, 1-9.

Rhino Alive (2016) *South Africa's missed opportunity to save the remaining rhino in the world*. [Online]. Rhino Resource Centre. Available at: www.rhinoresourcecenter.com/pdf_files/146/1462014666.pdf [Accessed 20 February 2019].

Rhino Alive (2018). *South Africa: National rhino poaching statistics - detailed analysis of the 2017 statistics.* [Online]. Private Rhino Owners Association (PROA). Available at: www.facebook.com/RhinoAlive/photos/a.455648507965862/745294002334643/?type=3&theater [Accessed 23 February 2019].

Rissman, A. R., Lozier, L., Comendant, T., Kareiva, P., Kiesecker, J. M., Shaw, M. R. and Merenlender, A. M. (2007). Conservation easements: Biodiversity protection and private use. *Conservation Biology*, 23, 709-718.

Rubino, E. C. and Pienaar, E. F. (2017). Applying a conceptual framework to rhinoceros conservation on private lands in South Africa. *Endangered Species Research*, 34, 89-102.

Rubino, E. C. and Pienaar, E. F. (2018a). Understanding South African private landowners decisions to manage rhinoceroses. *Human Dimensions of Wildlife*, 23, 160-175.

Rubino, E. C. and Pienaar, E. F. (2018b). Rhinoceros ownership and attitudes towards legalization of global horn trade within South Africa's private wildlife sector. *Oryx*. doi:10.1017/s0030605318000030

Rubino, E. C., Pienaar, E. F. and Soto, J. R. (2018). Structuring legal trade in rhino horn to incentivize the participation of South African private landowners. *Ecological Economics*, 154, 306-316.

South African National Parks (SANParks) (2019). *Media Release: SANParks and Greater Kruger partners' innovate to minimise impact of rhino poaching*. [Online]. SANParks. Available at: www.sanparks.org/about/news/?id=57799 [Accessed 19 May 2019].

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

Selier, J. (2019). *Supplemental information in support of the CITES CoP18 proposal to amend South Africa's export quota for black rhinoceros hunting trophies.* (*No. CoP18 Inf. 78)*. Geneva: CITES Secretariat.

Setsaas, T. H., Holmern, T., Mwakalebe, G., Stokke, S. and Røskaft, E. (2007). How does human exploitation affect impala populations in protected and partially protected areas? – A case study from the Serengeti Ecosystem, Tanzania. *Biological Conservation*, 136, 563-570.

Shafer, C. L. (1999). National park and reserve planning to protect biological diversity: some basic elements. *Landscape and Urban Planning*, 44, 123-153.

Shogren, J. F., Parkhurst, G. M. and Settle, C. (2003). Integrating economics and ecology to protect nature on private lands: models, methods and mindsets. *Environmental Science & Policy*, 6, 233-242.

Skonhoft, A. (1998). Resource utilization, property rights and welfare – Wildlife and the local people. *Ecological Economics*, 26, 67-80.

Skonhoft, A. (2007). Economic modelling approaches for wildlife and species conservation. *Ecological Economics*, 62, 223-231.

Skonhoft, A. and Solstad, J. T. (1998). The political economy of wildlife exploitation. *Land Economics*, 74, 16-31.

Smith, G. (2006). *The contribution of biodiversity conservation on private land to Australian cityscapes*. 42nd ISoCaRP Congress. Istanbul, Turkey, 14-18 September 2006.

Spenceley, A. (2005). Nature-based tourism and environmental sustainability in South Africa. *Journal of Sustainable Tourism*, 13, 136-170.

Spenceley, A. and Barnes, J. (2005). *Economic analysis of rhino conservation in a land-use context within the SADC region*. Harare: SADC Rhino Management Group.

Statistics South Africa (2012). *Income and expenditure of households 2010/2011*. Pretoria: Statistics South Africa.

Stone, L. S. and Stone, T. M. (2011). Community-based tourism enterprises: challenges and prospects for community participation; Khama Rhino Sanctuary Trust, Botswana. *Journal of Sustainable Tourism*, 19, 97-114.

Stuart, C. T., Macdonald, I. A. W. and Mills, M. G. L. (1985). History, current status and conservation of large mammalian predators in Cape Province, Republic of South Africa. *Biological Conservation*, 31, 7-19.

Sutherland, W. J., Aveling, R., Brooks, T. M., Clout, M., Dicks, L. V., Fellman, L., Fleishman, E., Gibbons, D. W., Keim, B., Lickorish, F. et al. (2014). A horizon scan of global conservation issues for 2014. *Trends in Ecology and Evolution*, 29, 15-22.

Swanepoel, G. (1998). The illegal trade in rhino horn: An example of an endangered species. *International Journal of Risk, Security and Crime Prevention,* 3, 207-220.

Taylor, W. A., Lindsey, P. A. & Davies-Mostert, H. (2015a). *An assessment of the economic, social and conservation value of the wildlife ranching industry and its potential to support the green economy in South Africa*. Johannesburg: The Endangered Wildlife Trust.

Taylor, G., Scharlemann, J. P. W., Rowcliffe, M., Kümpel, N., Harfoot, M. B. J., Fa, J. E., Melisch, R., Milner-Gulland, E. J., Bhagwat, S., Abernethy, K. A. et al. (2015b). Synthesising bushmeat research effort in West and Central Africa: A new regional database. *Biological Conservation*, 181, 199-205.

‘t Sas-Rolfes, M. (1997). *Does CITES work? Four case studies*. *IEA Environment Briefing No. 4*. London: Africa Resources Trust.

United Nations Office on Drugs and Crime (UNODC) (2012). Rhino poaching in Southern Africa. *Bulletin on organised crime in Southern Africa. Issue 1*. Pretoria: UN Office on Drugs and Crime Regional Office for Southern Africa.

van Kooten, G. C. (2008). Protecting the African elephant: A dynamic bioeconomic model of ivory trade. *Biological Conservation*, 141, 2012-2022.

Ververs, C., van Zijll Langhout, M., Hostens, M., Otto, M., Govaere, J., Durrant, B. and Van Soom, A. (2017). Reproductive performance parameters in a large population of game-ranched white rhinoceroses (*Ceratotherium simum simum*). *PLoS ONE*, 12, e0187751. doi.org/10.1371/journal.pone.0187751

Vodouhê, F. G., Coulibaly, O., Adégbidi and Sinsin, B. (2010). Community perception of biodiversity conservation within protected areas in Benin. *Forest Policy and Economics*, 12, 505-512.

von Hase, A., Rouget, M. and Cowling, R. M. (2010). Evaluating private land conservation in the Cape Lowlands, South Africa. *Conservation Biology*, 24, 1182-1189.

Walker, C. (1994). Black rhino on private land – the experience of Lapalala Wilderness, South Africa. *Pachyderm*, 18, 44-45.

Walpole, M. J., Morgan-Davies, M., Milledge, S., Bett, P. and Leader-Williams, N. (2001). Population dynamics and future conservation of a free-ranging black rhinoceros (*Diceros bicornis*) population in Kenya. *Biological Conservation*, 99, 237-243.

Warchol, G. L. (2004). The transnational illegal wildlife trade. *Criminal Justice Studies*, 17, 57-74.

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

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

Wato, Y. A., Wahungu, G. M. and Okello, M. M. (2006). Correlates of wildlife snaring patterns in Tsavo West National Park, Kenya. *Biological Conservation*, 432, 500-509.

Watson, F., Becker, M. S., McRobb, R. and Kanyembo, B. (2013). Spatial patterns of wire-snare poaching: Implications for community conservation in buffer zones around National Parks. *Biological Conservation*, 168, 1-9.

Weber, D. S., Mandler, T., Dyck, M., Van Coeverden De Groot, P. J., Less, D. S. and Clark, D. A. (2015). Unexpected and undesired conservation outcomes of wildlife trade bans - An emerging problem for stakeholders? *Global Ecology and Conservation*, 3, 389-400.

Wells, M. (1992). Biodiversity conservation, affluence and poverty: mismatched costs and benefits and efforts to remedy them. *Ambio*, 21, 237-243.

Western, D. (1982). Patterns of depletion in a Kenya rhino population and the conservation implications. *Biological Conservation*, 24, 147-156.

Wilcove, D. S., Bean, M. J., Long, B., Snape, W. J., Beehler, B. M. and Eisenberg, J. (2004). The private side of conservation. *Frontiers in Ecology and the Environment*, 2, 326-331.

Wilkinson, C. (2014). Canada. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Wilshusen, P. R., Brechin, S. R., Fortwangler, C. I. and West, P. C. (2002). Reinventing a square wheel: critique of a resurgent "protection paradigm" in international biodiversity conservation. *Society & Natural Resources*, 15, 17-40.

Wright, O. T., Cundill, G. and Bigg, D. (2016). Stakeholder perceptions of legal trade in rhinoceros horn and implications for private reserve management in the Eastern Cape, South Africa. *Oryx*, 52,175-185.

Zhang, L. (2014). China. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Chapter 2: Trends and challenges in private rhino ownership in South Africa

Abstract

Sustained poaching over the last decade has led to significant loss of black (*Diceros bicornis*) and southern white (*Ceratotherium simum simum*) rhinoceroses across South Africa. Whilst much research focus has been on the heavily targeted state-owned populations, little research has been undertaken to understand the trends and challenges faced by the private sector. We used historical surveys and a present-day questionnaire of private rhino owners to assess the trends in private rhino ownership across South Africa and the challenges facing the sector for the future. Private rhino ownership has increased substantially across South Africa over the past three decades, with over 42% of the entire population now in private ownership. Whilst total rhino numbers on private land are still increasing, the number of properties owning rhinos is declining. A wide range of properties engage in private rhino conservation; from very small properties focusing on private recreation and holding a range of species amongst similar property types, to very large, isolated, single-species breeding facilities. Private rhino owners utilise a wide range of anti-poaching strategies to protect their stock, with limited information available on their effectiveness despite significant expenditure. The economic impact associated with increased poaching of rhinos over the last decade is the major challenge to private rhino ownership. There is also some unwillingness among private rhino owners to follow government registration procedures. The general increase in private rhino ownership seen historically may decline as poaching increases and drives a potential move towards disinvestment in rhinos. Economic factors may be the factors that encourage disengagement in private rhino conservation. Failure to follow registration and monitoring procedures may further damage the reputation of the private sector as a valuable conservation agent for rhinos. Unless these challenges can be resolved, there may be increasing disinvestment by private rhino owners, with potential negative implications for South Africa's rhino population.

Additional keywords**:** Poaching; landowners; private conservation; anti-poaching; *Ceratotherium simum simum*; *Diceros bicornis*

Introduction

Across most of the world, conservation of megafauna is focused within state-owned protected areas, and exploitation of species of conservation priority is either not permitted or severely restricted. South Africa, Zimbabwe, Botswana and Namibia are unusual compared with much of the rest of the world, in that the ownership of wildlife in these countries has been largely privatised. So long as landowners have the correct permits/certificates in place, they may utilise the wildlife on their land to generate income (Pienaar et al., 2017; Taylor et al., 2015; Child, 2012; Muir-Leresche and Nelson, 2000). Devolving some of the financial responsibility for wildlife conservation to the private sector can reduce pressure on under-funded governments (Wilson et al., 2017).

Black rhino (*Diceros bicornis spp.*) and southern white rhino (*Ceratotherium simum simum*) represent species for which the private sector has become increasingly important for conservation since the 1970s. Private landowners can derive income from rhinos through tourism, trophy hunting, legal sale of horn within South Africa and breeding (Pienaar et al., 2017; Wilson et al., 2017; Taylor et al., 2015; Child, 2012; Muir-Leresche and Nelson, 2000). In Zambia, it has been shown that increased income allows greater investment in anti-poaching measures and may also generate further private sector and NGO investment and increased biomass of wild ungulates (Lindsey et al., 2014).

Freehold private land, dedicated to the management of wildlife, has proliferated in South Africa, Botswana, Namibia and Zimbabwe since the removal of subsidies for livestock rearing and the collapse of international agriculture markets (Carruthers, 2008). Populations of game species increased substantially in order to take advantage of the potential economic gains available, with impala (*Aepyceros melampus*) populations in South Africa increasing more than tenfold between 1950 and 1974 (Mossman and Mossman, 1976). By 1974, 399 game farms were identified in South Africa, with many other mixed game and commercial properties (Carruthers, 2008). The southern white rhino population of South Africa became part of this industry in 1986, when the first commercial sales by auction to private owners were held by the Natal Parks Board (Knight, 2015). Black rhino sales followed in 1990 (‘t Sas-Rolfes, 1997). Rhino populations in South Africa have increased tenfold since private ownership was permitted (DEA, 2013). By the end of 2017, approximately

7,500 rhinos were privately owned in South Africa, representing around 42% of the whole South African population (Emslie et al., 2019). Longitudinal studies of the growth of private rhino ownership in South Africa are however lacking. Given the importance of their potential role in raising numbers of individuals, this work aims to explore trends in the privately-owned rhino population of South Africa through time in relation to the total population.

It is widely accepted that extensive private reserves contribute to biodiversity contribution through the maintenance of natural habitat and protection of native species (Cousins et al., 2010; Gallo et al., 2009; Cousins et al., 2008; Jones et al., 2005; Douglas-Hamilton, 1997), although some have questioned the value of fenced properties, particularly where predator control may be utilised or where animals are intensively 'farmed' (Pitman et al., 2016; Cousins et al., 2010). The role of private properties in the WWF's Black Rhino Range Expansion Project (BRREP) is well known (Hayward et al., 2017; Cousins et al., 2008), but it is the conservation value of intensive breeding facilities which is more often questioned, particularly in regards to genetic management and risks of domestication (Cousins et al., 2008; van der Waal and Dekker, 2000). This work explores whether a move towards intensive breeding is apparent by considering the number of privately-owned rhinos and the number of properties to identify any increases in mean population density. The suggestion that these properties have a role in protecting the genetic variety in white rhinos as a reservoir for future reintroductions has been posited as defining their conservation value (Ververs et al., 2017). IUCN/SSC African Rhino Specialist Group defines Important populations as those numbering 20-50 and Key populations as 50-100 (Key 2) and over 100 (Key 1) animals (Hall-Martin et al., 2009), suggesting that the large populations often held on breeding properties do have conservation value. For that reason, throughout this work we use the definition of private land conservation of Selinske et al. (2015: pg. 282) as any land "owned and administered by individuals, communities, NGOs, or corporations with a primary goal of protecting, managing and/or ensuring the persistence of biodiversity". This ranges from extensive areas of natural habitat, with rhinos stocked amongst other native species, through to single-species breeding facilities. Whilst it is known that a range of properties exists, there is currently no information available regarding the specifics of this. This work

investigates a number of factors alongside the rhino population, such as the priorities of the property, the surrounding land uses and the range of other species held.

The continued increase in contribution of the private sector to rhino populations has occurred in the face of continued poaching pressure. Between 1990 and 2005, the average number of rhinos poached per year in South Africa was 14 (Milliken and Shaw, 2012); this number increased to over 1,000 between 2013 and 2017 (DEA 2017; DEA 2014). The proportion of these poached on private land is not publicly available information, but the Chairman of the Private Rhino Owners' Association has previously stated that approximately 20% of the rhinos poached in South Africa were privately owned (Jones, 2013). The South African Department of Environmental Affairs (DEA) has attributed this increase in rhino poaching to the combined effects of high demand and the international and national bans reducing available stock (DEA, 2013). Private rhino owners receive no government or NGO funding or support to protect their stock (Rubino and Pienaar, 2018a; Lee and Du Preez, 2016; Child, 2012) and so the costs of anti-poaching activities must be borne by the individual owners. Alongside a lack of financial support, private rhino owners have been noted to show distrust in the government (Rubino and Pienaar, 2018a; 2018b; Pienaar et al., 2017) with a general consensus that regulation is developed by people without an understanding of the relevant matters (Cocklin et al., 2007) and that rhino poaching is not a government priority (du Toit, 2006). Current challenges due to the recent increase in poaching, distrust of the government and the potential economic burden of preventing poaching events are also investigated throughout this work.

Anti-poaching strategies have become more militarised since the 1980s due to the need to respond to more heavily armed poachers (Lunstrum, 2014), with greater use of technology and techniques originally developed for military use (Duffy, 2014). This militarisation of anti-poaching is much more common on state-owned than on private land (Shaw and Rademeyer, 2016), but increasing poaching in the last decade has led to the development of such militarised actions on private land as well (Lunstrum, 2014). The costs of protecting privately-owned rhinos have therefore increased substantially (Balfour et al., 2015). Increasing costs of rhino protection have been linked to preventing reserve expansion in Zimbabwe (Langholz, 1996) and to increasing disinvestment in rhinos by private owners in South Africa (Jones, 2013).

Much of the research that has been conducted into anti-poaching strategies has focused on emerging technologies, with little research considering the use of traditional anti-poaching strategies on private land. This work aims to identify the range of anti-poaching strategies currently employed by private rhino owners. The widely implemented emerging technologies include the use of unmanned aerial vehicles (UAV) or remotely piloted aircraft systems (RPAS), more commonly known as drones. The mounting of still and video cameras and audio recorders on RPAS presents a wide range of opportunities for their use in anti-poaching activities, with some researchers (e.g. Cress and Zommers, 2014) suggesting that they may prove to be vital in reducing poaching. The ease of operation of RPAS and their relative robustness enhance their usefulness in the field (Gross, 2014) and decreasing prices of RPAS (Paneque-Gálvez et al., 2014) are likely to further increase the accessibility of RPAS technology.

However, the factors which make RPAS attractive in anti-poaching activities, also make them useful for poachers (Arts et al., 2015). A year-long RPAS test in Kruger National Park, initially piloted in the Olifants West area (Schiffman, 2014), found too many shortcomings for the programme to continue (Martin, 2017). Whilst the company that developed the technology claimed poachers were detected and shortcomings were due to lack of integration with the anti-poaching teams, the Park authorities claimed that the RPAS failed to identify people amongst animals and trees and did not detect any poachers (Martin, 2017).

Other emerging technologies that have been posited as means to tackle the rhino poaching crisis include the use of real-time sensors attached to rhinos (O'Donoghue and Rutz, 2016), and acoustic traps to triangulate sources of noise (Cress and Zommers, 2014). However, Arts et al. (2015) suggest caution with the development of such technologies, noting that real time data sets can be hacked and therefore potentially exploited by poachers. They suggest that too much focus on the promises of digital technology may close other options prematurely; without full understanding of the effectiveness of current, widely used anti-poaching measures, a focus purely on emerging technology appears naïve. In particular, understanding the effectiveness of less expensive technologies would be especially useful for those who generate the funds to undertake such activities themselves. This paper aims to

investigate the effectiveness of anti-poaching activities by considering the timing of their implementation and subsequent poaching events on properties.

In this paper, we evaluate the case of private rhino ownership in South Africa as an example of the contribution that the private sector can make to the conservation of rare and threatened species, and the challenges it faces in doing so. First, we quantify how the private sector ownership of rhinos in South Africa has grown, based on historical surveys of private rhino owners. The historical surveys utilised here have been used previously to show trends over the course of the survey period for specific aspects of rhino ownership (e.g. total population size), but this is the first time that several different aspects of the surveys have been combined across the full time scale of the surveys. Specifically, we analyse changes in mean population size (a factor not explicitly considered until the 2008 survey) to investigate any patterns in population density. A trend towards increased population size could indicate a move towards a focus on intensive large-scale breeding of rhinos within the private wildlife industry. We also consider the proportion of the total population which is protected by private rhino owners as a measure of their overall role in rhino conservation.

Given the effectiveness of questionnaires in assessing perceptions regarding ecological management decisions (White et al., 2005) we then designed a new questionnaire to investigate the range of properties involved in private rhino ownership in more detail. We also examine the priorities of properties and the range of anti-poaching measures employed by private rhino owners within South Africa. To understand why properties utilise a range of anti-poaching measures we also tested whether the number of rhinos on a property, the number of poaching events on a property, or the expenditure on security was related to the number of anti-poaching measures deployed. Whilst it is very difficult to assess the effectiveness of anti-poaching strategies, we also aimed to identify whether there was any evidence of reductions in poaching after the implementation of specific anti-poaching measures.

Finally, we used the questionnaire to identify the challenges associated with private rhino ownership. Given the potential risk of increasing expenditure on security leading to disinvestment in rhinos by private owners, it is important to understand the financial challenges rhino owners face to avoid disinvestment potentially reversing the historical growth in privately-owned rhino populations. We also anticipated that

the known distrust of the government may prove challenging to private rhino owners and so used the questionnaire to investigate the level of compliance among private rhino owners with regulations pertaining to the monitoring and recording of rhinos on a centralised database. We anticipated that the most recent legislation update, Norms and Standards for the Marking of Rhinoceros and Rhinoceros Horn, and for the Hunting of Rhinoceros for Trophy Hunting Purposes (2012), may not be fully adhered to by all private rhino owners. If this were the case, then the potential for all private rhino owners to claim full engagement with conservation of rhinos could be damaged.

Methods

Historical data

Semi-regular surveys have been carried out on the privately-owned white rhinos of South Africa since 1987 (Buijs, 1987). We collated data from the surveys in 1987 (Buijs, 1987), 1996 (Buijs and Papenfus, 1996), 1997 (Buijs, 1998), 1998 (Buijs, 1999), 2001 (Castley and Hall-Martin, 2003), 2008 (Hall-Martin et al., 2009) and 2014 (Balfour et al., 2015). As these results have been analysed prior to release, raw data were not available for analysis. Only limited datasets are publicly available for black rhinos (Adcock, 2005; Hall-Martin and Castley, 2003) so only white rhino trends were analysed. Over time, the methodology for these surveys has changed and the questions asked of private owners have also changed. For this reason, only trends in number or rhinos and numbers of properties (and therefore average population size) have been assessed here. We utilised total white rhino population data from across Africa from du Toit (2013) and Emslie et al. (2019; 2013) and compared it to the above data on privately owned populations to determine any trends across time with respect to the total population.

Questionnaire of private rhino owners

Due to the expected low completion rate, it was not possible to pilot the questionnaire. To ensure private rhino owners would be familiar with the format of the questionnaire, we designed a Qualtrics (*Qualtrics LLC, Provo, USA*) questionnaire similar to the 2014 survey of private white rhino owners (Balfour et al.,

2015). This also allowed us to use some of the same questions, which would enable us to compare the results with the Balfour et al. (2015) survey to identify any bias due to non-respondence (White et al., 2005). The full questionnaire is available in Appendix I. To investigate the range of properties involved in private rhino ownership, owners were asked for descriptive information regarding their property such as the total area of the property, location, priorities (e.g. conservation, tourism, breeding etc.), fencing type, presence of other species, neighbouring land uses and the number of rhinos they own. To explore the challenges faced by private rhino owners, we also asked for information on the range of anti-poaching measures employed on their property, the dates they were initialised, the expenditure (manpower or monetary) on each, and the total rhino-specific security costs (over and above those which would be required if rhino were not present on their property). We also asked the owners to provide details of poaching events which had occurred prior to, or subsequent to the instigation of anti-poaching measures, along with the number of rhinos on their property at the time (many of the details of the poaching events were not required for this chapter, but have been utilised in Chapters 4 and 5). To investigate the level of compliance among private rhino owners with government registration procedures, we also asked for details of rhino monitoring activities.

Following best practice suggested by White et al. (2005), we used closed questions to collate factual information and kept open ended questions as simple as possible. Participants were also able to decline to answer any of the questions. Before the questionnaire was distributed, ethical approval was obtained from the University of York, Environment Department Ethical Review Committee (Appendix II).

All expenditure was collected and analysed in South African Rand (ZAR), but results are presented to the nearest US dollar to facilitate comparison with other work. As the questionnaire was live throughout 2016, the IRS yearly average exchange rate of $1: ZAR15.319 is used throughout.

We identified 151 private rhino owning properties by internet searches including the terms ‘private’, ‘reserve’, ‘wildlife’, ‘rhino’, ‘big five/5’ and ‘South Africa’. For the purposes of this study, all participants are referred to as ‘owners’ as the anonymity of the questionnaire meant it was not always possible to identify who had completed it.

Where email addresses for the appropriate manager or owner of a reserve could be identified, we sent a questionnaire link directly. The positive response rate to the 51 direct emails was at least 18%. Where email addresses could not be identified, we sent an email to the general address provided for the reserve with the subject 'FAO reserve manager/owner'. The positive response rate from these 100 general emails was at least 4%. These response rates are broadly in line with those of other researchers investigating similar topics (Rubino and Pienaar, 2018b; Rubino et al., 2018; van der Waal and Dekker, 2000). We also posted the link to the questionnaire to a variety of social media groups dedicated to anti-rhino poaching. Where members of the group identified themselves as private rhino owners, we sent an individual link to the questionnaire. More than 43% of the questionnaire respondents remained anonymous and so it is unknown which method of contact they responded to and therefore impossible to give definitive response rates to the varying forms of communication. For the purposes of confidentiality, figures which could allow identification of specific properties have not been included. Not all respondents answered every question and so the number of respondents to each question is presented in the results. Some owners did not feel comfortable providing details of their rhino populations and anti-poaching activities in an online questionnaire, and so these were clarified during face to face discussions with some of the private rhino owners/managers as necessary.

Data analysis

For all descriptive statistics, medians have been presented due to the non-parametric distribution of the data (as determined by Shapiro-Wilk normality test for small data sets). Outliers were identified as data points which were at least double the next highest point. Further details cannot be provided in order to prevent identification of specific properties. Due to the small number of respondents and gaps in the data due to owners not answering every question, multivariate analyses of the data were not possible.

In assessing relationships between rhino population size and area of the property, Spearman's correlations were used due to the non-parametric distribution of the data. Spearman's correlations were further used when assessing relationships

between expenditure on security and numbers of rhino and area. Where results are categorical (increase in expenditure, property priorities, presence of other species known to be poaching targets, neighbouring land uses, fencing type and anti-poaching activities) differences between properties have been assessed using Kruskal-Wallis or Mann-Whitney U tests as appropriate due to the normality of the data. Due to the number of tests conducted, we utilise a p-value of 0.01 to minimise the potential for type-1 errors. All analyses were undertaken in IBM SPSS Statistics 24 (*IBM Corp, Armonk, USA*).

Results

History of private rhino ownership in South Africa

The surveys of white rhino owners from 1987 to 2008 indicate substantial increases in both the number of private properties holding white rhino and the total number of white rhinos held (Fig. 2.1a). The most recent survey indicates a decline for the first time in the number of properties. These factors taken together indicate an increase in the number of individual rhinos held by each property (Fig. 2.1b). Whilst there is considerable variation, mean population size per property has increased in line with the total population size increase between 1987 and 2014, with the most substantial increase between 2008 and 2014.

Comparing the privately-owned white rhino population to the total white rhino population of Africa (Fig. 2.2a) indicates that the privately-owned population has increased alongside the overall growth in total population. The decline noted in Fig. 2.1a has not impacted the overall growth and has been reversed in the 2017 population figures. Fig. 2.2b indicates that, as a percentage of the total population, private rhino ownership has consistently increased.

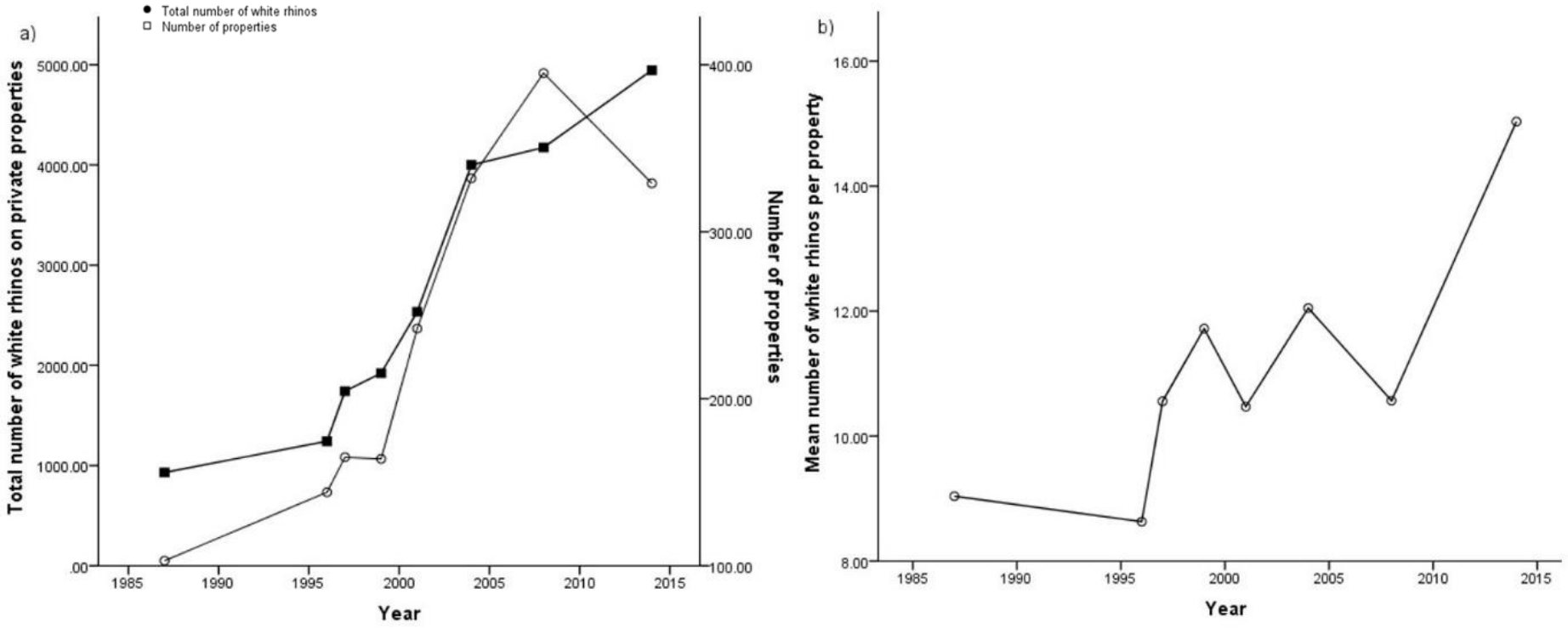

Figure 2.1: Trends in privately owned white rhino populations. The lack of availability of raw data has precluded the estimation of distributional statistics. a) Number of private properties holding white rhino and total number of white rhinos held, 1987-2014. b) Mean number of white rhinos per property, 1987-2014.

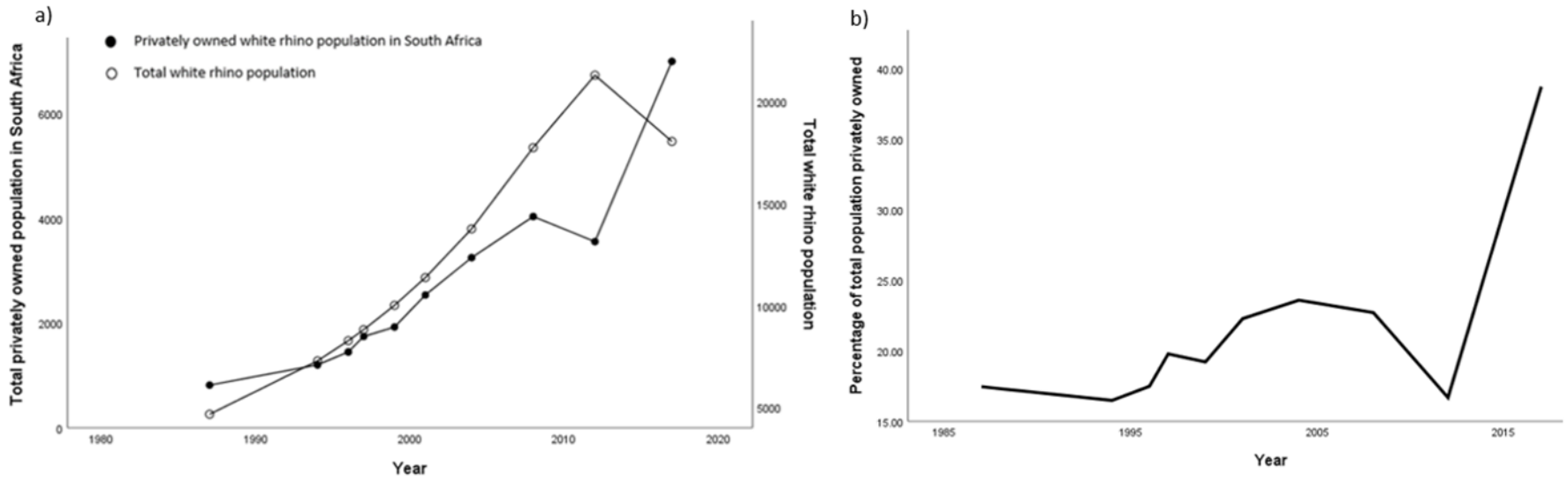

Figure 2.2: Trends in total and privately-owned white rhino populations. The lack of availability of raw data has precluded the estimation of distributional statistics. a) Number of privately-owned white rhino and total white rhino population held, 1987-2017. b) Percentage of total white rhino population which are privately-owned, 1987-2017.

Range of properties holding rhino

Whilst only 13 properties provided details of the number and age/sex breakdown of rhinos on their land, all 23 respondents completed most of the other questions regarding property descriptions.

We found no significant correlation (at p=0.01) between the total area of the property and the total number (both white and black) of rhinos held there (p=0.03), including after the removal of one very densely populated outlying property (p=0.04). Analysing the white rhino population only, also did not indicate any significant correlation (p=0.06). The area available to each rhino ranged from 0.04-8 km^2, with a median of 1.57 km^2 (n=13), giving a population density of 0.56 km^{-2} (range: 0.13-28). For white rhinos, the median area was 2.42 km^2 (n=13), giving a population density of 0.41 km^{-2} (range: 0.13-28). The number of properties holding black rhinos was too small to allow for meaningful analysis.

Neighbouring land uses varied, with most properties having more than one surrounding land use (13% were only alongside other wildlife habitats and 5% were fully surrounded by domestic livestock grazing). More than three-quarters of properties (78%) were positioned alongside other wildlife habitats, 70% neighboured roads and 61% abutted domestic animal grazing. Human habitations bordered far fewer properties (35% townships, 17% squatters' camps, 13% other human settlements). When considering combinations of neighbouring habitats, 22% of properties were surrounded by roads, domestic livestock grazing and other wildlife habitats, 17% were surrounded by both roads and other wildlife habitats, and 13% were bordered by roads, domestic livestock grazing, squatters' camps, townships and other wildlife habitats.

Whilst some properties (3/23) operated as single-species facilities, most held other species known to be poaching targets, with 56% holding elephants, 56% keeping lions and 65% holding other carnivores. Only 22% of properties had none of these species. Ecotourism was identified as the main priority for the properties (39% identified this as their primary priority) with conservation as the main secondary priority (40%; 29% defined conservation as their primary priority). Kruskal-Wallis testing found no differences in the area of a property, or the size of the rhino populations due to the priorities of a property. The fencing used to protect properties

ranged from those which had no fencing at all (17%), through to properties protected by both game and electric fencing (35%). Game fences alone surrounded 17% of properties and the remaining 30% had electric fencing only. Kruskal-Wallis testing found no differences in the area of a property, or the size of the rhino populations due to the type of fencing in place. Habitat types ranged widely, but most (60%; n=20) included open areas of savanna grassland.

Anti-poaching

Anti-poaching measures undertaken by properties ranged from those which were uncommon, such as volunteer patrols (7 out of 23 properties), unstaffed watchtowers (6/23), staffed watchtowers (5/23) alarms (7/23) and dehorning (9/23) to those which were more widely applied, such as permanent anti-poaching units (APU: 17/23) with patrol dogs (12/23), cameras (15/23) and staff patrols (19/23). “Other” anti-poaching measures instigated by properties included thermal imaging equipment, light aircraft patrols, ground to air communication, on site helicopter response team and SMS alerts of fence breaches. The mean number of anti-poaching measures employed by the properties was 4.70 (range: 1-8). Kruskal-Wallis testing indicated no differences in the number of anti-poaching strategies in place due to the size of property or the number of rhinos held. Mann-Whitney testing indicated that there were no differences in the use of different anti-poaching strategies due to the size of the rhino population or the size of the property.

Only seven properties provided information on the dates anti-poaching measures were adopted (and complete information was provided by only four properties). Most anti-poaching measures were instigated after poaching events had occurred. Whilst some anti-poaching measures (alarms and staff patrols) had failed to prevent subsequent poaching events on any property, others (APU, dogs, cameras, watchtowers and dehorning) had proven to be partially effective; deterring subsequent poaching events on some properties, but not others. At least five of the poached rhinos had been recently dehorned and additional information supplied noted that at least 13 had been poached shortly before they were due to be dehorned (and so dehorning permits had already been applied for).

Challenges to private rhino ownership

Eleven owners indicated that they had not considered disinvesting in rhino, whilst seven indicated that they had (Table 2.1).

Table 2.1: Priority of property and consideration of disinvestment in rhinos. Number in brackets indicates number of properties.

Properties which have considered disinvesting in rhino	Properties which have not considered disinvesting in rhino
Ecotourism (2)	Ecotourism (6)
Conservation (1)	Conservation (4)
Breeding (0)	Breeding (1)
Hunting (2)	Hunting (0)
Private recreation (1)	Private recreation (0)
Research (1)	Research (0)

Properties which prioritise ecotourism and conservation appear less likely to have considered disinvesting in rhinos than those with alternative priorities. Most of the owners who had indicated that they had considered no longer keeping rhinos referred to the security costs as the main reason (five provided this as their answer, with two not providing a reason), with some also highlighting the risks to their safety and that of their families.

<u>Security expenditure</u>

Twenty-two owners completed most of the section of the questionnaire relating to challenges to rhino ownership. Most private rhino owners (81%, n=21) identified poachers as the biggest threat to their rhino stock, with some highlighting local communities, internal informants, guests and the difficulty in monitoring large areas as other particular issues.

Twenty-one properties indicated increases in security costs over the last decade as poaching has increased. One property owner has owned the property for less than a decade and the other owner did not answer this question. More than half of properties (57%) indicated an increase in expenditure of over 200%, 14% indicated

an increase of 100-199%, 24% an increase of 50-99% and the remaining 5% an increase of 25-49%. Owners were asked to divide their security expenditure into general security costs and those which were rhino-specific. Some owners opted to provide only a combined cost. Kruskal-Wallis testing showed no differences in the increase in expenditure on security over the last decade due to current security expenditure (non-rhino, rhino and combined security), area, total number of rhinos or number of white rhinos on the property. After the removal of outliers, the median non-rhino security cost was equivalent to $1958/month (n=15: range: $65-10,444), the median rhino security expenditure was $4569/month (n=13: range: $653-16,320), and the combined total security expenditure each month had a median of $7,833 (n=15; range: $1,370-28,889). Only three properties provided monthly income figures, which ranged widely ($785-815,980) and so it was not possible to compare income with expenditure in any meaningful way. One property provided both person days and monetary costs for their APU (62 person days and ZAR35,000), therefore each person-day on this property cost ZAR564.52 ($36.85). Using this value to calculate total rhino-specific security expenditure produced no significant difference from the stated expenditure of the other reserves who provided this information (Wilcoxon: Z=10.00, p=0.92, n=6). We therefore determined that this was an accurate measure of anti-poaching effort and so applied it across the other properties. Linear regression suggested that there were no relationships between anti-poaching costs and the number of rhinos held (F=4.69, p=0.10, d.f.=1,6) or the number of poaching events on the property (F=0.568, p=0.51, d.f.=1,5).

Spearman's correlations indicated that combined security costs were not correlated with either the total number of rhinos on a property (p=0.026) or the number of white rhinos (p=0.032). Mann-Whitney testing indicated no differences in non-rhino security, rhino security costs or combined costs due to the anti-poaching activities in place. Kruskal-Wallis testing of security expenditure (non-rhino, rhino specific and combined) also showed no differences due to the priorities of the property or the presence of other species known to be poaching targets. After the removal of two outliers, Kruskal-Wallis testing of security expenditure (non-rhino, rhino specific and combined) also showed no differences due to the type of fencing installed on properties. Kruskal-Wallis testing indicated that there were no significant differences between the rhino-specific security costs (H=7.57, p=0.18, n=16), the number of

poaching events on the property (H=7.73, p=0.10, n=12) or the increase in security expenditure over the last decade (H=2.93, p=0.40, n=22) in relation to the number of anti-poaching measures employed on a property.

In considering the impact of surroundings on security expenditure, we compared the various security outgoings (rhino-specific, non-rhino and combined security costs) between properties which were bordered by specific land uses and those which were not. The only difference which approached significance was that non-rhino security expenditure was higher when properties neighbour other wildlife habitats (Mann-Whitney: U=34, p=0.016, n=15), with a median monthly expenditure of $98 (range: $63-783) for properties that do not neighbour other wildlife habitats and $1,306 (range: $623-3,264) for those that do. Mann-Whitney testing of all other surrounding land uses found no differences in non-rhino security expenditure. Further testing (Mann-Whitney) of rhino-specific security expenditure and combined security expenditure showed no differences due to surrounding land use.

Record keeping

Only one property opted not to answer any questions regarding their rhino directly. Answers regarding record keeping (e.g. what percentage of your rhinos have had DNA samples taken and submitted to the RhoDIS System? What percentage of your rhino are individually identifiable [through ear notching for example]?) suggest that record keeping was variable across properties. Whilst all properties kept the required (under the National Environmental Management: Biodiversity Act, 2004) records of introductions and movements of animals on and off their properties, some properties do not appear to have followed the record keeping requirements for other procedures. From 2012 (Norms and Standards for the Marking of Rhinoceros and Rhinoceros Horn, and for the Hunting of Rhinoceros for Trophy Hunting Purposes), any rhino darted for any reason (such as dehorning or ear notching) must have DNA collected and submitted to the national register, yet six properties (Table 2.2) do not appear to be adhering to these requirements.

Table 2.2: Discrepancies between procedures and DNA registration

Property Identifier	Dehorning undertaken	Percentage ear notched	Percentage registered	Discrepancy
3	No	80%	50%	Potential that discrepancy may be due to some being notched before 2012.
6	Yes	100%	50%	Likely discrepancy between procedures (notching and dehorning) undertaken and those registered.
7	No	70%	0%	Likely discrepancy between notching procedures undertaken and those registered.
8	No	85% black rhinos, 50% white rhinos	Unknown	All notched since 2012 should be registered.
15	No	100%	0%	Likely discrepancy between notching procedures undertaken and those registered.
17	Yes	100%	90%	Likely discrepancy between procedures (notching and dehorning) undertaken and those registered.

Discussion

Representativeness of questionnaire sample

Due to the sensitive nature of the information collected, we did not anticipate a large sample size (Wright et al., 2016; Davies-Mostert, 2014; Hall-Martin et al., 2009), but it was important that it was representative of the private rhino populations of South Africa. Despite a relatively low response rate, the total area represented by the properties (n=23) was 299,379 ha, which equates to approximately 10% of the area estimated to be maintained by private white rhino owners in 2014 (Balfour et al., 2015). The mean area of the properties was 13,016 ha, which is within 15% of the mean size of 11,436 ha determined by Langholz (1996). Six of the nine provinces of South Africa were represented in the data. The provinces not represented hold less than 3% of the national privately-owned population (Balfour et al., 2015).

The comparison with the Balfour et al. (2015) survey, to assess any bias due to non-respondents (White et al., 2005) indicated only minor differences in responses to questions which were identical or very similar (supplementary material Table S2.1), indicating that the survey sample is representative of the much larger group (n=171) included in their survey.

The total number of rhinos held by the properties who provided this information (n=13) was 2,122. Eliminating three exceptionally large populations left a mean number of rhinos per property of 28.60 (n=10; range: 5-81). Assuming the remaining properties held this mean number of animals indicates an approximate sample of 2,408 rhinos, which represents 31.34-35.56% of the total privately-owned rhino population in 2016 (Knight, 2017; Emslie et al., 2016). The total number of white rhinos represented by the data collection was 1989. After removal of three outlying populations the mean number of white rhinos per property was 24.50 (n=10; range: 5-57). Following the extrapolation explained above, the sample represents 2,234 white rhinos. The questionnaire therefore covers 32.39-36.38% of the private white rhino population (Emslie et al., 2016). Subtracting the extrapolated white rhino sample from the extrapolated total leaves an estimated 174 black rhinos. Five properties detailed black rhino stock to a total of 133 animals. This data set therefore represents 21.08-27.58% of the total estimated privately-owned black rhino population (Knight, 2017; Emslie et al., 2016). Because a majority of privately-owned black and white rhino were not covered by our responses, we suggest caution in

drawing conclusions about the entire population of private rhino owners in South Africa. Nevertheless, we do consider this sample to be adequate to provide a reliable indication of the privately-owned rhino population of South Africa.

Whilst we consider the sample representative of the privately-owned rhino population of South Africa, we acknowledge the limitations in utilising the questionnaire to collate the data. The limited response rate, which has prevented an appropriate sample size for statistical analysis (White et al., 2005), has resulted in predominantly descriptive data. Whilst the option to decline to answer questions is generally accepted as good practice in questionnaire design (White et al., 2005), it also resulted in gaps in our dataset (Bryman, 2012). Self-completed questionnaires also limit the range of questions that can be asked, by restricting open questions and eliminating the ability to probe further (Bryman, 2012).

Trends in private ownership of rhinos in South Africa

The historical increases in the privately-owned white rhino populations of South Africa stand in contrast to the general trend for most rhino populations. Black rhinos have been classified by the IUCN as 'endangered' up until 1994 but have been at a higher threat level ('critically endangered') more recently (Emslie, 2012a). This increase in threat level has also been observed for the Javan rhino (*Rhinoceros sondaicus*; van Strien et al., 2008a) and the Sumatran rhino (*Dicerorhinus sumatrensis*; van Strien et al., 2008b). The Indian rhino (*Rhinoceros unicornis*) is heavily protected in state parks of India and has reversed its decline, moving from an IUCN classification of 'endangered' in 1996, to 'vulnerable' in 2008 (Talukdar et al., 2008). Increases in private ownership, driven by sales, hunting and ecotourism have been linked with the improvement in the classification of the white rhino to its current 'near threatened' status (Emslie, 2012b) and it is clear from our results that private-ownership of rhinos in South Africa has tracked the increase in white rhino populations across Africa, with a generally increasing trend in the proportion of rhinos held by private owners.

A simple change in the numbers of rhinos may not reflect the conservation value of private rhino ownership however. The Balfour et al. (2015) survey indicates that nine privately-owned populations are classified under the IUCN classifications (Hall-

Martin et al., 2009) as Key 1, 12 as Key 2 and 25 as Important. With the increasing population size noted in Fig. 2.1, there may be an increase in the number of these valuable populations, despite a reduction in the overall number of properties if the suggested disinvestment continues. Key populations are likely to consist of intensive breeding facilities rather than extensive natural habitats (due to the area required for such numbers to live in natural conditions) and so the conservation value of these may be disputed. If, as claimed by Ververs et al. (2017), these properties can maintain natural behaviour and genetic diversity amongst their stock, then they may act as reservoirs for reintroductions in the future. With a median population density of 0.41 white rhino km^{-2}, the populations studied here were generally well within the natural ranges observed by Owen-Smith (1975: 3 km^{-2}). Thompson et al. (2016: 0.15 km^{-2}) and du Toit (2006: 0.1-1 km^{-2}). Using the Rubino et al. (2018) value of 1 km^{-2} as a measure of "strong commitment to habitat conservation" (pg. 308) only 4/13 properties were overstocked for conservation purposes. Three of these were breeding facilities and one is a natural habitat, albeit a very small one (250 ha).

Range of properties holding rhinos

The wide range of properties keeping rhinos is clear from the variety in the structures of the properties. Properties ranged from very small areas holding large numbers of rhino, through to large expanses of land with very low population densities, without any characteristic differences in the management strategies employed. Only the properties identified as breeding facilities (3/23) could be perceived to be keeping the animals in semi-captive condition, whilst the rest live in extensive systems requiring little supplementary feeding (Pienaar et al., 2017) and with minimal human interaction. The keeping of other species, anti-poaching activities, area, neighbouring land uses, number of rhinos held, and priorities of the properties ranged widely, indicating that there is no such thing as a 'typical private rhino owning property'.

The analysis of the effectiveness and expenditure on anti-poaching efforts suggests that whilst private rhino owners utilise a wide range of anti-poaching measures, none appear to be completely effective in deterring subsequent poaching events. We found no links between the number of measures implemented and security expenditure, or the number of poaching events on a property. We also found no links

between anti-poaching effort and the number of rhinos held, the number of poaching events, or the number of different measures implemented.

The results indicated that the implementation of anti-poaching measures was often triggered by a poaching event on the property and the range of measures utilised varied widely. However, none of the efforts appeared to be completely effective, with poaching events occurring on properties regardless of the number or range of anti-poaching strategies in place. Whilst most of the reserves utilised (presumably experienced) staff patrols and (often military; Milliken and Shaw, 2012) trained APUs, some reserves deployed volunteers to conduct patrols. Whilst this may be cheaper, the quality of patrol provided by volunteers may be questioned (Aung, 2007). The substantial expenditure associated with extra, trained patrols may be a limiting factor in private land anti-poaching efforts as well as on state land.

In 2015, Taylor et al. calculated the median wage for wildlife industry workers to be $224.62 per month, with a mean of $244.34. The analysis completed here found a mean person day security cost of $36.85. This suggests a monthly security expenditure of $1,031.80-1,142.35 per person. It is therefore clear that a substantial proportion of expenditure is over and above that required for staff wages and is likely to be spent on items such as equipment, fuel and ammunition. The economics of protecting wildlife have been studied elsewhere, including research focused specifically on rhinos (e.g. Taylor at el., 2015; Milliken and Shaw, 2012), but there was no indication from this study that simply increasing expenditure on anti-poaching efforts would reduce poaching.

The absence of clear links between security expenditure and the number of anti-poaching measures employed was unexpected and may be due to the limited number of properties involved in this study. It is also possible that some of the properties with the highest levels of expenditure employ fewer, more expensive measures, or that some owners have personal preferences for utilising particular methods on their property. A wider-scale project to investigate the cost-effectiveness of anti-poaching measures is therefore recommended in order to inform the most efficient allocation of the limited funds available for anti-poaching strategies.

The challenges of private rhino ownership

Whilst the range of properties varied widely, challenges faced were almost universal, with private owners considering disinvesting in rhino regardless of their main reason for operating. Only 35% of owners identified conservation as either their primary or secondary priority, but this was higher than any of the other stated priorities and is broadly in line with the findings of van der Waal and Dekker (2000) who found 27% prioritised conservation. Rubino and Pienaar (2018a; 2018b) identified a passion for rhinos and emotional connection to them as the main motivator for keeping them, with tourism value also a major consideration (Rubino and Pienaar, 2018b; Wright et al., 2016). The economic challenges of protecting rhinos from poaching are an important factor in the continuing involvement of private rhino owners in rhino conservation, but it may be the case that these issues are not as strong a motivator as conservation concerns (Honig et al., 2015; Langholz et al., 2000; van der Waal and Dekker, 2000). Properties engaging in ecotourism and conservation were less likely to indicate that they had considered disinvesting in rhinos than those identifying other priorities, supporting this suggestion that economic gains may not be the main motivators of these owners.

Substantial security expenditure was not unexpected (Rubino and Pienaar, 2018a; Rubino and Pienaar, 2018b), with a mean total annual security cost per hectare of $41, which sits within the broad (inflation adjusted) range determined by Taylor et al. (2014) of $0.83-321, although their calculated mean was much lower at $21. Rhino-specific security costs have previously been expressed as cost per rhino (Milliken and Shaw, 2012; Milner-Gulland et al., 1992), with the mean calculated here to be $1,823 per rhino; more than five times the (inflation adjusted) $352 estimated to be necessary in 1992 (Milner-Gulland et al., 1992). The (inflation adjusted) $2,436-3,248 extra rhino security per month required in 2012 (Milliken and Shaw, 2012), has now risen to $3,683 per month. The inconsistencies in security expenditure in relation to the number of rhinos and the size of the property mirrored the findings of Taylor et al. (2014), who also found no significant relationships.

The variation in record keeping amongst private rhino owners was not unexpected. Balfour et al. (2015) and Taylor et al. (2014) found similar inconsistencies in the registering of horn stockpiles; Balfour et al. (2015) suggest that the main reason for this is distrust in the government agents with whom such stockpiles (and details of

rhino stock that have been DNA sampled) would be registered. The suggestion made is that this information is too easily leaked to criminal elements and so would not remain confidential, thus putting properties and their rhino stock at risk. It is known that such corruption allows wildlife trafficking to occur (Duffy and St. John, 2013) and has been suggested (Shaw and Rademeyer, 2016) that the greater economic and development challenges in South Africa have resulted in rhino poaching being a lower priority for the government and that lenient sentences have undermined conservation activities (du Toit, 2006). Negative perceptions of nature conservation policy have been linked to disinterest in conserving forests in Finland (Paloniemi and Tikka, 2008) and policy conflicts restricting engagement of farmers in the United States (Polasky et al., 1997). Lack of trust in government agencies amongst private landowners in South Africa has also been noted by Rubino and Pienaar (2018b), Davies-Mostert (2014) and Pienaar et al. (2017). If rhino owners do not trust the government (national or provincial) then the disinterest noted in Finland may be replicated in South Africa and could potentially lead to disinvestment in rhino from the private sector. Increased involvement of private rhino owners in decision-making processes may help to reduce this.

The future of private rhino ownership

The future of private rhino ownership in South Africa is unclear; total numbers are rising, but after a rapid increase in the number of rhino-owning properties, a downturn was recorded for the first time in the 2014 owner survey. Whilst it is unclear if this is the start of a decline or not, data from the questionnaire suggest that there is a clear risk of private owners disinvesting in rhinos. The risk of disinvestment was highlighted at least seven years ago (Endangered Wildlife Trust, 2011) with 70 properties known to have disinvested in rhino so far (DEA, 2016). The percentage that indicated they had considered no longer keeping rhinos (38.89%) is considerably lower than the 78.8% identified by Rubino and Pienaar (2018b), but still higher than the 18.56% estimated to have disinvested between 2012 and 2014 (Balfour, et al., 2015), indicating that whilst many owners may be considering disinvesting, far fewer have actually done so. Expenditure on security was identified as the primary reason for considering disinvestment, but several were also concerned about the known risks to personal safety (Rubino and Pienaar, 2018b;

Wright et al., 2016; Balfour et al., 2015). For rhino conservation to continue on private land, the economic benefits of keeping rhinos must be higher than the costs (Rubino and Pienaar, 2017) and so increasing security expenditure may drive further disinvestment in the future. Disinvestment may result in more rhinos being held in intensive breeding facilities.

The pattern of average population size may indicate a move towards more intensive breeding of rhinos and fewer living in extensive, natural habitats, therefore reducing the potential conservation value of the privately-owned rhino population. The considerable financial costs of protecting stock may be partially met by trade in rhino horn. Whilst owners in this survey were not questioned about their thoughts on horn trade, 45.5% of owners in a previous study (Rubino and Pienaar, 2018b) identified horn as a good investment, with positive opinions towards horn trade generally noted amongst private rhino owners (Rubino and Pienaar, 2018b; Wright et al., 2016). The potential may exist for trade in rhino horn to generate the income necessary to fund anti-poaching activities and reduce disinvestment amongst private rhino owners (Child, 2012). With the reintroduction of domestic trade in horn within South Africa since the data for this paper were collected, there may be a potential for the generation of required income that has not been captured by this research. Further work is needed to assess the potential of this market.

The lack of trust in government agencies is also a potential threat to the future conservation value of private rhino ownership. Failure by some parties to engage with conservation policy may damage the claim that the private wildlife industry is focused on the conservation of rhinos and may encourage the perception that the main focus of private rhino owners is to generate income for themselves. Positive opinions towards the trade in horn and a move towards more intensive breeding of rhinos could further damage the perception of private rhino ownership as contributing to the conservation of rhinos in South Africa.

Conclusions

Private ownership of rare and threatened species is not common globally but is a well-established practice in South Africa. The number of white rhinos kept on private land represents a sizeable proportion of the total populations in the country and has

contributed substantially to the increase in the total white rhino population and subsequent improvement in its IUCN risk rating. The wide range of properties involved in private rhino conservation suggest that traditional ideas of large expanses of land dedicated purely to conservation may not be the only option for successful conservation. The historical increases in population size and the number of properties involved in private rhino ownership suggest a keen interest and engagement from the private sector in the conservation of these animals.

However, challenges to private rhino ownership are substantial and are consistent across the wide range of properties engaged in the sector. Whilst personal safety was a concern to some owners, the major challenges to current and continued private rhino conservation are primarily concerned with the substantial increases in expenditure due to increasing poaching over the last decade. There is some indication of a trend towards more intensive breeding of rhinos, with disinvestment likely to be amongst those keeping small numbers of rhinos in natural, extensive systems.

Disinvestment in rhinos due to economic factors and a failure by some parties to follow the required regulations regarding monitoring and registering of privately-held rhino stocks may work together to damage the perception of private rhino ownership as being valuable to rhino conservation.

Improved cooperation of private owners and reduced corruption in government and law enforcement are required to ensure owners are supported and appropriate enforcement action is taken during this poaching crisis to reduce the risks of disinvestment and the associated potential decrease in the conservation value of privately-owned rhinos. To ensure large-scale disinvestment does not occur, it may be necessary to support owners financially to continue in rhino protection, or to permit the trade in horn to generate income for use in anti-poaching expenditure. Sustainable use of wildlife has historical precedence in South Africa and rhino horn trade could be considered another step in that development.

Acknowledgements

We thank the private rhino owners who completed the owner survey, Pelham Jones for provision of the 2014 PROA survey, and the reviewers who provided valuable comments on previous drafts of this work. This research did not receive any specific funding.

References

Adcock, K. (2005). *Main excerpts from the SADC RMG's 2002-2004 black rhino status report summary for Namibia, South Africa and Zimbabwe*. Johannesburg: SADC Rhino Management Group.

Arts, K., van der Wal, R. and Adams, W. M., (2015). Digital technology and the conservation of nature. *Ambio*, 44 (suppl. 4), S661-S673.

Aung, U. M. (2007). Policy and practice in Myanmar's protected area system. *Journal of Environmental Management*, 84, 188-203.

Balfour, D., Knight, M. and Jones, P. (2015). *Status of white rhino on private and communal land in South Africa: 2012 - 2014*. Pretoria: Department of Environmental Affairs.

Bryman, A. (2012). *Social Research Methods*. Oxford: Oxford University Press.

Buijs, D. (1987). *A summary of the introduction of white rhino onto private land in the Republic of South Africa*. Johannesburg: Rhino and Elephant Foundation.

Buijs, D. (1998). *White rhinos on private land in South Africa 1997*. Johannesburg: African Rhino Owners Association.

Buijs, D. (1999). *Survey: White rhinos on private land (October 1999)*. Johannesburg: African Rhino Owners Association.

Buijs, D. and Papenfus, T. (1996). *White rhinos on private land in SA*. Johannesburg: African Rhino Owners Association.

Carruthers, J. (2008). 'Wilding the farm or farming the wild'? The evolution of scientific game ranching in South Africa from the 1960s to the present. *Transactions of the Royal Society of South Africa*, 63, 160-181.

Castley, J. G. and Hall-Martin, A. J. (2003). The status of the southern white rhinoceros (*Ceratotherium simum simum*) on private land in South Africa in 2001. *Pachyderm*, 34, 33-44.

Child, B. (2012). The sustainable use approach could save South Africa's rhinos. *South African Journal of Science*, 108, 231-25.

Cocklin, C., Mautner, N. and Dibden, J. (2007). Public policy, private landowners: perspectives on policy mechanisms for sustainable land management. *Journal of Environmental Management*, 85, 986-998.

Cousins, J. A., Sadler, J. P. and Evans, J. (2008). Exploring the role of private wildlife ranching as a conservation tool in South Africa: Stakeholder perspectives. *Ecology and Society*, 13, 43. https://www.ecologyandsociety.org/vol13/iss2/art43/

Cousins, J. A., Sadler, J. P. and Evans, J. (2010). The challenge of regulating private wildlife ranches for conservation in South Africa. *Ecology and Society*, 15, 28. https://www.ecologyandsociety.org/vol15/iss2/art28/

Cress, D. and Zommers, Z. (2014). Emerging technologies: Smarter ways to fight wildlife crime. Article reproduced from United Nations Environment Programme (UNEP) Global Environmental Alert Service (GEAS). *Environmental Development*, 12, 92-27

Davies-Mostert, H. T. (2014). Overcoming barriers to understanding the biodiversity contribution of private ranchlands. *Animal Conservation*, 17, 399-400.

Department of Environmental Affairs (DEA) (2013). *Rhino issue management report 2013*. Pretoria: Department of Environmental Affairs.

Department of Environmental Affairs (DEA) (2014). *South African government is aware that ongoing scourge of rhino poaching is linked to worldwide illicit wildlife trade* [Online] DEA. Available at: www.environment.gov.za/mediarelease/rhinopoaching_wildlifetrade [Accessed 01 May 2016].

Department of Environmental Affairs (DEA) (2016). *CITES CoP17 Conference in South Africa: Colloquium on preparations, with Minister in attendance. Committee*

Meeting Summary. 13 September 2016. [Online] Parliamentary Monitoring Group. Available at: https://pmg.org.za/committee-meeting/23252 [Accessed 18 May 2019].

Department of Environmental Affairs (DEA) (2017). *Minister Molewa highlights progress on integrated strategic management of rhinoceros.* [Online] DEA. Available at: www.gov.za/mediarelease/DEA_progressonintegrated_strategicmanagement_ofrhinoceros [Accessed 03 March 2017].

Douglas-Hamilton, I. (1997). Proposal for "green hunting" of elephants as an alternative to lethal sport hunting. *Pachyderm*, 24, 30-35.

Duffy, R. (2014). Waging a war to save biodiversity: the rise of militarized conservation. *International Affairs*, 90, 819-834.

Duffy, R. and St. John, F. A. V. (2013). *Poverty, poaching and trafficking: What are the links? Evidence on Demand*. London: Department for International Development.

du Toit, J. G. (2013). Problems in rhino conservation in South Africa. In: du Toit, J.G. (Ed.), *The Story of the White Rhinoceros*. Krugersdorp: Kejafa Knowledge Works.

du Toit, R. (Ed). (2006). *Guidelines for implementing SADC rhino conservation strategies*. Harare: SADC Programme for Rhino Conservation.

Emslie, R. (2012a). *Diceros bicornis. The ICUN Red List of Threatened Species 2012: e.T6557A16980917*. [Online]. IUCN. Available at: http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T6557A16980917.en [Accessed 16 December 2016].

Emslie, R. (2012b). *Ceratotherium simum. The ICUN Red List of Threatened Species 2012: e.T4185A16980466* [Online]. IUCN. Available at: http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T4185A16980466.en [Accessed 16 December 2016].

Emslie, R. H., Milliken, T. and Talukdar, B. (2013). *African and Asian rhinoceroses - status, conservation and trade. A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf. 9.14 (Rev. CoP15).* Report to

CITES 16th meeting (Bangkok, March 2013), CoP 16 Doc.54.2 annex. Geneva: CITES Secretariat.

Emslie, R. H., Milliken, T., Talukdar, B., Ellis, S., Adcock, K. and Knight, M. H. (2016). *African and Asian rhinoceroses - status, conservation and trade. A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf. 9.14 (Rev. CoP15).* Report to CITES 17th meeting (Johannesburg, September-October 2016), CoP 17 Doc.68 annex 5. Geneva: CITES Secretariat.

Emslie, R. H., Milliken, T., Talukdar, B., Burgess, G., Adcock, K., Balfour, D. and Knight, M. H. (2019). *African and Asian rhinoceroses - status, conservation and trade: A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf. 9.14 (Rev. CoP17) (No. CoP18 Doc. 83.1 Annex 2)*. Geneva: CITES Secretariat.

Endangered Wildlife Trust (2011). *A moratorium on rhino hunting - some thoughts and recommendations*. Johannesburg: Endangered Wildlife Trust.

Gallo, J. A., Pasquini, L., Reyers, B. and Cowling, R. M. (2009). The role of private conservation areas in biodiversity representation and target achievement within the Little Karoo region, South Africa. *Biological Conservation*, 142, 446-454.

Gross, M. (2014). Connecting with the natural world. *Current Biology*, 24, R629-R632.

Hall-Martin, A. J. and Castley, J. G. (2003). The status of black rhinoceros (*Diceros bicornis*) on private land in South Africa in 2001. *Pachyderm*, 34, 24-32.

Hall-Martin, A. J., du Toit, J. G., Hitchens, P. M. and Knight, M. H. (2009). *An exert of the 2008 survey of white rhinoceros,* Ceratotherium simum simum*, on private land in South Africa*. Cape Town: WWF-African Rhino Programme.

Hayward, M. W., Ripple, W. J., Kerley, G. I. H., Landman, M., Plotz, R. D. and Garnett, S. T. (2017). Neocolonial conservation: Is moving rhinos to Australia conservation or intellectual property loss? *Conservation Letters*, 11, e12354, doi.org/10.1111/conl.12354.

Honig, M., Peterson, S., Sheraing, C., Pintér, L. and Kotze, I. (2015). The conditions under which farmers are likely to adapt their behaviour: a case study of private land conservation in the Cape Winelands, South Africa. *Land Use Policy*, 48, 389-400.

Jones, P. (2013). *Rhino economics role of the private sector*. Speech to 16th CITES CoP, Bangkok.

Jones, B. T. B., Stolton, S. and Dudley, N. (2005). Private protected areas in east and southern Africa: contributing to biodiversity conservation and rural development. *Parks*, 15, 67-77.

Knight, M. (2015). Calling all rhino owners: How can you, the private rhino owner, help to solve the rhino crisis? *Wildlife Ranching*, 4, Rhino Supplement, 9-13.

Knight, M. H. (2017). African Rhino Specialist Group report. *Pachyderm*, 58, 17-35.

Langholz, J. (1996). Economics, objectives and successes of private nature in sub-Saharan reserves Africa and Latin America. *Conservation Biology*, 10, 271-280.

Langholz, J. A., Lassoie, J. P., Lee, D. and Chapman, D., (2000). Economic considerations of privately owned parks. *Ecological Economics*, 33, 173-183.

Lee, D. E. and Du Preez, M. (2016). Determining visitor preferences for rhinoceros conservation management at private, ecotourism game reserves in the Eastern Cape Province, South Africa: A choice modelling experiment. *Ecological Economics*, 130, 106-116.

Lindsey, P. A., Nyirenda, V. R., Barnes, J. I., Becker, M. S., McRobb, R., Tambling, C. J., Taylor, W. A., Watson, F. G. and ‘t Sas-Rolfes, M. (2014). Underperformance of African protected area networks and the case for new conservation models: Insights from Zambia. *PLoS One*, 9, e94109.

Lunstrum, E. (2014). Green militarization: Anti-poaching efforts and the spatial contours of Kruger National Park. *Annals of the Association of American Geographers*, 104, 816-832.

Martin, G. (2017). *No more drones for Kruger*. [Online] DefenceWeb. Available at: http://www.defenceweb.co.za/index.php?option=com_content&view=article&id=47259%3Ano-more-drones-for-kruger&catid=35%3AAerospace&Itemid=107 [Accessed 06 June 2019].

Milliken, T. and Shaw, J. (2012). *The South Africa – Viet Nam rhino horn trade nexus: A deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates*. Johannesburg: TRAFFIC.

Milner-Gulland, E. J., Beddington, J. R. and Leader-Williams, N. (1992). Dehorning African rhinos: a model of optimal frequency and profitability. *Proceedings of the Royal Society of London B*, 249, 83-87.

Mossman, S. and Mossman, A. (1976). *Wildlife utilization and game ranching: report on a study of recent progress in this field in southern Africa*. IUCN Occasional Paper No. 17. Gland: IUCN.

Muir-Leresche, K. and Nelson, R. H. (2000). *Private property rights to wildlife: The southern African experiment*. *ICER Working Paper 02-2000*. Torino: International Centre for Economic Research.

O'Donoghue, P. and Rutz, C. (2016). Real-time anti-poaching tags could help prevent imminent species extinctions. *Journal of Applied Ecology*, 53, 5-10.

Owen-Smith, N. (1975). The social ethology of the white rhinoceros *Ceratotherium simum* (Burchell, 1817). *Zeitschrift für Tierpsychologie*, 38, 337-384.

Paloniemi, R. and Tikka, P. M. (2008). Ecological and social aspects of biodiversity conservation on private lands. *Environmental Science & Policy*, 11, 336-346.

Paneque-Gálvez, J., McCall, M. K., Napoletano, B. M., Wich, S. A. and Koh, L. P. (2014). Small drones for community-based forest monitoring: An assessment of their feasibility and potential in tropical areas. *Forests*, 5, 1481-1507.

Pienaar, E. F., Rubino, E. C., Saayman, M. and van der Merwe, P. (2017). Attaining sustainable use on private game ranching lands in South Africa. *Land Use Policy*, 65, 176-185.

Pitman, R. T., Fattebert, J., Williams, S. T., Williams, K. S., Hill, R. A., Hunter, L. T. B., Slotow, R. and Balme, G. A. (2016). The conservation costs of game ranching. *Conservation Letters*, 10, 403-413.

Polasky, S., Doremus, H. and Rettig, B. (1997). Endangered species conservation on private land. *Contemporary Economic Policy*, 15, 66-76.

Rubino, E. C. and Pienaar, E. F. (2017). Applying a conceptual framework to rhinoceros conservation on private lands in South Africa. *Endangered Species Research*, 34, 89-102.

Rubino, E. C. and Pienaar, E. F. (2018a). Understanding South African private landowners decisions to manage rhinoceroses. *Human Dimensions of Wildlife*, 23, 160-175.

Rubino, E. C. and Pienaar, E. F. (2018b). Rhinoceros ownership and attitudes towards legalization of global horn trade within South Africa's private wildlife sector. *Oryx*. doi:10.1017/s0030605318000030

Rubino, E. C., Pienaar, E. F. and Soto, J. R. (2018). Structuring legal trade in rhino horn to incentivize the participation of South African private landowners. *Ecological Economics*, 154, 306-316.

Schiffman, R. (2014). Drones flying high as new tool for field biologists. *Science*, 344, 459.

Selinske, M. J., Coetzee, J., Purnell, K. and Knight, A. T. (2015). Understanding the motivations, satisfaction, and retention of landowners in private land conservation programs. *Conservation Letters,* 8, 282-289.

Shaw, M. and Rademeyer, J. (2016). A flawed war: Rethinking 'green militarisation' in the Kruger National Park. *Politikon*, 43, 173-192.

Talukdar, B. K., Emslie, R., Bist, S. S., Choudhury, A., Ellis, S., Bonal, B.S., Malakar, M.C., Talukdar, B. N. and Barua, M. (2008). *Rhinoceros unicornis. The ICUN Red List of Threatened Species 2008: e.T19496A8928657* [Online]. IUCN. Available at: http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T19496A8928657.en [Accessed 16 December 2016].

Taylor, A., Brebner, K., Coetzee, R., Davies-Mostert, H., Lindsey, P., Shaw, J. and 't Sas-Rolfes, M. (2014). *The viability of legalising trade in rhino horn in South Africa*. Pretoria: Department of Environmental Affairs.

Taylor, W. A., Lindsey, P. A. & Davies-Mostert, H. (2015). *An assessment of the economic, social and conservation value of the wildlife ranching industry and its*

potential to support the green economy in South Africa. Johannesburg: The Endangered Wildlife Trust.

Thompson, S., Avent, T. and Doughty, L. S. (2016). Range analysis and terrain preferences of adult white rhinoceros (*Ceratotherium simum*) in a South African private game reserve: Insights into carrying capacity and future management. *PLoS ONE*, 11, e0161724. doi: 10.1371/journal.pone.0161724

't Sas-Rolfes, M. (1997). *Does CITES work? Four case studies*. IEA Environment Briefing No. 4. London: Africa Resources Trust.

van der Waal, C. and Dekker, B. (2000), Game ranching in the northern province of South Africa. *South African Journal of Wildlife Research*, 30, 151-156.

van Strien, N. J., Steinmetz, R., Manullang, B., Sectionov, Han, K. H., Isnan, W., Rookmaaker, K., Sumardja, E., Khan, M. K. M. and Ellis, S. (2008a). *Rhinoceros sondaicus*. *The ICUN Red List of Threatened Species 2008: e.T19495A8925965* [Online]. IUCN. Available at: http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T19495A8925965.en [Accessed 16 December 2016].

van Strien, N. J., Manullang, B., Sectionov, Isnan, W., Khan, M. K. M., Sumardja, E., Ellis, S., Han, K. H., Boeadi, Payne, J. and Bradley Martin, E. (2008b). *Dicerorhinus sumatrensis. The ICUN Red List of Threatened Species 2008: e.T6553A12787457* [Online]. IUCN. Available at: http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T6553A12787457.en [Accessed 16 December 2016].

Ververs, C., van Zijll Langhout, M., Hostens, M., Otto, M., Govaere, J., Durrant, B. and Van Soom, A. (2017). Reproductive performance parameters in a large population of game-ranched white rhinoceroses (*Ceratotherium simum simum*). *PLoS ONE*, 12, e0187751. doi.org/10.1371/journal.pone.0187751

White, P. C. L., Vaughan Jennings, N., Renwick, A. R. and Barker, N. H. L. (2005). Questionnaires in ecology: A review of past use and recommendations for best practice. *Journal of Applied Ecology*, 42, 421-430.

Wilson, G. R., Hayward, M. W. and Wilson, C. (2017). Market-based incentives and private ownership of wildlife to remedy shortfalls in government funding for conservation. *Conservation Letters*, 10, 485-492.

Wright, O. T., Cundill, G. and Bigg, D. (2016). Stakeholder perceptions of legal trade in rhinoceros horn and implications for private reserve management in the Eastern Cape, South Africa. *Oryx*, 52, 175-185.

Supplementary Information

Table S2.1: Comparison of selected results from this survey and the Balfour et al. (2015) survey of private rhino owners

Question	Response from this work	Response from Balfour et al. (2015)
Mean property size (ha)	9886	9760
Rhino population density (rhino ha^{-1})	0.0041	0.0031
Sex ratio (female/male)	1.49	1.51
Age class (% calves: sub-adults: adults)	23.09: 26.98: 49.93	18.29: 31.57: 50.13
Non-compliance with registration procedures (% of respondents)	27.27	32
Rhino security expenditure (ZAR yr^{-1})	29053	21933

Chapter 3: Stakeholder perspectives on the value and challenges of private rhino ownership in South Africa

Preface

Understanding the perspectives of different stakeholders involved in private rhino ownership is essential to assess the conservation value, challenges and future of the industry. Assessing perspectives only of private rhino owners and managers presents a limited, and potentially biased, picture of the industry. Other stakeholders do not have a direct economic benefit from the private ownership of rhinos and so may hold different views. Other stakeholders are also likely to interact more with local people and guests (particularly the field guides and anti-poaching staff) and may also have the ability to influence the views of the wider public, both nationally and internationally (such as representatives from NGOs). This work aimed to investigate the perspectives of these wider stakeholders and identify areas of commonality and discrepancies between their opinions and those of the private owners and managers.

This chapter has been written in the style of *Human Dynamics of Wildlife* and therefore includes American spellings and uses a different referencing system to the rest of this thesis. The full citation for the paper is: Chapman, L. A. and White, P. C. L. (2019). Stakeholder perspectives on the value and challenges of private rhinoceros ownership in South Africa. *Human Dimensions of Wildlife*, doi: 10.1080/10871209.2020.1697838

Piran White is included as a co-author due to his contribution to reviewing and editing this work.

The ethics form for this chapter is available in Appendix III and an example of the participant information sheet and consent form given to all interviewees (available in both English and Afrikaans) is presented in Appendix IV.

Abstract

The value of private sector rhinoceros conservation in South Africa is a topic of much debate, often fueled by controversies surrounding trade in rhinoceros horn. We used semi-structured interviews (*n* = 16) to assess perceptions of private rhinoceros owners and other stakeholders regarding the value of the industry and its challenges. All stakeholders attested to the conservation value of privately-owned rhinoceroses and identified poaching as the main challenge. Most of the private owners identified the lack of legal international horn trade as driving the escalation in poaching, whereas other stakeholders perceived a wider range of contributing factors. The rhinoceros owners mostly favored international trade in rhinoceros horn, whereas non-governmental organization representatives were broadly opposed. Other stakeholders noted both positive and negative outcomes. Our results suggest greater collaboration between private sector stakeholders and government agencies will be essential for consensus around future management policies, especially concerning divisive options such as trade.

Keywords: private landowners; stakeholder analysis; poaching; horn trade; wildlife conservation

Introduction

As the effectiveness of state management of wildlife is debated (Damania & Hatch, 2005), more conservation actions are likely to be delegated to private landowners. Private lands host a considerable proportion of endangered terrestrial species, including some that are absent or not appropriately represented within designated protected areas (Wilcove et al., 2004). Private landowners in South Africa, for example, conserve a large proportion of the wild rhinoceros population, holding around 42% of the total southern white (*Ceratotherium simum simum*) and black (*Diceros bicornis spp*.) rhinoceros populations (Emslie et al., 2019). Southern white rhinoceroses make up the majority (91%) of the privately-owned population, with the smaller black rhinoceros comprising only 9% (Knight, 2017).

Private rhinoceros owners, therefore, have a potentially important contribution to make to rhinoceros conservation. However, there are few peer-reviewed studies of the motivations and perceptions of private rhinoceros owners in the country (Rubino & Pienaar, 2018a, 2018b), and there is little understanding of the variation in perceptions among those involved in the wider rhinoceros industry, including tourism. This study aimed to add to the small body of work on this topic (e.g., Cousins, Sadler, & Evans, 2008; Pienaar, Rubino, Saayman, & van der Merwe, 2017; Rubino & Pienaar, 2018a, 2018b; Wright, Cundill, & Biggs, 2016) by investigating the perceptions of a range of stakeholders within the private rhinoceros owning industry. This study considered perspectives on both conservation value and trade in rhinoceros horn among the wider industry involved in rhinoceros ownership.

Given the substantial increase in poaching in recent years (average of 14 rhinoceroses poached in South Africa per year between 1990 and 2005 to more than 1,000 per year between 2013 and 2017; DEA, 2019; Milliken & Shaw, 2012), we expected poaching to be a major challenge facing private rhinoceros owners, so we investigated what they perceived their challenges to be and why they believed the poaching situation has reached its current level. There is also a perception that the wider public (Rubino & Pienaar, 2018b) and non-governmental organizations (NGOs) (Wright et al., 2016) do not understand the conservation contribution of private rhinoceros owners. For that reason, we were also interested in investigating the potentially differing perspectives of other industry professionals who may have alternative views, especially representatives from NGOs and from staff who are likely to work more closely with guests (e.g., field guides) and local communities (e.g., field guides, anti-poaching staff). Given the range of current pressures on the private rhinoceros industry, we also investigated perceptions around future options and challenges. This work provides additional views of the current and future state of the private rhinoceros industry throughout South Africa, incorporating the views of both rhinoceros owners and wider stakeholders.

From February 2009 (Case 57221/12, 2015) to March 2017 (Case CCT/121/16 2017), domestic trade in rhinoceros horn was not permitted within South Africa, with some industry insiders claiming that the current poaching situation has been exacerbated by this national moratorium (Milliken & Shaw, 2012; Taylor et al., 2014).

The Department of Environmental Affairs had been investigating the feasibility of submitting a request to the 17th CITES Conference of Parties (CoP) to reduce restrictions on the international trade of rhinoceros horn (DEA, 2015). However, at a cabinet meeting on April 13, 2016, it was agreed that South Africa would not submit such an application. This decision from the DEA was generally welcomed by conservation charities (Save the Rhino, 2016) and widely condemned by private rhinoceros owners (Rhino Alive, 2016). This disparity in opinions between NGOs and private rhinoceros owners is one factor that we wished to examine in this analysis of stakeholders.

We utilized semi-structured interviews with a range of representatives from the private rhinoceros-owning industry to assess the thoughts of the wider industry on the value of private rhinoceros conservation, their perceptions of challenges to that value, and what they perceived to be the future of the private rhinoceros owning industry within South Africa. We were interested not only in the perceptions of owners and managers, but also individuals and organizations who are able to influence public perceptions of private rhinoceros conservation (field guides, anti-poaching unit [APU] staff, NGO representatives). We aimed to investigate the opinions of both private rhinoceros owners and managers, and those of the wider private rhinoceros industry to identify areas of commonality and discrepancies in their thoughts about private rhinoceros conservation and the future of the industry. In doing so, we built on the work of Pienaar et al. (2017), Rubino and Pienaar (2018a, 2018b), and Wright et al. (2016) by interviewing the wider industry about a range of pertinent topics.

Methods

Private rhinoceros owners and managers were identified for interviews from those who completed a previous online questionnaire. Of a total of 10 potential owner and manager interviewees initially expressing an interest in further involvement, we selected six due to the range of properties they represent. Three breeding properties were selected based on a range of sizes (from 150 ha to 8000 ha) and stocking densities (3.78 rhinoceroses km^2 to 28 rhinoceroses km^2). Three properties open to visitors were also selected based on the same criteria (area: 250 ha to 6300 ha;

stocking density: 0.34 rhinoceroses km^2 to 2.4 rhinoceroses km^2). One of the visitor-focused properties was part of the Associated Private Nature Reserves (APNR) adjacent to Kruger National Park, and so the owner managed rhinoceroses that move onto his land from the national park, but did not himself stock his land with the species. Another landowner was not a rhinoceros owner at the time, but was developing a management plan to keep rhinoceroses and emailed directly indicating a willingness to contribute to this research.

Remaining interviewees were identified through a combination of convenience sampling and snowball sampling based on referrals from previous interviewees (Bryman, 2012). Five field guides with a range of experience working on multiple private properties across South Africa were interviewed, as was an experienced anti-poaching operative. Representatives of NGOs involved in private rhinoceros ownership were also interviewed, including the founder of an NGO that provides conservation internships and funding for anti-poaching activities, an ecologist and research manager, and a former field guide now involved in managing research and education projects across South Africa (total n = 16).

Although we acknowledge the potential for voluntary response bias in this way of sampling, where the views of those who chose to participate may vary from those who did not (Taylor, Lindsey, & Davies-Mostert, 2015), the sensitivity of the subject matter meant it was difficult to recruit interviewees otherwise. Consistent with Pienaar et al. (2017), Rubino & Pienaar (2018a, 2018b), and Cousins et al. (2008), because our sample size was small, we present our findings here not as quantitative results representative of all individuals working in the private rhinoceros ownership industry, but as reflective opinions of select individuals within the field. Security concerns made it challenging to increase the sample size, but our sample includes important (e.g., NGO) stakeholders in this topic (Wright et al., 2016). We have represented the views of professionals working within the private rhinoceros ownership industry who are likely to impact public opinion of the industry and the challenges it faces.

All interviewees were given acronyms (private rhinoceros owner, PRO; private rhinoceros manager, PRM; potential private rhinoceros owner, PPRO; NGO

representative, NGO; field guide, FG; and anti-poaching unit representative, APU). Interviews were conducted in person during the following periods: (a) July and August 2016 (PRO1-4, PRM1, PPRO); (b) July 2017 (NGO2, FG1-5); and (c) July 2018 (NGO3, APU). A Skype interview was conducted with NGO1 in October 2016. The APNR landowner (PRM2) was unavailable for an interview, so they completed written answers to the interview questions in July 2016. Interviews were conducted in English and lasted between 10 and 72 minutes, with the mean being just under 28 minutes (median = 22 minutes).

During the semi-structured interviews, we asked a number of pre-determined questions:

- Why did you decide to keep rhinoceroses in the first place and what challenges have you faced in doing so in the past? (asked to private owners only)
- Do you think private rhinoceros owners have contributed to rhinoceros conservation?
- What do you think has contributed to the poaching situation?
- What is your relationship with the local community? (asked to owners only)
- How do you think local communities interact with private rhinoceros owners? (asked to non-rhinoceros owners only)
- What are your views on how the government has managed the rhinoceros poaching situation to date?
- What do you think about the opening of domestic and international trade?
- What future can you foresee for rhinoceroses in South Africa?

Interviewees were encouraged to discuss topics further, so deviations from the predetermined questions were common (Bryman, 2012). All interviews were transcribed, anonymized, and initially coded by the first author. Codes were then discussed between the authors to identify the themes discussed below (Bryman, 2012).

Results

Stakeholder perceptions are presented in relation to three main themes: (a) conservation of privately-owned rhinoceroses, (b) poaching, and (c) future of rhinoceroses in South Africa, including the international trade in horn. Illustrative quotes have been provided.

Value of Private Rhinoceros Conservation

Most owners referred to their "passion" for the species as their reason for keeping rhinoceroses, with others also highlighting their attractiveness to tourists and importance in maintaining ecosystems. Only PRO3 admitted to being driven purely by financial motives, describing himself as "collecting them (rhinoceroses)" and noting:

> *When it's extinct, CITES says "oh well!" Then I can take all my horns and sell them to who I want…Then my kids will be able to sell it for half a million a kilo.*

PPRO described his motivation as one of restoring the natural habitat by stocking native species rather than farming domestic livestock. He believed the potential to secure an income from rhinoceros conservation would allow him to continue his current efforts to create community ownership of the wildlife on his land.

All private owners and managers commented that rhinoceroses are generally easy animals to keep with only minor concerns in the past regarding drought and the potential for inbreeding; issues that are not specific to just rhinoceroses. All private owners and managers felt they contributed to the conservation of rhinoceroses in South Africa through the protection and growth of their populations. Interviewees who were not private owners or managers were generally enthusiastic about the role of private ownership:

> *They've allowed for extra space for the rhino populations to move into. They're educating the public into the plight of the rhinoceros. Without [a] doubt, the private landowners are definitely aiding the conservation of rhinoceros.* [NGO3]
>
> *If you have the rhinos and you are a private owner, you have the funds to protect them.* [FG3]

NGO2, however, questioned the value of private owners isolated from larger parks:

> *They don't seem to ever go back into large parks. Genetically, I think it's not well managed.*

Poaching

When asked about their thoughts on why rhinoceros poaching had increased significantly in the last decade, most interviewees focused on one or two factors.

> *Demand! It's very simple.* [PRO3]
>
> *I think it's because the rhino numbers actually grew to such an extent that they were more easily accessed throughout South Africa.* [NGO3]

Private rhinoceros owners tended to focus on the 2009-2017 moratorium that prevented legal trade of rhinoceros horn within South Africa:

> *The only reason why South Africa was surviving and the rhinos were increasing was because legal trade was allowed.* [PRO1]

The moratorium was only noted as an issue by two other interviewees (FG3 and FG4). Others noted an increase in rhinoceros horn's value as a status symbol:

> *It is a fallacy to think that the Chinese only use rhino horn for traditional Chinese medicine. They do use a huge portion of that for jewellery.* [NGO1]
>
> *It's become a status. It's become like a "you're the man" if you have this.* [FG2]

Only field guides and NGO3 considered the local socio-economic environment to be a concern, noting that local unemployment and lack of opportunity may drive some people toward poaching as a means of generating income.

Most owners and managers did not consider local communities to be a threat to their rhinoceroses, with only PRO3 and PRM2 implicating local people in poaching on their property. PRO1 talked about animosity from local people, but also emphasized how the presence of rhinoceroses contributed to educational and employment opportunities for the local community. PPRO also discussed employment opportunities and community ownership of the rhinoceroses that he wishes to stock.

Private owners and managers, field guides, and APUs were concerned about information leaking out from their employees and visitors to poachers beyond local communities:

> *Almost 100% of cases, rhino poaching cases, there's always inside information going out.* [PRO1]
>
> *It has been an issue in a lot of cases. They tend to give a lot of information away and sometimes unknowingly or unwittingly. They'll be talking on their phone and the neighbours will pick it up and word gets passed on and eventually information gets into the wrong hands.* [APU]

All interviewees felt that the government response to the poaching crisis could be improved:

> *Terrible; in 10 years, poaching has increased from 20 to 1200 per year and South Africa has lost 6000 rhinos. That is by definition proof that the government is not coping.* [PRO3]
>
> *I think their efforts may be sitting at 40%. I don't think there's enough political will.* [NGO1]

Future of Rhinoceroses in South Africa

Few interviewees were positive about the future of rhinoceroses in South Africa:

> *It feels pretty hopeless most of the time.* [PRO4]
>
> *I think we might lose all our rhinos.* [PPRO]

FG1, FG2, FG5, APU, NGO2, and NGO3 all felt that rhinoceroses can be saved, but believed they would be in a similar situation to the early years of the 20th century, with all rhinoceroses held in a single population and protected there. Some were concerned about the possibility of rhinoceroses being held in single species breeding facilities:

> *I think rhinos are going to be in these very small populations that are very highly controlled and highly protected.* [NGO2]
>
> *Move everybody to the same area and then try and breed them again.* [FG1]

There's going to be captive rhinos that are bred in captivity and farmed. [APU]

Although the private owners and managers were most negative in the future they see for rhinoceroses in South Africa, they were all determined to continue keeping them for as long as financially possible. All owners and managers highlighted the spiralling costs of protecting rhinoceroses from poaching as the main factor that may cause them to disinvest in rhinoceroses, with some also mentioning safety concerns. Several owners independently brought up the possibility of trade in rhinoceros horn as a means of providing the necessary income to protect the species, before they were questioned on the topic of trade.

Legal Trade in Rhinoceros Horn

Several owners stated that there was no reasoning for internal trade without international trade, as the market for horn lies outside South Africa. International trade was noted by several respondents as a means of generating income to fund anti-poaching activities.

Only two of the owners and managers interviewed were against the trade in horn (both national and international), with PRO4 highlighting that the issue was just one aspect of organized wildlife crime. FG5, NGO1, and NGO2 were also vehemently against the possibility of trade in rhinoceros horn, with both NGO1 and NGO2 discussing at length the issues of demand and the ability of South Africa's rhinoceros population to meet that demand. Other interviewees were generally more nuanced in their opinions, with NGO3, FG1, FG2, FG3, FG4, and APU all agreeing that although they would prefer for there not to be trade in rhinoceros horn, they could see why it would be beneficial in the short term as demand reduction programs were believed to be too long-term to protect the rhinoceros in the immediate future. All interviewees, regardless of their opinions toward trade, felt that if it were to happen, then appropriate policies and procedures must be in place. None believed that the current South African government processes would secure the future of rhinoceroses through effective management of international trade.

Discussion

Value of Private Rhinoceros Conservation

Consistent with findings by other authors (Rubino & Pienaar, 2018a, 2018b; Selinske, Coetzee, Purnell, & Knight, 2015; van der Waal & Dekker, 2000), most owners / managers identified their interest in conservation and passion for rhinoceroses as their reason for keeping their stock. Most did not focus on the potential income that could be generated from the species, supporting the assertion that profit is a secondary concern (Langholz, Lassoie, Lee, & Chapman, 2000). Although Rubino and Pienaar (2018b) identified private rhinoceros owners' frustration with international NGOs, those within South Africa, alongside other industry professionals interviewed here, generally considered private owners to be beneficial for rhinoceros conservation. Further engagement by private owners with NGOs outside South Africa may help to improve their international image.

Poaching

When asked to elucidate on why the situation had reached its current state, the reasons were varied and broadly split among the stakeholders. Previous studies have indicated a belief within the wildlife industry that the moratorium was to blame for increased poaching (Milliken & Shaw, 2012; Taylor et al., 2014), with Taylor et al. (2014) suggesting that it is "reasonable to consider a possible link between them" (p. 42). Milliken and Shaw (2012) suggested that this link may be due to the legal domestic supply illegally supplying foreign markets before the moratorium. Whether the removal of the moratorium will reduce poaching is unknown, but the ability of private owners to trade horns may now produce some limited income that many respondents felt they needed to continue protecting stocks.

Taylor et al. (2014) also identified the high demand, high price, increased income in end-user states, and depleted populations in some other rhinoceros range states as being among the driving factors for the increase in rhinoceros poaching; all factors that were identified by interviewees in our study. The field guides were more likely to consider socio-economic issues within South Africa that may lead local people to become involved in ground level poaching. Multiple studies have considered the influence of local people on wildlife protection with Kideghesho (2008) noting that

poaching may serve as self-compensation for the costs associated with living in close proximity to wildlife. Others have considered the impact of distributing benefits from wildlife to local communities to improve relationships, including the education of community groups and school children (Langholz, 1996), and providing employment (Kaltenborn, Nyahongo, Kideghesho, & Haaland, 2008; Langholz, 1996), which were noted by interviewees. One community factor that did concern stakeholders was the potential for information to be passed to poachers by staff, potentially degrading relations between reserves and local communities.

The lack of trust in the government and its ability to stabilize the situation was clear from the responses to interviews. The private owners do not receive government support (Langholz, 1996; Rubino & Pienaar, 2018b) and do not perceive the government as supportive or effective in this manner. This finding mirrors those of Rubino and Pienaar (2018a, 2018b) and Pienaar et al. (2017). Without concerted government efforts to redress the perceptions of corruption and policy inadequacies, the perception of government ineffectiveness seems unlikely to improve.

Future of Rhinoceroses in South Africa

Respondents were generally pessimistic in their thoughts on the future for rhinoceroses in South Africa. Many of the private owners and managers had considered disinvesting in rhinoceroses due to financial pressures of protecting them from poaching and the potential risks to them and their families (Rubino & Pienaar, 2018a; Wright et al., 2016).

Some interviewees also considered that rhinoceroses may end up reared in intensive farms, whereas others felt that rhinoceroses may eventually become extinct. Increased rarity of rhinoceroses would increase the value of their commodity and so further increase their drive toward extinction (Angulo, Deves, Saint Jalmes, & Courchamp, 2009), after which CITES regulations would not apply (Bulte, Mason, & Horan, 2003). Increasing value before extinction would make it beneficial for owners themselves to contribute to the decline; a notion defined as “banking on extinction” (Mason, Bulte, & Horan, 2012, p. 180).

Legal Trade in Rhinoceros Horn

To prevent the negative outcomes predicted above, many of the owners were strongly in favor of international trade in rhinoceros horn, which is consistent with the findings of Rubino and Pienaar (2018a, 2018b) and Wright et al. (2016) who also found strong support for trade among owners and managers.

The opposing opinions of conservation-orientated NGOs and private owners regarding the ethics and practicalities of trade in rhinoceros horn, although not unexpected, does raise some considerable difficulties in developing a coherent plan for future rhinoceros conservation that will secure widespread support. Wright et al. (2016) also found this disparity and suggested that improved dialogue between NGOs and owners may improve understanding of the utility of short-term trade in conjunction with demand reduction programs.

How trade could be implemented was not formally discussed with interviewees, but informal discussions with rhinoceros owners have indicated support for a central selling organization (CSO), similar to that previously utilized for diamonds by the De Beers Group (Milliken & Shaw, 2012). The low opinions held by the interviewees regarding the government suggest that it is unlikely a state-backed agency would be supported in managing trade, a finding supported by Rubino, Pienaar, and Soto (2018) who identified a government-backed CSO as less popular than one managed by a wildlife industry body.

Conclusions

The conservation value of private rhinoceros ownership is generally accepted within the private rhinoceros-owning industry. Greater integration with state-protected areas, through the sharing of research and good practice, or through increased stock transfer, alongside greater engagement with international NGOs may help to increase the visibility of that value to those outside of the industry. Such engagement may also reduce concerns and disparity regarding potential trade in rhinoceros horn.

Although the rhinoceros managers and owners tended to focus on the lack of supply of horn as the major factor contributing to the current poaching crisis, NGO representatives tended to focus on high demand. Other interviewees were more likely to consider the impact of socio-economic conditions that may lead local people to become involved in rhinoceros poaching. We recommend further research on the socio-economic conditions of local communities around poaching hotspots to investigate this suggested factor. With minimal sales of rhinoceros horn now taking place within South Africa, it may also be possible to ascertain whether the lifting of the moratorium has any impact in the long term.

To build trust and reduce the perception that the government response to the poaching escalation has been poor, we would encourage increased collaboration between private rhinoceros owners and government departments. Engagement with private owners in developing policies to challenge rhinoceros poaching would further improve this perception.

To ensure the future survival of rhinoceros within South Africa and the continued engagement of private owners in rhinoceros conservation, we advocate greater collaboration and improved communication among all stakeholders (e.g., agencies, NGOs, private owners).

Acknowledgements

We wish to thank the interviewees: Lynne MacTavish, Hans Kooy, Piet Warren, PC Ferreira, Stefran Broekman, Dex Kotze, Eugene Fuhri, Ian Hall, Pieter Kruger, Elri Schaap, Lozanne van Sittert, Patrick Minter, and those who wish to remain anonymous. We also thank Dirk Boshoff for assistance with interviews and translations, and the Scottish International Education Trust who provided a grant to Laura Chapman to allow the fieldwork to be carried out. We also thank the anonymous reviewers who provided valuable comments on previous versions.

References

Angulo E., Deves, A., Saint Jalmes, M., & Courchamp, F. (2009). Fatal attraction: Rare species in the spotlight. *Proceedings of the Royal Society B*, *276*, 1331-1337. doi:10.1098/rspb.2008.1475

Bryman, A. (2012). *Social research methods*. Oxford, UK: Oxford University Press.

Bulte, E. H., Mason, C. F., & Horan, R. D. (2003). Betting on extinction: Endangered species and speculation. *Land Economics*, *79*, 460-471. doi: 10.2307/3147293

Cousins, J. A., Sadler, J. P., & Evans, J. (2008). Exploring the role of private wildlife ranching as a conservation tool in South Africa: Stakeholder perspectives. *Ecology and Society*, *13*, 43.

Damania, R., & Hatch, J. (2005). Protecting Eden: Markets or government? *Ecological Economics*, *53*, 339-351. doi:10.1016/j.ecolecon.2004.09.015

Department of Environmental Affairs (DEA) (2015). Minister Edna Molewa highlights progress in the fight against rhino poaching. Retrieved from: https://www.environment.gov.za/mediarelease/molewa_highlightsprogress_onrhinopoaching

Department of Environmental Affairs (DEA) (2019). Minister of Environmental Affairs highlights progress on the implementation of the integrated strategic management of rhinoceros. Retrieved from: www.environment.gov.za/progressonimplementationofintegratedstrategicmanagementofrhinoceros

Emslie, R. H., Milliken, T., Talukdar, B., Burgess, G., Adcock, K., Balfour, D., & Knight, M. H. (2019). African and Asian rhinoceroses - Status, conservation and trade: A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf. 9.14 (Rev. CoP17) (No. CoP18 Doc. 83.1 Annex 2). Geneva: CITES Secretariat.

Kaltenborn, B. P., Nyahongo, J. W., Kideghesho, J. R., & Haaland, H. (2008). Serengeti National Park and its neighbours: Do they interact? *Journal for Nature Conservation*, *16*, 96-108. doi:10.1016/j.jnc.2008.02.001

Kideghesho J. R. (2008). *Who pays for wildlife conservation in Tanzania and who benefits?* Morogoro, Tanzania: Sokoine University Press.

Knight, M. H. (2017). African Rhino Specialist Group report. *Pachyderm, 58*, 17-35.

Langholz, J. (1996). Economics, objectives and successes of private nature reserves in Sub-Saharan Africa and Latin America. *Conservation Biology*, *10*, 271-280.

Langholz, J. A., Lassoie, J. P., Lee, D., & Chapman, D., (2000). Economic considerations of privately owned parks. *Ecological Economics*, *33*, 173-183. doi:10.1016/S0921-8009(99)00141-X

Mason, C. F., Bulte, E. H., & Horan, R. D. (2012). Banking on extinction: Endangered species and speculation. *Oxford Review of Economic Policy*, *28*, 180-192. doi:10.1093/oxrep/grs006

Milliken, T., & Shaw, J. (2012). *The South Africa – Vietnam rhino horn trade nexus: A deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates*. Johannesburg, South Africa: TRAFFIC.

Pienaar, E. F., Rubino, E. C., Saayman, M., & van der Merwe, P. (2017). Attaining sustainable use on private game ranching lands in South Africa. *Land Use Policy*, *65*, 176-185. doi:10.1016/j.landusepol.2017.04.005

Rhino Alive (2016). South Africa's missed opportunity to save the remaining rhino in the world. Retrieved from: www.rhinoresourcecenter.com/pdf_files/146/1462014666.pdf

Rubino, E. C., & Pienaar, E. F. (2018a). Rhinoceros ownership and attitudes towards legalization of global horn trade within South Africa's private wildlife sector. *Oryx,* 1-8. doi: 10.1017/s0030605318000030

Rubino, E. C., & Pienaar, E. F. (2018b). Understanding South African private landowners decisions to manage rhinoceroses. *Human Dimensions of Wildlife*, *23*, 160-175. doi:10.1080/10871209.2018.1402971

Rubino, E. C., Pienaar, E. F., & Soto, J. R. (2018). Structuring legal trade in rhino horn to incentivize the participation of South African private landowners. *Ecological Economics, 154,* 306-316.

Save the Rhino (2016). South Africa will not table CITES proposal on rhino horn trade. Retrieved from: https://www.savetherhino.org/latest_news/news/1476_south_africa_will_not_table_cites_proposal_on_rhino_horn_trade

Selinske, M. J., Coetzee, J., Purnell, K., & Knight, A. T. (2015). Understanding the motivations, satisfaction, and retention of landowners in private land conservation programs. *Conservation Letters*, *8*, 282-289. doi:10.1111/conl.12154

Taylor, W. A., Brebner, K., Coetzee, R., Davies-Mostert, H., Lindsey, P., Shaw, J., & ‘t Sas-Rolfes, M. (2014). *The viability of legalising trade in rhino horn in South Africa*. Pretoria, South Africa: Department of Environmental Affairs.

Taylor, W. A., Lindsey, P. A., & Davies-Mostert, H. (2015). *An assessment of the economic, social and conservation value of the wildlife ranching industry and its potential to support the green economy in South Africa*. Johannesburg, South Africa: The Endangered Wildlife Trust.

van der Waal, C., & Dekker, B. (2000). Game ranching in the northern province of South Africa. *South African Journal of Wildlife Research*, *30*, 151-156.

Wilcove, D. S., Bean, M. J., Long, B., Snape, W. J., Beehler, B. M., & Eisenberg, J. (2004). The private side of conservation. *Frontiers in Ecology and the Environment*, *2*, 326-331.

Wright, O. T., Cundill, G., & Biggs, D. (2016). Stakeholder perceptions of legal trade in rhinoceros horn and implications for private reserve management in the Eastern Cape, South Africa*. Oryx*, *52*, 175-185. doi:10.1017/S0030605316000764

Chapter 4: Trends in rhino poaching activity on private land in South Africa

Abstract

Poaching on private land may potentially significantly deplete the rhino population yet is poorly studied. Understanding patterns of poaching will enable more efficient deployment of anti-poaching efforts. This research investigates whether poachers who target private land in South Africa show patterns in their activity, by focusing on specific times or categories of rhino (in relation to species, sex and age) and whether this has changed across time. Using rhino owner and (mainstream and social) media reports, we complied a database of private land poaching events between 2003 and 2017. Trends in poaching activity were broadly consistent over time. Poaching is most likely at night, under the full moon, close to the property perimeter. Whilst there was no trend across the whole dataset, there was evidence of increased poaching during the weekend (Friday-Sunday) compared to weekdays (Monday-Thursday) in 2017. Prioritising anti-poaching efforts at these times may therefore be the most efficient use of limited resources. There was no evidence that poachers selectively target rhinos, suggesting that anti-poaching efforts directed at protecting specific individuals or groups may be ineffective. Our research also highlighted key data that were currently not clearly recorded, including collateral calf deaths and lost pregnancies, which may have a significant impact on the scale of the rhino poaching problem.

Keywords**:** *Ceratotherium simum simum*; *Diceros bicornis;* private landowners; social media research; environmental crime

Introduction

Conservation criminology is a recently developed field of research that offers a framework for understanding criminal behaviour that impacts upon the natural environment (Gore, 2011). The illegal trade in endangered species and their parts is one of the best-known examples of such environmental crime (Brack, 2002). Whilst attempts to understand the driving forces of poaching are common (e.g. Duffy, 2014; Lunstrum, 2014), and often focus on economic drivers of such behaviour (Bulte and van Kooten, 1999), research investigating the behaviour of poachers on the ground is only recently developing as a field (Beale et al., 2018; Critchlow et al., 2015; Rashidi et al., 2015). From a conservation criminology perspective, research is only

recently beginning to consider the behavioural drivers of poaching (Moreto, 2019; Lemieux, 2014; Kahler and Gore, 2012).

The poaching of southern white (*Ceratotherium simum simum*) and black rhinos (*Diceros bicornis*) is of particular importance due to the significant economic gains that can be made from the supply of rhino horn (Milliken and Shaw, 2012) and the high level of poaching rhino currently face in southern Africa. In 2015, poaching deaths represented 5.79% of South Africa's rhinos (Emslie et al., 2016). With increased poaching pressures reducing the white rhino population growth rate in South Africa to only 2% per annum (Knight et al., 2015), continued poaching will significantly impact upon the future of this species. There is therefore an urgent need to understand factors which contribute to poaching incidents.

The privately-owned rhino population of South Africa is substantial, comprising 33% of the national herd of black rhinos (Selier, 2019) and 45% of white rhinos (Emslie et al., 2019). Properties range from single species breeding facilities through to extensive natural areas, with a mean size of 9,761 ha (range: 54-103,000 ha; Balfour et al., 2015). Limited research has been undertaken on rhino poaching in state-protected areas (Koen et al., 2017), but private reserves tend to be disconnected from such research (Maciejewski et al., 2016). This work aims to add to the understanding of this topic, by utilising poaching reports to investigate rhino poaching incidents on private land across South Africa. Understanding the trends in poaching events in relation to when rhinos are poached and which animals are targeted may allow for more effective preventative measures. Predicting, and therefore potentially preventing, poaching events is much more effective in the long-term preservation of species than reactive action after a poaching event (Koen et al., 2017).

Rhinos have long been regarded as relatively easy to poach due to their generally solitary lifestyle, predictable behaviour, ease of approach (Western, 1982) and horns which are relatively easy to remove (Kock et al., 2008). In 2016, southern white rhinos made up the majority (90.7%) of the privately-owned population, with the black rhino comprising only 9.3% (Knight, 2017; Emslie et al., 2016). With their larger horns (Martin and Vigne, 2003), white rhinos have been previously noted to be preferred poaching targets (Knight et al., 2015; Milliken and Shaw, 2012) and would

therefore be over-represented in the poaching statistics, regardless of their larger population proportion. Whether this general pattern is replicated in poaching on private land only is currently unknown. We hypothesise that this targeting of heavier-horned individuals would translate into targeting of mature adults over sub-adults or calves. Males have heavier horns than females (Pienaar et al., 1991) and we hypothesise that males should therefore also be targeted preferentially. Anecdotal evidence, collated from informal discussions with private rhino owners, suggest a belief that these larger horned individuals are more attractive to rhino poachers and so these animals can be selectively dehorned to reduce the poaching risk on the property. Identifying whether such selection does occur would provide private rhino owners with the evidence needed to determine whether selective dehorning is an appropriate use of their limited anti-poaching capabilities.

Research on the poaching of rhinos on state land has indicated that poachers show a preference for poaching during the full moon (Mulero-Pázmány et al., 2014) and during twilight hours (Koen et al., 2017). It has also been noted that the level of rhino poaching on state land increases through the calendar year towards December (Koen et al., 2017; Mulero-Pázmány et al., 2014). There has been no publicly available published research on the trends of rhino poaching on private land, and there is no evidence regarding the transferability of poaching patterns from state to private land. The deployment of anti-poaching activities is therefore usually based on anecdotal evidence. Understanding the temporal patterns of poaching risk on private land could greatly benefit rhino owners in directing their anti-poaching activities more effectively, as different temporal patterns require different preventative actions (Ratcliffe, 2004). As private rhino owners receive no government support (Lee and Du Preez, 2016), they must fund their anti-poaching activities themselves. Increasing costs may reduce the effectiveness of rhino conservation on private land, having been linked to preventing reserve expansion in Zimbabwe (Langholz, 1996) and to increasing disinvestment in rhinos by private owners in South Africa (Jones, 2013). Identifying when anti-poaching actions are likely to be most effective may reduce expenditure and serve to mitigate some of these concerns. Whilst there is a wide body of work (Barichievy et al., 2017; Cheteni, 2014; Ferreira et al., 2014; Ferreira and Okita-Ouma, 2012; Wellsmith, 2011; Martin, 1996a) regarding the effectiveness of anti-poaching measures in tackling rhino poaching, private rhino owners

themselves are unable to impact upon the causes and drivers of poaching behaviour. For them, effective deployment of their anti-poaching capabilities may be the best way they can counter the issue.

Here, we use collated records of rhino poaching incidents on private land between 2003 and 2017, to identify any patterns in the selection of black and white rhinos, and in the selection of age or sex categories of rhinos for poaching. In particular, we test our hypotheses that poachers would target the more heavily-horned white rhinos and show a preference for the heavier horns of males over females and adults over the other age classes. We also investigate whether there are times when poaching is more likely on private land. To assess temporal changes in poaching trends, we investigate these trends between years. This is the first formal study to investigate country-wide data on poacher behaviour patterns on private land in South Africa. Previous work on state-owned land has been place-specific, focused on particular parks or reserves, whereas this study presents a picture of poaching behaviour across the whole country. Our findings provide private owners with a better understanding of the factors associated with an increased likelihood of a poaching event occurring on their property and so may help them prioritise their anti-poaching strategies most effectively.

Methods

Database

Data on poaching incidents were obtained directly from 23 private rhino owners and from mainstream and social media reports of poaching incidents on private property (as these data were publicly available, no ethical process was required for this data collection). Private owners were asked to provide details of all previous poaching events on their properties (from the questionnaire fully explained in Ch. 2 – Appendix I), which provided the earliest event in the final dataset (2003) and comprised a total of 48 rhinos poached. For security reasons, the mainstream and social media (Facebook) sources utilised have not been disclosed. To ensure the sample was as representative as possible, social media groups and pages covering rhino poaching at both national (nine sources) and provincial (ten sources covering all provinces except Free State, Northern Cape and Western Cape) levels were utilised, alongside

national newspaper websites. Social media sources represented a range of interest groups, from private rhino owners and anti-poaching groups to citizen engagement groups and veterinary organisations involved in the care of rhino orphans. Incidents reported by group members, but not corroborated by further (social) media reports, or by the group/page administrators, were discarded, as were reports where it was unclear if the incident happened on private land. Where multiple reports were suspected to be of the same incident, efforts were made to match details to avoid replication of data. After matching details against media reports to eliminate any repeats, the owner reports were combined with the media reports to produce a dataset of poaching events between 2003 and 2017, totalling 473, covering 127 properties, across all provinces. All events reported as poaching events were recorded, regardless of whether the animal survived and whether the horns were removed. To assess the potential future impacts of current poaching on rhino populations, data on collateral deaths of calves who died after their mothers were poached and pregnancies which were terminated due to the death of the mother were also recorded. The method of poaching was also noted, as was whether the animals had previously been dehorned by their owners or not. As many of the reports did not contain all the required information, the sample size, n, is given for each test.

Provincial differences

We collated the locations of poaching events only to test for any differences in the incident or individual data between provinces, which would preclude combining the data for further analysis. We conducted two-way Chi-squared analyses to test whether patterns of poaching across months, days and moon phase were consistent across provinces. Further two-way Chi-squared analyses identified relationships in the selection of individuals for poaching based on species, sex and age category across provinces.

Incident data

To assess temporal trends in poaching events, for each incident, where possible, the date, time of day and moon phase were recorded. Moon phase was determined by

using a moon phase calendar based on the date of the incident. If more than one animal was poached, the incident was only recorded once to avoid pseudo-replication of results. This resulted in 248 separate incidents for which at least some of the data were available. It was not possible to transform many of the variables, so the non-parametric distribution of the data, combined with multiple gaps in the dataset, precluded the use of multivariate analysis. We used Chi-squared analysis to determine whether there were any patterns in the timing of poaching incidents. For these analyses, we grouped years together where sample sizes were too small to allow for comparisons across time based on individual years. Where initial Chi-squared testing indicated significant results, post-hoc partial Chi-squared analysis was utilised.

Categories of poached rhinos

To investigate any evidence of selection of specific individuals, the species, age and sex of the poached animals were also recorded. All individuals targeted by poachers were included in this data set, including those where multiple individuals were poached in one incident, giving a total of 300. Whilst some reports identified poached animals as adult, calf etc., others gave the age of the individual. Thompson et al. (2016) provided a detailed breakdown of the age classes of white rhinos, whilst Walpole et al. (2001), defined black rhino calves as those under three years old, sub-adults as those aged four to seven, and adults as all those over seven years of age. Due to the crossover in age categories for both black and white rhinos, the exact age of individuals often not being reported, and the fact that individuals may reach sexual maturity earlier or later than others, we utilised the broader Walpole et al. (2001) definitions in this study. When a pregnant female or one with a calf was poached, that female was assumed to be an adult. The sex (1.52 F:M) and age (18.63% calves, 29.65% sub-adults and 51.72% adults) ratios from Balfour et al. (2015) were used for both species. We used a population ratio of 90.68% white rhino and 9.32% black rhino based on Emslie et al. (2016) and Knight (2017). Using these factors, we categorised rhinos as male/female, black/white and adult/subadult/calf.

As the rhino population is biased towards white rhinos, females and adults, for those reports which were complete (n=81), the proportion of expected rhinos was calculated by dividing the total counts by what would be expected from the

composition of the population (using the proportions above) if poached rhinos were selected at random. These proportional values were used in a linear regression model to identify any effect of species, age or sex in the number of rhinos poached. This regression allowed multiple variables to be considered but was constrained by the small sample size. Using the above population ratios, we utilised further univariate Chi-squared analyses on the available larger sample sizes (sex: n=217, species: n=210, age: n=158) to identify whether specific categories were more likely to be targeted by poachers than would be expected due to chance (Li et al., 2003).

Results

Provincial differences

Due to small expected values, all incident analyses between provinces required the combining of KwaZulu-Natal, Mpumalanga, Free State and Gauteng, and also the three Cape Provinces (Northern, Eastern and Western). Poaching across the country was not related to the day of the week (Two-way $\chi 2_{(27,\ n=187)}=29.94$, p=0.32), weekday against weekend (Two-way $\chi 2_{(7,\ n=187)}=0.73$, p=1) or the four major phases of the moon (Two-way $\chi 2_{(15,\ n=187)}=13.76$, p=0.54). There was no significant difference in poaching levels between different months of the year (Two-way $\chi 2_{(23,\ n=218)}=30.10$, p=0.15; months combined into pairs – January/February, March/April etc. due to low sample sizes).

For individual rhino analyses, Mpumalanga was not analysed, as none of the reports from that province contained information on the individuals poached. To test our hypothesis relating to the selection of males over females across provinces, data from Free State, Gauteng, Northern Cape and Western Cape had to be combined due to small sample sizes. This analysis indicated no relationship between selection for sex and province ($\chi 2_{(9,\ n=209)}=3.74$, p=0.93). Black rhino numbers were too small (n=16) for analysis between provinces, but white rhino figures (with Western Cape and Free State combined due to small sample sizes) showed no relationship with province ($\chi 2_{(6,\ n=186)}=0.60$, p=1). To assess any differences between provinces in terms of selection of different age categories, only data from Limpopo, KwaZulu-Natal and Eastern Cape were sufficient for analysis, and gave no indication of differences ($\chi 2_{(8,\ n=97)}=2.61$, p=0.96).

As these analyses indicated no differences in poaching trends between provinces, all data were combined for further analysis.

Incident data

We found no evidence to suggest that the day of the week had any significant effect on poaching overall ($\chi2_{(6, n=195)}$=2.02, p=0.92), or when data were broken down into year groups (2008-2011, 2012-2013, 2014-2015, 2015-2016 and 2017). There was also no significant difference between levels of poaching at weekends (Fri-Sun) and on weekdays (Mon-Thurs) ($\chi2_{(1, n=195)}$=1.84, p=0.12) across the whole dataset. When we compared poaching activity between week days and weekends across the year groups, we also found no significant differences for any year (2008-2010 were combined due to limited data) except for 2017, when there was a higher level of poaching at the weekend ($\chi2_{(1, n=45)}$=5.06, p=0.02).

An analysis of the impact of moonlight on poaching was conducted by dividing the data into quarter phases (0-25% full, 26-50%, 51-75% and 76%+). There was a significant difference in poaching between moon phases ($\chi2_{(3, n=195)}$=36.24, p<0.001). Partial Chi-squared values indicated that poaching was significantly higher than expected when the moon is over three quarters full and significantly lower than expected at 26-50% full. A higher frequency of poaching when the moon is 76-100% full was found across most time periods (2008-2011, 2012-2014 and 2017; Table 4.1), although no differences in poaching due to moon phase were found in 2015 or 2016.

*Table 4.1: Chi-squared analyses of rhino poaching events due to moon phases (significant values are indicated *)*

	All moon phases (d.f.=3)			Partial Chi-squared (76-100% removed: d.f.=2)		
Year	χ2	n	p-value	χ2	n	p-value
2008-2011	15.59	35	*0.014	4.45	17	0.11
2012-2014	8.36	53	*0.039	4.55	33	0.10
2017	10.69	45	*0.013	2.18	25	0.34

There were significant differences in poaching events across the months of the year ($\chi 2_{(11,\ n=228)}$= 19.75, p= 0.05), but this showed no seasonal pattern. Whilst overall poaching tends to increase as the year progresses, we found no significant differences in poaching across the months of the different year groups: 2006-2012 ($\chi 2_{(11,\ n=69)}$=16.74, p=0.12), 2013-2015 ($\chi 2_{(11,\ n=71)}$=13, p=0.29), 2016-2017 ($\chi 2_{(11,\ n=88)}$=16.01, p=0.14). Higher levels of poaching occurred in January, March, August and October, with lower poaching levels in May, June, July, September and December (Fig. 4.1).

Whilst the exact time of some poaching incidents was reported, many reports simply stated ‘early morning’ or ‘day’. Far more poaching events (n=51) occurred at night (52.9%), rather than at dawn or dusk (33.3%) or during the day (13.7%). The small data set precluded temporal analysis of this data.

For poaching events where detailed location data were available (n=57), 29.8% occurred on the perimeter, 35.1% within 3km of perimeter, 22.8% in the core, 8.8% in breeding kamps and 3.5% in bomas. Animals poached near the perimeter were mostly poached alongside roads (70.8%), 8.3% alongside roads and settlements and 20.8% alongside other wildlife habitats (n=24). Where the poaching method was provided (n=258), most of the animals were shot (89.2%), 16.7% were darted, four were poisoned and one was caught in a snare. Whilst the poisoning and snaring incidents were one-off occasions (the poisoning was in 2012 in the Eastern Cape and the snaring was in 2011 in Limpopo) and guns were used consistently through time and across all provinces, darting of rhinos was predominantly based in the Eastern Cape. Darting events did occur in other provinces, but never in more than one year.

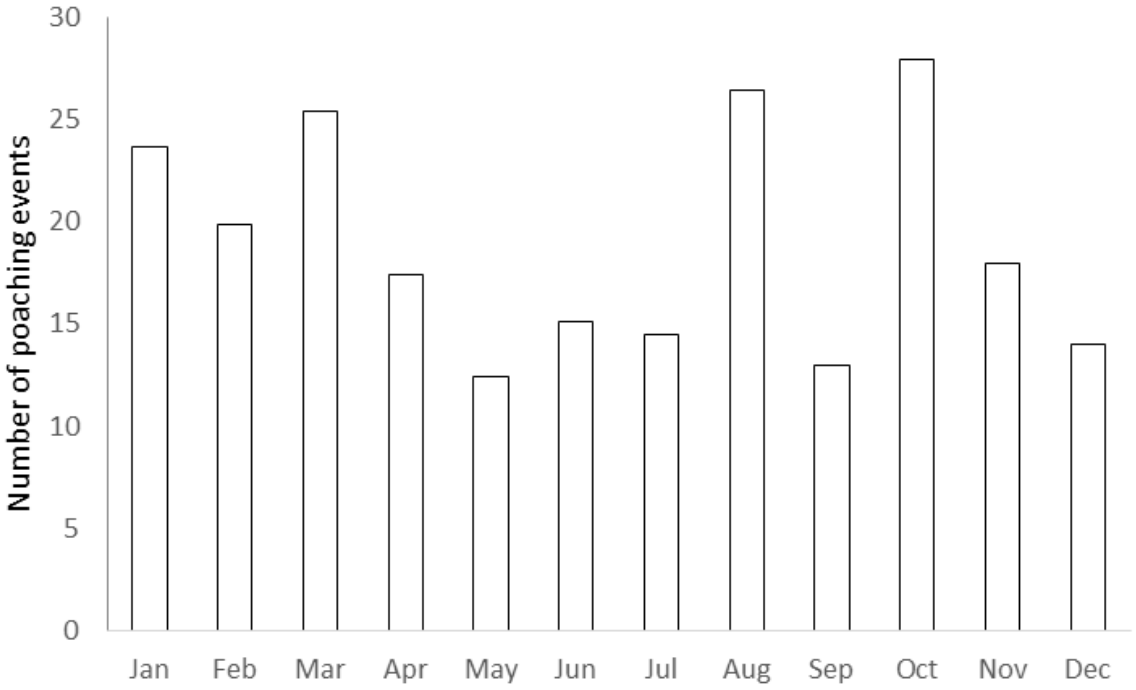

Figure 4.1: Total rhino poaching events by month (2006-2017)

Categories of poached rhinos

Linear regression to identify any evidence of selection of specific individuals by poachers indicated no linear relationship between the number of animals poached relative to their proportion in the population due to sex, age or species ($F=1.31$, $d.f=1,10$, $p=0.34$). Further univariate Chi-squared analysis of larger datasets provided no evidence to suggest that the heavier-horned males were targeted by poachers over females ($\chi2_{(1, n=217)}=0.50$, $p=0.48$), or that larger-horned white rhinos were selected over black rhinos ($\chi2_{(1, n=210)}=0.018$, $p=0.89$). These findings were consistent across all years. We also found no indication of selection by poachers in relation to the age of rhino (calf, sub-adult or adult) ($\chi2_{(2, n=158)}=5.86$, $p=0.053$), although this was approaching significance. There was no significant selection due to age in any year.

Alongside those incidents recorded as poaching events, a further seven calves were recorded as subsequently dying following the loss of their mother and 29 pregnancies were lost.

Discussion

We were unable to find an official definition of ‘poaching’ from the Department of Environmental Affairs (DEA), yet Austin (2019) notes that animals which are wounded and subsequently die are not included in the official poaching statistics. Previous informal discussions with private rhino owners and social media statements issued by some NGOs (Saving the Survivors, 2015) highlight a further belief that animals which are not dehorned are also not recorded in the official figures. One report included that the cause of death was septicaemia and was therefore not officially a poaching death. As it was not possible to determine which events were recorded as official poaching events, all were included in the data set. For 2017, the dataset represents 41.07% of all the rhino poaching events on private land (Rhino Alive, 2018). We do not suggest that this dataset fully represents all poaching on private land in South Africa, but rather it broadly represents a general picture of poaching events. As we found no evidence of differences in trends in poaching activity between provinces, we suggest the following general findings can be applied across the whole country.

Incident data

We found some evidence of a greater level of poaching towards the end of the week and at the weekend, as had been suggested during informal discussions with private rhino owners, but this difference was only statistically significant for 2017. Further analysis of data from 2018 and beyond may indicate if this pattern is continuing.

As was expected, we found a link between moon phase and rhino poaching, due to the increased visibility afforded by a fuller moon improving the poachers’ chances of success. Whilst Gwin (2012) suggested that a half moon is preferred by poachers, other authors’ findings concurred with ours (Mulero-Pázmány et al., 2014; Milliken and Shaw, 2012; Martin, 1996b). However, this pattern was not consistent across all years. We found no evidence of poachers focussing their efforts during full moon periods in 2015 or 2016, indicating that there may have been a change in poacher behaviour during this time. Our finding that poaching was not lower than expected when the moon was 0-25% full runs contrary to the general pattern, but it may be that some poachers opt to operate under the cover of almost complete darkness.

There were differences in the number of poaching events in different months of the year, but no consistent trends. Studies on poaching of other species (Haines et al., 2012) have found seasonal differences in poaching events, as has other research focused on rhino poaching, both in Africa (Koen et al., 2017; Mulero-Pázmány et al., 2014) and in Asia (Martin, 1992). The general reported trend is an increase in rhino poaching towards the end of the year (DEA, 2016; Milliken and Shaw, 2012). However, the Rhino Alive (2018) data indicate that, in 2017, total poaching peaks (state and private land combined) occurred in January, March, May, June, July and September and poaching on private land peaked in January and October. The poaching peaks in January, March and October apparent in the Rhino Alive data were reflected in the dataset analysed here. The Rhino Alive data also suggest poaching on private land was lowest in July, November and December, which was reflected in our findings of poaching lows in July and December. It is clear that poaching is inconsistent across the year and there is no strong evidence from this study to suggest it is any more likely to occur during specific months than others.

The finding that most rhinos were poached at night was also expected. Whilst Koen et al. (2017) suggests that twilight is thought to be preferred by poachers and Martin (1996b) found Asian rhino poachers were more likely to poach in the early morning or late afternoon, anecdotal evidence suggested that night would be preferred by rhino poachers. Around a third of poaching events in this study did occur at dawn or dusk, supporting the suggestion that these times would also be important for poaching.

Finally, it was anticipated that more rhinos would be poached with guns than by other methods, with prior research on rhino poaching in South Africa (Mulero-Pázmány et al., 2014; Milliken and Shaw, 2012) identifying that poaching by means other than shooting the animal is uncommon. Our findings indicate that darting of rhinos is primarily confined to the Eastern Cape and is rare elsewhere, suggesting that there may be differences in the method of poaching utilised by poachers in different provinces. Further information would be required to confirm this.

The higher frequency of poaching events recorded at the perimeters of properties also conforms to the results from other studies, although it must be noted that this sample size was limited. Wato et al. (2006), Metzger at al. (2007), and Watson et al.

(2013) all found links with poaching and proximity to the perimeter of protected areas, with Wato et al. (2006) recommending a 10 km buffer zone along boundaries to reduce poaching risk. However, this would not be feasible for most of the private properties in our study due to their relatively small size (mean area of properties for which owner reports were provided was 13,637 ha). Conducting poaching close to the perimeter would reduce the length of time a poacher needs to remain on a property and the presence of a nearby road would aid access (Mulero-Pázmány et al., 2014). The indication that poaching was low when perimeters were alongside roads with settlements suggests an acknowledgement of the risk of being seen entering or leaving a property. Martin and Vigne (2003) found greater risks in areas with roads and agricultural settlements, but the reserve where their research was conducted was mostly surrounded by other wilderness areas and so it may be that roads with agricultural settlements were the only points of access to that property.

Categories of poached rhinos

We found no indication that specific categories of rhinos are targeted preferentially by poachers. Whilst Knight et al. (2015) suggest that white rhinos make up 95% of poached rhinos (greater than their population contribution), and Milliken and Shaw (2012) suggest they are over-represented in the poaching statistics, we found no evidence to support that. Contrary to our initial hypothesis, the heavier horn of white rhino (Martin and Vigne, 2003) appeared to be irrelevant to poachers when selecting a target. There also appeared to be no indication of selection of heavier horned (Pienaar et al., 1991) males over females, also contrary to our initial hypothesis. This apparent lack of selection towards larger-horned targets is in accordance with the assertion by Lee and Roberts (2016) that rational poachers do not poach selectively. Poachers are opportunistic; poaching animals they encounter, rather than directly targeting individuals (Milner-Gulland and Leader-Williams, 1992). Whilst the presence of an individual with a large horn may entice poachers onto a property, there is no evidence to suggest that animal would be more likely to be targeted by a poacher than any other on the property. Berger et al. (1993) also found no evidence of discrimination by poachers between larger and smaller horned individuals of black rhinos in Namibia during the early 1990s, suggesting that this aspect of poacher behaviour has not varied over time.

Our finding that calves were poached in proportion to their abundance in the population was unexpected. The South African Department of Environmental Affairs (DEA, 2015) states that poachers target adults and leave the calves, but the data analysed here suggest that calves are targeted as any other rhino. Many of the poaching reports noted that dependent calves were rescued, indicating that not all poachers will target them, yet many poachers are clearly targeting even the small mass of horn that can be obtained from a calf. The large number of pregnancies lost, combined with orphaned calves which subsequently died and the lost reproductive potential from poached females suggest that the future impacts of current rhino poaching levels may not be fully represented by looking purely at deaths. Given that birth and death rates of white rhinos are associated with both density and rainfall (Ferreira et al., 2015) management of rhino populations in light of poaching must consider wider demographic factors, especially this potential loss of future reproduction.

Dehorning

At least five of the poached rhinos in our study had been recently dehorned. As discussed above, the presence of a large-horned individual may encourage poachers onto a property and so dehorning may seem prudent. However, the results presented here indicate that individuals are not directly targeted, and so selective dehorning of individuals may not be effective. Several others were poached after permit applications to dehorn them had been made (as noted in some media reports). Damania and Hatch (2005) suggest that salaried staff members, where income is not dependent upon performance, have no incentives not to accept bribes from poachers and it may be the case that this relates not only to reserve workers, but also potentially to those involved in production of dehorning permits. Poachers are known to take dehorned animals (Berger et al., 1993), but the suggestion that there may be an aspect of corruption in the process of securing permits to dehorn, leading to properties due to dehorn being specifically targeted, has, as far as we are aware, not been thoroughly researched. This potential is however out with the scope of this current study.

Conclusions

Rhino poachers do not appear to show strong weekly or monthly trends in their poaching activities but are more likely to poach at night and particularly during a full moon. There is a suggestion that poachers may be more likely to poach during the weekend (Friday-Sunday) rather than during the week. However, given this trend was only found for 2017, we recommend further research to identify whether this is a continuing pattern. Animals are potentially more vulnerable to poaching when they are in close proximity to the perimeter of a property, particularly if a road adjoins the property at that point. Anti-poaching efforts may therefore be more effectively targeted during the hours between dusk and dawn, especially on nights when the moon is full and between Friday and Sunday. Targeted protection along the perimeters of reserves would also be prudent. Whilst we have identified some specific times when rhino poaching on private land may be more likely, it is important to note that outside of these times, even though poaching is less likely, it is not rare. Targeted anti-poaching actions are unlikely to eliminate the threat of rhino poaching, but on properties where anti-poaching strategies and/or funds are limited, it may be more effective to prioritise periods which fit this profile.

Our results suggest that poachers do not appear to target specific categories of rhinos and so we do not believe that any individuals should be considered more at risk than others. Whilst we acknowledge that the presence of large-horned individuals may entice poachers to enter a property, there is no evidence to suggest they will bypass alternative targets in efforts to pursue specific individuals. We suggest that the collateral deaths of calves orphaned by poaching and those lost in utero be clearly identified within the official poaching statistics to ascertain a full understanding of the potential future impact of poaching on rhino populations.

Acknowledgements

The authors would like to thank the private rhino owners who provided information on their rhinos and Joana Cruz and Anna Riach for statistical advice. We also thank the anonymous reviewers who provided valuable comments on previous drafts of this work. This research did not receive any specific funding.

References

Austin, K. L. (2019). *Follow the guns: An overlooked key to combat rhino poaching and wildlife crime.* [Online] Conflict Awareness Project. Available at: www.followtheguns.org [Accessed 24 April 2019].

Balfour, D., Knight, M. and Jones, P. (2015). *Status of white rhino on private and communal land in South Africa: 2012 - 2014*. Pretoria: Department of Environmental Affairs.

Barichievy, C., Munro, L., Clinning, G., Whittington-Jones, B. and Masterson, G. (2017). Do armed field-rangers deter rhino poachers? An empirical analysis. *Biological Conservation*, 209, 554-560.

Beale, C. M., Hauenstein, S., Mduma, S., Frederick, H., Jones, T., Bracebridge, C., Maliti, H. and Kohi, E. M. (2018). Spatial analysis of aerial survey data reveals correlates of elephant carcasses within a heavily poached ecosystem. *Biological Conservation*, 218, 258-267.

Berger, J., Cunningham, C., Gawuseb, A. A. and Lindeque, M. (1993). "Costs" and short-term survivorship of hornless black rhino. *Conservation Biology*, 7, 920-924.

Brack, D. (2002). Combatting international environmental crime. *Global Environmental Change*, 12, 143-147.

Bulte, E. H. and van Kooten, G. C. (1999). Economic efficiency, resource conservation and the ivory trade ban. *Ecological Economics*, 28, 171-181.

Cheteni, P. (2014). An analysis of antipoaching techniques in Africa: a case of rhino poaching. *Environmental Economics*, 5, 63-70.

Critchlow, R., Plumptre, A. J., Driciru, M., Rwetsiba, A., Stokes, E. J., Tumwesigye, C., Wanyama, F. and Beale, C. M. (2015). Spatiotemporal trends of illegal activities from ranger-collected data in a Ugandan National Park. *Conservation Biology*, 29, 1458-1470.

Damania, R. and Hatch, J. (2005). Protecting Eden: markets or government? *Ecological Economics*, 53, 339-351.

Department of Environmental Affairs (DEA) (2016). *CITES CoP17 Conference in South Africa: Colloquium on preparations, with Minister in attendance. Committee*

meeting summary. 13 September 2016 [Online]. Parliamentary Monitoring Group. Available at: https://pmg.org.za/committee-meeting/23252 [Accessed 04 June 2019].

Duffy, R. (2014). Waging a war to save biodiversity: the rise of militarized conservation. *International Affairs*, 90, 819-834.

Emslie, R. H., Milliken, T., Talukdar, B., Ellis, S., Adcock, K. and Knight, M. H. (2016). *African and Asian rhinoceroses - status, conservation and trade. A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf. 9.14* (Rev. CoP15). Report to CITES 16th meeting (Johannesburg, September-October 2016), CoP 17 Doc.68 annex 5: 1-21. Geneva: CITES Secretariat.

Emslie, R. H., Milliken, T., Talukdar, B., Burgess, G., Adcock, K., Balfour, D. and Knight, M. H. (2019). *African and Asian rhinoceroses - status, conservation and trade: A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf. 9.14 (Rev. CoP17) (No. CoP18 Doc. 83.1 Annex 2)*. Geneva: CITES Secretariat.

Ferreira, S. M. and Okita-Ouma, B. (2012). A proposed framework for short-, medium- and long-term responses by range and consumer states to curb poaching for African rhino horn. *Pachyderm*, 51, 52-59.

Ferreira, S. M., Pfab, M. and Knight, M. (2014). Management strategies to curb rhino poaching: Alternative approaches using a cost-benefit approach. *South African Journal of Science*, 110, 1-8.

Ferreira, S. M., Greaver, C., Knight, G. A., Knight, M. H., Smit, I. P. J. and Pienaar, D. (2015). Disruption of rhino demography by poachers may lead to population declines in Kruger National Park, South Africa. *PLoS One*, 10, e0127783.

Gore, M. L. (2011). The science of conservation crime. *Conservation Biology*, 25 (4), 659-661.

Gwin, P. (2012). Rhino Wars. *National Geographic*, 106-125.

Haines, A. M., Elledge, D., Wilsing L. K., Grabe, M., Barske, M. D., Burke, N. and Webb, S. L. (2012). Spatially explicit analysis of poaching activity as a conservation management tool. *Wildlife Society Bulletin*, 36, 685-692.

Jones, P. (2013). *Rhino economics role of the private sector*. Speech to 16th CITES CoP, Bangkok.

Kahler, J. S. and Gore, M. L. (2012). Beyond the cooking pot and pocket book: Factors influencing noncompliance with wildlife poaching rules. *International Journal of Comparative and Applied Criminal Justice*, 36, 103-120.

Knight, M. H. (2017). African Rhino Specialist Group report. *Pachyderm,* 58, 17-35.

Knight, M. H., Emslie, R. H., Smart, R. and Balfour, D. (2015). *Biodiversity management plan for the white rhinoceros (Ceratotherium simum) in South Africa 2015-2020*. Pretoria: Department of Environmental Affairs.

Kock, R., Amin, R. and Subedi, N. (2008). Postscript: Rogue Army staff involved in poaching in Bardia National Park, Nepal, 2007-2008. *Pachyderm*, 45, 115-116.

Koen, H., de Villiers, J. P., Roodt, H. and de Waal, A. (2017). An expert-driven causal model of the rhino poaching problem. *Ecological Modelling*, 347, 29-39.

Langholz, J. (1996). Economics, objectives and successes of private nature in sub-Saharan reserves Africa and Latin America. *Conservation Biology*, 10, 271-280.

Lee, D. E. and Du Preez, M. (2016). Determining visitor preferences for rhinoceros conservation management at private, ecotourism game reserves in the Eastern Cape Province, South Africa: A choice modelling experiment. *Ecological Economics*, 130, 106-116.

Lee, T. E. and Roberts, D. L. (2016). Devaluing rhino horn as a theoretical game, *Ecological Modelling*, 337, 73-78.

Lemieux, A. M. (Ed.) (2014). *Situational Prevention of Poaching*. Abingdon: Routledge.

Li, Y., Guo, Z., Yang, Q., Wang, Y. and Niemelä, J. (2003). The implications of poaching for giant panda conservation. *Biological Conservation*, 111, 125-136.

Lunstrum, E. (2014). Green militarization: Anti-poaching efforts and the spatial contours of Kruger National Park. *Annals of the Association of American Geographers*, 104, 816-832.

Maciejewski, K., Baum, J. and Cumming, G. S. (2016). Integration of private land conservation areas in a network of statutory protected areas: Implications for sustainability. *Biological Conservation*, 200, 200-206.

Martin, E. B. (1992). The poisoning of rhinos and tigers in Nepal. *Oryx*, 26, 82-86.

Martin, E. B. (1996a). The importance of park budgets, intelligence networks and competent management for successful conservation of the greater one-horned rhinoceros. *Pachyderm*, 22, 10-17.

Martin, E. B. (1996b). Smuggling routes for west Bengal's rhino horn and recent successes in curbing poaching. *Pachyderm*, 21, 28-34.

Martin, E. and Vigne, L. (2003). Trade in rhino horn from eastern Africa to Yemen. *Pachyderm*, 34, 75-87.

Metzger, K. L., Sinclair, A. R. E., Campbell, K. L. I., Hilborn, R., Hopcraft, J. G. C., Mduma, S. A. R. and Reich, R. M, (2007). Using historical data to establish baselines for conservation: The black rhinoceros (*Diceros bicornis*) of the Serengeti as a case study. *Biological Conservation*, 139, 358-374.

Milliken, T. and Shaw, J. (2012). *The South Africa – Viet Nam rhino horn trade nexus: A deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates*. Johannesburg: TRAFFIC.

Milner-Gulland, E. J. and Leader-Williams, N. (1992). A model of incentives for the illegal exploitation of black rhinos and elephants: poaching pays in Luangwa Valley, Zambia. *Journal of Applied Ecology*, 29, 388-401.

Moreto, W. D. (2019). Provoked poachers? Applying a situational precipitator framework to examine the nexus between human-wildlife conflict, retaliatory killings and poaching. *Criminal Justice Studies*, 32, 63-80.

Mulero-Pázmány, M., Stolper, R., van Essen, L. D., Negro, J. J. and Sassen, T. (2014). Remotely piloted aircraft systems as a rhinoceros anti-poaching tool in Africa. *PLoS ONE*, 9, e83873.

Pienaar, D. J., Hall-Martin, A. J. and Hitchens, P. M. (1991). Horn growth rates of free-ranging white and black rhinoceros. *Koedoe*, 34, 97-105.

Rashidi, P., Wang, T., Skidmore, A., Mehdipoor, H., Darvishzadeh, R., Ngene, S., Vrieling, A. and Toxopeus, A. G. (2016). Elephant poaching risk assessed using spatial and non-spatial Bayesian models. *Ecological Modelling*, 338, 60-68.

Ratcliffe, J. H. (2004). The hotspot matrix: a framework for the spatial-temporal targeting of crime reduction. *Police Practice and Research*, 5, 5-23.

Rhino Alive (2018). *South Africa: National rhino poaching statistics - detailed analysis of the 2017 statistics* [Online] Rhino Alive. Available at: https://www.facebook.com/RhinoAlive/photos/a.455648507965862/745294002334643/?type=3&theater [Accessed 04 June 2019].

Saving the Survivors (2015). *Things you never knew about poaching statistics* [Online] Saving the Survivors. Available at: https://www.facebook.com/savingthesurvivors/photos/a.727427787298531/918972144810760/?type=3 [Accessed 04 June 2019].

Selier, J. (2019). *Supplemental information in support of the CITES CoP18 proposal to amend South Africa's export quota for black rhinoceros hunting trophies.* (*No. CoP18 Inf. 78)*. Geneva: CITES Secretariat.

Thompson, S., Avent, T. and Doughty, L. S. (2016). Range analysis and terrain preferences of adult white rhinoceros (*Ceratotherium simum*) in a South African private game reserve: Insights into carrying capacity and future management. *PLoS ONE*, 11, e0161724.

Walpole, M. J., Morgan-Davies, M., Milledge, S., Bett, P. and Leader-Williams, N. (2001). Population dynamics and future conservation of a free-ranging black rhinoceros (*Diceros bicornis*) population in Kenya. *Biological Conservation*, 99, 237-243.

Wato, Y. A., Wahungu, G. M. and Okello, M. M. (2006). Correlates of wildlife snaring patterns in Tsavo West National Park, Kenya. *Biological Conservation*, 432, 500-509.

Watson, F., Becker, M. S., McRobb, R. and Kanyembo, B. (2013). Spatial patterns of wire-snare poaching: Implications for community conservation in buffer zones around National Parks. *Biological Conservation*, 168, 1-9.

Wellsmith, M. (2011). Wildlife crime: The problems of enforcement. *European Journal on Criminal Policy and Research*, 17, 125-148.

Western, D. (1982). Patterns of depletion in a Kenya rhino population and the conservation implications. *Biological Conservation*, 24, 147-156.

Chapter 5: Hotspot analysis of risk factors associated with rhino poaching on private land

Abstract

Understanding hotspots of rhino poaching on private land may provide useful data for enforcement agencies targeting rhino poachers. This research investigates spatial trends of rhino poaching across South Africa from 2003 to 2017, utilising mainstream and social media reports of poaching events. Potential socio-economic risk factors were taken from 2011 census data at municipal level. Hotspot analysis indicated poaching is low within the Northern Cape and Western Cape, with hotspots in Limpopo, North West, KwaZulu-Natal and Eastern Cape, although poaching is not evenly distributed within provinces.

Areas in close proximity to state or provincial parks holding rhinos, international airports and large towns and cities were generally found to be most at risk of poaching events. Within the Eastern Cape, poaching is heavily concentrated around Port Elizabeth. Socio-economic factors were most heavily linked to poaching in KwaZulu-Natal, where there were significant links between poaching and unemployment and low engagement in formal education.

These results indicate that privately-owned rhinos in some areas are at high risk of being poached and suggest that enforcement activities targeting rhino poachers should be a priority in these areas. Given the associations between rhino poaching and education and employment in KwaZulu-Natal, increased government and private sector support for education and employment prospects within this province may help to reduce rhino poaching.

Keywords: social media research; hotspot analysis; South Africa

Introduction

With around 22% of all rhino poaching in South Africa occurring on private land (Rhino Alive, 2018) and 25% of the national herd of black (*Diceros bicornis*) and 45% of white rhinos (*Ceratotherium simum simum*) in private hands (Emslie et al., 2019), poaching of privately-owned rhinos represents a sizeable threat to the future of rhino populations within South Africa. Poaching has increased substantially since 2007 with rhino horn estimated to be worth more than gold or cocaine on the black market (Massé and Lunstrum, 2016). Such a valuable commodity is a clear target for

organised crime and so this work aims to assess hotspots of poaching activities that could assist in tackling such poaching on private land.

This work utilises the principles of hotspot analysis widely used in criminal research and applies them specifically to the case of poaching of rhinos on private land in South Africa. Investigating hotspots of criminal activity through spatial analysis is an emerging field of research, with much of the focus on neighbourhood crime (Rummens et al., 2017; Sadler et al., 2017; Twinham, 2017; Wang et al., 2013), but a focus on wildlife poaching is also emerging (Beale et al., 2018; Rashidi et al., 2015; 2016; Critchlow et al., 2015; Piel et al., 2015; Sharma et al., 2014; Haines et al., 2012). Whilst Koen at al. (2017) investigated rhino poaching within Kruger National Park, as far as we are aware, this is the first time efforts have been made to investigate hotspots of rhino poaching on private land across the whole of South Africa.

Alongside mapping general patterns of poaching across South Africa, we also aim to investigate risk factors which may contribute to these patterns. In particular, we consider proximity to state and provincially-owned rhino populations as well as ease of trafficking horn from where it was poached to where it can leave South Africa, via transport infrastructure such as roads, seaports or international airports. In attempting to understand socio-economic impacts on rhino poaching, we also investigate individual municipalities to identify socio-economic factors which are associated with higher risk to privately owned rhino populations. Identifying hotspots at the scales utilised here allows for effective targeting of enforcement action.

As rhino poaching has increased over time and threats have spread across provinces (DEA, 2014), it is important to understand how potential risk factors have changed at a local level. For example, Massé and Lunstrum (2016) have noted the exceptionally high levels of poaching within Kruger National Park, and poachers in the vicinity of the park may move beyond its boundaries to target privately owned animals in the region. Similar spill-over poaching pressures may apply to other state or provincial reserves holding rhinos. Failure to acknowledge the changing space-time dynamics of crime and its contributory local risk factors, may lead to ineffective management decisions and allow more crime to occur (Wellsmith, 2011; Pressey at al., 2007).

Whilst some prior research on elephants (Rashidi et al., 2016) found no correlation between poaching and proximity to roads, other authors have found that areas of reserves alongside roads are the most vulnerable areas (Martin and Vigne, 2003) and have suggested that roads are important for ease of access and escape for poachers (Moneron et al., 2017; Haines et al., 2012; Swanepoel, 1998). Proximity to such access points is often considered in hotspot analysis of poaching (Aziz et al., 2017; Rashidi et al., 2016; Martin and Vigne, 2003). It has also been suggested that areas in close proximity to cities and mines (du Toit, 1998) are more at risk of rhino poaching.

OR Tambo International Airport, Johannesburg, has been acknowledged by the South African Department of Environmental Affairs (DEA, 2018; DEA, 2016; DEA, 2015) as the main exit point for rhino horn leaving South Africa, alongside King Shaka International Airport (DEA, 2016), with a TRAFFIC study concluding that transport by air is the most common method of removing horn from South Africa (Moneron et al., 2017). In contrast, a study of rhino horn sellers in Vietnam found that most horn is shipped by sea (Crosta et al., 2017), which was also noted to be a means of transporting horn in the TRAFFIC study (Moneron et al., 2017). In attempting to understand spatial trends in rhino poaching it is therefore important to consider proximity to seaports, airports and to roads leading to Johannesburg, or indeed out of South Africa.

Since it has been stated that rhino poachers are usually local people (Rubino and Pienaar, 2017; Warchol et al., 2003; Swanepoel, 1998) from rural settlements (du Toit, 1998), understanding the socio-economic environment of the local area is vital in determining factors which may contribute to increased rhino poaching. Local human populations are often considered in poaching analysis, with Brashares et al. (2011) finding strong links between socio-economic factors and the consumption of bushmeat and Kühl et al (2009) finding links between poverty and unemployment and saiga (*Saiga tatarica*) poaching. Whilst we acknowledge that individuals will have specific motivations driving them towards rhino poaching, the socio-economic environment of the local community is likely to impact upon these individuals (Mackenzie and Hartter, 2013). Understanding the socio-economic factors that contribute to poaching is therefore essential in effectively tackling the problem (Critchlow et al., 2015; Humphreys and Smith, 2014).

Using the principles devised by Piel et al. (2015) in their study on the spatial distribution of snares, and De Valck et al. (2016) researching outdoor recreation preferences and substitutability of nature areas, we undertake kernel density analysis of rhino poaching events on private land across South Africa between 2003 and 2017 to identify hotspots of rhino poaching activity. This provides vital information for tackling rhino poaching on private land and highlights priority areas for action that may be dissimilar to those on state or provincial land. We also investigate proximity to other factors that may indicate higher risk (state or provincial parks holding rhinos, international airports, major roads, cities, mines and seaports) and investigate the socio-economic conditions in areas identified as poaching hotspots. Our study provides evidence that can contribute to the effective policing of poaching events and trafficking of rhino horn out of South Africa, and in identifying the human factors that contribute to rhino poaching.

Methods

Data collection

The data utilised in this chapter, were collated from the same database as described in Ch. 4.

Reports directly from private rhino owners and from a combination of mainstream (national newspaper websites) and social media sources were combined to produce a database of rhino poaching incidents. Private rhino owners provided details of all previous poaching events on their properties, comprising a total of 48 rhinos poached and providing the earliest report in the data set (2003). Social media pages and groups were selected to be as representative as possible and covered both poaching at both national (nine sources) and provincial (ten sources covering all provinces except Free State, Northern Cape and Western Cape) levels. Social media sources represented private rhino owner groups, anti-poaching groups, citizen engagement groups and a number of organisations involved in the rescue and rehabilitation of wounded rhinos and orphans. For security reasons, the mainstream and social media (Facebook) sources utilised will remain confidential. All possible efforts were made to ensure reports were not duplicated and that only events which occurred on private land were recorded. The co-ordinates of properties where

poaching events occurred were recorded, or of the nearest town if only that information was provided. If more than one animal was poached in an incident, the event was recorded only once to avoid pseudo-replication of results. Subsequent poaching events on the property were recorded as additional data points with a different set of co-ordinates within the property boundary or local town. The final dataset comprised 473 poaching events between 2003 and 2017, covering all provinces of South Africa. All events reported as poaching events were recorded, regardless of whether the animal survived or not and whether the horns were removed or not.

Very few poaching events were recorded across the time frame (2003-2017) from Mpumalanga (n=16). Data from Balfour et al. (2015) and Rhino Alive (2018) indicated high poaching levels in Mpumalanga suggesting that this province was under-represented in this dataset. To avoid drawing conclusions from an incomplete and potentially unrepresentative sample, the events that were recorded from Mpumalanga were not included in any analysis.

Hotspot analysis

Of the 473 poaching events recorded, 215 locations were identified for hotspot analysis. Events were discarded if the location could not be identified accurately (to at least the municipality level). The 215 records were divided into six temporal groups, of approximately 35, with total poaching figures of around 1,000 in each temporal group (2003-2011: 1,086, 2012: 668, 2013-2014: 2,219, 2015: 1,175, 2016: 1,054 and 2017: 1,028). Poaching records for 2003 to 2011, and 2013 to 2014 were combined due to small data sets available for each year individually. The first group consisted of 42 locations between 2003 and 2011, the second 31 locations from 2012, the third 39 locations from 2013 and 2014, the fourth 37 locations from 2015, the fifth 35 locations from 2016 and the final group consisted of 31 locations from 2017. These temporal groups were used to produce maps of poaching hotspots, across grid cells of half a degree of latitude (approximately 55.5 x 55.5 km) over the whole of South Africa. We opted for half a degree (approximately 3,080.25 km^2) as it was broadly in line with the median size of the municipalities of South Africa (3,738.5 km^2, range: 236-44,231 km^2). All grid cells outside the terrestrial borders of South

Africa were excluded (n=503), as were those located within Mpumalanga (n=30), leaving 419 grid cells for analysis.

To visualise spatial patterns in poaching events on private land, we produced kernel density maps in R. Kernel density estimation utilised the point data from each poaching event to produce smoothed maps of poaching density across South Africa to identify hotspots of poaching activity within each temporal group. Kernel density estimation allocates each cell a value relative to every other cell (the relative poaching score). By converting the maps into raster data, we were able to determine the relative poaching score of each grid cell across the time frame. We also produced a map identifying hotspots across the entire time period, by combining all of the data from the different temporal groups.

From the map covering the entire time period, the relative poaching scores were used as a proxy for poaching risk in each cell for the further analysis described below. The relative poaching scores were plotted and formed three clear groups, defined as those of low poaching risk (n=316), medium poaching risk (n=60) and high poaching risk (n=43) (Fig. 5.1) Kruskal-Wallis analysis (H=237.02, n=419, p<0.001) and post-hoc Mann-Whitney testing (low: medium U=-188.00, p<0.001; medium: high U=51.50, p=0.03) indicated significant differences between each level, confirming that they could be treated independently.

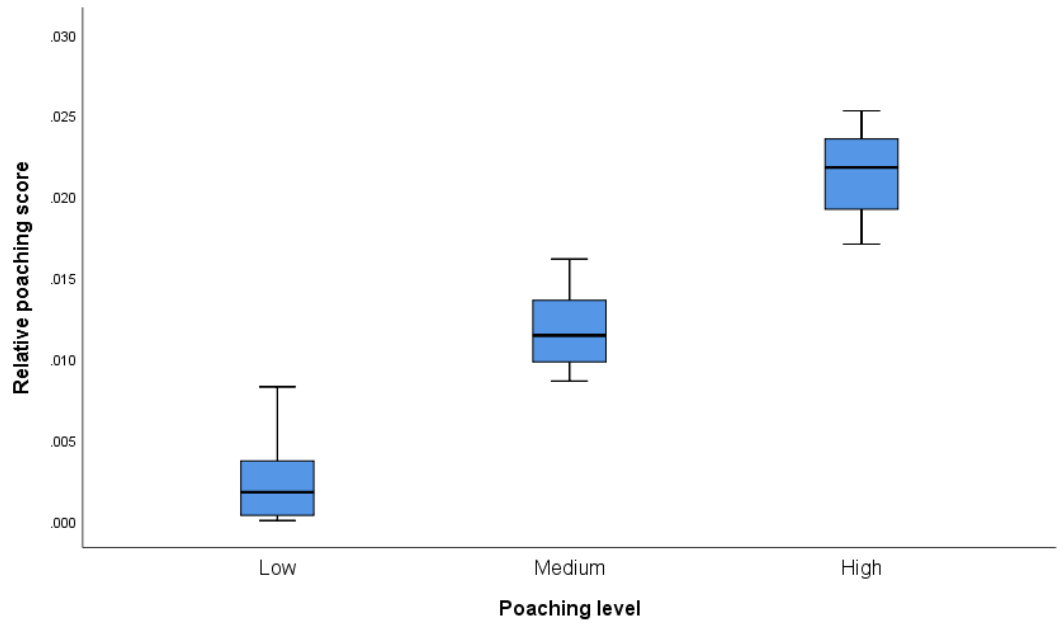

Figure 5.1: Boxplot of relative poaching scores for grid cells separated into low, medium and high poaching levels.

Proximity analysis

Using the co-ordinates of the grid cells, the proximity of each cell (measured in straight line distance) to the nearest state or provincial park that holds rhino, the nearest international airport, the nearest of the 15 largest (defined by population size) towns/cities, the nearest major seaport, the nearest mine and the nearest N road (national roads which connect major cities) were calculated (Fig. 5.2). Due to issues with transforming the data to fit the assumptions of multivariate analysis and several complexities created by the close proximity of some of the sites, it was not possible to conduct multivariate analysis on this dataset. Each proximity factor was therefore analysed separately, with results presented and discussed in light of other, potentially confounding proximity factors.

For each proximity factor, initial correlation (Pearson's or Spearman's dependent upon the normality of the data) was undertaken to identify any potential relationship between proximity to that factor and the relative poaching score of each grid cell. The distances were then arranged into groups according to the poaching level of the cell (low, medium or high) and any differences between the levels assessed using Kruskal-Wallis/ANOVA and post-hoc tests as appropriate according to the distribution of the data.

Proximity analysis was repeated using only the cells for four individual provinces (Eastern Cape, KwaZulu-Natal, Limpopo and North West) to assess any differences from the national picture. As all of the major mines are concentrated in Limpopo and North West, proximity to mines was analysed for these provinces only. As none of the cells within the North West or Limpopo are within 440 km of a seaport, proximity to seaports was not analysed for these provinces. Provincial analysis was not possible for the Western Cape or Northern Cape as all cells fell into the low risk category, or for the Free State (low poaching risk: n=42, medium poaching risk: n=3) and Gauteng (n=6) due to small sample size. Due to the number of tests conducted, we utilise a critical p-value of 0.01 to minimise the potential for type-1 errors.

Socio-economic analysis

Socio-economic data was only available at the municipality scale and so could not be reliably combined with the half-degree of latitude scale utilised for the proximity analysis.

The map collating all the poaching event data from 2003 to 2017 was used to allow comparisons between local and metropolitan municipalities across the entire time scale. Each half-degree of latitude grid cell was allocated to a specific municipality according to the location of its central point, providing the relative poaching score for that grid cell. Smaller municipalities, which did not cover a whole grid cell, were allocated the relative poaching score of the cell they were within. These relative poaching scores allowed the municipalities to be allocated poaching levels (low, medium, high) as described above. Especially large municipalities which contained more than one poaching level (n=11), were assigned a relative poaching score and poaching level for both groups. None of the municipalities covered all three poaching levels.

Socio-economic data were collated from the 2011 census of the South African population (Statistics SA, not dated). The risk factors explored were those likely to be associated with poverty and lack of opportunities; namely unemployment rate (%), youth unemployment rate (%), the percentage of people aged 20 and over with no formal schooling, the percentage of households which were agricultural, population density (people per km^2) and the mean number of people per household. Where municipalities have been combined since the 2011 census, data were combined. One municipality (Collins Chabane Local Municipality) was created by annexing parts of other municipalities. The census data for that municipality has therefore been left in the original ones. This left a total of 195 municipalities (plus 11 repeats as explained above) for analysis.

As with the proximity analysis, issues with sample size, transforming the data and collinearity of variables precluded the use of multivariate analysis. Each socio-economic factor was therefore analysed individually, with results presented and discussed in light of other, potentially confounding socio-economic factors. The correlation analysis of relative poaching scores, and ANOVA/Kruskal-Wallis or t-tests/Mann-Whitney U tests for differences between poaching levels described

above, were repeated for the socio-economic data, at both a national and provincial (Eastern Cape, KwaZulu-Natal, Limpopo and North West) level.

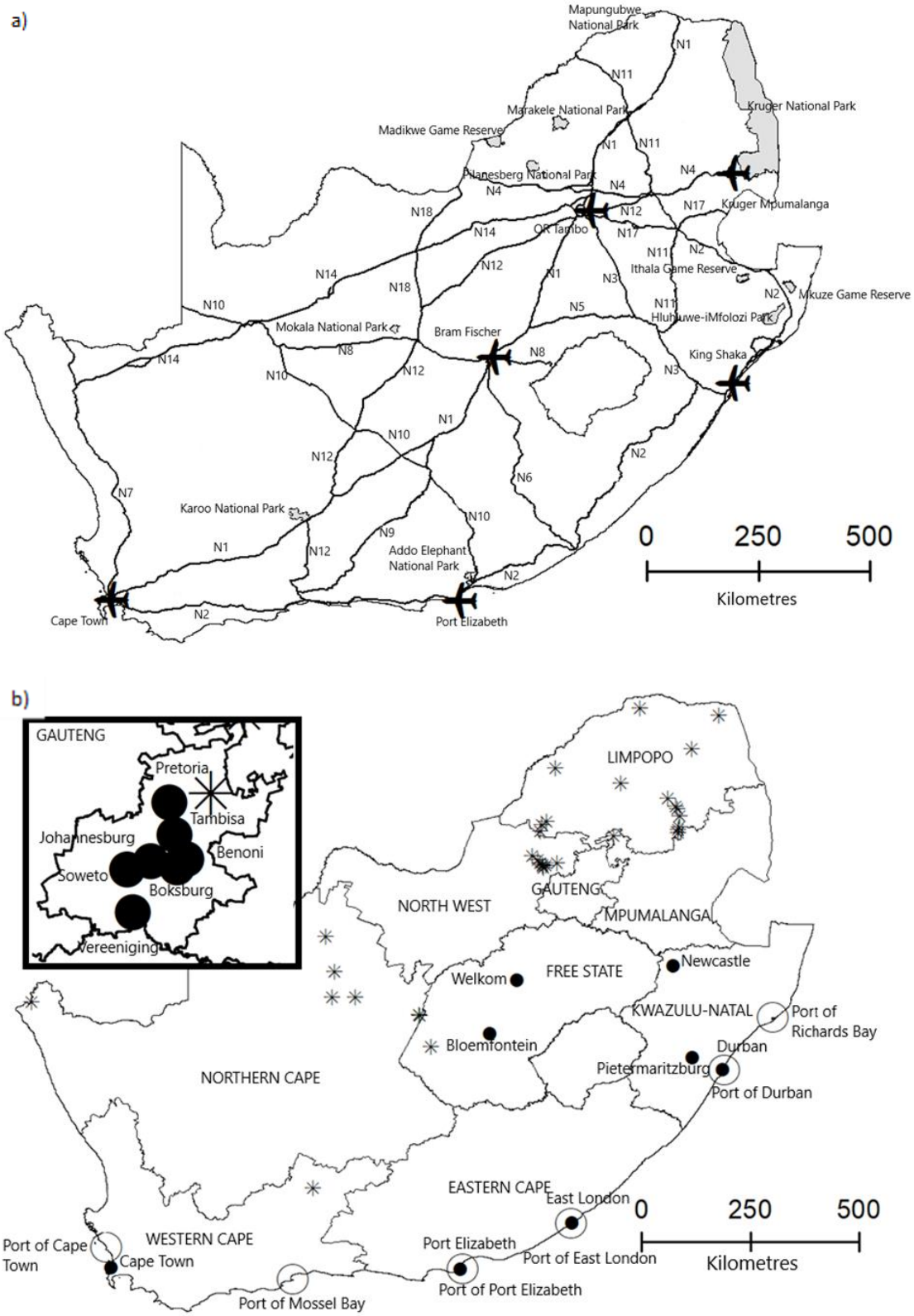

Figure 5.2: Map of South Africa with a) N roads, major national/provincial parks and international airports identified b) Provinces, mines (*), ports (○) and major towns/cities (●) identified. Due to the number of large cities/towns in Gauteng, the province is shown in the inset box in Fig. 5.2b.

Results

National poaching trends

Across the whole timescale of the analysis, poaching was concentrated in areas of Limpopo, North West, KwaZulu-Natal and Eastern Cape (Fig. 5.3). The most intense poaching was found in the north eastern areas of the North West province and the southern parts of Limpopo. North eastern KwaZulu-Natal and the southern central areas of the Eastern Cape were also heavily targeted. As time progressed, more poaching occurred in the Eastern Cape (particularly in 2015 and 2016) and the Free State than in earlier years. The Northern Cape and Western Cape showed the lowest levels of poaching across the timescale.

Across the country, relative poaching score showed a clear correlation with proximity to the nearest state or provincial park holding rhinos (r_S=-0.68, n=419, p<0.001: Fig. 5.4), with higher poaching found in areas closer to such parks (H=132.75, n=419, p<0.001). Post-hoc pairwise comparisons indicated that areas of low level poaching are significantly further away from these parks than areas of medium (p<0.001) and high (p<0.001) levels of poaching. There was no statistically significant difference between medium and high level poaching areas (p=0.82).

Correlations between relative poaching score and other proximity factors also indicated relationships, but it is likely that they were strongly influenced by the high number of grid cells with low levels of poaching. The analysis of differences between poaching levels indicated that there areas of higher poaching occur significantly closer to airports (H=52.81, n=419, p<0.001; Fig. 5.5a). Post-hoc pairwise comparisons indicated that areas of low level poaching are significantly further away from international airports than areas of medium (p<0.001) and high (p<0.001) levels of poaching. There was no statistically significant difference between medium and high level poaching areas (p=0.22). There is also higher poaching in areas closer to major towns/cities (H=30.36, n=419, p<0.001; Fig. 5.5b). Post-hoc pairwise comparisons indicated that areas of low level poaching are significantly further away from major towns/cities than areas of medium (p<0.001) and high (p<0.001) levels of poaching. There was no statistically significant difference between medium and high level poaching areas (p=0.90).

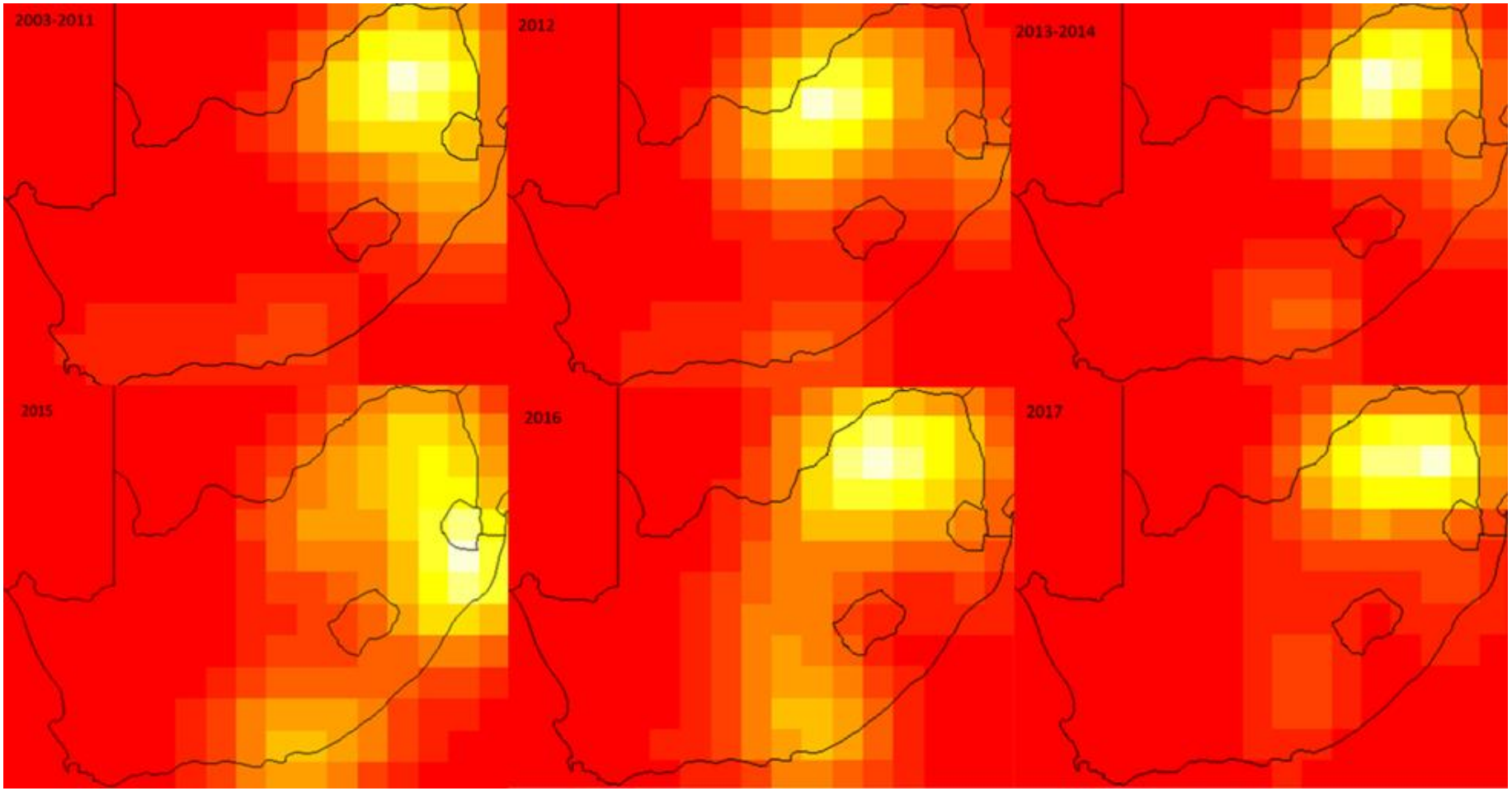

Figure 5.3: Hotspot maps of poaching activity on private land in South Africa, 2003-2017. Lighter areas correspond to increased rhino poaching on private land.

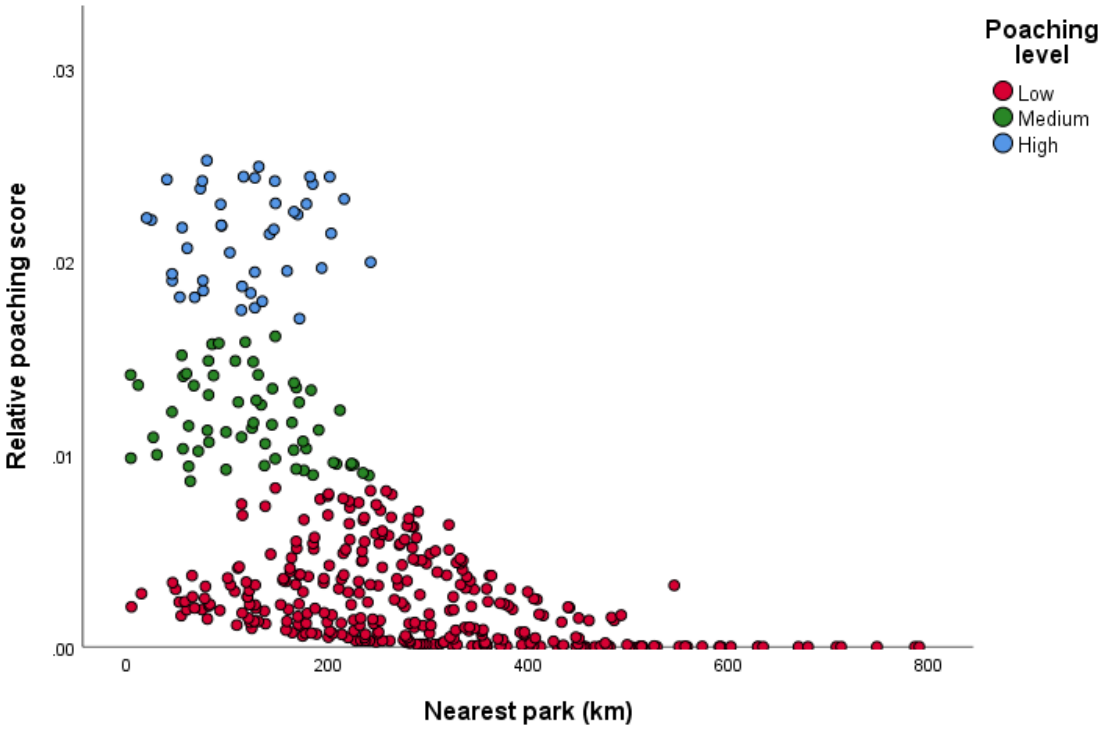

Figure 5.4: Scatterplot of correlation between relative poaching score and proximity to nearest state or provincial park holding rhinos

Poaching was found to be higher further away from the nearest seaport (H=38.19, n=419, p<0.001; Fig. 5.5c). Post-hoc pairwise comparisons indicated that areas of high level poaching are significantly further away from seaports than areas of medium (p<0.001) and low (p<0.001) levels of poaching. There was no statistically significant difference between medium and low level poaching areas (p=0.81).

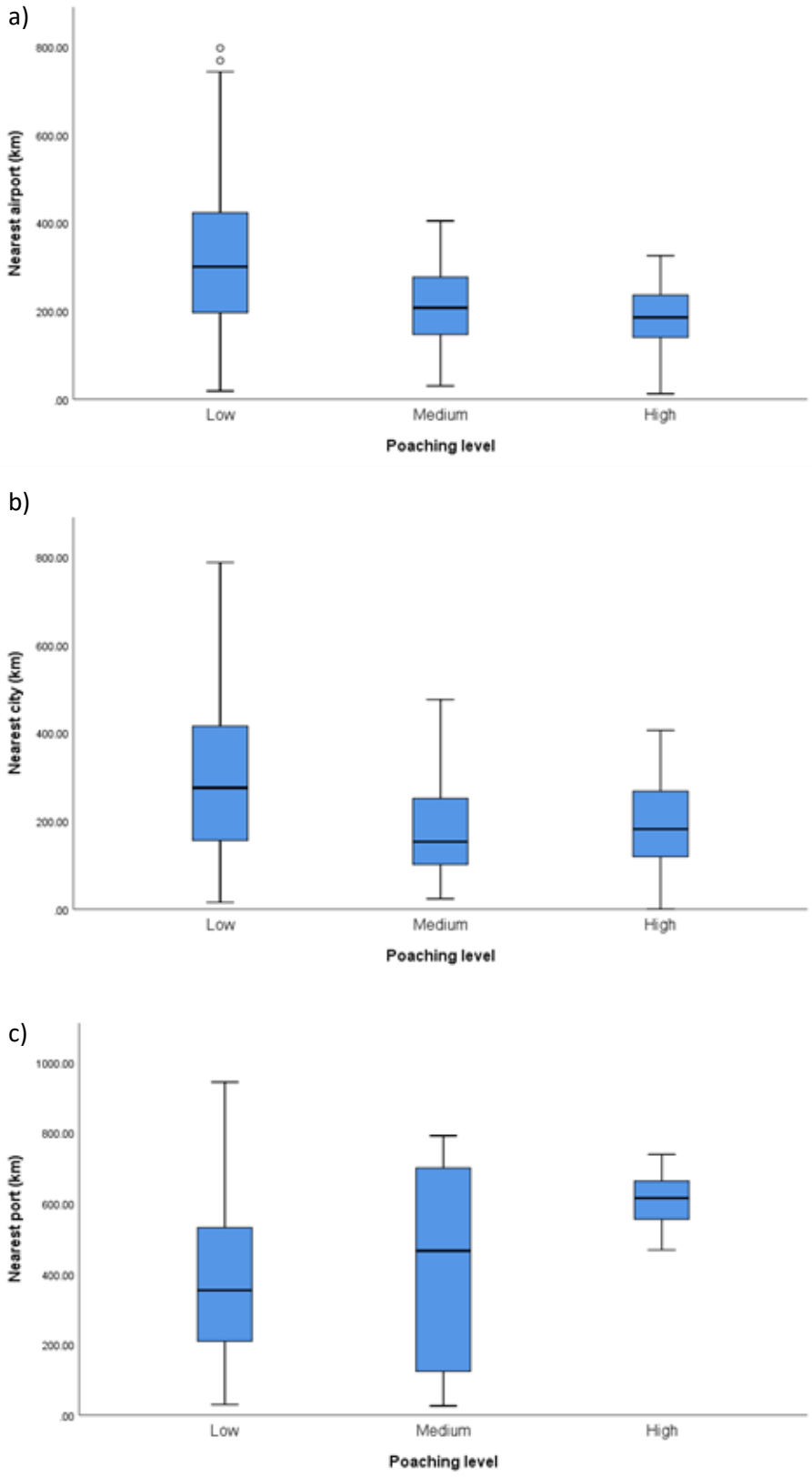

Figure 5.5: Boxplots of poaching levels and proximity to nearest a) international airport (with outliers highlighted) b) major city/town c) seaport

There were no significant correlations between relative poaching score and proximity to either roads or mines and there were no statistically significant differences in proximity to roads (H=0.69, n=419, p=0.71) and mines (H=0.11, n=419, p=0.15) between low, medium and high level poaching areas. Whilst poaching overall was not found to be linked to proximity to the nearest N road but was lower in the areas closest to the N7, N10 and N14 than in areas closer to many of the other roads (Fig. 5.6).

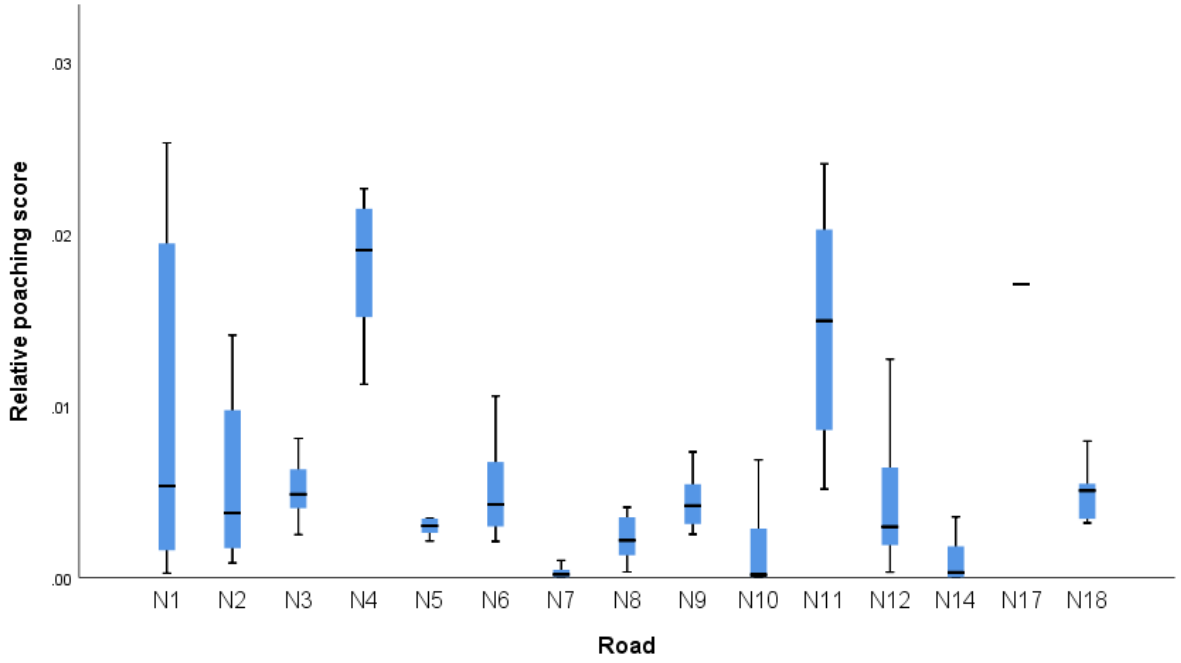

Figure 5.6: Poaching level in relation to the nearest N road

None of the socio-economic factors showed any clear correlations with relative poaching score nationally. Areas of higher population density were found to be areas of higher levels of poaching (H=31.67, n=206, p<0.001; Fig. 5.7a). Post-hoc pairwise comparisons indicated that areas of low level poaching have significantly lower population density than areas of medium (p<0.001) and high (p<0.001) levels of poaching. There was no statistically significant difference between medium and high level poaching areas (p=0.18). Both unemployment rate and youth unemployment rate were highest in areas of medium level poaching (Figs. 5.7b and 5.7c).

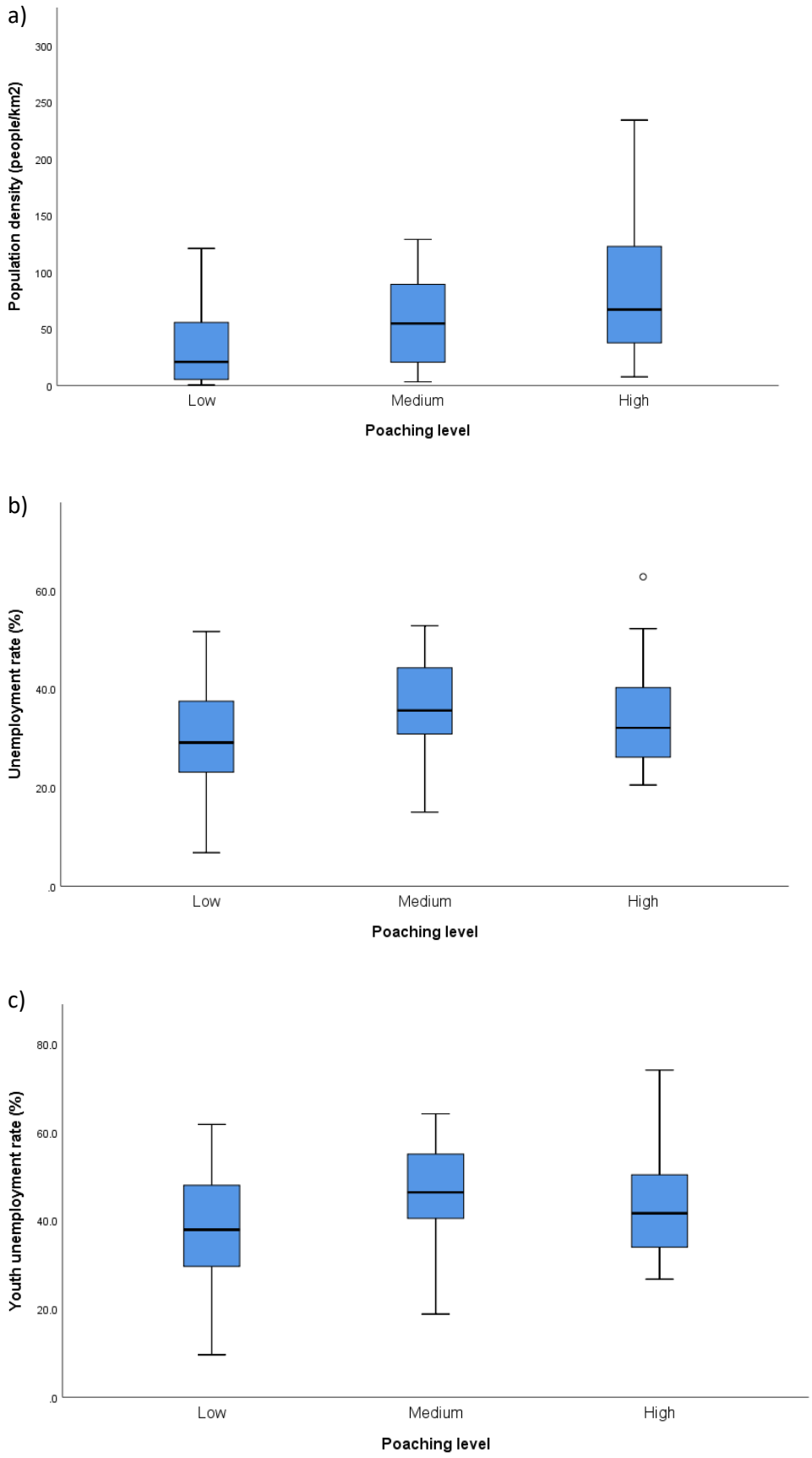

Figure 5.7: Boxplots of poaching levels and a) population density b) unemployment rate (with outlier highlighted) c) youth unemployment rate

Pairwise comparisons indicated that areas of low level poaching have significantly lower unemployment than areas of medium levels of poaching ($p=0.001$). There was no statistically significant difference between medium and high level poaching areas ($p=0.47$) or between low and high level poaching areas ($p=0.07$). For youth unemployment, pairwise comparisons indicated that areas of low level poaching have significantly lower youth unemployment than areas of medium levels of poaching ($p<0.001$). There was no statistically significant difference between medium and high level poaching areas ($p=0.49$) or between low and high level poaching areas ($p=0.04$). This pattern was also found for the percentage of people aged 20 and above with no formal schooling, but the differences were not statistically significant at $p=0.01$ ($H=8.80$, $n=206$, $p=0.012$).The percentage of agricultural households ($H=4.16$, $n=206$, $p=0.13$) and the number of people per household ($H=6.05$, $n=206$, $p=0.05$) showed no significant differences due to poaching level in the local area.

Provincial poaching trends

Eastern Cape

Poaching in the Eastern Cape was concentrated around Port Elizabeth, with clear correlation between relative poaching score and proximity to the airport ($r=-0.65$, $n=65$, $p<0.001$; Fig. 5.8a), and higher poaching found in areas closer to the international airport ($t=6.00$, $d.f.=63$, $p<0.001$). Proximity to the nearby national park also showed significant correlation with relative poaching score ($r=-.085$, $n=65$, $p<0.001$; Fig. 5.8b), with higher poaching found in areas closer to the park ($t=8.42$, $d.f.=50.19$, $p<0.001$).

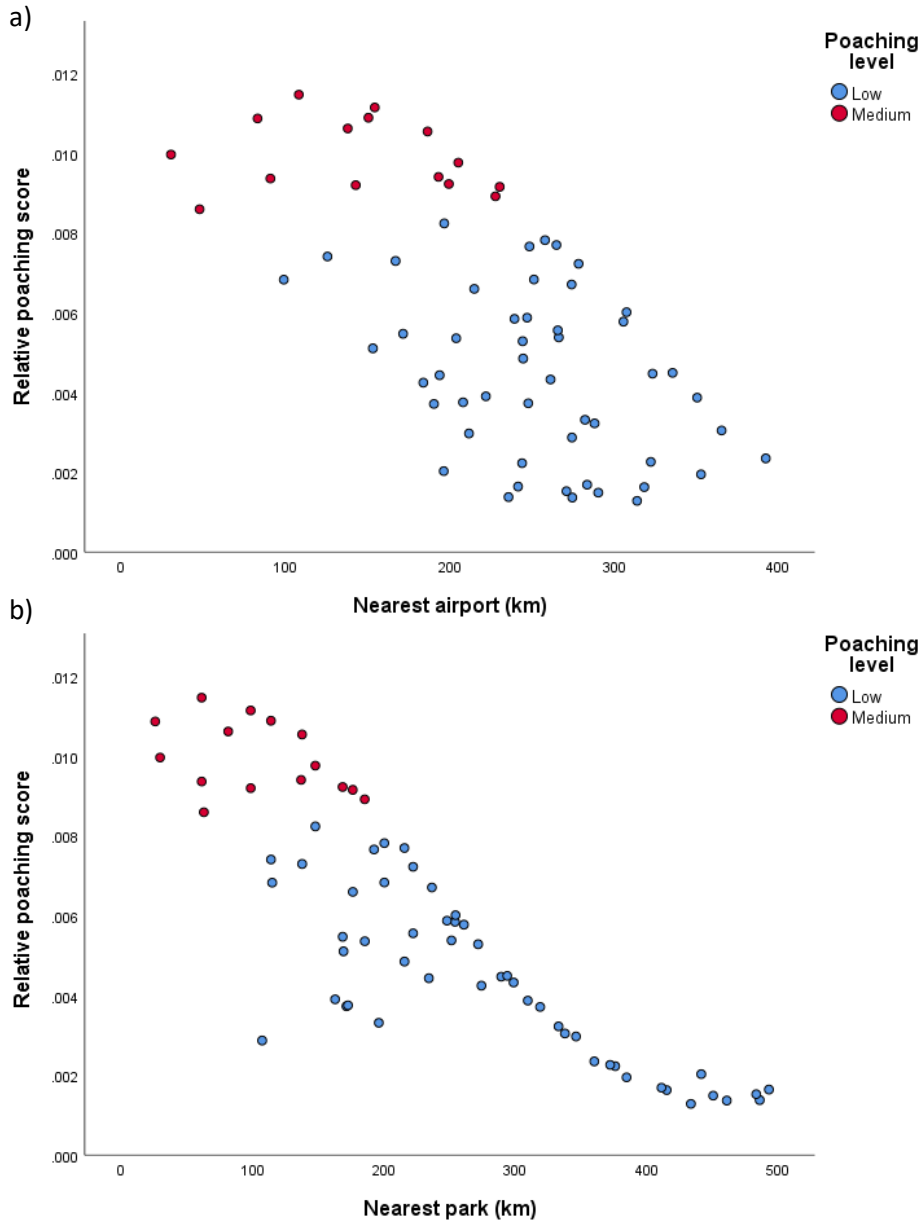

Figure 5.8: Scatterplots of correlation between relative poaching score and proximity to a) nearest international airport b) state or provincial park holding rhinos within the Eastern Cape

Correlations between relative poaching score and proximity to the seaport and nearest major town/city were less clear. However, analysis of differences between poaching levels did indicate that areas of higher poaching were significantly closer to the major town/city ($H=16.26$, $n=65$, $p<0.001$; Fig. 5.9a) and seaport ($H=-0.49$, $n=65$, $p<0.001$; Fig. 5.9b). There were no differences in proximity to the nearest road due to poaching level ($H=1.33$, $n=65$, $p=0.25$).

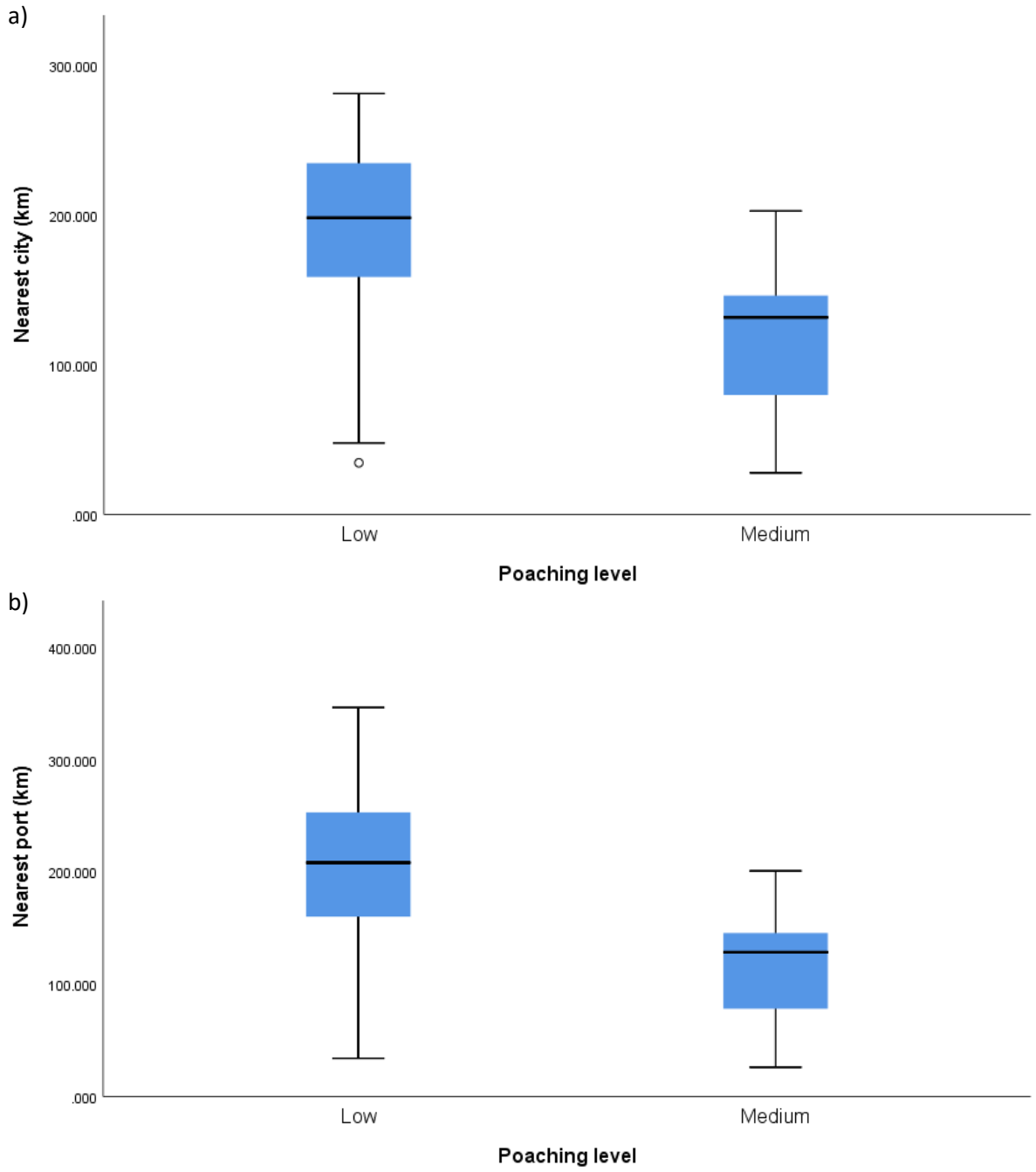

Figure 5.9: Boxplots of poaching levels within the Eastern Cape and proximity to nearest a) major town/city b) seaport

None of the socio-economic factors showed any clear correlations with relative poaching score within the Eastern Cape. There was no difference in population density due to poaching level in this province (U=83.0, n=34, p=0.26), nor where there any differences in unemployment rate (t=1.10, d.f.=32, p=0.28), youth unemployment rate (U=87.5, n=34, p=0.34) or the number of people per household

(U=53.0, n=34, p=0.02). In this province, poaching was higher in areas with a lower percentage of the population aged over 20 with no formal schooling (t=3.25, d.f.=32, p=0.003; Fig. 5.10a) and a lower percentage of agricultural households (U=40.0, n=34, p=0.004; Fig. 5.10b).

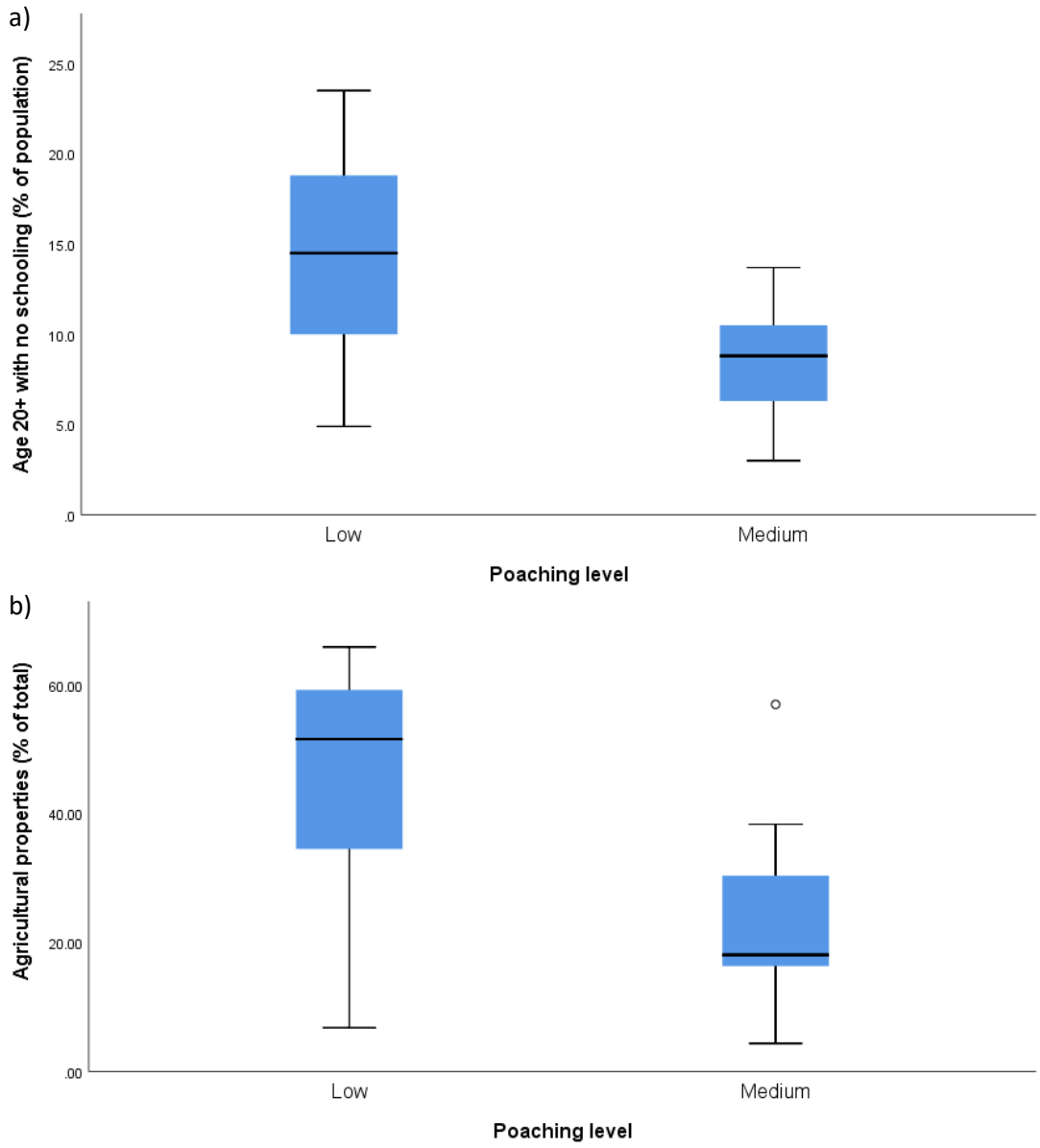

Figure 5.10: Boxplots of poaching levels within the Eastern Cape and a) percentage of the population aged 20 and above with no formal schooling b) percentage of properties which are agricultural (with outlier highlighted)

KwaZulu-Natal

In KwaZulu-Natal there was a clear correlations between relative poaching score and proximity to the nearest state/provincial park holding rhinos (r=-0.95, n=33, p<0.001; Fig. 5.11), with areas of high poaching being statistically significantly closer to such parks (t=8.14, d.f.=31, p<0.001).

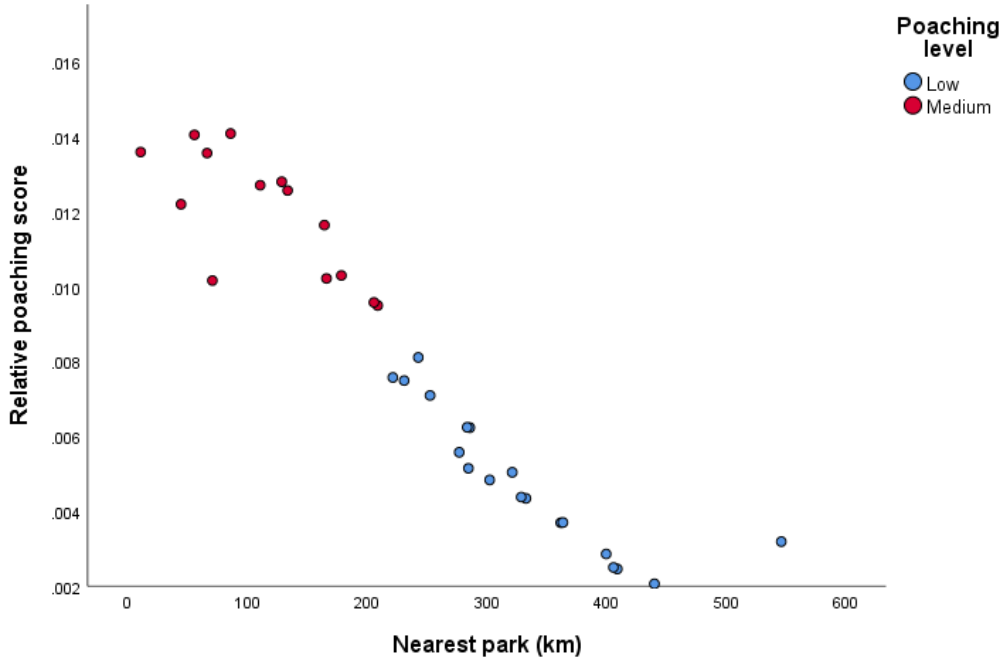

Figure 5.11: Scatterplot of correlation between relative poaching score and proximity to nearest state or provincial park holding rhinos in KwaZulu-Natal

Correlations between relative poaching score and proximity to the nearest major town/city were less clear, but analysis of differences between poaching levels did indicate that areas of high poaching were significantly closer to major towns/cities (t=-4.21, d.f.=18.89, p<0.001; Fig. 5.12).There was no correlation between relative poaching score and proximity to the nearest international airport (r=0.12, n=33, p=0.51), nor where there any differences in proximity due to poaching level (t=-0.83, d.f.=31, p=0.41). The same pattern was found when investigating proximity to the nearest seaport, which also showed no significant correlations (r=-0.36, n=33, p=0.04) and no difference in proximity due to poaching level (t=1.80, d.f.=31, p=0.08). Proximity to major roads also showed no correlation with relative poaching score (r_s=0.12, n=33, p=0.52) and no difference in proximity between poaching levels (U=165.0, n=33, p=0.26).

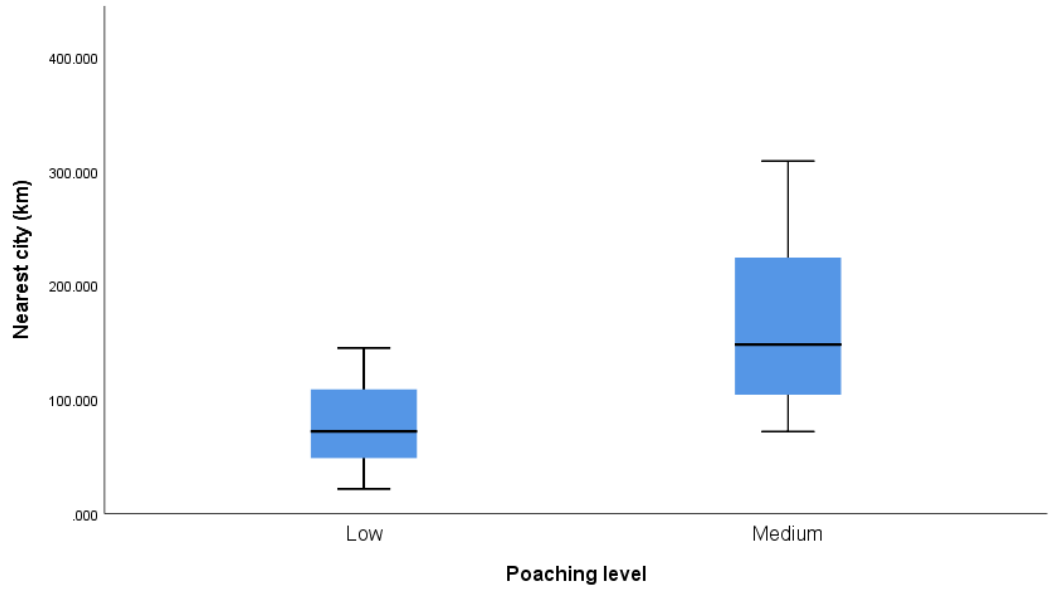

Figure 5.12: Boxplots of poaching levels within KwaZulu-Natal and proximity to the nearest major town/city

None of the socio-economic factors showed any significant correlations with relative poaching score within KwaZulu-Natal. There was no difference in population density in KwaZulu-Natal due to poaching level (t=-0.006, d.f.=35, p=1.00), nor where there any differences in youth unemployment rate (t=-2.66, d.f.=35, p=0.012) or the percentage of households which were agricultural (U=214.00, n=37, p=0.20). In this province, poaching was higher in areas with a higher unemployment rate (U=257.50, n=37, p=0.007; Fig. 5.13a), a higher mean number of people per household (t=-3.10, d.f.=35, p=0.004; Fig. 5.13b) and a higher percentage of the population aged over 20 with no formal schooling (t=-3.51, d.f.=35, p=0.001; Fig. 5.13c).

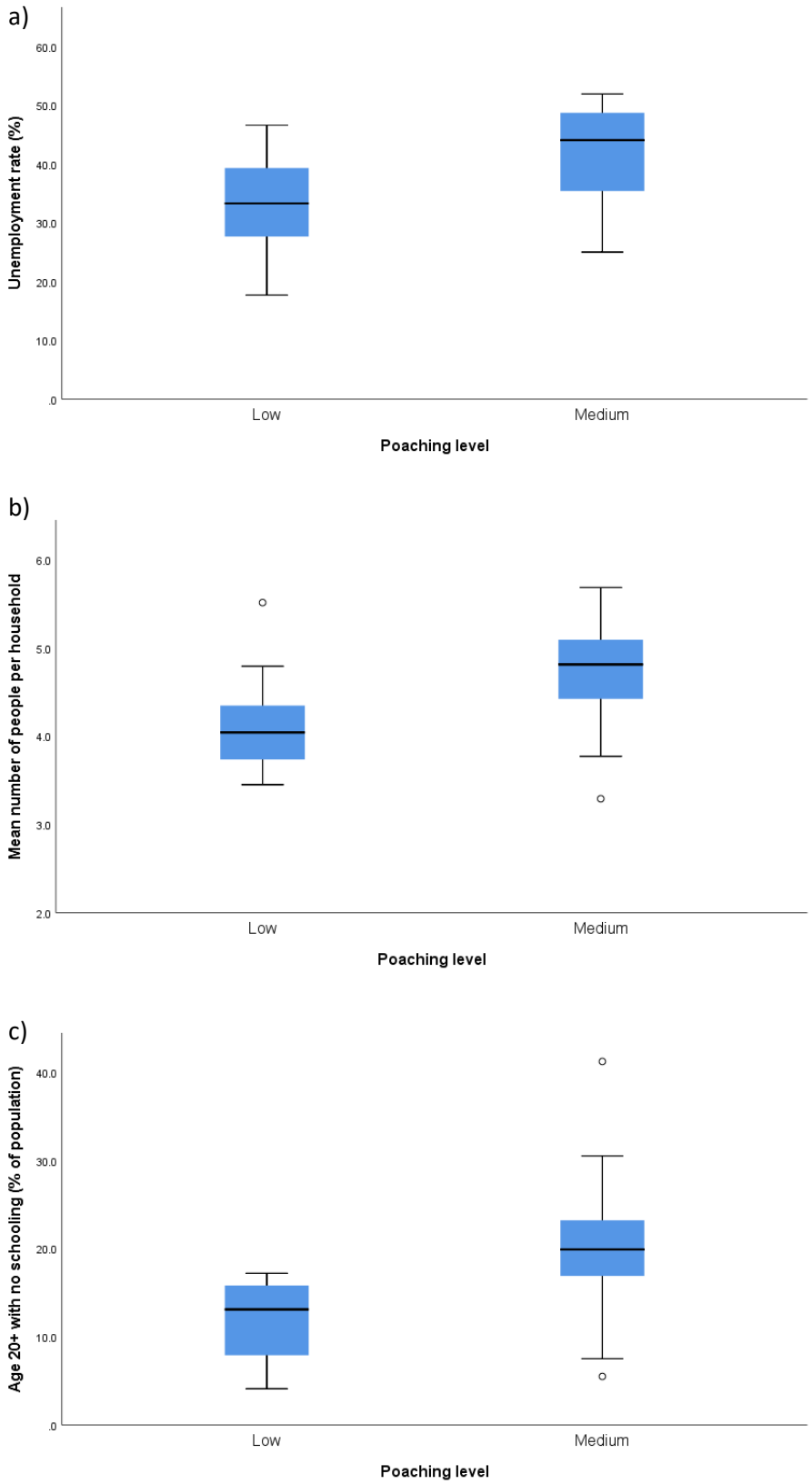

Figure 5.13: Boxplots of poaching levels within KwaZulu-Natal and a) unemployment rate b) mean number of people per household c) percentage of the population aged 20 and above with no formal schooling (with outliers highlighted)

Limpopo

In Limpopo, there was no correlation between relative poaching score and proximity to the nearest state or provincial park holding rhinos (r_s=0.31, n=44, p=0.04), nor was there a difference in proximity due to poaching level (t=-1.40, d.f.=42, p=0.17). There was also no correlation between relative poaching score and proximity to the nearest road (r_s=1.00, n=44, p=0.19) or proximity to the nearest mine (r_s=1.00, n=44, p=0.70), nor was there a difference in proximity due to poaching level for roads (t=0.30, d.f.=21.76, p=0.77) or mines (t=-0.93, d.f.=42, p=0.36).

There was a clear correlation between relative poaching score and proximity to the nearest international airport (r_s=-0.79, n=44, p<0.001; Fig. 5.14a), with statistically significantly higher poaching found in areas closer to the nearest international airport (t=6.90, d.f.=42, p<0.001). Poaching also shows a correlation with proximity to the nearest major town/city (r_s=-0.99, n=44, p<0.001; Fig. 5.14b) with poaching significantly higher nearer to major towns/cities within Limpopo (t=4.96, d.f.=42, p<0.001).

None of the socio-economic factors showed any significant clear correlations with relative poaching score within Limpopo. There was no difference in population density in Limpopo due to poaching level (t=-0.79, d.f.=23, p=0.47), nor where there any differences in unemployment rate (U=46.50, n=25, p=0.51), youth unemployment rate (U=45.50, n=25, p=0.46), the mean number of people per household (U=64.0, n=25, p=0.59), the percentage of households which were agricultural (t=0.55, d.f.=23, p=0.59) or the percentage of the population aged over 20 with no formal schooling (t=0.16, d.f.=23, p=0.88).

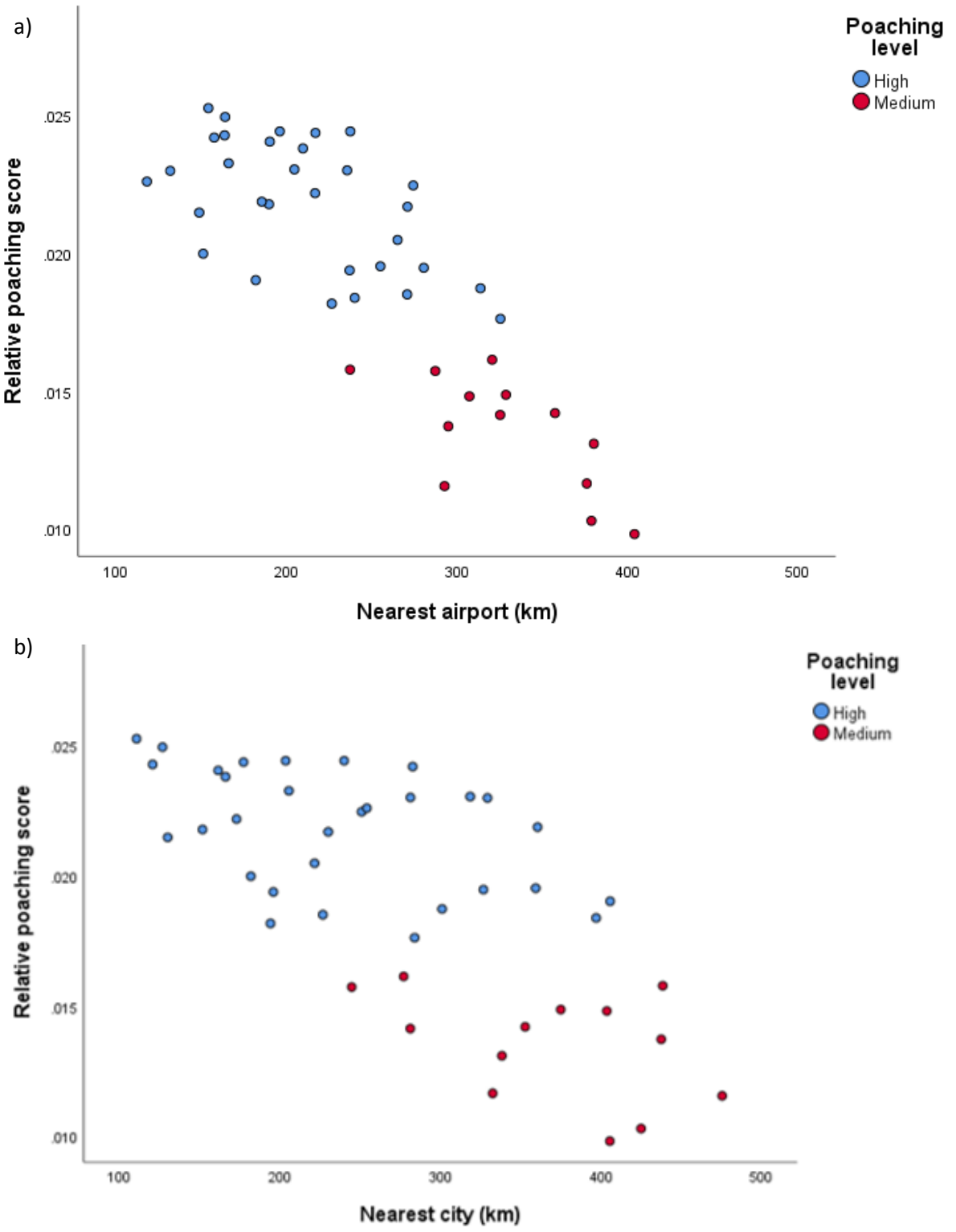

Figure 5.14: Scatterplots of correlation between relative poaching score and proximity to nearest a) airport and b) major town/city in Limpopo

North West

Within the North West province, poaching was found to be correlated with several proximity factors (Fig. 5.15). Poaching increases with closer proximity to the nearest state or provincial park holding rhinos ($r=-0.88$, $n=39$, $p<0.001$; Fig. 5.15a), with significant differences found in proximity due to the poaching level ($F=41.10$, $d.f.=2,36$, $p<0.001$). Post-hoc pairwise comparisons indicated that areas of low level poaching are significantly further away from such parks than areas of medium ($p<0.001$) and high ($p<0.001$) levels of poaching, with high level poaching areas also significantly closer than medium level areas ($p<0.001$). Proximity to the nearest international airport was also found to be correlated with relative poaching score ($r=-0.87$, $n=39$, $p<0.001$; Fig. 5.15b), with significant differences found in proximity due to the poaching level ($F=28.30$, $d.f.=2,36$, $p<0.001$). Post-hoc pairwise comparisons indicated that areas of low level poaching are significantly further away from international airports than areas of medium ($p<0.001$) and high ($p<0.001$) levels of poaching. There was no statistically significant (at $p=0.01$) difference between medium and high level poaching areas ($p=0.0.012$), although this was approaching significance. There is also a correlation between relative poaching score and proximity to major towns/cities ($r=-0.84$, $n=39$, $p<0.001$; Fig. 5.15c), with significant differences found in proximity due to the poaching level ($F=24.28$, $d.f.=2,36$, $p<0.001$). Post-hoc pairwise comparisons indicated that areas of low level poaching are significantly further away from major towns/cities than areas of medium ($p<0.001$) and high ($p<0.001$) levels of poaching. There was no statistically significant difference between medium and high level poaching areas ($p=0.06$).

There was no clear correlation between proximity to roads and relative poaching score, nor where there any differences in proximity to the nearest road due to poaching level ($H=3.37$, $n=39$, $p=0.19$). There was no significant correlation between proximity to mines and relative poaching score ($r=-0.12$, $n=39$, $p=0.47$), nor where there any differences in proximity to the nearest mine due to poaching level ($H=0.33$, $n=39$, $p=0.85$).

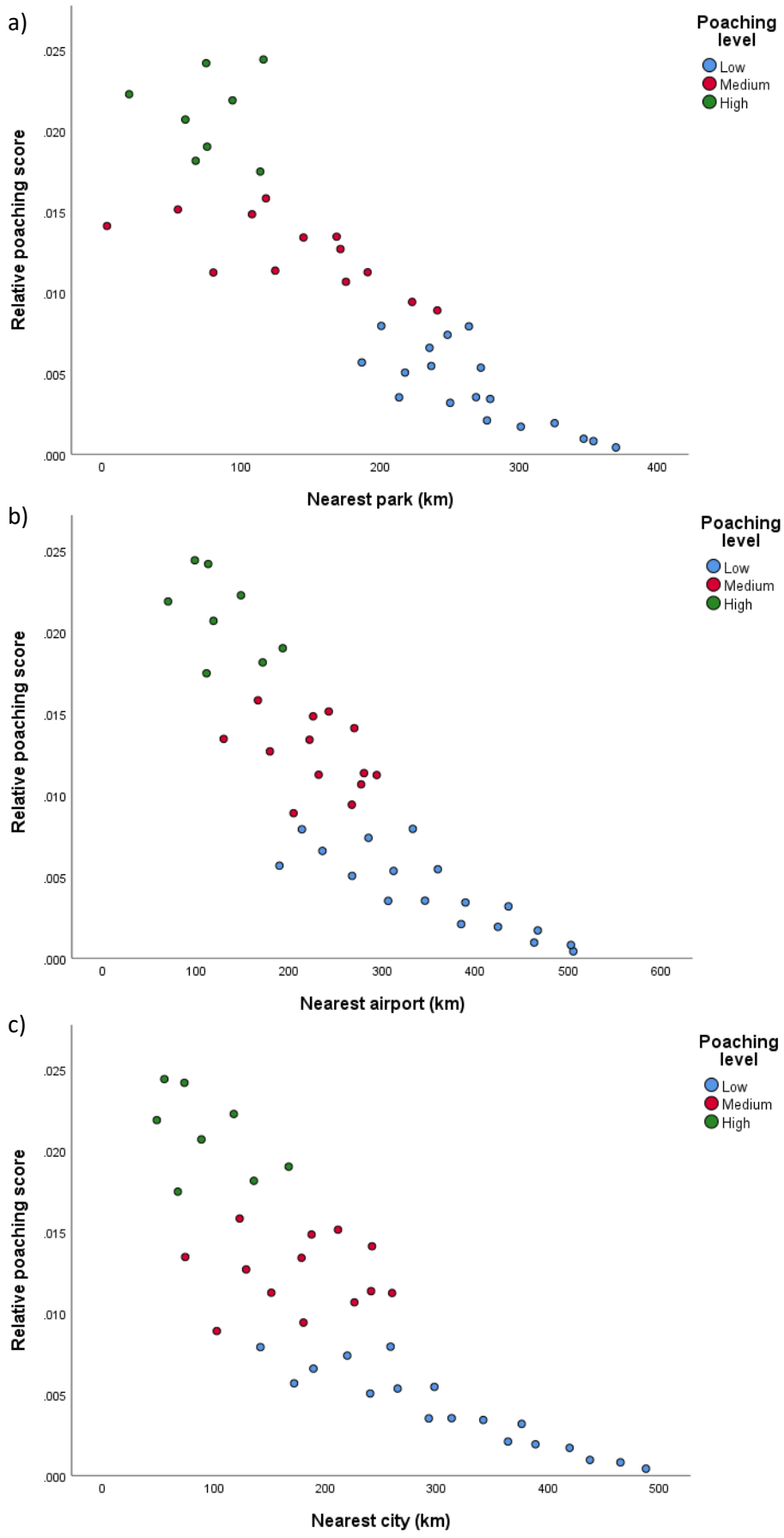

Figure 5.15: Scatterplots of correlation between relative poaching score and proximity to nearest a) state or provincial park holding rhinos b) airport and c) major town/city in North West

Within the North West province, relative poaching score showed a clear correlation with the percentage of the population aged over 20 with no formal schooling (r=-0.76, n=20, p<0.001; Fig. 5.16). Analysis of differences due to poaching level indicated significant results (F=10.15, d.f.=2,17, p=0.001) with post hoc testing indicating that areas of high poaching have significantly (p=0.001) lower levels of people aged over 20 with no formal schooling. There was no significant difference between low and medium poaching levels (p=0.06) or medium and high poaching levels (p=0.12).

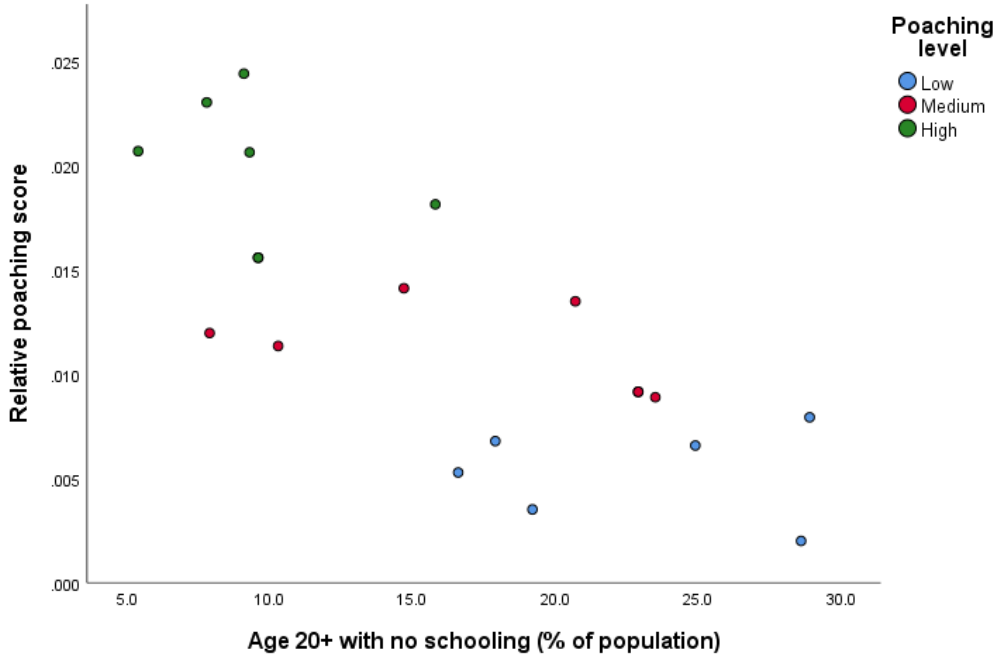

Figure 5.16: Scatterplot of correlation between relative poaching score and percentage of population aged over 20 with no formal schooling in the North West

There were no clear and significant correlations between relative poaching score and the other socio-economic factors within the North West. Nor were there many differences in these factors due to poaching level, with no significant differences found for population density (H=7.46, n=20, p=0.02), the percentage of households which were agricultural (F=1.95, d.f.=2,17, p=0.17), the unemployment rate (F=0.58, d.f.=2,17, p=0.57) or the youth unemployment rate (F=0.12, d.f.=2,17, p=0.89).

Whilst the correlations between relative poaching score and the mean number of people per household were unclear, poaching was higher in areas with a higher mean number of people per household (F=7.73, d.f.=2,17, p=0.004; Fig. 5.17) with post hoc testing indicating that areas of high poaching have significantly fewer

people per household (p=0.003). There was no significant difference between low and medium poaching levels (p=0.43) or medium and high poaching levels (p=0.04).

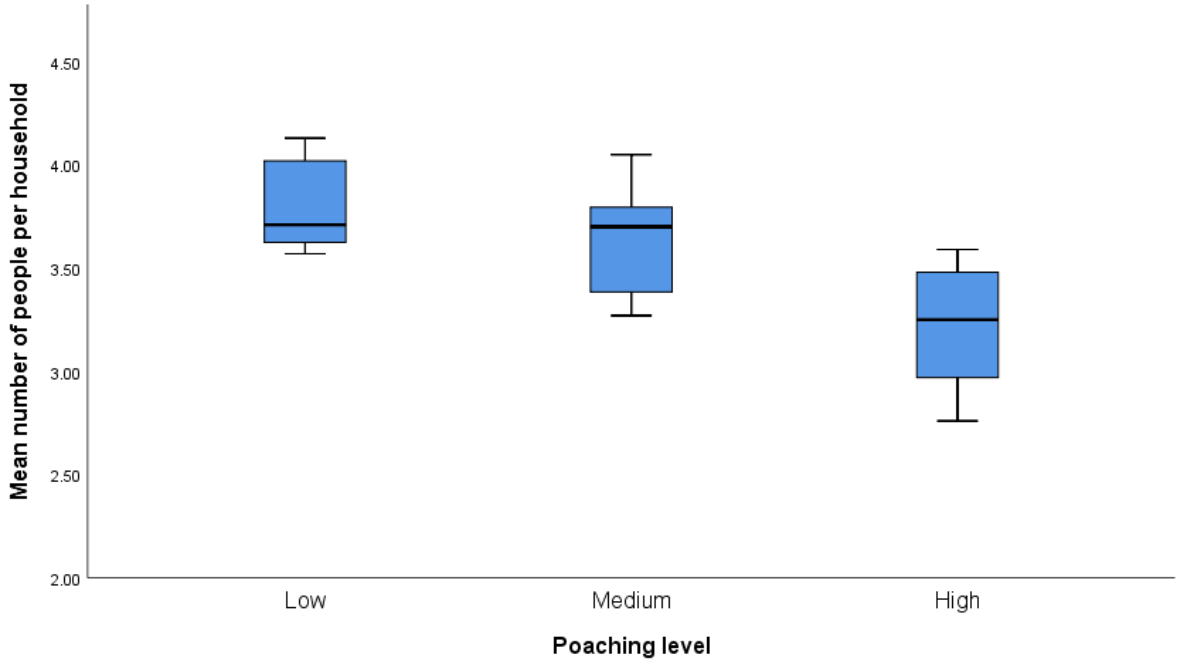

Figure 5.17: Boxplot of poaching levels and mean number of people per household in the North West

Discussion

Rhino poaching hotspots

We conducted the first national assessment of rhino poaching hotspots on private land across South Africa, with the exclusion of Mpumalanga province. The poaching hotspots we identified are relatively stable across time and indicate high levels of poaching in Limpopo, KwaZulu-Natal North West and Eastern Cape. These patterns are consistent with the national poaching statistics (DEA, 2018), privately-owned rhino poaching statistics from 2017 (Rhino Alive, 2018) and the general pattern of private rhino ownership across South Africa (Balfour et al., 2015). The low levels of poaching in Northern Cape and Western Cape are also reflected in the official data, despite high levels of rhino ownership in the Northern Cape (Balfour et al., 2015). KwaZulu-Natal has high levels of poaching in the official data, and appears as a hotspot in this analysis, which contradicts the findings of Scott and de Bod (2018) who noted very low levels of poaching on private land in that province. The increase in poaching in KwaZulu-Natal has been linked to diversification in the import of

firearms to Mozambique, from a single importer near the Kruger National Park border to individuals operating near the border with KwaZulu-Natal (Austin, 2019). Our analysis does suggest a temporary increase in poaching around the central areas of South Africa in 2016, but this does not appear to have continued into 2017. Whilst the hotspot analysis indicated that Gauteng province has high levels of poaching, the privately-owned rhino poaching statistics from 2017 (Rhino Alive, 2018) indicate very low levels of poaching within this province. It is likely therefore that this is due to the inherent limitations of hotspot mapping through kernel analysis, which shows a gradual decline from high to low areas, with no defined cut-off point (Ratcliffe, 2004).

Official statistics produced by the DEA until the end of 2014 (DEA, 2014), showed similar results to those found here with generally increasing poaching in the Eastern Cape, KwaZulu-Natal and Limpopo and inconsistent trends in Gauteng, Northern Cape and the Free State. The official statistics show increasing poaching in the North West and decreasing poaching in Western Cape, but it must be noted that these data refer to all poached rhinos and so are not directly comparable with the data analysed here from private land only. As the official data are only produced at a provincial level, it is not possible to determine whether the areas within provinces highlighted by our analysis (detail not provided for rhino security reasons) are poaching hotspots in general, but we consider our analysis reflective of the threat to privately owned rhino populations.

Due to the high level of private rhino ownership in Mpumalanga (Balfour et al., 2015) and high representation within the official poaching statistics (DEA, 2018), it is reasonable to conclude that privately-owned rhinos within Mpumalanga are also at a high risk. Even though there were insufficient records from Mpumalanga for this province to be included in the analysis, many parts of the province are highlighted by Fig. 5.3 as areas of high poaching concentration. Further collection of data regarding poaching events in Mpumalanga would be required to confirm this.

Spatial factors relating to rhino poaching on private land

In assessing spatial factors which may be linked to rhino poaching on private land, we considered those which had previously been identified as risk factors in studies

on predominantly public land. At a national level, poaching was higher in areas closer to state/provincial parks holding rhinos, international airports and large towns/cities. It must be noted that the national picture is likely to be strongly influenced by the concentration of private land poaching hotspots around Limpopo and the North West particularly. Both of these provinces have large areas dedicated to the state or provincial protection of wildlife and both are relatively close to Gauteng province, with its large international airport (OR Tambo International Airport) and many large, densely populated towns and cities. Whilst it is likely that some of these relationships are due to the above noted issues with a lack of cut-off points in hotspot analysis (Ratcliffe, 2004) the DEA (21018; 2016; 2015) has acknowledged that OR Tambo International Airport is the main route out of South Africa for rhino horn. du Toit (1998) highlighted the risk of poaching in areas close to large cities and Swanepoel (1998) noted that Gauteng is a hotspot of poachers, rather than poaching activity, due to its many thoroughfares, airports and criminal syndicates. Whilst we acknowledge the potential issue of cut-off points in hotspot analysis, the results presented here suggest that the possible importance of proximity to Gauteng in rhino poaching on private land should not be completely discounted.

Contrary to the national picture, within Limpopo there was no relationship between poaching and proximity to state or provincial parks holding rhinos. As the Kruger National Park forms most of the eastern boundary of Limpopo, few places are far from the park and so a relationship may not necessarily be expected. Considering poaching in general, and not just that on private land, Kruger has the highest level of poaching in South Africa (Massé and Lunstrum, 2016). It would therefore be expected that properties close to Kruger could be targeted by poachers already in the vicinity. Multiple authors have attributed this high level of poaching to poachers crossing the open border between South Africa and Mozambique that runs through Kruger (Rubino and Pienaar, 2017; Massé and Lunstrum, 2016; Lunstrum, 2015; Lunstrum, 2014; Chaderopa 2013), although both Shaw and Rademeyer (2016) and Eloff (2012) have highlighted that many of the poachers in Kruger are South Africans and not Mozambicans. There is also an international airport within Kruger National Park (Kruger Mpumalanga International Airport), further complicating the interpretation of these findings. The provincial analysis for Limpopo did indicate that

poaching is higher in close proximity to an international airport but separating a relationship between the park and the airport is virtually impossible with the data available. The scarcity of data from Mpumalanga further complicates this issue and prevents potential separation of these factors. Further data regarding the poaching of rhinos on private land within Mpumalanga could potentially mitigate this problem and allow these two proximity factors (proximity to the park and to the airport) to be separated.

In KwaZulu-Natal, there was no relationship found between poaching and proximity to international airports, despite King Shaka International Airport being very close to the city of Durban. The suggestion is therefore that whilst King Shaka International Airport may be a major route for rhino horn out of South Africa (DEA, 2016), horns are not poached nearby.

Whilst Crosta et al. (2017) assert that most rhino horn reaches Vietnam by sea, proximity to seaports was found to be associated with a lower risk of poaching nationally, suggesting that rather than being poached locally, horn is transported longer distances to seaports. It must however be noted that the national analysis of proximity to seaports is likely to have been substantially influenced by the high levels of poaching within the landlocked provinces of Limpopo and the North West. KwaZulu-Natal has two major seaports, but poaching was not found to be associated with proximity to seaports within this province. However, within the Eastern Cape, high levels of poaching were found nearer to seaports, but the largest of these is Port Elizabeth, which is in close proximity to the city of Port Elizabeth, an international airport and a large national park which holds rhinos. The close proximity of these factors means it is not possible to determine if one is a higher risk factor than the others, but the general trend indicates that the greater Port Elizabeth area is a high risk area for rhino poaching.

The distribution of mines within South Africa is disparate, with most mining areas concentrated within the high poaching regions of Limpopo and the North West and most of the rest located in the low poaching areas of the Northern Cape. Despite assertions from du Toit (1998), we found no relationship between poaching and proximity to mines at either a national level, or within Limpopo or the North West.

Whilst several authors have linked poaching with ease of access through major roads (Moneron et al., 2017; Haines et al., 2012; Martin and Vigne, 2003; Swanepoel, 1998), our findings concurred with those of Rashidi et al. (2016), indicating no relationship between poaching and proximity to major roads at either a national or provincial level. Areas closest to the N7, N10 and N14 show low levels of poaching, but this was not unexpected as a large proportion of each of these roads is within the Northern Cape, where poaching is very low.

Socio-economic factors relating to rhino poaching on private land

To effectively tackle poaching, it is essential to determine the socio-economic factors which may be driving such actions (Critchlow et al., 2015; Humphreys and Smith, 2014). Socio-economic analysis at a national level provided inconsistent results. Whilst previous authors (Mulero-Pázmány et al., 2014; Messer, 2010; Kühl et al., 2009) that poachers are poor local people, we found no conclusive evidence to fully support this. The only socio-economic risk factor associated with increased rhino poaching on private land at a national level was increased population density. However, given the associations discussed above with proximity to large cities, particularly the densely populated areas of Gauteng, this is unsurprising. Population density was not found to be linked to poaching in any of the provincial analyses undertaken.

There was no evidence of the purported association (du Toit, 1998) between rhino poaching and rural communities, with no relationships found between poaching and the percentage of households in an area which are agricultural at a national level, or within most of the provinces analysed. The opposite relationship was found within the Eastern Cape, where poaching was higher in areas which were less agricultural. Again, this is likely to be due to the focus on Port Elizabeth previously discussed, but the differing scales available for proximity and socio-economic data prevented the combining of these data and so precluded the possibility of identifying combined spatial and socio-economic patterns.

The number of people per household has historically been utilised as a measure of poverty (Randall and Coast, 2015), which could explain the link between increased poaching in areas with higher people per household in both the North West and

KwaZulu-Natal. Unemployment rate was found to be associated with poaching only in KwaZulu-Natal, supporting the idea that poaching in this province may be undertaken by poor local people (Mulero-Pázmány et al., 2014; Messer, 2010; Kühl et al., 2009). The lack of a link to unemployment within the North West province, suggests that this may not be the case in this area and the most recent information available on poverty within provinces in South Africa (Statistics SA, 2017) indicates that generally the North West suffers less poverty than KwaZulu-Natal, which has the highest level of poverty within South Africa. Economic success has been identified as a driving factor in increasing household size (Randall and Coast, 2015). Whilst traditionally poverty required large households, relative economic success can also attract an increased number of dependents.

A more positive indication for the future, is that youth unemployment was not found to be associated with increased poaching either nationally or at provincial level (although this was approaching significance within KwaZulu-Natal). There were also few links found between poaching and the proportion of the population aged over 20 who have no formal schooling (again, this factor was approaching significance nationally). Whilst a lack of formal schooling was found to show a link with increased poaching in KwaZulu-Natal, this may be associated with the significant poverty in the province discussed above. In both the North West and Eastern Cape, the inverse relationship was found, whereby poaching was higher in areas where fewer people had no formal schooling. Swanepoel (1998), found that similar results to those found here, with 60% of poachers having an education above grade 10 in that study. Again, this is likely due to the relative wealth of the North West and strong links to the city of Port Elizabeth.

Whilst it may be the case that poor, local people have been linked to rhino poaching in the past, or are associated with poaching on public land, we have found no clear indications that socio-economic factors can be linked to rhino poaching on private land outside of KwaZulu-Natal. The noted risks of poaching by local people (Dobson and Lynes, 2008; Warchol et al., 2003) appear to apply to privately-owned rhinos in this province only. Engagement of local people through employment in conservation has been widely discussed in the literature (e.g. Brashares et al., 2011; Vodouhê et al., 2010) and ought to be considered to aid in the protection of privately-owned rhino populations in KwaZulu-Natal. Encouraging engagement with education and

increased opportunities for employment would have consequences far beyond just that of reducing rhino poaching and would contribute positively to the social and economic stability of KwaZulu-Natal as a whole. However, to be effective at this scale will require considerable effort and prioritisation from central and provincial government.

Conclusions

Spatial patterns of rhino poaching on private land mainly reflect national poaching trends across all ownership types (private, provincial and national) and the patterns of concentration of privately-owned rhinos across the country. Owners in these areas should consider their stock to be at risk of poaching. Law enforcement efforts should also be targeted appropriately in areas where poaching is most likely to occur. Collation of data on poaching events in Mpumalanga is needed to enable identification of poaching hotspots within that province.

Spatial trends are not even across the country, with poaching generally higher in areas close to international airports, large towns and cities and state or provincial parks which hold rhinos. Within the Eastern Cape, poaching is focused around Port Elizabeth. Actions aimed at deterring poaching activity should therefore be focused around these high-risk areas and privately-owned rhino populations within these areas should be considered to be at risk. Whilst there are large numbers of privately-owned rhinos in the Northern Cape, poaching is low across the province.

In exploring the possible root causes of poaching behaviour, our socio-economic analyses indicate few links out with KwaZulu-Natal. Within this province there is a link between rhino poaching on private land and unemployment and low engagement in formal education. Focus on improving the prospects of local human populations within KwaZulu-Natal, particularly those in close proximity to populations of privately-owned rhinos, may help to address this. It may be beneficial for private rhino owners to engage more with local people, particularly in terms of employment opportunities. Participation in education and the potential for employment within the wildlife industry, or assistance to own their own rhinos may help to engage local people with rhino conservation rather than poaching.

Acknowledgements

The authors wish to thank all the private rhino owners who contributed information on poaching of their stock to this research and Colin McLean for assistance with spatial analysis in R. This work received no specific funding.

References

Austin, K. L. (2019). *Follow the guns: An overlooked key to combat rhino poaching and wildlife crime.* [Online] Conflict Awareness Project. Available at: www.followtheguns.org [Accessed 24 April 2019].

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

Balfour, D., Knight, M. and Jones, P. (2015). *Status of white rhino on private and communal land in South Africa: 2012 - 2014*. Pretoria: Department of Environmental Affairs.

Beale, C. M., Hauenstein, S., Mduma, S., Frederick, H., Jones, T., Bracebridge, C., Maliti, H. and Kohi, E. M. (2018). Spatial analysis of aerial survey data reveals correlates of elephant carcasses within a heavily poached ecosystem. *Biological Conservation,* 218, 258-267.

Brashares, J. S., Golden, C. D., Weinbaum, K. Z., Barrett, C. B. and Okello, G. V. (2011). Economic and geographic drivers of wildlife consumption. *Proceedings of the National Academy of Sciences of the United States of America,* 108, 13931-13936

Chaderopa, C. (2013). Crossborder cooperation in transboundary conservation-development initiatives in southern Africa: The role of borders of the mind. *Tourism Management,* 39, 50-61.

Critchlow, R., Plumptre, A. J., Driciru, M., Rwetsiba, A., Stokes, E. J., Tumwesigye, C., Wanyama, F. and Beale, C. M. (2015). Spatiotemporal trends of illegal activities from ranger-collected data in a Ugandan National Park. *Conservation Biology,* 29, 1458-1470.

Crosta, A., Sutherland, K. and Talerico, C. (2017). *Grinding rhino. An undercover investigation on rhino horn trafficking in China and Vietnam*. Los Angeles: Elephant Action League.

Department of Environmental Affairs (DEA) (2014). *South African government is aware that ongoing scourge of rhino poaching is linked to worldwide Illicit wildlife trade. 20 November 2014*. [Online] DEA. Available at: www.environment.gov.za/mediarelease/rhinopoaching_wildlifetrade [Accessed 10 October 2018].

Department of Environmental Affairs (DEA) (2015). *Minister Edna Molewa highlights progress in the fight against rhino poaching. 30 August 2015*. [Online] DEA. Available at: www.environment.gov.za/mediarelease/molewa_highlightsprogress_onrhinopoaching [Accessed 10 October 2018].

Department of Environmental Affairs (DEA) (2016). *Minister Edna Molewa highlights progress in the fight against rhino poaching. 21 January 2016*. [Online] DEA. Available at: www.environment.gov.za/mediarelease/molewa_highlightsprogress_againstrhinopoaching [Accessed 10 October 2018].

Department of Environmental Affairs (DEA) (2018). *Minister Edna Molewa highlights progress on the implementation of the integrated strategic management of rhinoceros. 25 January 2018*. [Online] DEA. Available at: www.environment.gov.za/mediarelease/molewa_highlightsprogressonimplementationofintegratedstrategicmanagementofrhinoceros [Accessed 28 August 2018].

De Valck, J., Broekx, S., Liekens, I., De Nocker, L., Van Orshoven, J. and Vranken, L. (2016). Contrasting collective preferences for outdoor recreation and substitutability of nature areas using hot spot mapping. *Landscape and Urban Planning,* 151, 64-78.

Dobson, A. and Lynes, L. (2008). How does poaching affect the size of national parks? *Trends in Ecology and Evolution,* 23, 177-180.

du Toit, J. G. (1998). *A Manual for Owners of White Rhinos*. Onderstepoort: South African Veterinary Foundation.

Eloff, C. (2012). Rhino poaching in SA - is it a losing battle? *PositionIT*, Jan/Feb 2012, 57-62.

Emslie, R. H., Milliken, T., Talukdar, B., Burgess, G., Adcock, K., Balfour, D. and Knight, M. H. (2019). *African and Asian Rhinoceroses - status, conservation and trade: A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf. 9.14 (Rev. CoP17) (No. CoP18 Doc. 83.1 Annex 2)*. Geneva: CITES Secretariat.

Haines, A. M., Elledge, D., Wilsing, L. K., Grabe, M., Barske, M. D., Burke, N. and Webb, S. L. (2012). Spatially explicit analysis of poaching activity as a conservation management tool. *Wildlife Society Bulletin,* 36, 685-692.

Humphreys, J. and Smith, M. L. R. (2014). The 'rhinofication' of South African security. *International Affairs,* 90, 795-818.

Koen, H., de Villiers, J. P., Roodt, H. and de Waal, A. (2017). An expert-driven causal model of the rhino poaching problem. *Ecological Modelling,* 347, 29-39.

Kühl, A., Balinova, N., Bykova, E., Arylov, Y. N., Esipov, A., Lushchekina, A. A. and Milner-Gulland, E. J. (2009). The role of saiga poaching in rural communities: Linkages between attitudes, socio-economic circumstances and behaviour. *Biological Conservation,* 142, 1442-1449.

Lunstrum, E. (2014). Green militarization: Anti-poaching efforts and the spatial contours of Kruger National Park. *Annals of the Association of American Geographers,* 104, 816-832.

Lunstrum, E. (2015). Conservation meets militarisation in Kruger National Park: Historical encounters and complex legacies. *Conservation and Society,* 13, 356-369.

Mackenzie, C. A. and Hartter, J. (2013). Demand and proximity: drivers of illegal forest extraction. *Oryx,* 47, 288-297.

Martin, E. and Vigne, L. (2003). Trade in rhino horn from eastern Africa to Yemen. *Pachyderm,* 34, 75-87.

Massé, F. and Lunstrum, E. (2016). Accumulation by securitization: Commercial poaching, neoliberal conservation and the creation of new wildlife frontiers. *Geoforum,* 69, 227-237.

Messer, K. D. (2010). Protecting endangered species: When are shoot-on-sight policies the only viable option to stop poaching? *Ecological Economics,* 69, 2334-2340.

Moneron, S., Okes, N. and Rademeyer, J. (2017). *Pendants, Powder and Pathways*. Pretoria: TRAFFIC.

Mulero-Pázmány, M., Stolper, R., van Essen, L.D., Negro, J. J. and Sassen, T. (2014). Remotely piloted aircraft systems as a rhinoceros anti-poaching tool in Africa. *PLoS ONE*, 9, e83873.

Piel, A. K., Leonel, A., Johnson, C. and Stewart, F. A. (2015). Deterring poachers in western Tanzania: The presence of wildlife researchers. *Global Ecology and Conservation,* 3, 188-199.

Pressey, R. L., Cabeza, M., Watts, M. E., Cowling, R. M. and Wilson, K. A. (2007). Conservation planning in a changing world. *Trends in Ecology and Evolution,* 22, 583-592.

Randall, S. and Coast, E. (2015). Poverty in African households: the limits of survey and census representations. *The Journal of Development Studies*, 51, 162-177.

Rashidi, P., Wang, T., Skidmore, A., Vrieling, A., Darvishzadeh, R., Toxopeus, B., Ngene, S. and Omondi, P. (2015). Spatial and spatiotemporal clustering methods for detecting elephant poaching hotspots. *Ecological Modelling,* 297, 180-186.

Rashidi, P., Wang, T., Skidmore, A., Mehdipoor, H., Darvishzadeh, R., Ngene, S., Vrieling, A. and Toxopeus, A.G. (2016). Elephant poaching risk assessed using spatial and non-spatial Bayesian models*. Ecological Modelling,* 338, 60-68.

Ratcliffe, J. H. (2004). The hotspot matrix: a framework for the spatial-temporal targeting of crime reduction. *Police Practice and Research,* 5, 5-23.

Rhino Alive. (2018). *South Africa: National rhino poaching statistics - detailed analysis of the 2017 statistics*. [Online] Rhino Alive. Available at:

www.facebook.com/RhinoAlive/photos/a.455648507965862/745294002334643/?type=3&theater [Accessed 05 March 2018].

Rubino, E. C. and Pienaar, E. F. (2017). Applying a conceptual framework to rhinoceros conservation on private lands in South Africa. *Endangered Species Research*, 34, 89-102.

Rubino, E. C. and Pienaar, E. F. (2018). Understanding South African private landowners decisions to manage rhinoceroses. *Human Dimensions of Wildlife,* 23, 160-175.

Rummens, A., Hardyns, W. and Pauwels, L. (2017). The use of predictive analysis in spatiotemporal crime forecasting: Building and testing a model in an urban context. *Applied Geography,* 86, 255-261.

Sadler, R. C., Pizarro, J., Turchan, B., Gasteyer, S. P. and McGarrell, E. F. (2017). Exploring the spatial-temporal relationships between a community greening program and neighborhood rates of crime. *Applied Geography,* 83, 13-26.

Scott, S. and de Bod, B. (2018). *Rhino poaching update - we look behind the numbers*. [Online] Africa Geographic Online. Available at: https://africageographic.com/blog/rhino-poaching-update-we-look-behind-the-numbers/ [Accessed 08 February 2018].

Sharma, K., Wright, B., Joseph, T. and Desai, N. (2014). Tiger poaching and trafficking in India: Estimating rates of occurrence and detection over four decades. *Biological Conservation,* 179, 33-39.

Shaw, M. and Rademeyer, J. (2016). A flawed war: Rethinking 'green militarisation' in the Kruger National Park. *Politikon,* 43, 173-192.

Statistics SA (Not dated). *Census 2011.* [Online] Statistics South Africa. Available at: www.statssa.gov.za/?page_id=964 [Accessed 17 May 2018].

Statistics SA (2017). *Poverty Trends in South Africa. An examination of absolute poverty between 2006 and 2015*. Pretoria: Statistics South Africa.

Swanepoel, G. (1998). The illegal trade in rhino horn: An example of an endangered species. *International Journal of Risk, Security and Crime Prevention,* 3, 207-220.

Twinham, T. (2017). Danger zone: Land use and the geography of neighborhood crime. *Journal of Urban Economics,* 100, 104-119.

Vodouhê, F. G., Coulibaly, O., Adégbidi, A. and Sinsin, B. (2010). Community perception of biodiversity conservation within protected areas in Benin. *Forest Policy and Economics,* 12, 505-512.

Wang, D., Ding, W., Lo, H., Morabito, M., Chen, P., Salazar, J. and Stepinski, T. (2013). Understanding the spatial distribution of crime based on its related variables using geospatial discriminative patterns. *Computers, Environment and Urban Systems,* 39, 93-106.

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

Wellsmith, M. (2011). Wildlife crime: the problems of enforcement. *European Journal on Criminal Policy and Research,* 17, 125-148.

Chapter 6:

Findings of this work in light of the initial aims and objectives

Evaluation of the methodology used

Wider discussion of issues raised by the work

Suggestions for further work

Final conclusions and recommendations

This study is the first attempt to examine the behaviour of rhino poachers on private land in South Africa. In light of the current poaching crisis, this work also assesses the conservation value of private rhino conservation across South Africa and the challenges faced by private rhino owners.

This chapter provides:

- A summary of the findings of this work in light of the initial aims and objectives
- An evaluation of the methodology used
- A wider discussion of issues raised by the work:
    - The accuracy of poaching statistics
    - How rhino poaching may change in the future
    - The role of private rhino owners in the conservation of rhinos in the future
    - Legal international trade in rhino horn
    - Local community engagement in private rhino conservation
- Suggestions for further work that could be carried out to further the collective knowledge on both the efficacy of private-sector rhino conservation and the challenges faced by private rhino owners due to poaching
- Final conclusions and recommendations

Summary of findings

There were two main aims of the research. The first was to assess the conservation value of privately-owned rhino populations in South Africa and the challenges private rhino owners face. The second was to understand the spatial, temporal and socio-economic factors that have contributed to the substantial increase in rhino poaching that has occurred in the last decade – the major challenge faced by private rhino owners.

The conservation value of private rhino ownership and the challenges they face were considered through the use of historical surveys of private rhino owners (Chapter 2), a questionnaire of private rhino owners and managers (Chapter 2) and interviews with a variety of stakeholders involved in private rhino management and conservation (Chapter 3). Having understood that poaching was the major challenge

faced by private rhino owners, the temporal (Chapter 4), spatial and socio-economic (Chapter 5) factors associated with poaching on private land were assessed. How this challenge has been tackled through the use of a variety of anti-poaching strategies was also investigated (Chapter 2).

To achieve the two main aims, several objectives were identified, as follows:

1. To identify the role of private rhino owners in the resurgence of the southern white rhino from a species numbering less than 50 to one now numbering over 18,000.

The analysis of historical surveys of private rhino ownership conducted in Chapter 2 indicates increasing numbers of rhinos held on private land and a generally increasing number of properties engaged in this practice. There was however some evidence of a failure by some parties to follow the required regulations regarding monitoring and registering of privately-held rhino stocks.

The analysis of stakeholder undertaken in Chapter 3 indicates that private rhino owners and managers were generally clear on the conservation value of their animals and felt they were providing a valuable conservation resource. Most stakeholders directly employed by private rhino owners also felt that private rhino owners provide a valuable conservation role, but some NGO representatives question the conservation value of private rhino ownership.

2. To explore the range or properties engaging in private rhino conservation.

The Chapter 2 questionnaire of private rhino owners identified a wide range of properties engaging in private rhino ownership, from single-species breeding facilities, to large properties consisting of a wide range of species living in their natural environment with minimal human contact. Most were found to hold rhinos at a population density described (Rubino et al., 2018) as a measure of “strong commitment to habitat conservation” (pg. 308). There was evidence however of a potential move away from extensive areas of land dedicated to wildlife management towards more intensive breeding of rhinos on single-species properties. This, combined with support for trade in rhino horn identified in the stakeholder analysis in

Chapter 3, may damage the perception of private rhino ownership as being valuable to rhino conservation.

3. To explore the range of anti-poaching strategies employed by private rhino owners.

The analysis of anti-poaching strategies in Chapter 2 identified a wide range of anti-poaching strategies utilised by private rhino owners, from volunteer anti-poaching patrols and unmanned watchtowers, through to trained anti-poaching units with dogs and on-site helicopter response teams. Security expenditure is not linked to the number of anti-poaching strategies utilised, nor to the level of poaching on a particular property.

Anti-poaching strategies tend to be deployed after a poaching event, but none have proven to be completely effective on all properties, with subsequent poaching events occurring regardless of the number or range of anti-poaching strategies in place.

4. To explore the perspectives of different stakeholders involved in private rhino ownership.

Whilst there was general consistency in views on the conservation value of private rhino ownership, the stakeholder analysis in Chapter 3 identified some other areas of disagreement. When asked to assess the reasons why poaching has increased so much in recent years, stakeholders tended to focus on different areas. Rhino owners and managers considered the lack of a legal horn trade to be most important, whilst NGO representatives tended to focus on high demand. Other interviewees were more likely to consider the impact of local socio-economic conditions.

A consensus was found amongst all stakeholders when asked about their perceptions of the reaction of the South African government to the poaching crisis, with all stakeholders feeling it has been poor. There was a lack of consensus regarding the potential for horn trade, with support strong for trade amongst many owners, but a much more nuanced view was found amongst the remaining stakeholders.

5. To identify challenges to private rhino ownership that may impact on owners' decision to continue in their rhino conservation efforts.

The questionnaire for Chapter 2 and stakeholder analysis from Chapter 3 identified a range of challenges faced by private rhino owners. Whilst some owners identified risks to their staff and families by their continued keeping of rhinos, all identified poaching, and the associated economic impact, as the major challenge to their continued engagement in private rhino ownership.

6. To assess trends in rhino poaching on private land across South Africa between 2003 and 2017.

The assessment of temporal trends in rhino poaching on private land conducted in Chapter 4 indicated that poachers do not appear to show strong weekly or monthly trends in their poaching activities but are more likely to poach at night and particularly during a full moon. In more recent years there has been a move towards increased poaching during the weekend (Friday-Sunday) rather than during the week. Rhino poachers appear to act rationally (Lee and Roberts, 2016) in their selection of targets and so rhinos are poached roughly in proportion to their contribution to the total population in terms of species, sex and age.

7. To identify hotspots of rhino poaching on private land across South Africa between 2003 and 2017 and identify socio-economic and spatial factors which may impact on these hotspots.

The Chapter 5 hotspot analysis of spatial trends in rhino poaching on private land mainly reflected national poaching trends across all ownership types (private, provincial and national) and the patterns of concentration of privately-owned rhinos across the country. Spatial trends are not even across the country, with poaching generally higher in areas close to international airports, large towns and cities and state or provincial parks which hold rhinos. Within the Eastern Cape, poaching is

focused around Port Elizabeth. Poaching is low within the Northern Cape, despite large numbers of privately-owned rhinos living within that province. Socio-economic factors do not appear to impact greatly upon rhino poaching on private land, apart from in KwaZulu-Natal, where there is a link between unemployment and low engagement in formal education and increasing rhino poaching on private land.

Evaluation of methodologies

Engaging private rhino owners

The greatest challenge in completing the data collection for this research, was convincing private rhino owners to supply potentially valuable data to someone they do not know. A personal relationship with one private rhino owner (Lynne MacTavish) resulted in a meeting with the Chairman of the Private Rhino Owners Association (PROA), Pelham Jones. His involvement provided not only the Balfour et al. (2015) study on private white rhino ownership between 2012 and 2014, but also enabled me to design the questionnaire used throughout this work (predominantly the work presented in Chapter 2, although some of the poaching reports used in Chapter 4 and 5 also came from this questionnaire), based on that study. Understandably, he was unwilling to provide details of his members, which meant that a database had to be constructed from internet searches related to private rhino ownership (for full details see Chapter 2: Methods: Questionnaire of private rhino owners). Whilst the sample size obtained for the questionnaire was low (n=23), those private rhino owners who did complete the survey represented a wide range of property types. In line with similar studies (also with small sample sizes; Rubino and Pienaar, 2018a; Rubino and Pienaar, 2018b; Pienaar et al., 2017; Wright et al., 2016; Cousins et al., 2008), it must be clear that this work is not presented as a conclusive description of all private rhino owners but is considered as indicative of the range of views held in the industry. For this survey to have fully represented all private rhino owners, it would be necessary to access the data held by the PROA, and even then, it must be noted that there are many private rhino owners who are not members of this organisation. For confidentially reasons, this was not possible.

Once questionnaires had been completed, contact was made with all those who had indicated that they would like to be further involved in the research. Some indicated

that they were no longer willing to engage; and some were simply unavailable for follow up interviews to form Chapter 3. Again, interviews were conducted with a limited sample of rhino owners and managers, but all efforts were made to ensure that they represented the range of property types and views held by private rhino owners. Subsequent interviewees were identified through contacts provided by the private rhino owners and managers, and through convenience sampling of field guides and anti-poaching staff. Again, I acknowledge the limitations of this work and present it only as indicative of the range of people involved in the industry. Combining this work with previous work conducted by Rubino and Pienaar (2018a; 2018b), Pienaar et al. (2017), Wright et al. (2016) and Cousins et al. (2008) forms a much fuller picture of the range of opinions within the industry.

Collating poaching data

One of the greatest challenges in conducting this research was collating data which was truly representative of rhino poaching on private land within South Africa. As it was not possible to access official data regarding poaching events on private land (in many cases due to the fact that criminal investigations were still ongoing), the only option available was to try and compile a database through publicly available information. With a final dataset of over 470 poaching events, I believe that the data I was able to collect is broadly representative of poaching on private land across South Africa. The results generally support what was expected from studies on state land (Koen at al., 2017; Mulero-Pázmány et al., 2014) and other work looking at trade routes (Crosta et al., 2017; Moneron et al., 2017).The findings also support evidence from criminal prosecutions of poachers, seizures of rhino horn and the thoughts of private rhino owners. Whilst full access to all reports of rhino poaching events on private land would clearly have provided a fuller dataset from which to work, I believe that collating the data from the publicly available (social) media sources has provided enough evidence to build a reliable picture of poaching trends.

Obtaining accurate information on the level of poaching on private land is complex, as the statistics presented by the Department of Environmental Affairs (DEA) do not break the data down into state and private land. The Chairman of the PROA has claimed that 20% of all rhino poaching events occur on private land (Jones, 2013).

Yet the Balfour et al. (2015) survey of white rhino owners suggests that, in 2012, 9.73% of all poaching events were on private land, which increased to 14.2% in 2013 and dropped again to 11.28% in 2014. The data from Rhino Alive (2018), utilised in Chapter 4, indicates that in 2017, 27.86% of all rhino poaching in South Africa was on private land.

Whilst it is entirely feasible that figures vary widely between provinces and across years, the lack of clarity in the level of poaching on private land is a challenge. As the Rhino Alive (which is an initiative of the PROA and therefore likely to represent its members) data match the final official numbers produced by the DEA (2019), we can assume they are broadly accurate. To assess the reliability of the data used in the analysis of Chapters 4 and 5, Tables 6.1 and 6.2 below indicate the percentage of poaching events across provinces and across months in 2017 that were represented in the dataset.

Table 6.1: Comparison of dataset and Rhino Alive poaching figure by province for 2017

Province	Percentage in Rhino Alive data	Percentage in collated dataset
Eastern Cape	3.57	11.36
Free State	16.07	3.41
Gauteng	1.34	1.14
KwaZulu-Natal	4.46	6.82
Limpopo	33.04	36.36
Mpumalanga	18.75	3.41
Northern Cape	10.27	12.5
North West	12.5	23.86
Western Cape	0.00	1.14

Table 6.2: Comparison of dataset and Rhino Alive poaching figure by month for 2017

Month	Percentage in Rhino Alive data	Percentage in collated dataset
January	15.63	8.24
February	7.59	7.06
March	6.70	18.82
April	6.25	5.88
May	9.38	11.76
June	8.93	12.94
July	6.25	12.94
August	8.93	12.94
September	8.48	1.18
October	12.95	5.88
November	4.46	1.18
December	4.46	1.18

As can clearly be seen from Tables 6.1 and 6.2, there are some areas of the country (notably Mpumalanga and Free State) and some months of the year (January, September and October) where the dataset under-represents private land poaching in 2017. The Free State has seen a notable increase in poaching in recent years (Scott and de Bod, 2018), which was reflected in the hotspot analysis (Chapter 5, Fig. 5.3). For that reason, the Free State data were determined to be broadly representative of poaching in that province across time. The Mpumalanga data were consistently low compared to national figures and so it was not determined to be reliable and was therefore not included in the hotspot analysis in Chapter 5. Whilst initial assessment of Table 6.2 may suggest that some months are under-represented, the analysis of the complete dataset in Chapter 4 (Fig. 4.1) indicates that the pattern across time was broadly representative of private land poaching. The apparent over-representation of the Eastern Cape, North West and March is discussed below (Accuracy of poaching statistics).

Modelling of data

Whilst I believe the data utilised in Chapters 4 and 5 are broadly representative of the poaching of rhinos on private land across South Africa, it was not possible to conduct multivariate analysis to assess trends in a more reliable manner. Whilst other authors have utilised a variety of modelling methods (Beale et al., 2018; Rashidi et al., 2016; Critchlow et al., 2015; Haines et al., 2012) or a mixed-methods approach (Koen et al., 2017), such analysis was not possible with the data collated here.

For Chapter 4, it was possible to conduct linear regression of poaching of individuals to assess any selection for sex, species or age, but it was not possible to undertake similar analysis of temporal trends. A fuller dataset, comprising not only of more poaching events, but also full details for all recorded events may have permitted such analysis. Given that poaching events were collated from (social) media report, it was not possible to ensure that all relevant data were included in each report. As poached rhino carcasses are not always immediately found, even if the relevant information were included in all reports, it may still have not been detailed enough (for example if the exact day of the poaching was unknown) to produce a full and accurate enough dataset to permit more complex analysis.

The data utilised in Chapter 5 were limited by the inherent risks of making public the exact locations of poaching events. Were that information available then it is likely that more data points could have been produced. In many occasions the only available location was the nearest town, or municipality, but to fully explore spatial trends it would have been more informative to have been able to identify the exact location of the poached animal, ideally to its exact location within a property. This data may have allowed for a finer scale to have been utilised in the hotspot analysis and so provided more information. It is also the case that, in many occasions, it is not possible to determine exactly where an animal was poached as injured rhinos can travel many kilometres before they finally succumb to their wounds and fall to the ground where their horns are then removed. Had this information been available, then the proximity data would also have been more reliable as exact distances could have been calculated. Since this information was not available, it was only possible to determine straight line distance for use in the proximity analysis, which could not consider management or geographic features which could aid/hinder access to

rhinos in specific areas. The analysis of socio-economic data was predominantly limited again by the scale of the available data. With census data only being available at a municipality level, it could not be reliably combined with the proximity analysis. This also limited the number of points within each municipality, which limited the use of multivariate analysis through the assumptions of modelling techniques regarding the number of data points and the number of factors being explored. Again, finer scale data may have enabled more detailed analysis, but such data is not readily available.

Given that the analysis in Chapters 4 and 5 is inherently limited by the available data, I believe that we have produced results which are as broadly representative of trends in poaching of rhinos on private land across South Africa as could be reasonably found. Without significant involvement of a variety of agencies across South Africa it is simply not possible to collate the data utilised here at the finer scale required to undertake more complex modelling analysis.

Issues raised by this work

Accuracy of poaching statistics

The official poaching statistics for 2018 (DEA, 2019) indicated a substantial decrease in total poaching numbers, with the figure dropping below 1000 for the first time in six years. However, this figure has been questioned, with Elise Serfontein (Founding Director of StopRhinoPoaching.com) quoted as saying that the way the official figures have been calculated has changed in 2018 (Phillips, 2019). Tables 6.1 and 6.2 indicate that the dataset used for analysis in Chapters 4 and 5 shows some evidence of over-representation of some provinces (Eastern Cape and Western Cape) and months (March), where the dataset suggests poaching events have not been fully covered by the Rhino Alive (2018) data. A more likely explanation is related to the complexity of what is considered a “poaching” event under the official statistics. The official statistics simply record rhinos which have been “poached”, without providing a definition of what constitutes a poaching event. One of the records included in the analysis in this work stated that the cause of death was recorded as septicaemia (from the bullet wound) and so the death would not be recorded as a poaching death. Similarly, Phillips (2019) cites an “anti-rhino poaching

official" as confirming that they have been involved in instances where a rhino has died during treatment for poaching wounds and police have not recorded it as a poaching death. Further suggestions have been made that indicate rhinos which initially survive and receive veterinary treatment, but which subsequently die, are not recorded as poaching deaths (Austin, 2019; Saving the Survivors, 2015), nor are those where the horns are not taken (Saving the Survivors, 2015). In the report of the 2008 survey of private rhino owners (Hall-Martin et al., 2009), the authors claim there were no poaching events on private land prior to 2007, yet reports from owners who provided data for this research included single poaching events from 2003 and 2006, both of which resulted in the animals being dehorned and dying. The lack of clarity in what constitutes an official poaching event meant that all records using the words "poached" or "poaching" were included in this dataset. Table 6.3 shows the results of the events recorded in the dataset used for this work.

Table 6.3: Known outcomes of poaching events recorded in the dataset

Outcome	Number	Percentage
Killed and dehorned	222	46.9
Poached (assumed dehorned and killed)	120	25.4
Killed (status of horns unknown)	44	9.3
Killed and not dehorned	32	6.8
Not killed and not dehorned (long-term survival unknown)	15	3.2
Dehorned and survived (long-term survival unknown)	39	8.2
Survived (status of horns unknown)	1	0.2
Total	473	100

If the claims discussed above are accurate, and animals which are not dehorned, or not immediately killed are not recorded in the official statistics then poaching levels may be substantially higher than officially stated. Using the data from this study, poaching deaths may be more than 6.77% higher than officially recorded (assuming that all recorded as "killed" were also dehorned and all those that were recorded as initially surviving survived long-term) and the number of animals actually targeted by poachers (assuming official statistics only record those "killed and dehorned" and "poached") could be more than 27.7% higher than official figures. Another potentially

confounding issue is the collateral loss of calves and pregnancies. In this study, seven calves were recorded as dying following the deaths of their mothers, and 29 pregnancies were lost (Chapter 4). With a total of 473 individuals recorded in the dataset, this then represents an additional 7.61%. The Balfour et al. (2015) study does not record lost pregnancies, but did find that between 2012 and 2014, 26 collateral calves were lost from 345 adult poaching deaths; an additional 7.54%.

To assess the true impact of poaching on rhinos in South Africa, and assess their population trends reliably, it is essential to obtain accurate data regarding the total population size (Ferreira et al., 2012). The DEA regularly releases population numbers for the Kruger National Park (Kruger), as shown in Figure 6.1.

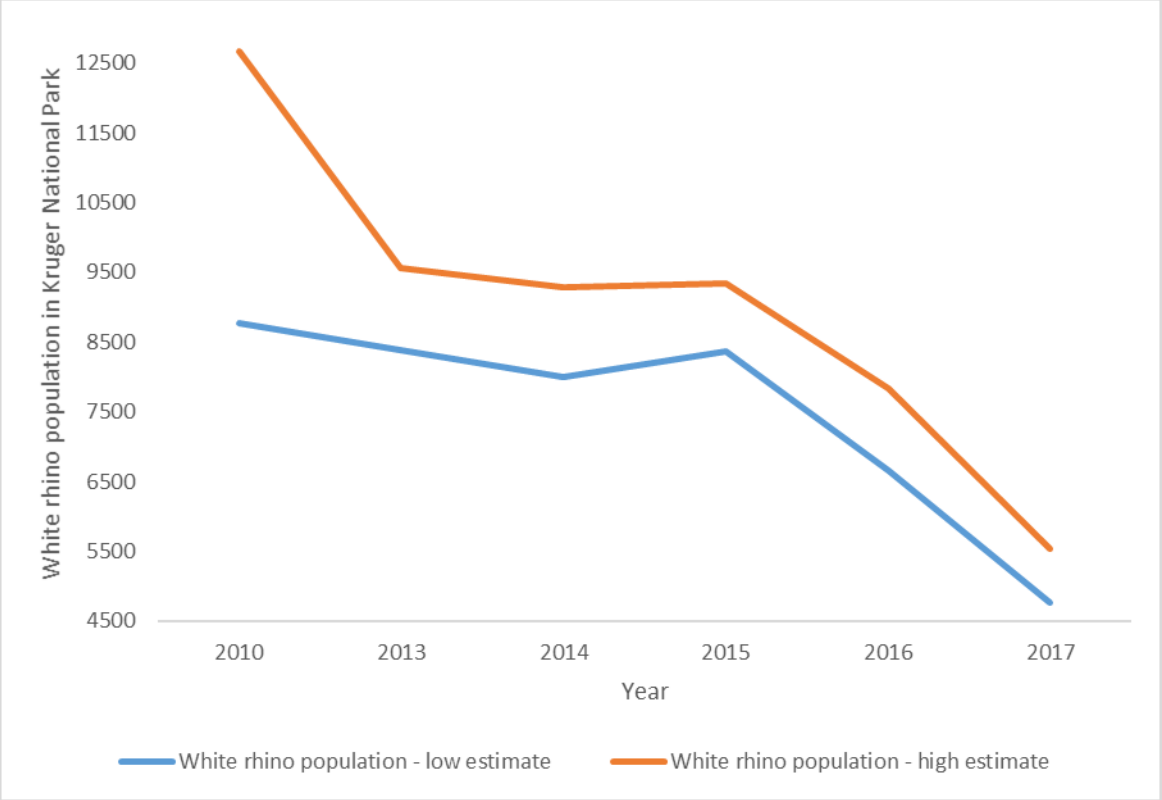

Figure 6.1: Maximum and minimum white rhino population in Kruger National Park (DEA, 2018; DEA, 2017; DEA, 2015)

These population figures can be used to assess relative poaching pressure within Kruger. Using the population counts from Fig. 6.1 and detected poaching carcasses found within Kruger (DEA, 2017; DEA, 2014) comparative poaching pressure can be calculated for white rhino. In 2010, poaching accounted for 1.15-1.67% of the total Kruger white rhino population, but this increased to 8.90-10.34% by 2014. It has

since stabilised to between 8.45 and 9.96% during 2015 and 2016. Without clear population numbers or poaching levels on private land, it is impossible to determine exact changes in poaching pressure on private land. However, using the official poaching statistics and data prepared by Emslie et al. (2013; 2016), it is possible to determine that the percentage of animals poached outside of the Kruger, relative to their proportion of the population, increased from 1.86-3.06% in 2010, to 3.47-3.85% in 2015. Looking only at privately owned populations, the Balfour et al. (2015) data suggests that poaching deaths represented 1.83% of the reported population in 2012, 3.76% in 2013 and 3.07% in 2014. Using the Emslie et al. (2019) population figures of around 7,500 rhinos in private hands in South Africa at the end of 2017, the 2017 poaching figures (Rhino Alive, 2018) represent 2.99% of the total privately-owned population.

Whilst the Kruger white rhino population figures do appear to show that the DEA acknowledges a decrease in the white rhino population within the park, even these figures have been called into question. Whilst the DEA has claimed that the figures have been ascertained using “peer-reviewed scientific methods” (DEA, 2015), the methodology was not confirmed by the DEA until the February 2017 update, where it was stated that the population was counted using the “scientifically accepted block count method” (DEA, 2017). Joubert (2015) has noted that these are aerial counts. Aerial counts are known to be unreliable for surveying rhinos, having been found to underestimate black rhino population sizes in Pilanesberg National Park (Brockett, 2002) and accounting for only 50% of black rhino in Tanzania (Goddard, 1967). This could then suggest that the figures released by the DEA are an underestimate of the Kruger population. However, wildlife veterinarian, Kobus du Toit has challenged the official Kruger population numbers by evaluating births, deaths and natural population growth rates (de Bruin, 2015). He believes that the 2015 population could not have been any higher than 4,585; less than 55% of the low estimate of 8,365 released by the DEA. That there is such discrepancy between official block count figures and those calculated based on population parameters is of great concern. If the figure of less 3,000 proposed by du Toit (de Bruin, 2015) is accurate, then the 2015 poaching deaths in the park (826: DEA, 2017) represent 27.53% of the total population. With a natural white rhino population growth rate of 7.2% (Emslie et al., 2016), it is evident that poaching deaths are outstripping growth rates even at the

higher population size stated by the DEA. The results of the most recent census of the Kruger rhino population have been withheld due to “some confusing results” (Parliamentary Monitoring Group, 2019). If du Toit’s (de Bruin, 2015) estimate of the population size is accurate, then South Africa’s rhino population may be substantially lower, and in even greater peril than has been acknowledged up to now.

Future poaching

The figures discussed above (Accuracy of poaching statistics) seem to indicate that poaching on private land represents around 3% of the privately-owned population per annum across South Africa. Project Rhino (an association of government agencies, private owners, NGOs and other partners in KwaZulu-Natal) claims that, from 2011-2015, 24% of all rhinos poached in KwaZulu-Natal were on private land, but this dropped to only 4.5% in 2016 and 2017 (Project Rhino, 2017). This matches the 4.5% in KwaZulu-Natal in 2017 stated by Rhino Alive (2018). Whilst there does appear to have been a local decrease in private land poaching in KwaZulu-Natal, the rest of the evidence suggests that poaching on private land in general is increasing. With decreasing poaching within Kruger National Park (DEA, 2019) the fear is that poachers will continue to move out from the park and target neighbouring properties. This is especially concerning when the number of poachers arrested in Kruger in 2018 was higher than in 2017 (DEA, 2019), despite the lower number of poaching events. The suggestion is therefore that rhinos are becoming harder to find within the park and so poaching pressure may increase on state and private land to the detriment of the animals held there.

Whilst rhino poaching has increased significantly, it appears that it is still treated as a low priority crime by law enforcement, who are also known to be involved in the corruption surrounding rhino poaching (Knight, 2015; Warchol, 2004). The HAWKS, a specialised priority crime division of the South African Police Service (SAPS) have developed standardised procedures for dealing with poaching events (Milliken and Shaw, 2012), but it is clear that these are not always being followed. On one occasion, in 2014, police officers called to the scene of a poaching incident took selfies with the carcasses, brought coolers of beer with them and cut meat from the poached animals to braai (barbeque) (L. MacTavish, pers. comm.). This poor

response from law enforcement results in the poor perceptions of law enforcement and government agencies noted by the stakeholders in Chapter 3. If private rhino owners cannot trust the police to assist them in their fight against rhino poachers then they may opt to disinvest in rhinos, or they may start to employ more of the militarised anti-poaching strategies employed on state land, despite the legal 'grey area' this entails for private landowners. Informal discussions with volunteer anti-poaching personnel indicate a willingness to engage in illegal activity, including murder, to prevent rhino poaching events.

Without effective law enforcement high levels of poaching will continue (Rayan and Linkie, 2015). Increased law enforcement has been shown to have had a dramatic effect on the poaching of babirusa (*Babyrousa babyrussa*), but this did decline over time (Milner-Gulland and Clayton, 2002). The penalties applied to poaching must be effective as small penalties do not act as deterrents, especially when poachers perceive a low risk of being caught (Clements et al., 2010; Milner-Gulland and Leader-Williams, 1992). It has been suggested (Milner-Gulland and Leader-Williams, 1992) that if the penalty is related to output then poaching is less likely, but if it is consistent regardless of poaching level then poaching is high. Penalties must therefore relate to total kills and not just trophies poachers are found in possession of (Milner-Gulland and Leader-Williams, 1992). However, in areas where wages are very low, a small fine may be just as impossible to pay as a large one and so simply increasing fines does not necessarily act as a deterrent to poaching (Messer, 2010). In some areas, even the death penalty has proven unsuccessful in curbing poaching (Leader-Williams and Milner-Gulland, 1993). Rhino poachers in South Africa face penalties of over ZAR40,000 (Cheteni, 2014), yet it has been noted that a team of three poachers could earn up to ZAR1 million per rhino poached (DoD, 2013). The South African justice system does appear to be considering rhino poaching a serious offence, with a stated current conviction rate of 88.8% (DEA, 2016). Of the 48 people convicted of offences relating to rhino poaching between April 2015 and March 2016, 24 were imprisoned, 21 were fined and three were handed suspended sentences (DEA, 2016). Most were convicted of firearms and trespassing offences, but 16 were convicted of charges directly relating to rhino poaching; including possession of rhino horn, dealing in rhino horn and illegal hunting of rhinos (DEA, 2016). Whilst this conviction rate is high, it must be noted that 317 people were arrested for poaching

related offences in 2015 and 1,175 rhinos were poached (DEA, 2016), so whilst those who are charged are often convicted, it is clear that many are not caught and many who are caught, are not charged. The international aspects of this criminal activity mean that arrests and prosecutions are not just happening in South Africa, with arrests undertaken in at least eight incidences pertaining to the illegal trade in rhino horn between May and August 2015 in Czech Republic, Hong Kong, India, Kenya, Mozambique, Vietnam and the United States of America (TRAFFIC, 2015). The International Criminal Police Organization (INTERPOL) has also executed arrests around the world under the auspices of “Project Wisdom”, directed at curbing the trade in elephant ivory and rhino horn (INTERPOL, 2017).

Whilst there is clear international engagement in reducing rhino poaching, and stated commitment from the SAPS and South African Government, private rhino owners do not perceive this. The risks of disinvestment and the potential for increased militarisation of private anti-poaching efforts are especially concerning in face of the potential increase in poaching pressure on private land as poaching falls within Kruger National Park.

The role of private rhino ownership in the future

Previously, Nature Reserves in South Africa were declared by provincial authorities and had few strict requirements (Cumming and Daniels, 2014). However, the National Environment Management: Protected Areas Act (Act 57 of 2003) permits areas to be declared as private protected areas, subject to the same protection and legal requirements as state land (Cumming and Daniels, 2014). How popular this has been amongst private landowners is however unclear. With most conservation acts set at the provincial level (Knight et al., 2013) it is possible that different provinces could set requirements that work best within their boundaries to encourage wider engagement in conservation practices amongst private rhino owners.

Sodhi et al. (2011) loosely define conservation success as “any evidence of positive conservation outcomes, such as population increases of endangered species following targeted interventions” (pg. 585). By that definition, the conservation value of private rhino owners in growing the population following the implementation of Operation Rhino is clear. However, there is more to conservation than simple

increases in numbers. The wider benefits to biodiversity of large expansive reserves are generally accepted (Cousins et al. 2010; Gallo et al. 2009; Cousins et al. 2008; Jones et al. 2005; Douglas-Hamilton 1997) and the valuable role of private landowners in providing land for the WWF's Black Rhino Range Expansion Project (BRREP) is unquestioned (Hayward et al. 2017; Cousins et al. 2008), but when animals are fenced and intensively farmed, the conservation value is debatable (Pitman et al. 2016; Cousins et al. 2010). Whilst there is an argument to be made that farms maintain a reservoir of genetic material that may be required for future rhino (re)introduction (Ververs et al., 2017), the broader conservation role of such properties is more difficult to ascertain than expansive reserves stocked with other native species. Fencing animals into areas creates edge effects (Massey et al., 2014), constrains their population growth and restricts gene flow, but, when large enough or when gene flow is maintained through regularly transferring animals in and out of populations to create artificial metapopulations, fenced areas can effectively conserve wildlife (Hayward and Kerley, 2009). Fewer extensive areas, or simply fewer forming metapopulations may therefore have substantial impacts on the conservation value of private rhino ownership. Small reserves are able to retain diverse communities through effective use of management techniques (East, 1981) and may be better able to protect rhinos from poachers, but the conservation value of single-species farms (beyond simply increasing numbers) is questionable.

It has been more than 30 years since the role of private owners in rhino conservation was acknowledged (Cohn, 1988) and 20 years since it was noted that with state land having reached carrying capacity, white rhino populations can only continue to grow through collaboration with private rhino owners (Emslie and Brooks, 1999). Private game reserves also contribute over US$11.3 million per year to the regional economy (Sims-Castley et al., 2005) and so have a substantial economic benefit to South Africa as well as a conservation role. One conservation strategy that could potentially encourage rhino owners on extensive properties to continue with their engagement in rhino conservation is payment for ecosystem services (PES), which provides landowners with payments for working in a manner that protects biodiversity (Ingram et al., 2014). As they are focused on ecosystem services, rather than protection of specific species (Dinerstein et al., 2012), PES programmes have some limits in their application to private rhino farmers. However, most of the private

owners involved in this research have extensive areas of natural habitat for their animals. These areas can provide vital ecosystem services if managed correctly. I have personally witnessed occasions where local people have cut fences into private reserves to allow their livestock access to the grazing and water available, so it is clear that such properties are maintained in a manner that supports these vital ecosystem services. As landowners who are intrinsically motivated to engage in conservation are more likely to continue such behaviours if they receive a supportive reward for doing so (Stern, 2006), it is likely that there would be support for PES strategies amongst private owners who overwhelmingly cited their passion for rhinos as their reason for keeping them (Chapter 3).

Payment for such services could assist private rhino owners in generating the extra income that they require to manage the increasing costs of anti-poaching activities. Currently, private rhino owners do not receive any government support for such actions (Lee and Du Preez, 2015; Kreuter et al., 2010), yet the South African Government has committed to cooperation with private rhino owners (DEA, 2019). Subsidies to support anti-poaching activities (identified in Chapters 2 and 3 as the major economic challenges to continued involvement in private rhino ownership) could be a means of cooperation (Rubino and Pienaar, 2017). The noted distaste of the general public for private rhino owners may make providing financial support to private rhino owners politically difficult, but wider acknowledgement of the ecosystem services provided by expansive reserves may permit the government to engage in PES activities with private rhino owners whilst also mitigating public concerns. Major rhino charities also do not provide support for privately owned rhinos (Save the Rhino explicitly states that they do not “fund programmes involving privately owned rhinos”; Save the Rhino, 2016). Whether such restrictions would apply to community-owned rhinos, or private rhino owners involved in PES programmes is unclear.

Rhino horn trade

As an alternative to financial support from the government or NGOs, there have been wider discussions about the possibility of generating income for rhino protection through the development of a legal international trade in horn, with rhino owners involved in this work generally supportive of such a trade (Chapter 3). Some

authors have suggested that permits could be implemented which would require owners to manage sufficient habitat to meet conservation objectives before they could engage in trade (Rubino and Pienaar, 2017). Rubino et al. (2018) found that private rhino owners as a whole have no clear objections to such an idea and suggest that this could potentially serve to mitigate the concerns regarding increased intensification of rhino management.

Rhino horn was removed from the China's official compendium of drugs, including those used in traditional Chinese medicine (TCM), in the early 1990s (Crosta et al., 2017). However, with the 25-year ban being lifted to permit use in special circumstances (EIA International, 2019), the arguments surrounding the possibility of legal international trade in rhino horn are likely to increase. The government of South Africa has presented conflicting messages regarding its perceptions of the possibility of trade in rhino horn. At a cabinet meeting on 13th April 2016, it was agreed that South Africa would not apply to CITES to permit trade in rhino horn (Government Communication and Information System, 2016), despite this proposal being included in the DEA 2016 budget (National Treasury, 2016). Such conflicting messages have been mentioned in informal discussions with rhino owners and also impacted on their generally poor perception of the government response to the poaching crisis noted in Chapter 3.

With cost-benefit analysis indicating that private rhino ownership will only continue if the benefits outweigh the costs (Rubino and Pienaar, 2017), there is a clear risk of disinvestment in the face of continued poaching pressure without potential to generate additional income. Such income could be generated by trade in rhino horn. Hume (2013) discusses the potential of lifting the international trade ban and further expanding the production of rhino horn by encouraging more landowners to keep and rear rhinos in order to not only make a living for themselves, but also to conserve the species. This idea is echoed by researchers, with Biggs et al. (2013: pg. 1038) going so far as to state that a regulated and humane legal trade in rhino horn is "the only remaining option" and would generate funds for further rhino conservation and provide further incentives for the keeping of rhinos. It is also claimed that, were the legal trade to have undesirable consequences, it could be fairly easily and quickly closed again (Biggs et al., 2013) as demand is much easier to manage when markets are legal ('t Sas-Rolfes, 2012). Bulte and Damania (2005)

conclude that, with quotas in place, “wildlife farming will unambiguously promote conservation” (pg. 1222). However, the chairman of the International Union for the Conservation of Nature and Natural Resources (IUCN) Species Survival Commission (SSC) African Rhino Specialist Group (AfRSG), Dr Mike Knight, considers the idea that legal trade would “cure” the poaching issue to be “simplistic” (Knight, 2015: pg. 12).

Since rhino horn grows back, rhinos (unlike many animals used in traditional medicine) do not need to die in order for their useful product to be collected; they can simply have the horns cut. This would provide a constant supply of horn as even the horns of old adults (those over 25 years of age) grow on average 36.5 mm per year (Pienaar et al., 1991). The horns of younger animals grow much faster; 150 mm in the first year and 59.8 mm per year in adults under 25 (Pienaar et al., 1991). It is also known (Pienaar et al., 1991) that horns grow back faster after they have been lost naturally, but research on dehorned rhinos (Rachlow and Berger, 1997) indicates that horn regrowth is slower. Based on a price of only US$2,000 per kilogram, an adult male white rhino over 20 years of age will produce around US$2,600 of horn annually (Rachlow and Berger, 1997). Even without dehorning of rhinos, the natural death rate, of around 2.6%, would generate a significant number of horns each year (Biggs et al., 2013). Taylor et al. (2017) estimated that the current South African rhino population could generate 5,319-13,356 kg y^{-1} of horn through a combination of dehorning, utilising stockpiles and trophy hunting (although they acknowledge this is an unlikely source of horn for trade). Given the current poaching level, they estimate that 5,346 kg currently reach the illegal market each year.

Some researchers have conducted market studies and found that willingness to pay amongst horn users in Vietnam was highest when horns were removed in a non-lethal way from wild rhinos and lowest when horn was from poached animals (Macmillan et al., 2017). Others however have focused on the idea that farmed product is likely to be less desirable to consumers than horn from wild animals. Crosta et al. (2017) found dealers claiming that horns with blood patterns that indicate the animal was still alive when the horn was removed, are more valuable. Drury (2009) highlighted a belief amongst wildlife consumers that wild product is superior and that though there would be people who would buy a (presumably) cheaper legal farmed product, there would still be considerable demand for the

illegal wild product. They noted that the perceived lack of quality in farmed bear bile has led to increased demand for whole gall bladders and bile from wild bears, thereby increasing the pressure on wild populations. Dutton et al. (2011) conducted a market analysis and found that consumers were willing to pay significantly more for wild bile than farmed bile, thereby concluding that the ability of farmed bile to reduce demand is limited. It must be noted however, that the consumers in this study were asked to imagine that the wild bear bile was legally available. One modelling paper (Crookes and Blignaut, 2015) concluded that lifting the ban on rhino horn trade would not eliminate demand and would not in fact result in a profitable market without consumer behaviour modification. However, this study based the analysis on a value of only US$364 per rhino per annum.

Aside from the concerns regarding the preference of consumers for wild over farmed horn or otherwise, the size of the market is also unclear. The use of TCM is not decreasing (‘t Sas-Rolfes, 2012) and some have suggested that legalising the trade in rhino horn could stimulate markets which have previously been dormant (Prins and Okita-Ouma, 2013; Ferreira and Okita-Ouma, 2012). This concern about dormant markets was highlighted by one of the NGO representatives interviewed for Chapter 3.

Others do not believe that trade will lead to increased demand (‘t Sas-Rolfes, 2012) and argue that demand reduction programmes are too slow (Crosta et al., 2017) and do not stigmatise consumption (Macmillan et al., 2017). That legal trade will further destigmatise consumption has led to concerns that legalising trade would inadvertently stimulate demand from those who would not choose to use an illegal product (Bulte and Damania, 2005).

Due to the illegality of the market, it is very difficult to predict its elasticity and how it may change if horn were available legally (Taylor et al., 2017; ‘t Sas-Rolfes, 2012; Bulte and Damania, 2005; Milner-Gulland, 1993). To assess the feasibility of trade and the impact it may have on wild populations, there needs to be a far deeper understanding of the supply and demand dynamics (Challender and MacMillan, 2014). Moyle (2003) highlights the risks of treating market price as an indicator of demand, as there are many different factors that control market processes. Whilst renewed legal trade in Australian saltwater crocodiles did not encourage

overharvesting or poaching (Moyle, 2003), it is unclear how trade could impact rhino populations. The potential for a legal market to ease the laundering of illegal product is also unknown (Taylor et al., 2017; Bulte and Damania, 2005), although it has been suggested that the profitability of legal product would be a strong incentive to prevent laundering of illegal product (‘t Sas-Rolfes, 2012).

What form legal international trade in horn would take is unclear, with some rhino owners calling for a central selling organisation (CSO), as discussed in Chapter 3. The details of such an organisation have not been developed without progress towards international trade and so there would need to be substantially more information presented on the form this would take before its potential could be assessed. What is clear is that private rhino owners are not in favour of government management of trade (Rubino et al., 2018)

Since the trade in rhino horn within South Africa was relegalised in 2017, very little information has been made available about how the trade has progressed. The regular progress report on implementation of the Integrated Strategic Management of Rhinoceros, covering the period 1 January to 31 December 2018, did include some information on this topic (DEA, 2019). The report notes that 36 permits have been granted in total, 15 permits for the sale of 1,342 rhino horns and 19 for horn buyers. Two further permits were granted for the donation and receiving of 14 horns. It is not clear how many of the permits were used, or whether the horns remain within South Africa. To assess the effectiveness of this trade, such information must be examined.

Local community engagement in private rhino conservation

Whilst the South African Government has made it clear that “cooperation with private rhino owners has become the norm” (DEA, 2019) there is a perception that the wider public (Rubino and Pienaar, 2018a) and NGOs (Wright et al., 2016) do not understand the conservation contribution of private rhino owners. The lack of engagement with local communities demonstrated by the majority of private owners in this research (Chapter 3) may be a factor in this. If the wider public cannot perceive the conservation role of private rhino owners, then it is up to private rhino owners to try and clearly articulate their value. This is especially important, not just

amongst private rhino owners, but amongst private sector conservation in general, as there is evidence of increasing private sector investment in conservation (Hamrick, 2016). If conservation more broadly is to be devolved to more private sector partners, then their role and value must be obvious to other stakeholders.

Failure by some parties to engage with conservation policy (as demonstrated by the failure of some owners to follow monitoring and recording regulations: Chapter 2) may damage the claim that the private wildlife industry is focused on the conservation of rhinos and may encourage the perception that the main focus of private rhino owners is to generate income for themselves. Whilst there are no published studies concerning the opinion of the South African public towards private ownership of wildlife, informal observations from the many social media groups used in this work suggest that it is not positive. Memes such as those shown in Fig. 6.2 (sources withheld to prevent identification of groups/pages), were widely shared whilst the various appeals around the moratorium on trade were progressing through the South African court system.

Figure 6.2: Selection of memes widely shared on rhino poaching interest groups/pages on Facebook

It is clear from such social media behaviour, that private rhino owners are not held in high esteem by some members of the general public. These memes were also shared by moderators of the groups, many of whom are NGO partners. The general perception in these groups is that all private rhino owners are in favour of horn trade and that is the only reason that they keep rhinos. To improve such perceptions, private rhino owners may need to focus their communication efforts less on horn

trade and more on the conservation role they play and the risks to rhino populations if large numbers choose to disinvest.

Alongside the negative view some members of the public have towards private rhino owners, private rhino owners also often have poor perceptions of the public in their local area. Whilst private rhino owners rarely engage with the public in a positive way, other stakeholders were much more likely to consider the possibilities of working with local people (Chapter 3). To effectively reduce poaching, strategies must include a wider view of the socio-economic environment in which they are to be deployed (Morais et al., 2018). The potential impact of local people in poaching rhinos in KwaZulu-Natal was highlighted in Chapter 5 and so there must be a discussion of the ways local people can benefit from rhinos in their local area, rather than seeing them as an opportunity to generate income through illegal means.

Private game reserves generally have fewer staff than national or provincial parks and more limited funds available for community involvement, but there are still ways in which local communities can be encouraged to value the wildlife in these areas, rather than treating it as a resource to be exploited. Adcock and Emslie (1994) highlighted one particular private hunting operation that employed fourteen full time local staff and fifteen others seasonally for seven months of the year, to equate to twenty-four full time jobs. If each of those employees supported five other people, then almost 120 people were economically supported by that one private hunting operation. It must be remembered however that direct employment in conservation activities benefits only those employed and their families, not the wider community (Barrett and Arcese, 1995). Warchol and Johnson (2009) also suggest ways in which private reserves can gradually develop relationships with local communities, which may not currently exist, by employing groups of local residents for maintenance work, shrub clearance and other occasional work, but on the basis that if any are found to be poaching then none of that group will be hired again. Whether this peer pressure approach to reducing poaching would work everywhere is unclear, although some Zambian chiefs have engaged with the National Parks and Wildlife Service in the past and evicted poachers from their village (Kelso, 1993).

One of the most common ways in which local communities can be encouraged to become more involved in conservation is through employment as scouts/rangers.

Poor relations between parks and local people have been linked to changes in the recruitment of staff, with fewer being from local communities and with rangers having less engagement with local people (Butt, 2012). The Ruvuma Elephant Project in Tanzania has been especially effective in reducing their poaching through the employment of 200 local game scouts (Lotter and Clark, 2014). Such practices however are open to corruption with some scouts colluding with their neighbours in poaching activities and accepting bribes (Gibson and Marks, 1995). There are opportunities to engage local people in rhino conservation in this way, with some private owners training and employing local people as anti-poaching units (APUs: Kiss, 1990). If they are from local communities, APUs may be more dedicated to their work (Warchol and Johnson, 2009) as they directly benefit from the existence of the animals in their local area. As they are more likely to live in the local community, they are likely to have better relationships with other local people and so may be better able to deal with poachers at a community level rather than in a legal manner (Warchol and Johnson, 2009; Aung, 2007).

Several of the rhino owners/managers involved in this research were very clear that local people employed by them were involved in supplying information to poachers in the local community (Chapter 3) and so it is clear that the potential for integrating illegal income sources with direct employment in conservation does occur. If local people can be engaged as reserve allies, then this flow of information may potentially assist conservation action through the valuable information they may be able to provide regarding illegal activity in the area (Roe et al., 2015). One potential way in which this could be encouraged is through the use of community conservation schemes, including integrated community development projects (ICDP).

The ICDP project in Northern Canada discussed in Chapter 1 (Freeman and Wenzel, 2006) does not confer ownership of polar bears to the local communities, but permits the consumptive use of the animals. Granting these consumptive use rights has clear parallels with the consumptive use of rhinos in South Africa. Whether similar schemes could be developed in South Africa to permit local communities to sustainably utilise the wildlife in nearby protected areas is worth exploring. One of the private landowners involved in this research does not currently keep rhinos on their land but has developed an ICDP plan for such an activity on their property in the Northern Cape (Ferreira, not dated). The plan involves leasing rhinos from

government stocks and claiming ownership of the offspring. They would then be owned 90% by the landowner and 10% by three local community partners. All staff employed for the rhino project would come from the local community and all profit would be split on the 90:10 principle already mentioned. This landowner already has similar policies in place for some game species and so the precedent does exist for such ideas. With increasing tourism in the Karoo region, 20% of those tourists visiting game parks (Atkinson, 2016), large numbers of privately-owned rhinos in the Northern Cape (Balfour et al., 2015) and low levels of poaching in the province (Rhino Alive, 2018; Chapter 5 of this work), this appears to be an ideal place to develop such activities.

One group of researchers (Kreuter et al., 2010) highlighted collaboration between private reserves in southern Africa as an example of community based natural resource management (CBNRM), regardless of whether their motives are primarily economic or based on concern for the natural environment. They focused on reserves adjacent to national parks, such as Timbavati and Klaserie, which form part of the Associated Private Nature Reserves (APNR) alongside the KNP, with Umbabat and Balule. This means they have dropped the fences between themselves and the park and manage their land in line with the management strategy of KNP. This allows them access (for tourism and hunting) to the animals that move onto their land from the main KNP area. These properties manage the activities of the lodge owners within their land, through their constitutions (based on their agreements with KNP), to ensure hunting is controlled and lodge numbers are not exceeded. Timbavati and Klaserie (the case studies in the paper) face sanctions from SANParks if they do not adhere to their management plans; including potentially the reinstatement of fences. These reserves have also been involved in local community initiatives, including funding HIV/AIDS awareness programs, ecological training and staff training in their local communities, but the authors caution that they must consider local communities in their management and long-term plans to ensure future success. Such collaborations between farmers to form large conservancies is common in Namibia (Barnes and de Jager, 1996), but rare in South Africa. If this idea were to be further developed beyond the KNP, it could serve to mitigate some of the concerns raised (Chapter 3) about the lack of connectivity

between privately-owned rhino populations. This could also aid in the more effective deployment of anti-poaching strategies if such efforts were to be combined.

The DEA (2013) have actively encouraged community management of white rhinos in collaboration with private rhino owners by suggesting private owners donate 4,800 white rhinos to local communities (40 each to 120 communities) and work with them to ensure a growth rate of 5%, resulting in 29,000 by 2037. There is however no evidence to suggest that this idea has ever been put into practice. The AfRSG (2016) figures indicate that only 0.8% of South Africa's white rhinos (1,482) are under communal (community) ownership, along with only 118 black rhinos. Promotion of community ownership of wildlife could allow for the development of wildlife tourism microentrepreneurship within local communities (Morais et al., 2018). Such developments have the potential to act as link between local communities and larger parks (privately owned, or managed by government agencies), or form reserves in the manner of the APNR example discussed above, potentially further improving relationships between these currently disparate groups (Morais et al., 2018).

The potential value of engaging local communities with private rhino ownership or employment by private rhino owners appears clear. However, there are several barriers to success. The significant investment required to establish new, community-run areas for private rhino conservation is not insubstantial, nor is the level of training that would be required to enable effective conservation on such properties. The ability to generate income from these schemes would also require significant investment in training in areas such as hospitality. The negative opinions of local people demonstrated by many private rhino owners also present significant challenges to such ideas, but long-term preservation of their animals may require private rhino owners to engage in such activities despite their personal feelings towards them. With the links between socio-economic conditions of the local community and rhino poaching being so clear within KwaZulu-Natal (Chapter 5), this province presents as the ideal place to investigate the feasibility of community conservation schemes within South Africa.

Future work

Due to the risks associated with discussing their stock and their anti-poaching strategies, engagement of private rhino owners in this work was low. It is therefore presented as indicative as the variety of properties involved in private rhino ownership and the views held by those involved in the industry. Aside from combining the findings here with other work on the subject (Rubino and Pienaar, 2018a; Rubino and Pienaar, 2018b; Pienaar et al., 2017; Wright et al., 2016; Cousins et al., 2008) a fuller picture of the industry could only be provided by surveying every single private rhino owner in South Africa. However, even the official surveys conducted by the Private Rhino Owners Association (PROA) in collaboration with the DEA have not been successful in this endeavour.

To fully assess the poaching on private land, it would be necessary to access all records of such events. As this was not possible (for several reasons discussed previously), again the poaching information (Chapters 4 and 5) are presented as indicative, rather than an accurate representation of the situation. In particular, it would be useful to include more reports from Mpumalanga province. The low representation of this province in the dataset prevented any conclusions being made about poaching within that area. Given the large privately-owned white rhino population in Mpumalanga (Balfour et al., 2015) and the high level of poaching there (Rhino Alive, 2018), it is likely that such information would greatly add to the analysis presented here. A full dataset would also permit more complex analysis of the data (discussed above: Modelling of data), which was of limited use here due to the limitations of the dataset.

The anti-poaching information collated here (Chapter 2) forms a pilot study of such strategies. A full assessment of the use and effectiveness of anti-poaching activities would therefore be valuable for aiding the protection of privately-owned rhinos.

Trade has been discussed throughout this work and remains a subject that requires significantly more research effort. Whilst there is so much unknown about the impacts international trade in rhino horn may have, it would seem prudent to continue to prevent such actions. However, the calls for trade from private rhino owners should not be ignored and therefore experts who are both pro- and anti-trade should collaborate to fully explore the potential of such trade. Greater transparency

from the DEA regarding the recently relegalised internal trade in horn should assist with this.

Final conclusions and recommendations

Private rhino owning properties vary in their area, populations and priorities, yet face many of the same challenges. It is clear that private rhino owners have played a significant role in increasing population sizes, but their wider conservation role is generally unknown beyond the industry. Private rhino owners should engage with NGOs and local communities to improve poor perceptions of their conservation role. Whilst increased collaboration with local communities in particular may have associated risks, potential exists for increased employment and positive engagement. The potential for community ownership of rhinos in the form of ICDP or other CBNRM programmes should also be considered, with funding potentially from provincial or national government, or NGO partners. The potential for NGOs to engage with private rhino owners in PES schemes also exists and would assist in greater visibility of their wider role in conserving biodiversity. Greater integration with state-owned rhino populations could also assist in publicising the wider role of private rhino owners. Such integration and collaborations could assist with reducing the poaching challenges and associated economic pressures experienced by private rhino owners.

Whilst poaching is a challenge across the country, it is not evenly dispersed. Poaching on private land generally is focused in areas with large privately-owned rhino populations and where poaching is high across all land ownership. However, different provinces show differences in their hotspots. For that reason, it is unlikely that a national strategy on private-land poaching would be effective. Given that most conservation regulations are implemented at provincial level, the opportunity exists for provinces to develop strategies to tackle poaching in ways which would be most effective in their particular area. There are few socio-economic factors linked to poaching across the country, but within KwaZulu-Natal there are strong associations with unemployment and lack of formal education. The potential opportunities for local community engagement in rhino conservation discussed above could serve to mitigate some of these factors within this province.

At a broader level, it would clearly be valuable for clearer information to be available regarding the official definition of poaching utilised by the DEA. The lack of clarity makes it very difficult to assess the potential future scale of the poaching crisis. The inclusion of information regarding lost pregnancies and collateral calf deaths would also be useful in assessing the future of rhino populations. It is also essential that there is clarification on the size of the rhino population within Kruger National Park. With official estimates varying so far from what has been calculated using population demographics, it is possible that the population is substantially smaller than is currently thought. If this is the case, then the risk to rhino populations in South Africa may be very much higher than is currently understood. In that situation, private rhino owners would have an even more valuable role to play in the conservation of large numbers of these animals.

In light of that potential, the risk of disinvestment by private rhino owners is especially concerning. Improved support for private rhino owners may be necessary to prevent such disinvestment. Whilst there are calls to legalise international trade in horn to generate income and help reduce the risk of disinvestment, there are many arguments both in favour and against the possibility of international trade in rhino horn. Any considerations around future developments in horn trade would benefit from greater collaboration and improved communication between all stakeholders, to ensure that any changes in regulations would meet the concerns of all parties. If trade is not permitted, then alternative means of supporting private rhino owners to prevent disinvestment and allow their continued conservation activities must be considered.

References

Adcock, K. and Emslie, R. (1994). *The role of trophy hunting in white rhino conservation, with special reference to BOP Parks.* In: *Proceedings of a Symposium on "Rhinos as Game Ranch Animals*", Onderstepoort, South Africa, 9-10 September 1994. Wildlife Group, South African Veterinary Association.

AfRSG (IUCN SSC African Rhino Specialist Group) (2016). *African rhino range states' African rhino conservation plan*. [Online] IUCN. Available at:

www.environment.gov.za/sites/default/files/docs/african_rhinoconservation_plan.pdf [Accessed 18 April 2019].

Atkinson, D. (2016). Is South Africa's Great Karoo region becoming a tourist destination? *Journal of Arid Environments*, 127, 199-210.

Aung, U. M. (2007). Policy and practice in Myanmar's protected area system. *Journal of Environmental Management*, 84, 188-203.

Austin, K. L. (2019). *Follow the guns: An overlooked key to combat rhino poaching and wildlife crime*. [Online] Conflict Awareness Project. Available at: www.followtheguns.org [Accessed 24 April 2019].

Balfour, D., Knight, M. and Jones, P. (2015). *Status of white rhino on private and communal land in South Africa: 2012 - 2014*. Pretoria: Department of Environmental Affairs.

Barnes, J. I. and de Jager, J. L. V. (1996). Economic and financial incentives for wildlife use on private land in Namibia and the implications for policy. *South African Journal of Wildlife Research*, 26, 37-46.

Barrett, C. B. and Arcese, P. (1995). Are Integrated Conservation-Development Projects (ICDPs) sustainable? On the conservation of large mammals in sub-Saharan Africa. *World Development*, 23, 1073-1084.

Beale, C. M., Hauenstein, S., Mduma, S., Frederick, H., Jones, T., Bracebridge, C., Maliti, H. and Kohi, E. M. (2018). Spatial analysis of aerial survey data reveals correlates of elephant carcasses within a heavily poached ecosystem. *Biological Conservation*, 218, 258-267.

Biggs, D., Courchamp, F., Martin, R. and Possingham, H. P. (2013). Legal trade of Africa's rhino horns. *Science*, 339, 1038-1039.

Brockett, B. H. (2002). Accuracy, bias and precision of helicopter-based counts of black rhinoceros in Pilanesberg National Park, South Africa. *South African Journal of Wildlife Research*, 32, 121-136.

Bulte, E. H. and Damania, R. (2005). An economic assessment of wildlife farming and conservation. *Conservation Biology*, 19, 1222-1233.

Butt, B. (2012). Commoditizing the safari and making space for conflict: Place, identity and parks in East Africa. *Political Geography*, 31, 104-113.

Challender, D. W. S. and MacMillan, D. C. (2014). Poaching is more than an enforcement problem. *Conservation Letters*, 7, 484-494.

Cheteni, P. (2014). An analysis of anti-poaching techniques in Africa: a case of rhino poaching. *Environmental Economics*, 5, 63-70.

Clements, R., Rayan, D. M., Zafir, A. W. A., Venkataraman, A., Alfred, R., Payne, J., Ambu, L. and Sharma, D. S. K. (2010). Trio under threat: can we secure the future of rhinos, elephants and tigers in Malaysia? *Biodiversity Conservation*, 19, 1115-1136.

Cohn, J. P. (1988). Halting the rhino's demise. *BioScience*, 38, 740-744.

Cousins, J. A., Sadler, J. P. and Evans, J. (2008). Exploring the role of private wildlife ranching as a conservation tool in South Africa: Stakeholder perspectives. *Ecology and Society*, 13, 43 https://www.ecologyandsociety.org/vol13/iss2/art43/

Cousins, J. A., Sadler, J. P. and Evans, J. (2010). The challenge of regulating private wildlife ranches for conservation in South Africa. *Ecology and Society*, 15, 28. https://www.ecologyandsociety.org/vol15/iss2/art28/

Cumming, T. and Daniels, F. (2014). South Africa. In: Stolton, S., Redford, K. H. and Dudley, N. (Eds.). *The Futures of Privately Protected Areas*. Gland: IUCN.

Critchlow, R., Plumptre, A. J., Driciru, M., Rwetsiba, A., Stokes, E. J., Tumwesigye, C., Wanyama, F. and Beale, C. M. (2015). Spatiotemporal trends of illegal activities from ranger-collected data in a Ugandan National Park*. Conservation Biology*, 29, 1458-1470.

Crookes, D. J. and Blignaut, J. N. (2015). Debunking the myth that a legal trade will solve the rhino horn crisis: A system dynamics model for market demand. *Journal for Nature Conservation*, 28, 11-18.

Crosta, A., Sutherland, K. and Talerico, C. (2017). *Grinding rhino. An undercover investigation on rhino horn trafficking in China and Vietnam*. Los Angeles: Elephant Action League.

de Bruin, L. (2015). *Kruger rhino numbers in crisis, says expert*. [Online] Oxpeckers Available at: https://oxpeckers.org/2015/06/kruger-rhino-numbers-in-crisis-says-expert/ [Accessed 12 May 2019].

Department of Defence (DoD) (2013). *Moves against rhino poachers are starting to bear fruit*. [Online] Department of Defence. Available at: http://www.dod.mil.za/operations/poaching/rhino.htm [Accessed 06 September 2018].

Department of Environmental Affairs (DEA) (2013). *Rhino issue management report 2013*. Pretoria: Department of Environmental Affairs.

Department of Environmental Affairs (DEA), (2014). *Update on rhino poaching statistics (17 January 2014 update).* [Online] DEA. Available at: http://www.environment.gov.za/mediarelease/rhinopoaching_statistics_17jan2014 [Accessed 08 February 2018].

Department of Environmental Affairs (DEA), (2015)*. Minister Edna Molewa highlights progress in the fight against rhino poaching 30 August 2015*. [Online] DEA. Available at:https://www.environment.gov.za/mediarelease/molewa_highlightsprogress_onrhinopoaching [Accessed 12 May 2019].

Department of Environmental Affairs (DEA) (2016). *Finalised rhino matters for April 2015 to March 2016* [Online] DEA. Available at: www.environment.gov.za/sites/default/files/docs/rhinomatters_april2015_march2016.pdf [Accessed 20 February 2019].

Department of Environmental Affairs (DEA), (2017). *Minister Molewa highlights progress on integrated strategic management of rhinoceros 27 February 2017.* [Online] DEA. Available at: https://www.environment.gov.za/mediarelease/molewa_progressonintegrated_strategicmanagement_ofrhinoceros [Accessed 09 January 2018].

Department of Environmental Affairs (DEA), (2018). *Department of Environmental Affairs highlights progress on the implementation of the integrated strategic management of rhinoceros 21 September 2018.* [Online] DEA. Available at: https://www.environment.gov.za/mediarelease/progressonimplementationofISMR [Accessed 26 May 2019].

Department of Environmental Affairs (DEA), (2019). *Minister Nomvula Mokonyane highlights progress on the implementation of the integrated strategic management of rhinoceros and other associated endangered species in SA 13 February 2019.* [Online] DEA. Available at: https://www.environment.gov.za/mediarelease/mokonyane_2018integratedstrategic_managementofrhinoceros_2019feb [Accessed 11 May 2019].

Dinerstein, E., Varma, K., Wikramanayake, E., Powell, G., Lumpkin, S., Naidoo, R., Korchinsky, M., Del Valle, C., Lohani, S., Seidensticker, J. et al. (2012). Enhancing conservation, ecosystem services and local livelihoods through a wildlife premium mechanism. *Conservation Biology*, 27, 14-23.

Douglas-Hamilton, I. (1997). Proposal for "green hunting" of elephants as an alternative to lethal sport hunting. *Pachyderm*, 24, 30-35.

Drury, R. (2009). Reducing urban demand for wild animals in Vietnam: Examining the potential of wildlife farming as a conservation tool. *Conservation Letters*, 2, 263-270.

Dutton, A. J., Hepburn, C. and MacDonald, D. W. (2011). A stated preference investigation into the Chinese demand for farmed vs. wild bear bile. *PLoS ONE*, 6, 1-10.

East, R. (1981). Species-areas curves and populations of large mammals in African savannah reserves. *Biological Conservation*, 21, 111-126.

EIA International (2019). *Chinese Government document signals decision to open tiger trade is quietly going ahead*. [Online] EIA International. Available at: https://eia-international.org/chinese-government-document-signals-decision-to-open-tiger-trade-is-quietly-going-ahead/ [Accessed 24 April 2019].

Emslie, R. H. and Brooks, M. (1999). *African Rhino: Status survey and conservation action plan*. Gland: IUCN.

Emslie, R. H., Milliken, T. and Talukdar, B. (2013). *African and Asian rhinoceros - status, conservation and trade. A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf. Doc. 9.14 (Rev. CoP15)*.

Report to CITES 16th meeting (Bangkok, March 2013), CoP 16 Doc.54.2 Annex. Geneva: CITES Secretariat.

Emslie, R. H., Milliken, T., Talukdar, B., Ellis, S., Adcock, K. and Knight, M. H. (2016). *African and Asian rhinoceroses - status, conservation and trade. A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf. 9.14 (Rev. CoP15).* Report to CITES 17th meeting (Johannesburg, September-October 2016), CoP 17 Doc.68 annex 5. Geneva: CITES Secretariat.

Emslie, R. H., Milliken, T., Talukdar, B., Burgess, G., Adcock, K., Balfour, D. and Knight, M. H. (2019). *African and Asian rhinoceroses - status, conservation and trade: A report from the IUCN Species Survival Commission (IUCN/SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf. 9.14 (Rev. CoP17) (No. CoP18 Doc. 83.1 Annex 2)*. Geneva: CITES Secretariat.

Ferreira, P. C. (not dated). *Karoo Gariep Nature Reserve Rhino Conservation Business Plan*. Hanover: Karoo Gariep Nature Reserve.

Ferreira, S. M. and Okita-Ouma, B. (2012). A proposed framework for short-, medium- and long-term responses by range and consumer states to curb poaching for African rhino horn. *Pachyderm*, 51, 52-59.

Ferreira, S. M., Botha, J. M. and Emmett, M. C. (2012). Anthropogenic influences on conservation values of white rhinoceros. *PLoS ONE*, 7, 1-14

Freeman, M. M. R. and Wenzel, G. W. (2000). The nature and significance of polar bear conservation hunting in the Canadian Arctic. *Arctic*, 59, 21-30.

Gallo, J. A., Pasquini, L., Reyers, B. and Cowling, R. M. (2009). The role of private conservation areas in biodiversity representation and target achievement within the Little Karoo region, South Africa. *Biological Conservation*, 142, 446-454.

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

Goddard, J. (1967). The validity of censusing black rhinoceros populations from the air. *East African Wildlife Journal*, 5, 18-23.

Government Communication and Information System (2016). *Statement on the Cabinet Meeting of 13 April 2016* [Online]. Government Communication and Information System. Available at: www.gcis.gov.za/newsroom/media-releases/statement-cabinet-meeting-13-april-2016 [Accessed 20 February 2019].

Haines, A. M., Elledge, D., Wilsing L. K., Grabe, M., Barske, M. D., Burke, N. and Webb, S. L. (2012). Spatially explicit analysis of poaching activity as a conservation management tool. *Wildlife Society Bulletin*, 36, 685-692.

Hall-Martin, A. J., du Toit, J. G., Hitchens, P. M. and Knight, M. H. (2009). *An exert of the 2008 survey of white rhinoceros, Ceratotherium simum simum, on private land in South Africa*. Cape Town: WWF-African Rhino Programme.

Hamrick, K. (2016). *State of private investment in conservation 2016. A landscape assessment of an emerging market*. JPMorgan Chase & Co.: New York.

Hayward, M. W. and Kerley, G. I. H. (2009). Fencing for conservation: Restriction of evolutionary potential or a riposte to threatening processes? *Biological Conservation*, 142, 1-13.

Hayward, M. W., Ripple, W. J., Kerley, G. I. H., Landman, M., Plotz, R. D. and Garnett, S. T. (2017). Neocolonial conservation: Is moving rhinos to Australia conservation or intellectual property loss? *Conservation Letters*, 11, e12354.

Hume, J. (2013). Saving rhino from extinction. *African Indaba*, 11, 14-17.

Ingram, J. C., Wilkie, D., Clements, T., M, cNab, R. B., Nelson, F., Baur, E. H., Sachedina, H. T., Peterson, D. D. and Foley, C. A. H. (2014). Evidence of payments for ecosystem services as a mechanism for supporting biodiversity conservation and rural livelihoods. *Ecosystem Service*, 7, 10-21.

International Criminal Police Organization (INTERPOL) (2017). *Project Wisdom*. [Online]. INTERPOL. Available at: www.interpol.int/content/download/5177/file/Project%20Wisdom.pdf [Accessed 02 May 2019].

Jones, B. T. B., Stolton, S. and Dudley, N. (2005). Private protected areas in east and southern Africa: contributing to biodiversity conservation and rural development. *Parks*, 15, 67-77.

Jones, P. (2013). *Rhino economics role of the private sector*. Speech to CITES CoP Bangkok, 2013

Joubert, S.C.J. (2015). White rhinoceros populations in the Kruger National Park during the 1900's. In: du Toit, J.G. (Ed.), *The Story of the White Rhinoceros*. Krugersdorp: Kejafa Knowledge Works.

Kelso, B. J. (1993). Hunting for conservation. *Africa Report*, 38, 68-71.

Kiss, A. (1990). *Living with wildlife: wildlife resource management with local participants in Africa*. *Technical Paper, 130*. Washington DC: World Bank.

Knight, M. (2015). Calling all rhino owners: How can you, the private rhino owner, help to solve the rhino crisis? *Wildlife Ranching*, 4, Rhino Supplement, 9-13.

Knight, M. H., Balfour, D. and Emslie, R. H. (2013). *Biodiversity management plan for the black rhinoceros (Diceros bicornis) in South Africa 2011-2020*. *Government Notice No. 36096.* Pretoria: Department of Environmental Affairs.

Koen, H., de Villiers, J.P., Roodt, H. & de Waal, A. (2017). An expert-driven causal model of the rhino poaching problem. *Ecological Modelling*, 347, 29-39.

Kreuter, U., Peel, M. and Warner, E. (2010). Wildlife conservation and community-based natural resource management in southern Africa's private nature reserves. *Society and Natural Resources*, 23, 507-524.

Leader-Williams, N. and Milner-Gulland, E. J. (1993). Policies for the enforcement of wildlife laws: The balance between detection and penalties in Luangwa Valley, Zambia. *Conservation Biology*, 7, 611-617.

Lee, D. E. and Du Preez, M. (2015). *Determining visitor preferences for rhinoceros conservation management at private, ecotourism game reserves in the Eastern Cape Province, South Africa: A choice modelling experiment*. *ERSA Working Paper 502*. Cape Town: Economic Research Southern Africa.

Lee, T. E. and Roberts, D. L. (2016). Devaluing rhino horn as a theoretical game, *Ecological Modelling*, 337, 73-78.

Lotter, W. and Clark, K. (2014). Community involvement and joint operations aid effective anti-poaching. *Parks*, 20, 19-28.

MacMillan, D., Bozzola, M., Hanley, N., Kasterine, A. & Sheremet, O. (2017). *Demand in Viet Nam for rhino horn used in traditional medicine*. Geneva: International Trade Centre.

Massey, A. L., King, A. A. and Foufopoulos, J. (2014). Fencing protected areas: A long-term assessment of the effects of reserve establishment and fencing on African mammalian diversity. *Biological Conservation*, 176, 162-171.

Messer, K. D. (2010). Protecting endangered species: When are shoot-on-sight policies the only viable option to stop poaching? *Ecological Economics*, 69, 2334-2340.

Milliken, T. and Shaw, J. (2012). *The South Africa – Viet Nam rhino horn trade nexus: A deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates*. Johannesburg: TRAFFIC.

Milner-Gulland, E. J. (1993). An economic analysis of consumer demand for ivory and rhino horn. *Environmental & Resource Economics*, 3, 73-95.

Milner-Gulland, E. J. and Clayton, L. (2002). The trade in barbirusas and wild pigs in North Sulawesi, Indonesia. *Ecological Economics*, 42, 165-183.

Milner-Gulland, E. J. and Leader-Williams, N. (1992). A model of incentives for the illegal exploitation of black rhinos and elephants: poaching pays in Luangwa Valley, Zambia. *Journal of Applied Ecology*, 29, 388-401.

Moneron, S., Okes, N. and Rademeyer, J. (2017). *Pendants, Powder and Pathways*. Pretoria: TRAFFIC.

Morais, D. B., Bunn, D., Hoogendoorn, G. and KC, B. (2018). The potential role of tourism microentrepreneurship in the prevention of rhino poaching. *International Development Planning Review*, 40, 443-461.

Moyle, B. (2003). Regulation, Conservation and Incentives. In Oldfield, S. (Ed). *The Trade in Wildlife: Regulation for Conservation*. London: Earthscan Publications Ltd.

Mulero-Pázmány, M., Stolper, R., van Essen, L.D., Negro, J.J. & Sassen, T. (2014). Remotely piloted aircraft systems as a rhinoceros anti-poaching tool in Africa. *PLoS ONE*, 9, e83873.

National Treasury (2016). *2016 Budget. Estimates of national expenditure. Environmental Affairs.* [Online]. Department of National Treasury. Available at: www.treasury.gov.za/documents/national%20budget/2016/enebooklets/Vote%2027%20Environmental%20Affairs.pdf [Accessed 20 February 2019].

Parliamentary Monitoring Group (2019). *SANParks & SANBI Annual Performance Plan & Quarter 4 performance with Minister Environment, Forestry and Fisheries.* [Online]. Parliamentary Monitoring Group. Available at: pmg.org.za/committee-meeting/28760/?utm_campaign=minute-alert&utm_source=transactional&utm_medium=email&fbclid=IwAR1qsGgBy7s7x5de5uBdKjVAjX76avJ3uDgtg363DLpUuiFBioFh6thM8 [Accessed 12 September 2019].

Phillips, L. (2019). Latest rhino poaching statistics called into question. *Farmer's Weekly*. [Online] Caxton Magazines Digital. Available at: www.farmersweekly.co.za/argi-news/south-africa/latest-rhino-poaching-statistics-called-into-question/ [Accessed 06 March 2019].

Pienaar, D. J., Hall-Martin, A. J. and Hitchens, P. M. (1991). Horn growth rates of free-ranging white and black rhinoceros. *Koedoe*, 34, 97-105.

Pienaar, E. F., Rubino, E. C., Saayman, M. and van der Merwe, P. (2017). Attaining sustainable use on private game ranching lands in South Africa. *Land Use Policy*, 65, 176-185.

Pitman, R. T., Fattebert, J., Williams, S. T., Williams, K. S., Hill, R. A., Hunter, L. T. B., Slotow, R. and Balme, G. A. (2016). The conservation costs of game ranching. *Conservation Letters*, 10, 403-413.

Prins, H. H. T. and Okita-Ouma, B. (2013). Rhino poaching: unique challenges. *Science*, 140, 1167-1168.

Project Rhino (2017). *Press release: Project Rhino's call to de-horn rhino*. [Online] Project Rhino. Available at: https://www.facebook.com/notes/project-rhino/press-release-project-rhinos-call-to-de-horn-rhino/1904646566227325 [Accessed 11 May 2019].

Rachlow, J. L. and Berger, J. (1997). Conservation implications of patterns of horn regeneration in dehorned white rhinos. *Conservation Biology*, 11, 84-89.

Rashidi, P., Wang, T., Skidmore, A., Mehdipoor, H., Darvishzadeh, R., Ngene, S., Vrieling, A. and Toxopeus, A. G. (2016). Elephant poaching risk assessed using spatial and non-spatial Bayesian models. *Ecological Modelling*, 338, 60-68.

Rayan, D. M. and Linkie, M. (2015). Conserving tigers in Malaysia: A science-driven approach for eliciting conservation policy change. *Biological Conservation*, 134, 18-26.

Rhino Alive (2018). *South Africa: National rhino poaching statistics - detailed analysis of the 2017 statistics.* [Online]. Private Rhino Owners Association (PROA). Last updated: 4 March 2018. Available at: https://www.facebook.com/RhinoAlive/photos/a.455648507965862/745294002334643/?type=3&theater [Accessed 23 February 2019].

Roe, D., Cooney, R., Dublin, H., Challender, D., Biggs, D., Skinner, D., Abensperg-Traun, M., Ahlers, N., Melisch, R. and Murphree, M. (2015). *Beyond enforcement: engaging communities in tackling wildlife crime*. [Online] IIED. Available at: http://pubs.iied.org/pdfs/17293IIED.pdf [Accessed 06 June 2019].

Rubino, E. C. and Pienaar, E. F. (2017). Applying a conceptual framework to rhinoceros conservation on private lands in South Africa. *Endangered Species Research*, 34, 89-102.

Rubino, E.C. and Pienaar, E.F. (2018a). Understanding South African private landowners decisions to manage rhinoceroses. *Human Dimensions of Wildlife*, 23, 160-175.

Rubino, E.C. and Pienaar, E.F. (2018b). Rhinoceros ownership and attitudes towards legalization of global horn trade within South Africa's private wildlife sector. *Oryx*. doi:10.1017/s0030605318000030

Rubino, E. C., Pienaar, E. F. and Soto, J. R. (2018). Structuring legal trade in rhino horn to incentivize the participation of South African private landowners. *Ecological Economics*, 154, 306-316.

Save the Rhino (2016). *How to apply for a grant from Save the Rhino*. [Online]. Save the Rhino. Available at: www.savetherhino.org/about-us/grants/grant-making-policy/ [Accessed 20 February 2019].

Saving the Survivors (2015). *Things you never knew about poaching statistics* [Online] Saving the Survivors. Available at: https://www.facebook.com/savingthesurvivors/photos/a.727427787298531/918972144810760/?type=3&theater [Accessed 11 May 2019].

Scott, S. and de Bod, B. (2018). Rhino poaching update - we look behind the numbers. *Africa Geographic Online*. [Online] Africa Geographic. Available at: https://africageographic.com/blog/rhino-poaching-update-we-look-behind-the-numbers/ [Accessed 08/02/18].

Sims-Castley, R., Kerley, G. I. H., Geach, B. and Langholz, J. (2005). Socio-economic significance of ecotourism-based private game reserves in South Africa's Eastern Cape Province. *Parks*, 15, 6-18.

Sodhi, N. S., Butler, R., Laurance, W. F. and Gibson, L. (2011). Conservation successes at micro-, meso- and macroscales. *Trends in Ecology and Evolution*, 26, 585-594.

Taylor, A., Balfour, D., Brebner, D. K., Coetzee, R., Davies-Mostert, H., Lindsey, P. A., Shaw, J. and 't Sas-Rolfes, M. (2017). Sustainable rhino horn production at the pointy end of the rhino horn trade debate. *Biological Conservation*, 216, 60-68.

TRAFFIC (2015). Rhinoceros. *TRAFFIC Bulletin*, 27, 70-72.

‘t Sas-Rolfes, M. (2012). *The rhino poaching crisis: a market analysis*. [Online] Rhino Economics. Available at: http://www.rhino-economics.com/wp-content/uploads/2012/04/The-Rhino-Poaching-Crisis-by-Michael-t-Sas-Rolfes-Final.pdf [Accessed 06 September 2016].

Ververs, C., van Zijll Langhout, M., Hostens, M., Otto, M., Govaere, J., Durrant, B. and Van Soom, A. (2017). Reproductive performance parameters in a large

population of game-ranched white rhinoceroses (*Ceratotherium simum simum*). *PLoS ONE*, 12, e0187751.

Warchol, G. L. (2004). The transnational illegal wildlife trade. *Criminal Justice Studies*, 17, 57-74.

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

Wright, O.T., Cundill, G. and Bigg, D. (2016). Stakeholder perceptions of legal trade in rhinoceros horn and implications for private reserve management in the Eastern Cape, South Africa. *Oryx*, 52, 175-185.

Appendices

Appendix I: Qualtrics questionnaire distributed to private rhino owners

Appendix II: Ethical review form for questionnaire

Appendix III: Ethical review form for interviews

Appendix IV: Example (rhino owners) participant information sheet and consent form (English and Afrikaans)

Appendix I: Qualtrics questionnaire distributed to private rhino owners

Rhino poaching on private land

This research is being conducted in order to identify trends in the poaching of rhino on private land in South Africa. Your contribution, regardless of whether you have experienced rhino poaching on your property or not, is invaluable. Please answer as many questions as you can. You are not required to provide any personal information which could directly identify either you or your property. If you do wish to provide a contact name and/or email address that information will be removed from the rest of your answers to ensure your answers cannot be linked to your property. By completing this questionnaire you consent to your answers being used in this research.

Municipality and/or district where your property is located

_____

What is the size of your property?

_____

What habitat types are found on your property?

_____

What type of fencing does your property have?

_____

Monthly income of property

_____

Monthly security expenditure - excluding specific anti-rhino poaching expenditure

_____

Monthly anti-rhino poaching expenditure (over and above normal security expenditure)

_____

Approximately how much has your security expenditure increased by over the last decade?

- ○ 0-24% (1)
- ○ 25-49% (2)
- ○ 50-99% (3)
- ○ 100-199% (4)
- ○ Over 200% (5)

Which anti-poaching methods are/have been employed on your property? Select all that apply. For each, please also specify what years they were in place - e.g. 2005-2008, 2009-ongoing etc.

- [ ] Staff anti-poaching patrols (1) _____
- [ ] Volunteer anti-poaching patrols (2) _____
- [ ] Trained APU (3) _____
- [ ] Anti-poaching dogs (4)_____
- [ ] Security cameras (5) _____
- [ ] Security alarms (6) _____
- [ ] Unstaffed watch towers (7) _____
- [ ] Staffed watch towers (8) _____
- [ ] Drones (9) _____
- [ ] Dehorning of rhino (10) _____
- [ ] Other - please specify (11) _____

For each method of anti-poaching you currently employ, please indicate how much time per month (in person-days) is invested, or the average cost per month

- [ ] Staff anti-poaching patrols (1) _____
- [ ] Volunteer anti-poaching patrols (2)_____
- [ ] Trained APU (3) _____
- [ ] Anti-poaching dogs (4)_____
- [ ] Security cameras (5) _____
- [ ] Security alarms (6) _____
- [ ] Unstaffed watch towers (7)_____
- [ ] Staffed watch towers (8) _____
- [ ] Drones (9) _____
- [ ] Dehorning of rhino (10) _____
- [ ] Other - please specify (11) _____

Does your property have any of the following? Select all that apply.

- [ ] Carnivores, excluding lions (1)
- [ ] Lions (2)
- [ ] Elephants (3)

Primary objective of property

- ○ Private recreation (1)
- ○ Eco-tourism (2)
- ○ Breeding (3)
- ○ Hunting (4)
- ○ Conservation (5)
- ○ Other - please specify (6)_____

Secondary objective of property (if applicable)

- ○ Private recreation (1)
- ○ Eco-tourism (2)
- ○ Breeding (3)
- ○ Hunting (4)
- ○ Conservation (5)
- ○ Other - please specify (6) _____

What surrounds your property? Select all that apply.

- [ ] Roads (1)
- [ ] Domestic animal grazing (2)
- [ ] Squatters camp (3)
- [ ] Township (4)
- [ ] Other wildlife habitats (5)
- [ ] Other please specify (6) _____

What do you consider to be the biggest risk factors to the rhino on your property?

_____

Have you considered no longer keeping rhino on your property? If so, why?

_____

How often have you found evidence that rhino poachers have been on/near your property in the last 12 months? What evidence have you found of this?

- ○ Less than 3 times in 12 months (1)
- ○ Between 3 and 6 times (2)
- ○ Around once a month (3)
- ○ Around once a week (4)
- ○ More than once a week (5)

_____

How often have you found evidence that bush meat poachers have been on/near your property in the last 12 months? Please indicate what evidence you have found in of this in the box.

- ○ More than 3 times in 12 months (1)
- ○ Less than 3 times in 12 months (2)
- ○ Less than once a month (3)
- ○ 2-3 times a month (4)
- ○ Once a week (5)
- ○ More than once a week (6)

_____

End of Block: Property Information

Start of Block: Rhino

How frequently do you monitor your rhino population?

- ○ Daily (1)
- ○ Weekly (2)
- ○ Monthly (3)
- ○ Quarterly (4)
- ○ Annually (5)

How are your rhino monitored?

_____

What percentage of your rhino are individually identifiable (through ear notching for example)?

_____

What percentage of your rhino have horn and/or body transponders?

_____

What percentage of your rhino have had DNA samples taken and submitted to the RhoDIS System?

_____

For what percentage of your rhino do you have detailed records of births (dates, mother, potential father) for the past five years?

_____

For what percentage of your rhino do you have detailed records of mortalities (dates, causes, time since death, how/who found carcass etc.) for the past five years?

_____

For what percentage of your rhino do you have detailed records of introductions & removals (age, sex, dates, rhino IDs, origins/ destinations, prices etc.) for the past 5 years?

_____

How many white rhino do you have in the following groups?

	If these are estimates, please state "approx." (1)
Juvenile male (1)	
Juvenile female (2)	
Sub-adult male (3)	
Sub-adult female (4)	
Adult male (5)	
Adult female (6)	

How many black rhino do you have in the following groups?

	If these are estimates, please state "approx." (1)
Juvenile male (1)	
Juvenile female (2)	
Sub-adult male (3)	
Sub-adult female (4)	
Adult male (5)	
Adult female (6)	

End of Block: Rhino

Start of Block: Poaching Incidents

Please enter details of all known rhino poaching incidents on your property

Date of poaching incident (1)	Species - white or black rhino (2)	Male or female rhino? (3)	Approximate age of poached animal (4)	Result? - killed and dehorned/ killed not dehorned/ dehorned not killed (5)	Where on property? - perimeter/ within 3km of perimeter/ core (6)	If the rhino was poached near the perimeter, what lies along that boundary - road/ settlement etc? (7)	Method of poaching - gunshot/ snare/ poison/ darting with sedative/ other (please specify) (8)	Pregnant or with dependent calf? If calf was also poached, please complete another entry for the calf. If not, what happened to the calf? (9)	Approximate number of rhino on property at that time (10)	Habitat the poached rhino was found in (11)	Approximate time of day poaching occurred (if known) (12)

End of Block: Poaching Incidents

Start of Block: Thank you

Thank you so much for completing this survey.

If you would be interested in receiving regular updates on the progress of this research and accessing the results, please provide an email address:

_____

If you would be interested in contributing further to this research, in the form of interviews and focus groups, please also provide a contact name:

_____

End of Block: Thank you

Appendix II: Ethical review form for questionnaire

Environment Department, University of York
Research Ethics Approval Form

1 Project Information (Everyone) **a)** Title of Project Rhino poaching on private farms in South Africa
b) Name of Principal Investigator (PI) or Research Student and Supervisor Laura Chapman (PhD student) Piran White (Supervisor)
c) Degree course (students) or SEI-Y or Env Dept (staff) PhD Environmental Science
d) Names of Co-investigators (CIs) and their organisational affiliation N/A
e) How many additional research staff will be gathering data for the project? Names and their organisational affiliation (if known) N/A
f) Proposed project start date (At least four weeks in the future) March 2016
g) Estimated project end date June 2021
h) Who is funding the project? Self funded Has funding been confirmed? N/A
You may find the following codes of ethical practice and conduct relevant to your project: British Psychological Society code of conduct: http://www.bps.org.uk/the-society/code-of-conduct/code-ofconduct_home.cfm BCS Chartered Institute for IT Code of Conduct: http://www.bcs.org/server.php?show=nav.6030 Society of Environmental Toxicology and Chemistry (SETAC) code of ethics http://www.setac.org/?page=SETACEthics Guidelines for the Treatment of Animals in Behavioural Research and Teaching http://asab.nottingham.ac.uk/ethics/guidelines.php

2. Does this project need ethical approval?	**Yes**	**No**

a) Does the project involve collecting primary data from, or about, living human beings?	X	
b) Does the project involve analysing primary or unpublished data from, or about, living human beings?	X	
c) Does the project involve collecting or analysing primary or unpublished data about people who have recently died, other than data that are already in the public domain?		X
d) Does the project involve collecting or analysing primary or unpublished data about or from organisations or agencies of any kind, other than data that are already in the public domain?	X	
e) Does the project involve research with non-human animals (vertebrates or invertebrates)?		X
f) Does the project place the participants or the researchers in a dangerous environment, risk of physical harm, psychological or emotional distress?		X

If you answered **Yes** to any of these questions, please proceed to **Section 3**.

If you answered **No** to all these questions:

• You should type your name in the signature space in the Declaration in **Section 16**. Then email the form to the Ethics Committee for our records.
• Students must ask their Project Supervisor to also type their name in the declaration. Students should not submit your form directly. The supervisor must check the application and submit it.

3) Does the project require Disclosure and Barring Service (DBS) previously known as **Criminal Records Bureau checks?**	**Yes**	**No**
a) Does the project involve direct contact by any member of the research team with children or people under 18 years of age?		**X**
b) Does the project involve direct contact by any member of the research team with adults who have learning difficulties?		**X**
c) Does the project involve direct contact by any member of the research team with adults who are infirm or physically disabled?		**X**
d) Does the project involve direct contact by any member of the research team with adults who are resident in social care or medical establishments?		**X**
e) Does the project involve direct contact by any member of the research team with adults in the custody of the criminal justice system?		**X**

f) Has a Disclosure and Barring Service (DBS) check been stipulated as a condition of access to any source of data required for the project?		**X**

If you answered **Yes** to **any** of these questions, please:

Explain the nature of the contact required and the circumstances in which contact will be made during the project.
If you require a DBS check, please contact the DBS or check their website for more details https://www.gov.uk/disclosure-barring-service-check/contact-disclosure-and-barring-service

4) Is this project liable to scrutiny by external ethical review arrangements?	**Yes**	**No**
a) Has a favourable ethical opinion been given for this project by a social care research ethics committee, NHS, The Biology Dept Ethics Committee or by any other external research?		**X**
b) Will this project be submitted for ethical approval to a social care committee or any other external research ethics		**X**

If you answered **No to both of these questions**, please proceed to **Section 5.**

If you answered **Yes** to either of these questions:

• You should type your name in the signature space in the Declaration in **Section 16**. An email attachment sent from your University inbox will be assumed to have been signed electronically. Then email the form to the Ethics Committee for our records.

• Students must ask their Project Supervisor to also type their name in the declaration, and they should send a copy to the Ethics Committee for checking and filing. Students – do not submit your form directly to us. Your supervisor must check the application and submit it.

5) More detail about the project

a) What are the aims and objectives of the project?

This research aims to collect data regarding trends in rhino poaching on private farms.

The data should:

Identify any trends in the properties that have experienced/no-experienced rhino poaching.

Identify the effectiveness of a variety of anti-poaching techniques

Provide the basis for a risk assessment for properties based on their location, stock and anti-poaching methods.

b) Briefly describe the principal methods, the sources of data or evidence to be used and the number and type of research participants/animals who will be recruited to the project. A Qualtrics questionnaire (attached) has been produced that will be emailed to as many private rhino owners as can be identified. Approximately 90 properties have been identified so far. The data will be combined with publicly accessible census data to investigate the socio-economic environment in which these properties operate.
c) What research instrument(s), validated scales or methods will be used to collect data? Attached questionnaire.
d) If you are using an external research instrument, validated scale or research method, please specify. Qualtrics online questionnaire
e) If you are not using an externally validated scale or research method, please attach a copy of the research instrument you will use to collect data. For example, a measurement scale, questionnaire, interview schedule, observation protocol for ethnographic work or in the case of unstructured data collection a topic list.

6 Confidentiality, security and retention of research data	**Yes**	**No**
a) Are there any reasons why you cannot guarantee the full security and confidentiality of any personal or confidential data (including potentially sensitive data on animals) collected for the project?		**X**
b) Is there a significant possibility that any of your participants, or people associated with them, or sites where endangered or otherwise sensitive species, could be directly or indirectly identified in the outputs from this project?		**X**
c) Is there a significant possibility that confidential information could be traced back to a specific organisation or agency as a result of the way you write up the results of the project?		**X**
d) Will any members of the project team retain any personal or confidential data at the end of the project, other than in fully anonymised form?		**X**

If you answered **No** to all of these questions, please:

• Explain how you will ensure the confidentiality and security of your research data, both during and after the project.

6e) Participants will not be required to give the name of their property and will only give their name or contact information if they do not wish to do so. If they provide a name or contact email address (to participate in follow-up research), then that will be removed from the data and stored in a separate, password protected, file. All properties will be allocated a number and will only be identified by that throughout the research. Participants will be required to provide the municipality and/or district

of their property to allow for more detailed analysis to be conducted. However, this is not spatially detailed enough to allow a property to be identified. The main data set will be stored in a password protected file on my University computer, to be backed up on the University system.

If you answered **Yes** to any of these questions, please:

• Explain the reasons why it is essential to breach normal research protocol regarding confidentiality, security and retention of research data.

6f) Write your explanation here

7) Informed consent	**Yes**	**No**
a) Will all participants be fully informed why the project is being conducted and what their participation will involve, and will this information be given before the project begins?	**X**	
b) Will every participant be asked to give written consent to participating in the project, before it begins?		**X**
c) Will all participants be fully informed about what data will be collected, and what will be done with these data during and after the project?	**X**	
d) Will explicit consent be sought for audio, video or photographic recording of participants?		**N/A**
e) Will every participant understand what rights they have not to take part, and/or to withdraw themselves and their data from the project if they do take part?	**X**	
f) Will every participant understand that they do not need to give you reasons for deciding not to take part or to withdraw themselves and their data from the project and that there will be no repercussions as a result?	**X**	
g) If the project involves deceiving, or covert observation of, participants, will you debrief them at the earliest possible opportunity?		**N/A**

If you answered **Yes** to all these questions, please:

• Explain briefly how you will implement the informed consent scheme described in your answers.

• Attach copies of your participant information sheet and consent form as evidence of your plans.

7h) Write your explanation here

If you answered **No** to any of these questions, please:

• Explain why it is essential for the project to be conducted in a way that will not allow all participants the opportunity to exercise fully-informed consent.

• Explain how you propose to address the ethical issues arising from the absence of

transparency.

• Attach copies of your participant information sheet and consent form as evidence of your plans.

7i) The questionnaire will be distributed by email with the link to the questionnaire. The beginning of the questionnaire (and the email) will include the following paragraph:

This research is being conducted in order to identify trends in the poaching of rhino on private land in South Africa. Your contribution, regardless of whether you have experienced rhino poaching on your property or not, is invaluable. Please answer as many questions as you can. You are not required to provide any personal information which could directly identify either you or your property. If you do wish to provide a contact name and/or email address that information will be removed from the rest of your answers to ensure your answers cannot be linked to your property. By completing this questionnaire you consent to your answers being used in this research.

8) Risk of harm	**Yes**	**No**
a) Is there any significant risk that your project may lead to physical harm to participants or researchers?		**X**
b) Is there any significant risk that your project may lead to psychological or emotional distress to participants?		**X**
c) Is there any significant risk that your project may lead harm to the reputation of participants, or their employers, or of any other persons or organisations?		**X**

If you answered **Yes** to any of these questions, please:

• Explain the nature of the risks involved, why it is necessary for the participants or researchers to be exposed to such risks.

• Explain how you propose to assess, manage and mitigate any risks to participants or researchers.

• Explain the arrangements by which you will ensure that participants understand and consent to these risks.

• Explain the arrangements you will make to refer participants or researchers to sources of help, if they are seriously distressed or harmed as a result of taking part in the project.

• Explain the arrangements for recording and reporting any adverse consequences of the research.

8d) Write your explanation here:

9) Risk of disclosure of harm or potential harm	**Yes**	**No**
a) Is there a significant risk that the project will lead participants to disclose evidence of previous criminal offences, or their intention to commit criminal offences?		**X**

b) Is there a significant risk that the project will lead participants to disclose evidence that children or vulnerable adults are being harmed, or are at risk of harm?		**X**
c) Is there any significant risk that your project may lead harm to the reputation of participants, or their employers, or of any other persons or organisations?		**X**
d) Is there a significant risk that the project will lead participants to disclose evidence of serious risk of other types of harm?		**X**

If you answered **Yes** to any of these questions, please:

• Explain why it is necessary to take the risks of potential or actual disclosure.

• Explain what actions you would take, if such disclosures were to occur.

• Explain what advice you will take and from whom before taking these actions.

• Explain what information you will give participants about the possible consequences of disclosing information about criminal or serious risk of harm

9e) Write your explanation here:

10) Payment of participants	**Yes**	**No**
a) Do you intend to offer participants cash payments or any other kind of inducements or compensation for taking part in your project?		**X**
b) Is there any significant possibility that such inducements will cause participants to consent to risks that they might not otherwise find acceptable?		**N/A**
c) Is there any significant possibility that the prospect of payment or other rewards will systematically skew the data provided by participants in any way?		**N/A**
d) Will you inform participants that accepting compensation or inducements does not negate their right to withdraw from the project?		**N/A**

If you answered Yes to any of these questions, please:

• Explain the nature of the inducements or the amount of the payments that will be offered.

• Explain the reasons why it is necessary to offer payments.

• Explain why you consider it is ethically and methodologically acceptable to offer payments.

10e) Write your explanation here:

11) Capacity to give valid consent	Yes	No
a) Do you propose to recruit any participants who are under 18 years of age?		**X**
b) Do you propose to recruit any participants who have learning difficulties?		**X**
c) Do you propose to recruit any participants with communication difficulties, including difficulties arising from limited facility with the English language?	**X**	
d) Will you inform participants that accepting compensation or inducements does not negate their right to withdraw from the project?		**N/A**
e) Do you propose to recruit any participants who are very elderly or infirm?		**X**
f) Do you propose to recruit any participants with mental health problems or other medical problems that may impair their cognitive abilities?		**X**
g) Do you propose to recruit any participants who may not be able to understand fully the nature of the research and the implications for them of participating in it?		**X**

If you answered Yes to any of the questions, please:

• Explain how you will ensure that the interests and wishes of participants are understood and taken in to account.

• Explain how in the case of children the wishes of their parents or guardians are understood and taken into account.

11h) Many of the people who completed this data collection are likely to speak Afrikaans as their first language. I have a rudimentary understanding of Afrikaans and am able to call upon many native speakers to help interpret any answers I cannot translate. English is a compulsory subject in South African schools and has been for many years, so there is no reason why any of the participants should not be able to read the questionnaire in English and answer in Afrikaans if they wish.

12) Is participation genuinely voluntary?	Yes	No
a) Are you proposing to recruit participants who are employees or students of the University of York or of organisation(s) that are formal collaborators in the project?		**X**
b) Are you proposing to recruit participants who are employees recruited through other business, voluntary or public sector organisations?		**X**
c) Are you proposing to recruit participants who are pupils or students recruited through educational institutions?		**X**

d) Are you proposing to recruit participants who are clients recruited through voluntary or public services?		**X**
e) Are you proposing to recruit participants who are living in residential communities or institutions?		**X**
f) Are you proposing to recruit participants who are in-patients in a hospital or other medical establishment?		**X**
g) Are you proposing to recruit participants who are recruited by virtue of their employment in the police or armed services?		**X**
h) Are you proposing to recruit participants who are being detained or sanctioned in the criminal justice system?		**X**
i) Are you proposing to recruit participants who may not feel empowered to refuse to participate in the research?		**X**

If you answered **Yes** to any of these questions, please:

• Explain how your participants will be recruited.

• Explain what steps you will take to ensure that participation in this project is genuinely voluntary.

12j) Write your explanation here:

13) Online and Internet Research	**Yes**	**No**
a) Will any part of your project involve collecting data by means of electronic media, such as the Internet or e-mail?	**X**	
b) Is there a significant possibility that the project will encourage children under 18 to access inappropriate websites, or correspond with people who pose risk of harm?		**X**
c) Is there a significant possibility that the project will cause participants to become distressed or harmed, in ways that may not be apparent to the researcher(s)?		**X**
d) Will the project incur any other risks that arise specifically from the use of electronic media?		**X**

If you answered **Yes** to any of these questions, please:

• Explain why you propose to use electronic media.

• Explain how you propose to address the risks associated with online/internet research.

• Ensure that your answers to the previous sections address any issues related to online research.

13e) The link to the online Qualtrics questionnaire will be sent to participants by email. They can then follow the link and complete the questionnaire anonymously. Email is the most efficient way to contact as many potential participants as possible. As all of the potential participants have been identified through their

public websites, they all have access to the internet and so this means of data collection will not exclude any potential participants,

14) Other ethical risks	**Yes**	**No**
a) Are there any other ethical issues or risks of harm raised by your project that have not been covered by previous questions?		**X**

If you answered **Yes** to this question, please:

• Explain the nature of these ethical issues and risks.

• Explain why you need to incur these ethical issues and risks.

• Explain how you propose to deal with these ethical issues and risks.

14b) Write your explanation here:

15) Research with non-human animals	**Yes**	**No**
a) Will any part of your project involve the study of animals in their natural habitat?		**X**
b) Will your project involve the recording of behaviour of animals in a non-natural setting that is outside of the control of the researcher?		**X**
c) Will your field work involve any direct intervention other than recording the behaviour of the animals available for observation?		**X**
d) Is the species you plan to research endangered, locally rare or part of sensitive ecosystem protected by legislation?		**X**
e) Is there any significant possibility that the welfare of the target species or those sharing the local environment/habitat will be detrimentally affected?		**X**
f) Is there any significant possibility that the habitat of the animals will be damaged by the project, such that their health and survival will be endangered?		**X**
g) Will project work involve intervention work in a non-natural setting in relation to invertebrate species other than *Octopus vulgaris*?		**X**
h) Will project work involve intervention work or handling non-human vertebrates or *Octopus vulgaris**? **If yes, then you might require a licence under the Animals Scientific Procedures Act (1986) – contact the Ethics Committee**		**X**

If you answered **Yes** to any of these questions, please:

• Explain the reasons for conducting the project in the way you propose, and the academic benefits that will flow from it.

• Explain the nature of the risks to the animals and their habitat.

• Explain how you propose to assess, manage and mitigate these risks.

* The Animals Scientific Procedures Act (1986) was amended in 1993. As a result the common

octopus (*Octopus vulgaris*), as an invertebrate species, is now covered by the act.

15i) Write your explanation here:

16) Principal Investigator's Declaration

Please ensure that you:

• Tick all the boxes below that are relevant to your project and type your name in the declaration below.

• Students must get their Project Supervisor to countersign this declaration.

I believe that this project does not require research ethics approval.	
I have completed Sections 1-2 and kept a copy for my own records.	**X**
I realise I may be asked to provide a copy of this form at any time.	**X**
I request that this project is exempt from internal research ethics review because it will be, or has been, reviewed by an external Research Ethics Committee.	
I have completed Sections 1-4 and attach/will attach a copy of the favourable ethical review issued by the external Research Ethics Committee. Please give the name of the external Research Ethics Committee here:	
I request an ethics review and confirm that I have answered all relevant questions in this form honestly.	**X**
I confirm that I will carry out the project in the ways described in this form. I will immediately suspend research and request a new ethical approval if the project subsequently changes the information I have given in this form.	**X**
I confirm that I, and all members of my research team (if any), have read and agree to abide by the University's Code of practice and principles for good ethical governance	**X**

Appendix III: Ethical review form for interviews

Environment Department, University of York
Research Ethics Approval Form

1 Project Information (Everyone) **a)** Title of Project Rhino poaching on private farms in South Africa
b) Name of Principal Investigator (PI) or Research Student and Supervisor Laura Chapman (PhD student) Piran White (Supervisor)
c) Degree course (students) or SEI-Y or Env Dept (staff) PhD Environmental Science
d) Names of Co-investigators (CIs) and their organisational affiliation N/A
e) How many additional research staff will be gathering data for the project? One Names and their organisational affiliation (if known) Dirk Boshoff, Assistant General Manager at Ngamiland Adventure Safaris, Botswana – Dirk is a native Afrikaans speaker and will be helping with any required translations.
f) Proposed project start date (At least four weeks in the future) 20/07/16
g) Estimated project end date June 2021
h) Who is funding the project? Self-funded Has funding been confirmed? N/A
You may find the following codes of ethical practice and conduct relevant to your project: British Psychological Society code of conduct: http://www.bps.org.uk/the-society/code-of-conduct/code-ofconduct_home.cfm BCS Chartered Institute for IT Code of Conduct: http://www.bcs.org/server.php?show=nav.6030 Society of Environmental Toxicology and Chemistry (SETAC) code of ethics http://www.setac.org/?page=SETACEthics Guidelines for the Treatment of Animals in Behavioural Research and Teaching http://asab.nottingham.ac.uk/ethics/guidelines.php

2. Does this project need ethical approval?	**Yes**	**No**
a) Does the project involve collecting primary data from, or about, living human beings?	X	
b) Does the project involve analysing primary or unpublished data from, or about, living human beings?	X	
c) Does the project involve collecting or analysing primary or unpublished data about people who have recently died, other than data that are already in the public domain?		X
d) Does the project involve collecting or analysing primary or unpublished data about or from organisations or agencies of any kind, other than data that are already in the public domain?	X	
e) Does the project involve research with non-human animals (vertebrates or invertebrates)?		X
f) Does the project place the participants or the researchers in a dangerous environment, risk of physical harm, psychological or emotional distress?		X

If you answered **Yes** to any of these questions, please proceed to **Section 3**.

If you answered **No** to all these questions:
• You should type your name in the signature space in the Declaration in **Section 16**. Then email the form to the Ethics Committee for our records.
• Students must ask their Project Supervisor to also type their name in the declaration. Students should not submit your form directly. The supervisor must check the application and submit it.

3) Does the project require Disclosure and Barring Service (DBS) previously known as **Criminal Records Bureau checks?**	**Yes**	**No** X
a) Does the project involve direct contact by any member of the research team with children or people under 18 years of age?		X
b) Does the project involve direct contact by any member of the research team with adults who have learning difficulties?		X
c) Does the project involve direct contact by any member of the research team with adults who are infirm or physically disabled?		X
d) Does the project involve direct contact by any member of the research team with adults who are resident in social care or medical establishments?		X
e) Does the project involve direct contact by any member of the research team with adults in the custody of the criminal justice system?		X

f) Has a Disclosure and Barring Service (DBS) check been stipulated as a condition of access to any source of data required for the project?		X

If you answered **Yes** to **any** of these questions, please:

Explain the nature of the contact required and the circumstances in which contact will be made during the project.

If you require a DBS check, please contact the DBS or check their website for more details https://www.gov.uk/disclosure-barring-service-check/contact-disclosure-and-barring-service

4) Is this project liable to scrutiny by external ethical review arrangements?	**Yes**	**No** X
a) Has a favourable ethical opinion been given for this project by a social care research ethics committee, NHS, The Biology Dept Ethics Committee or by any other external research?		N/A
b) Will this project be submitted for ethical approval to a social care committee or any other external research ethics		N/A

If you answered **No to both of these questions**, please proceed to **Section 5.**

If you answered **Yes** to either of these questions:

• You should type your name in the signature space in the Declaration in **Section 16**. An email attachment sent from your University inbox will be assumed to have been signed electronically. Then email the form to the Ethics Committee for our records.

• Students must ask their Project Supervisor to also type their name in the declaration, and they should send a copy to the Ethics Committee for checking and filing. Students – do not submit your form directly to us. Your supervisor must check the application and submit it.

5) More detail about the project

a) What are the aims and objectives of the project?

Identify the factors that private owners consider to be most threatening to their rhino.

Evaluate the future of private rhino ownership based on the opinions of private owners.

b) Briefly describe the principal methods, the sources of data or evidence to be used and the number and type of research participants/animals who will be recruited to the project.

Participants will take part in a semi-structured interview to discuss why they keep rhino and what they see as the future for private rhino ownership. These interviews will be combined with the answers that many rhino owners, have already provided

to the anonymous online questionnaire in order to build up a more detailed picture of private rhino ownership. All participants (of which there are seven confirmed so far and another seeking approval) have completed the online questionnaire and requested further involvement in this research. The participants represent a range of private rhino owners, from those keeping small numbers in bomas, to those with dozens of rhino living in wild reserves and others who breed hundreds/thousands. One participant does not currently keep rhino, but is currently in the process of developing a rhino tourism project and so offers a different perspective to those who already keep rhino, as will additional stakeholders TBC.
c) What research instrument(s), validated scales or methods will be used to collect data? Semi-structured interviews – interview guide attached.
d) If you are using an external research instrument, validated scale or research method, please specify. N/A
e) If you are not using an externally validated scale or research method, please attach a copy of the research instrument you will use to collect data. For example, a measurement scale, questionnaire, interview schedule, observation protocol for ethnographic work or in the case of unstructured data collection a topic list.

6 Confidentiality, security and retention of research data	**Yes**	**No**
a) Are there any reasons why you cannot guarantee the full security and confidentiality of any personal or confidential data (including potentially sensitive data on animals) collected for the project?		X
b) Is there a significant possibility that any of your participants, or people associated with them, or sites where endangered or otherwise sensitive species, could be directly or indirectly identified in the outputs from this project?		X
c) Is there a significant possibility that confidential information could be traced back to a specific organisation or agency as a result of the way you write up the results of the project?		X
d) Will any members of the project team retain any personal or confidential data at the end of the project, other than in fully anonymised form?		X

If you answered **No** to all of these questions, please:

• Explain how you will ensure the confidentiality and security of your research data, both during and after the project.

6e) Interviews will be recorded onto a password protected recorder and later copied onto password protected files on a computer at the University of York. The recordings will be transcribed as soon as possible after the interviews, with the transcripts also being password protected. The recordings of the interviews and

transcripts will be kept until the completion of the research project in 2019. Participants may view the transcripts of their interview by contacting Laura Chapman by email. As quotes may be utilised in the writing up of this research, participants will be asked to provide a way in which they can be identified that protects their anonymity and that of their property e.g. “rhino breeder, Limpopo Province”. They do not need to provide this if they do not wish to and in that case will be simply referred to as “Anonymous rhino owner 1,2…”.

If you answered **Yes** to any of these questions, please:

• Explain the reasons why it is essential to breach normal research protocol regarding confidentiality, security and retention of research data.

6f) Write your explanation here

7) Informed consent	**Yes**	**No**
a) Will all participants be fully informed why the project is being conducted and what their participation will involve, and will this information be given before the project begins?	X	
b) Will every participant be asked to give written consent to participating in the project, before it begins?	X	
c) Will all participants be fully informed about what data will be collected, and what will be done with these data during and after the project?	X	
d) Will explicit consent be sought for audio, video or photographic recording of participants?	X	
e) Will every participant understand what rights they have not to take part, and/or to withdraw themselves and their data from the project if they do take part?	X	
f) Will every participant understand that they do not need to give you reasons for deciding not to take part or to withdraw themselves and their data from the project and that there will be no repercussions as a result?	X	
g) If the project involves deceiving, or covert observation of, participants, will you debrief them at the earliest possible opportunity?		N/A

If you answered **Yes** to all these questions, please:

• Explain briefly how you will implement the informed consent scheme described in your answers.

• Attach copies of your participant information sheet and consent form as evidence of your plans.

7h) Full participant information guide has been produced (attached) as has a consent form (also attached). The guide is available in both English and Afrikaans.

If you answered **No** to any of these questions, please:

• Explain why it is essential for the project to be conducted in a way that will not allow all participants the opportunity to exercise fully-informed consent.

• Explain how you propose to address the ethical issues arising from the absence of transparency.

• Attach copies of your participant information sheet and consent form as evidence of your plans.

7i) Write your explanation here

8) Risk of harm	**Yes**	**No**
a) Is there any significant risk that your project may lead to physical harm to participants or researchers?		X
b) Is there any significant risk that your project may lead to psychological or emotional distress to participants?		X
c) Is there any significant risk that your project may lead harm to the reputation of participants, or their employers, or of any other persons or organisations?		X

If you answered **Yes** to any of these questions, please:

• Explain the nature of the risks involved, why it is necessary for the participants or researchers to be exposed to such risks.

• Explain how you propose to assess, manage and mitigate any risks to participants or researchers.

• Explain the arrangements by which you will ensure that participants understand and consent to these risks.

• Explain the arrangements you will make to refer participants or researchers to sources of help, if they are seriously distressed or harmed as a result of taking part in the project.

• Explain the arrangements for recording and reporting any adverse consequences of the research.

8d) Write your explanation here:

9) Risk of disclosure of harm or potential harm	**Yes**	**No**
a) Is there a significant risk that the project will lead participants to disclose evidence of previous criminal offences, or their intention to commit criminal offences?		X
b) Is there a significant risk that the project will lead participants to disclose evidence that children or vulnerable adults are being harmed, or are at risk of harm?		X
c) Is there any significant risk that your project may lead harm to the reputation of participants, or their employers, or of any other persons or organisations?		X

d) Is there a significant risk that the project will lead participants to disclose evidence of serious risk of other types of harm?		X

If you answered **Yes** to any of these questions, please:

• Explain why it is necessary to take the risks of potential or actual disclosure.

• Explain what actions you would take, if such disclosures were to occur.

• Explain what advice you will take and from whom before taking these actions.

• Explain what information you will give participants about the possible consequences of disclosing information about criminal or serious risk of harm

9e) Write your explanation here:

10) Payment of participants	**Yes**	**No**
a) Do you intend to offer participants cash payments or any other kind of inducements or compensation for taking part in your project?		X
b) Is there any significant possibility that such inducements will cause participants to consent to risks that they might not otherwise find acceptable?		N/A
c) Is there any significant possibility that the prospect of payment or other rewards will systematically skew the data provided by participants in any way?		N/A
d) Will you inform participants that accepting compensation or inducements does not negate their right to withdraw from the project?		N/A

If you answered Yes to any of these questions, please:

• Explain the nature of the inducements or the amount of the payments that will be offered.

• Explain the reasons why it is necessary to offer payments.

• Explain why you consider it is ethically and methodologically acceptable to offer payments.

10e) Write your explanation here:

11) Capacity to give valid consent	**Yes**	**No**
a) Do you propose to recruit any participants who are under 18 years of age?		X

b) Do you propose to recruit any participants who have learning difficulties?		X
c) Do you propose to recruit any participants with communication difficulties, including difficulties arising from limited facility with the English language?	X	
d) Will you inform participants that accepting compensation or inducements does not negate their right to withdraw from the project?		N/A
e) Do you propose to recruit any participants who are very elderly or infirm?		X
f) Do you propose to recruit any participants with mental health problems or other medical problems that may impair their cognitive abilities?		X
g) Do you propose to recruit any participants who may not be able to understand fully the nature of the research and the implications for them of participating in it?		X

If you answered Yes to any of the questions, please:

• Explain how you will ensure that the interests and wishes of participants are understood and taken in to account.

• Explain how in the case of children the wishes of their parents or guardians are understood and taken into account.

11h) Write your explanation here
Whilst all of the participants can speak English, for several it is not their native language. For that reason, the participant information guide and consent form have been translated into Afrikaans. A native Afrikaans speaker will also assist with the interviews if required and agreed by the participant.

12) Is participation genuinely voluntary?	**Yes**	**No**
a) Are you proposing to recruit participants who are employees or students of the University of York or of organisation(s) that are formal collaborators in the project?		X
b) Are you proposing to recruit participants who are employees recruited through other business, voluntary or public sector organisations?		X
c) Are you proposing to recruit participants who are pupils or students recruited through educational institutions?		X

d) Are you proposing to recruit participants who are clients recruited through voluntary or public services?		X
e) Are you proposing to recruit participants who are living in residential communities or institutions?		X
f) Are you proposing to recruit participants who are in-patients in a hospital or other medical establishment?		X
g) Are you proposing to recruit participants who are recruited by virtue of their employment in the police or armed services?		X
h) Are you proposing to recruit participants who are being detained or sanctioned in the criminal justice system?		X
i) Are you proposing to recruit participants who may not feel empowered to refuse to participate in the research?		X

If you answered **Yes** to any of these questions, please:

• Explain how your participants will be recruited.

• Explain what steps you will take to ensure that participation in this project is genuinely voluntary.

12j) Write your explanation here:

13) Online and Internet Research	**Yes**	**No**
a) Will any part of your project involve collecting data by means of electronic media, such as the Internet or e-mail?		X
b) Is there a significant possibility that the project will encourage children under 18 to access inappropriate websites, or correspond with people who pose risk of harm?		X
c) Is there a significant possibility that the project will cause participants to become distressed or harmed, in ways that may not be apparent to the researcher(s)?		X
d) Will the project incur any other risks that arise specifically from the use of electronic media?		X

If you answered **Yes** to any of these questions, please:

• Explain why you propose to use electronic media.

• Explain how you propose to address the risks associated with online/internet research.

• Ensure that your answers to the previous sections address any issues related to online research.

13e) Write your explanation here

14) Other ethical risks	**Yes**	**No**
a) Are there any other ethical issues or risks of harm raised by your project that have not been covered by previous questions?		X

If you answered **Yes** to this question, please:

• Explain the nature of these ethical issues and risks.

• Explain why you need to incur these ethical issues and risks.

• Explain how you propose to deal with these ethical issues and risks.

14b) Write your explanation here:

15) Research with non-human animals	**Yes**	**No**
a) Will any part of your project involve the study of animals in their natural habitat?		X
b) Will your project involve the recording of behaviour of animals in a non-natural setting that is outside of the control of the researcher?		X
c) Will your field work involve any direct intervention other than recording the behaviour of the animals available for observation?		X
d) Is the species you plan to research endangered, locally rare or part of sensitive ecosystem protected by legislation?		**X**
e) Is there any significant possibility that the welfare of the target species or those sharing the local environment/habitat will be detrimentally affected?		X
f) Is there any significant possibility that the habitat of the animals will be damaged by the project, such that their health and survival will be endangered?		X
g) Will project work involve intervention work in a non-natural setting in relation to invertebrate species other than *Octopus vulgaris*?		X
h) Will project work involve intervention work or handling non-human vertebrates or *Octopus vulgaris**? **If yes, then you might require a licence under the Animals Scientific Procedures Act (1986) – contact the Ethics Committee**		X

If you answered **Yes** to any of these questions, please:

• Explain the reasons for conducting the project in the way you propose, and the academic benefits that will flow from it.

• Explain the nature of the risks to the animals and their habitat.

• Explain how you propose to assess, manage and mitigate these risks.

* The Animals Scientific Procedures Act (1986) was amended in 1993. As a result the common octopus (*Octopus vulgaris*), as an invertebrate species, is now covered by the act.

15i) Write your explanation here:

16) Principal Investigator's Declaration

Please ensure that you:

• Tick all the boxes below that are relevant to your project and type your name in the declaration below.

• Students must get their Project Supervisor to countersign this declaration.

I believe that this project does not require research ethics approval.	
I have completed Sections 1-2 and kept a copy for my own records.	X
I realise I may be asked to provide a copy of this form at any time.	X
I request that this project is exempt from internal research ethics review because it will be, or has been, reviewed by an external Research Ethics Committee.	
I have completed Sections 1-4 and attach/will attach a copy of the favourable ethical review issued by the external Research Ethics Committee. Please give the name of the external Research Ethics Committee here:	
I request an ethics review and confirm that I have answered all relevant questions in this form honestly.	X
I confirm that I will carry out the project in the ways described in this form. I will immediately suspend research and request a new ethical approval if the project subsequently changes the information I have given in this form.	X
I confirm that I, and all members of my research team (if any), have read and agree to abide by the University's Code of practice and principles for good ethical governance	X

Appendix IV: Example (rhino owners) participant information sheet and consent form (English and Afrikaans)

PARTICIPANT INFORMATION SHEET

Section A: The Research Project

1. **Title of project:**

   Private rhino ownership
2. **Brief summary of research.**
   This research consists of interviews with participants who have indicated a willingness to be further involved in this research having initially completed an online questionnaire for a previous section of the research project. The interviews will focus on private rhino ownership and the issues faced by private rhino owners, now and in the future.

3. This research forms part of a doctoral project being undertaken by Laura Chapman at the University of York, under the supervision of Professor Piran White.

Section B: Your Participation in the Research Project

1. **What will I be asked to do?**
   You will be asked to participate in a semi-structured interview to discuss why you keep rhino and what you see as the future for private rhino ownership. These interviews will be combined with the answers that many rhino owners, including yourself, have already provided to the anonymous online questionnaire in order to build up a more detailed picture of private rhino ownership. It is intended to follow up these interviews in 2017 and 2018 to allow for potential policy changes to be followed. You can opt to withdraw from this research at any time, without having to provide a reason, and participation in this interview does not necessitate participation in further interviews. As the online questionnaires have already been anonymised, the information provided in these interviews cannot be connected to the answers you have provided in the questionnaire. A native Afrikaans speaker (Dirk Boshoff, Assistant General Manager at Ngamiland Adventure Safaris, Botswana) will be available during the interviews, but you may request for him to leave if you prefer.

2. **Will my participation in the study be kept confidential?**
   Interviews will be recorded onto a password protected recorder and later copied onto password protected files on a computer at the University of York.

The recordings will be transcribed as soon as possible after the interviews, with the transcripts also being password protected. The recordings of the interviews and transcripts will be kept until the completion of the research project in 2019. You may view the transcripts of your interview by contacting Laura Chapman by email.

3. **Use of quotes**
   As quotes may be utilised in the writing up of this research, you are asked to provide a way in which you can be identified that protects your anonymity and that of your property e.g. “rhino breeder, Limpopo Province”. You will be asked to provide this on the participant consent form. You do not need to provide this if you do not wish to and in that case will be simply referred to as “Anonymous rhino owner 1,2…”. You may also request that direct quotes are not utilised if you wish.

4. **Summary of research findings**
   You will be provided with a copy of the final report via email. You will also be emailed individually with all of the information that relates specifically to your property. You will be able to request editing of any information that you feel may identify you or your property.

NAME OF PARTICIPANT:

Title of the Project: Private rhino ownership

Researcher contact details: Laura Chapman

lac552@york.ac.uk

1. I agree to take part in the above research. I have read the Participant Information Sheet for the study. I understand what my role will be in this research, and all my questions have been answered to my satisfaction.

2. I understand that I am free to withdraw from the research at any time, without giving a reason.

3. I am free to ask questions at any time before and during the study.

4. I understand what will happen to the data collected from me for the research.

5. I have been provided with a copy of the Participant Information Sheet.

6. Please delete as appropriate:

   I understand that quotes from me will be used in the dissemination of the research, but will not be attributed to me directly.
   All references to me should be attributed to …….

   OR

   I do not give permission for direct quotes to be utilised

7. I understand that the interview will be recorded.

Data protection: I agree to Laura Chapman processing personal data which I have supplied. I agree to the processing of such data for any purposes connected with the research as outlined to me.

Name of participant (print) ……

Signed:……. Date: ……

I WISH TO WITHDRAW FROM THIS STUDY

If you wish to withdraw from the research, please speak to Laura Chapman in person, or email at lac552@york.ac.uk.
You do not have to give a reason for why you would like to withdraw.

DEELNEMER INLIGTINGSBLAD

Afdeling A: Die Navorsingsprojek

1. Titel van projek:

Privaat renostereienaarskap

2. Kort opsomming van navorsing.

Hierdie navorsing bevat onderhoude met deelnemers wat 'n bereidwilligheid aangedui het om verder betrokke te raak by hierdie navorsing deur aanvanklik 'n aanlynvraelys oor 'n vorige afdeling van die navorsingsprojek voltooihet . Die onderhoude sal fokus op privaat renostereienaarskap en die kwessies waarmee die privaat renostereienaars te doen kry, nou en in die toekoms.

3. Hierdie navorsing maak deel uit van 'n doktorale projek deur Laura Chapman onderneem aan die Universiteit van York, onder die toesig van Professer Piran White.

Afdeling B: U deelname aan die navorsingsprojek

1. Wat sal ek gevra word om te doen?

Jy sal gevra word om deel te neem aan 'n halfgestruktureerde onderhoud om te bespreek waarom jy renosters aanhou en wat jy sien as die toekoms vir privaat renostereienaarskap. Hierdie onderhoude sal gekombineer word met die antwoorde wat baie renostereienaars, insluitend jouself, reeds tot die anonieme aanlyn vraelys verskaf het ten einde 'n meer volledige prentjie van private renostereienaarskap op te bou. Die voorneme is om hierdie onderhoude op te volg in 2017 en 2018 om toe te laat vir moontlike beleidsveranderinge kan volg.. Jy kan ter enige tyd onttrek van hierdie navorsing sonder om 'n rede te verskaf, en deelname aan hierdie onderhoud vereis nie deelname aan verdere onderhoude nie. Aangesien die aanlyn vraelyste reeds anoniem is , sal die inligting uit hierdie onderhoude nie gekoppel word aan die antwoorde wat u verskaf in die vraelys nie. ' ’n Afrikaanssprekende (Dirk Boshoff, Assistent Hoofbestuurder by Ngamiland Adventure Safaris, Botswana) sal gedurende die onderhoude teenwoordig wees, maar hy kan verskoon word indien u dit sou verkies..

2. Sal my deelname aan die studie vertroulik gehou word?

Onderhoude sal op 'n wagwoord beskermde klank opneemer aangeteken en later gekopieer na wagwoord beskermde lêers op 'n rekenaar by die Universiteit van York. Die opnames sal so gou as moontlik getranskribeer word na die onderhoude met die transkripsies ook wagwoord beskerm. Die opnames van die onderhoude en transkripsies sal gehou word tot met die voltooiing van die navorsingsprojek in 2019. Jy kan die transkripsies van die onderhoud verkry deur met kontak te maak met Laura Chapman per e-pos.

3. Gebruik van aanhalings

Aangesien aanhalings gebruik kan word in die aantekeninge van hierdie navorsing, word jy gevra om 'n wyse te voorsien waarop jy uitgeken kan word sodat jou identiteit beskerm bly asook dié van jou eiendom bv "Renosterteler, Limpopo Province". Jy sal gevra word om hierdie te verskaf op die deelnemer toestemmingsvorm. Jy hoef dit nie te voorsien as jy nie wil nie en in daardie geval sal eenvoudig verwys word na "Anoniem renostereienaar 1,2 ...". U kan ook versoek dat direkte aanhalings nie gebruik word nie as u wil.

4. Opsomming van navorsingsbevindings

Jy sal voorsien word van 'n afskrif van die finale verslag via e-pos. Jy sal ook persoonlik per e-pos voorsien word van al die inligting wat spesifiek betrekking het op jou eiendom. Jy sal ook kan versoek om redigering van enige inligting wat jy voel jou eiendom kan.

NAAM VAN DEELNEMER:

Titel van die projek: Privaat renoster eienaarskap

Kontakbesonderhede van navorser: Laura Chapman

lac552@york.ac.uk

1. Ek stem saam om deel te neem in die bogenoemde navorsing. Ek het die deelnemer Inligtingsblad vir die studie gelees. Ek verstaan wat my rol sal wees in hierdie navorsing en al my vrae is beantwoord na my sin.

2. Ek verstaan dat ek vry is om te onttrek van die navorsing op enige tyd, sonder om 'n rede te verskaf.

3. Ek is vry om vrae te vra op enige tyd voor en tydens die studie.

4. Ek verstaan wat met die data wat van my verkry is vir die navorsing, sal gebeur.

5. Ek is voorsien van 'n afskrif van die deelnemerinligtingsblad.

6. Ek verstaan dat aanhalings van my sal gebruik word in die verspreiding van die navorsing, maar sal nie direk toegeskryf word aan my nie.

Alle verwysings na my moet toegeskryf word aan .....

OF

Ek gee nie toestemming vir direkte aanhalings om gebruik te word nie.

7. Ek verstaan dat die onderhoud sal opgeneem word.

Die beskerming van data: Ek gee toestemming aan Laura Chapman vir die verwerking van die persoonlike data wat ek verskaf het. Ek stem saam met die verwerking van die data vir enige doeleindes wat verband hou met die navorsing soos uiteengesit vir my.

Naam van deelnemer (drukskrif) .....

Onderteken deur: ..... Datum: .....

Ek wil onttrek uit hierdie studie

As jy wil om te onttrek van die navorsing, praat asseblief met Laura Chapman persoonlik, of e-pos by lac552@york.ac.uk.

Jy hoef nie ‘n rede te verskaf waarom jy wil onttrek van die studie nie.