Analysis of Rhino Poaching in KwaZulu-Natal, South Africa

Caroline Lockwood

September 2010

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science and the Diploma of Imperial College London

"It is no small miracle that rhinos still walk the face of the earth. No other group of animals has been so highly prized for so long yet managed to survive human onslaught"

(Alan Rabinowitz)

Black rhino *(Diceros bicornis)* and calf

Table of figures

Abstract

South Africa has a proud history of rhino conservation with significant proportions of Africa's rhino populations protected and managed within state-run and privately owned properties. South Africa is experiencing unprecedented rhino poaching, in terms of both total rhino deaths and the level of sophistication employed by the poachers. While the total rhino harvest rates (trophy hunting and poaching) are not yet considered unsustainable to the overall South African rhino populations, the rate at which the poaching is increasing and the involvement of organised criminals (national and international) is a major concern. The aim of this study is to investigate which spatial and temporal variables or combination of, best explain the distribution of rhino poaching patterns in KZN South Africa, along with an exploration of local rhino property managers and owners attitudes regarding poaching and rhino protection costs.

The results of the Generalised Linear Model revealed the State Management, Housing Density, Presence of a Road Through a Property as the best-fit model, although the highly correlated relationships between Management, Area, Roads and Rhino Population Density could be masking the true effect, and further research at a finer scale would be required. The qualitative analysis of landowner and reserve manager attitudes and opinions yielded a wide variety of issues that are all worthy of further discussion and investigation.

Word count: 12,355

Acknowledgements

Firstly, I would like to sincerely thank my supervisors, E.J Milner-Gulland and Bob Smith. Your guidance, support, kind understanding and encouragement throughout this journey have been invaluable to me. I feel incredibly fortunate to have been able to work with you both. Thank you.

Thank you to the staff at Ezemvelo KZN Wildlife; your dedication to South African conservation is inspiring. Thank you to Peter Goodman for your guidance, John Craigie for your calm assistance during a stressful data collection phase and an extra special thank you to Dr. Boyd Escott your GIS help at the 11th hour was above and beyond the call of duty.

Thank you to the Wageners and the Carrolls for welcoming me into your homes during my 5-week stay and welcoming me into your family.

I would also like to thank Mona & Rick Dittamore, Peter Culpin, Stuart Lane, Catherine Donnolly, Caroline Williams, Clare Simm, Lori Bergemann and Jonny & Mickey Baxendale, for your friendship, support, inspiration and encouragement.

Thank you to my parents, Ross and Diane Lockwood and to my partner Christian del Valle – my family. I cannot find the words to describe how much all of your love and support means to me, but I know now that I can achieve anything and everything with you by my side.

This thesis is dedicated in loving memory to Safi Sana – pure and splendid in both name and nature.

Safi Sana
4th May 2011 - 5th September 2011

1 Introduction

After a number of years in which significant conservation outcomes were achieved that made South Africa the 'engine' for recovery population recovery, the country is now experiencing a period of unprecedented setbacks in the management of its black *(Diceros bicornis)* and white *(Ceratotherium simum simum)* rhinoceros populations.

The significance of these setbacks can be seen when viewed in the wider context of rhino conservation. Black rhinos currently number 4,840 (up from 2,500 in 1990's, and from 4,240 in 2007), while white rhinos have a healthier population with numbers estimated at 20,150 (from less than 200 in 1900's, and from 17,500 in 2007) (www.iucnredlist.org). Until recently, these population gains were often considered as being amongst African conservation success stories (Castley 2003; Hall-Martin, 2003) but nevertheless their conservation status remains precarious and the IUCN Red Listing for both species is Near Threatened and Critically Endangered respectively (www.iucnredlist.org).

A significant contribution to the rhino's overall population rebound over the last three decades can be credited to management practices in South Africa. Evidence of this can be seen in the fact that, as of 2007, South Africa conserves 35% of all African black rhino and 93% of all white rhino (www.gov.za). This impressive conservation effort has been attributed to the combined protection and enforcement measures initiated by the government-run national parks and more recently, privately owned reserves (Amin, 2006). The introduction in South Africa of the private sector to rhino conservation in 1990 (Walker, 1994) marked

a significant change in land use management, whereby a more profitable and sustainable business model utilising wildlife, replaced the more conventional livestock model (Goodman et al, 2002). Reserves could now generate more revenue from wildlife than livestock though non-consumptive (eco-tourism, photographic safaris) and consumptive (regulated sport and trophy hunting) wildlife utilisation and from selling surplus rhinos to other parks, both domestically and internationally (Karsten 2011; Leader-Williams, 2005). Viewed from South Africa, the nature of the threat to rhinos seems now to be undergoing a shift that has put historic gains at risk. Poaching, in terms of both total number of rhino deaths and the level of sophistication employed by the poachers has reached levels that are alarming to conservationists, land owners and politicians and is now a topic for international discussion across multiple forums (www.cites.org; www.bbc.co.uk).

Poaching pressure is illustrated by the fact that in the South African province of KwaZulu-Natal (KZN) between 1990 and 2007 (inclusive), 80 rhino deaths were attributed to poaching while the same number were poached between 2008 to 2010. Likewise, poaching sophistication is revealed by the mode of killing used during the pre-2008 years. In this earlier period, poaching deaths were mainly attributed to snaring (often intended to capture bushmeat) where rhino were not specifically targeted but nevertheless killed.

This is in contrast to the period commencing in 2008, which saw the beginning of well funded and highly organised poaching syndicates specifically targeting rhino populations. Throughout South Africa, wildlife authorities are seeing a significant rise in the number of poaching incidents utilising automatic weapons,

night-vision equipment and helicopters. A prima facie observation suggests a positive correlation between the rising price and demand for rhino horn linked to its rarity value and a rise in the sophistication and frequency of poaching (Hall et al, 2008)

This relationship is one of the reasons criticism has been focused on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regarding the ineffective international trade ban on rhino horn and other products (Pires, 2011). When the ban was implemented in 1977, consumers exhibited stockpiling behaviour, creating a rise in rhino horn price and further increasing demand for horn (t'Sas-Rolfe, 2000). Additionally, the rarity of rhino has also been cited as a potential driver for their own decline, due to consumer demand to own rare and luxury 'social-status' items (Hall et al, 2008). Currently, the black market for rhino horn is seeing unprecedented price rises, and horn now fetches amounts as high as US$30,000 - 50,000 per kilogram (www.bbc.co.uk). With demand for such a high priced commodity, further fuelled by an expanding and wealthier middle class in China and other eastern countries (Ellis, 2005) the financial incentive to poach is extremely high and provides a very lucrative business for criminal organisations.

While the total rhino harvest rates (trophy hunting and reported poaching) are not yet considered unsustainable to the overall South African rhino populations (Knight, 2009), the rate at which the poaching is increasing and the involvement of organised criminals (domestic and international) is a major concern. Should poaching activity continue to escalate, there is the potential to reduce the supply of a productive source population, reduce the financial incentive for private

landowner involvement in rhino conservation, and African rhino populations could begin to decline again (Goodman et al, 2002).

1.1 Relevance of Study

South Africa has a proud history of rhino conservation with significant proportions of continental Africa's rhino populations (35% black and 93% white) protected and managed within state-run and privately owned properties (www.info.gov.za) and this de facto public-private partnership is a frequently cited conservation success story and a blueprint for similar projects worldwide (Cousins et al, 2008)

There is a prevailing view, that wildlife must increasingly 'pay its way' in a world of increasing human-related pressures (Rosser, 2010, Kock, 1994). In South Africa, substantial financial and human resources have been invested over the past three decades to deliver successful outcomes in rhino conservation. The financial gains derived from both consumptive and non-consumptive uses have benefitted both landowners and rural communities alike, reinforcing conservation efforts for the species (Spenceley, 2005). Worldwide, national and international bodies are facing increasing budgetary pressures and capacity constraints, particularly in the developing world. This can limit their effectiveness in implementing laws and other policy measures, hindering conservation efforts (Rowcliffe et al, 2004).

This is no different in South Africa, where such financial incentives have come under strain in recent years however, as game wardens and ranch owners, in response to the increases in poaching seen over the past four years, have invested further resources into anti-poaching enforcement and detection. It is

important for South Africa to protect the overall conservation investments made to date, as the world renowned, wildlife based tourism industry (both consumptive and non-consumptive) is an important contributor to the country's GDP now and in the future (www.southafrica.info).

This interplay between increased poaching pressure and the requirement to deploy increased protection plays out as an 'arms race' of sorts, whereby in order to effectively protect rhino populations and neutralise the demand-fuelled increased effort from poachers, evermore investment into protection and security is needed. Questions surround whether a threshold could be crossed beyond which the black-market value for rhino horn and resultant poaching outstrips the ability of conservation-related funding to provide sufficient incentives for counter-measures. In the short to medium term, as South African and international conservationists, law enforcement agencies and policy-makers address the new dynamic arising from peaking prices for horn, it is crucially important that limited resources are allocated to areas of high risk, where their deployment will make the most difference in deterring and interdicting poaching.

This study hopes to contribute its findings to rhino poaching issues by highlighting and testing a number of factors that could indicate the vulnerability of a property to poaching. By doing this, it is hoped that the results might be used to help inform rhino reserve managers and conservation authorities on where to allocate conservation funding and anti poaching resources to yield maximum protection and probability of success.

1.2 Aims and Objectives

The aim of this study is to investigate which factors best explain the distribution of rhino poaching patterns in KZN South Africa. This is complemented by an exploratory analysis of local rhino property managers' and owners' attitudes regarding poaching and rhino protection costs, and the associated challenges that they now face.

This study will accomplish this aim via the following research objectives:

Identify the spatial and reserve management-related variables that may influence the vulnerability of a property based upon a review of the literature, key informant interviews and potentially important factors identified in the local press.

Investigate correlations between spatial and temporal variables and calculate which variables or combination of, best explain the distribution of rhino poaching incidents using a generalised linear model and other appropriate statistical tests.

Explore the implications of the attitudes of rhino property managers towards rhino poaching and protection costs for the future of rhino conservation in the region via a scenario-based questionnaire targeted at rhino property managers and owners in KZN.

Make recommendations for future research and conservation actions based on results of the results of the study and other potentially important factors gathered from literature, press articles and other media based sources

The combined results from this research can contribute to improving public-private rhino conservation strategies, protection policy and reserve management in KZN, with further potential for similar research expanded upon and conducted in other regions of South Africa.

1.3 Overview of thesis

- **Section Two** - will provide background information for the thesis through a review of previous research on poaching patterns utilising spatial analysis, a brief summary of the evolution of rhino conservation in Southern Africa, concluding with the successful rhino conservation practices of South Africa and the current pressures rhino conservationists are facing.

- **Section Three** – will describe the methodology employed during the data collection and analysis phases.

- **Section Four** - will present the results of the study.

- **Section Five** - will discuss the results of the study in relation to previous research, extrapolate the findings into the wider context of rhino conservation within South Africa and conclude with a discussion of the studies limitations and recommendations for further research.

White rhino *(Ceratotherium simum simum)* Calf

2 Background

2.1 Conservation of mega-fauna in southern Africa

In a world increasingly dominated by humans, challenges facing conservation biologists, wildlife managers and government authorities are many (Redford & Richter 1999). When large megafauna are concerned, these challenges can be increased due to the fact that they often require large home ranges to support populations and can have negative impacts for people living nearby, creating human-wildlife conflict (Walpole et al, 2003). Additional conservation pressures can occur for mammal species due to the demand for bushmeat (Rowcliffe et al, 2004) or the domestic and international wildlife trade in live animals (Ellis, 2005).

While it's necessary to address these issues (Hartter & Goldman, 2011; Hayward & Kerley, 2009), 'fortress conservation' and similar approaches, which rely on exclusion, fences and armed guards can cause additional problems. Large scale fenced properties to reduce contact between people and wildlife can have negative socio-economic impacts for local people and can disrupt ecological impacts (Hayward & Kerley, 2009; Rowcliffe et al, 2004). This has led over time to the design of alternative models less reliant on pure preservation. Southern African countries, often inspired by South Africa, have created positive conservation outcomes relating to large mammal species and their habitat (Wynberg; 2002). And Southern Africa has often been used as a test-bed for new models aimed at addressing conservation issues related to megafauna, based on the principle that in order to maintain long-term viable populations of

threatened species and habitats, wildlife must 'pay its way' (Cousins et al, 2003; Adams, 1998). Using these principles of sustainable utilisation, they hope to build the interests of relevant stakeholders through the creation of incentives to protect species or habitats (Hutton & Leader-Williams, 2003).

Southern African countries have utilised species management based upon these key principles and while not a 'cure-all', there have been recorded local successes, particularly Botswana, Namibia and (until recent political problems) Zimbabwe (Arnzten, 2003; Barnes, 2001; de Alessi, 2000). Although this blueprint is recognised as a viable tool for conservation, it does have some problems (Spiteri & Nepalz, 2006), such as the need for strong governance and equitable sharing of benefits (Fischer, 2010). Some disagree with the consumptive utilisation of wildlife and will argue that the morals of removing individuals from an overall population is objectionable and should not be done at all (Leader-Williams et al, 2005). And others question if the risks associated with removing key individuals from a population might decrease the conservation benefits (www.telegraph.co.uk) or that it may encourage poaching (Nelson, 2006). There are also debates as to the actual benefit of community-based conservation models, which are funded by activities like eco-tourism (Attwell, 1999; Kiss, 1990, 2004).

An move from solely state-funded and managed conservation, to one based upon incentives, private landowners and the community is required by many as necessary for long-term sustainability (de Alessi, 2000; Goodman et al, 2002). In South Africa, where protected areas cover approximately 5% of surface area, and there a demand for additional community land, expanding protected area is

difficult. This is one of the reasons why conservation requires private landowners, so the total land area under conservation can increase. 9000 wildlife ranches are estimated to be under private management in South Africa, which comprises of over 20 million hectare or, 16.5% of the country's total surface area (Cousins et al, 2008; Spenceley, 2005).

In the case of South Africa's rhino, where the benefits have been shared between the reserve owners, rural communities and other stakeholders, the results have been successful. (Goodman et al, 2002; Spenceley, 2005). The involvement of the private sector is particularly important for global rhino conservation as the reserves acted as managers of meta-populations and a secure source from which surplus individuals can be transferred to other rhino reserves to bolster their population numbers and density (Goodman et al, 2002), demonstrating a sustainable conservation finance solution.

2.2 Summary and context of the conservation status of rhino in southern Africa: past and present

Africa's rhino species along with three Asian species of rhino (found in small numbers in Sumatra, Java and India) are each in a precarious conservation status (listed on Appendix 1 of CITES; www.cites.org) that is driven by human persecution and habit destruction. Throughout history all five species have been the victims of human vanity: as hunting trophies, ornamental carvings and for use in Chinese Herbal medicine thought to restore strength, cure ills and increase the life essence of those who consume them (Ellis, 2005).

The two subspecies of white rhino have gone down separate routes, with the northern subspecies *Ceratotherium simum cottoni* now extinct in the wild, and

the southern white in a stronger position in terms of population. Southern whites are more docile in nature and are grazers, while the black rhino are considered more aggressive and prefer wooded habitat. Because of these differences in nature and location, white rhino are often easier targets for hunters and poachers. Both species, and particularly the white rhino, have greatly benefitted from the management approaches in southern Africa and the population of southern white rhinos today are more than that of all other rhino species combined (Ellis, 2005).

The killing of rhinos today is legal in small numbers in several African countries, including South Africa, where it is managed for sport and trophy hunting and as a financial benefit for private landowners (Leader-Williams et al, 2005; Nelson, 2006). Despite objections from anti hunting and animal welfare groups, there is some evidence that both populations of rhino can be sustain off-take through a system of hunting quota and permits, along with monitoring and adaptive management (Leader-Williams et al, 2005; Milner-Gulland and Leader-Williams, 1992; Nelson, 2006).

Poaching is now the main threat to the species and the number incidents reported in South Africa, outlined in the previous section of this study could potentially damage ongoing rhino conservation, which was built upon the principle of sustainable use.

Today one third of all mammal and bird species are considered under threat from extinction in direct response to unsustainable off-take (Cowlishaw et al, 2005) and rhino are no exception to this fact. Demand for highly prized wildlife products is common around the world and rhino are by no means the only

exploited species. Elephant ivory, tiger bone, shells from turtle species, pangolin, shark fin, mahogany timber and countless other flora and fauna are at risk from extinction due over-consumption and illlegal trade (Seidensticker, 2010; Redford & Richter, 1999). It is also unfortunate that demand for these species can also be fuelled by their increasing rarity (Hall et al, 2008; Nawaz, 2007; Ellis, 2005; www.traffic.org).

In order to ensure the continued survival of the any species, and in this case the rhino, continued research is required to investigate current issues, such as the increased poaching incidents. The results of which could feed into an adaptive management approach utilised by State run and Private/Communally owned properties to ensure the continued success of rhino conservation in South Africa.

2.3 Study site

KZN is home to a population of 10.8 million people, 21.4% of the South African population and is the second highest populated region (www.statssa.gov.za), with 50.6% of the population living in rural communities (higher than the national average of 37%). While KZN is considered to be the third richest province, in terms of total income, the province is nevertheless affected by high poverty, high unemployment and an uneven distribution of wealth; with African and Coloured households in rural and agricultural areas affected the most (Provide, 2005). KZN contain a large proportion of the countries rhino population and the majority fall under the management of the regional wildlife authority, Ezemvelo KZN Wildlife (EKZNW). As such, KZN is considered by South African wildlife authorities and the rhino conservation community to be of key importance (Karsten et al, 2011; Goodman pers comm).

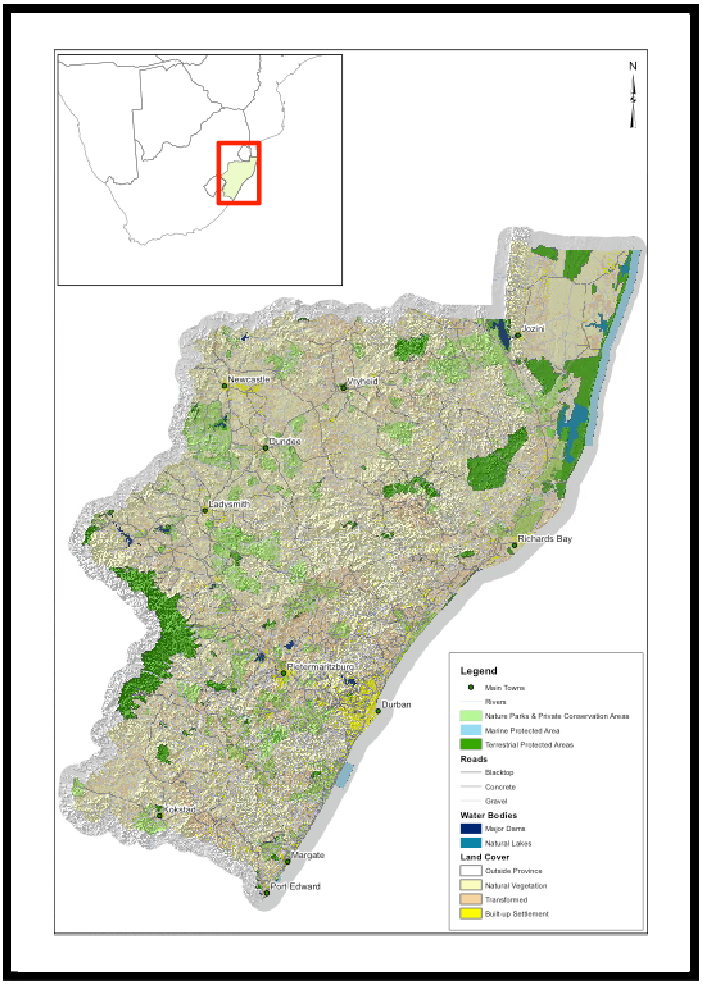

Figure 2.1 - Map of KwaZulu-Natal, South Africa (red rectangle insert) and detailed map of study province. (B. Escott & C. Lockwood, 2011)

3 Methods

The scope of this study sets out to gather quantitative spatial and temporal data, property specific variables accompanied by qualitative questionnaire data. The combination of qualitative and quantitative methodology is often used in social sciences research and can often result in a more comprehensive and in-depth account of the study objectives, than what can be revealed by one technique alone (Jick, 1979).

All quantitative data were supplied by EKZNW, the government authority tasked to 'protect and enhance environmental assets and natural resources' for the province of KZN (www.kznwildlife.com). While qualitative data was gathered via questionnaire surveys distributed to state run property managers and private/communally owned properties. (Private and communally owned properties will be referred henceforth as P/C).

All statistical analysis and graphics were process in R© software version 2.11.1 (R Development Core Team, 2010) with the exception of bar graphs, which were created in Microsoft® Excel® 2008 for Mac version 12.3.0. All GIS analysis was processed in ArcGIS 9.3.

During the course of this study, a number of issues regarding data availability and processing were encountered. These limitations are discussed in greater detail below where appropriate (See 3.1 Data Collection).

As a further limitation, due to security and data sensitivity reasons, and upon request by EKZNW, rhino properties will be referred to by a numbered code and the full dataset will not be published herein.

3.1 Data Collection

A Generalised Linear Model (GLM) was created using a combination of the variables summarised in Table 3.1.)

Variables	Rationale	Hypothesis	Source
Rhino Population Density	Rhino population density is related to poacher 'catch per unit effort'. As rhino density increases, the effort required in finding a rhino to poach decreases.	As rhino population density increases, the likelihood of a poaching incident increases	Metzger (2009)
Property Area (Km^2)	The area of the property is related to the amount of effort and resources required for anti poaching patrols. Anti poaching resources within larger protected areas would therefore have to increase the effort required to detect a poacher. Also as the area of a property increases, so does the property perimeter, increasing the human pressure and 'edge effect' placed upon that property.	As the area of a property increases the likelihood of a poaching incident increases	Metzger (2009) Lindsey et al (2011)
Land Management	To differentiate between State and Non-State funded rhino reserves. State funded properties maybe more likely to have budgetary constraints and less available resources for conservation in comparison to a non state funded property that are run as a profitable business and not subject to governments prioritising limited funding to other public sectors and might be impacted by the need to balance costs and benefits of keeping a given species.	Non-State funded rhino reserves are less likely to experience a rhino-poaching incident	De Alessi (2000) Norton (2000)
Distance to Roads Outside a Property	Public road networks are related to the accessibility and 'escape' routes for a poacher to a particular property. Road networks that are located closer to a protected area may be more accessible to poachers or increased traffic might be seen as an impediment to criminal activity.	As the distance to roads outside a property decreases the likelihood of a poaching incident increases	Nawaz (2007) Liu et al (2009) Wato (2006)
Distance to Roads Inside a Property	Mobility and accessibility within a property is related to poacher 'catch per unit effort' and also the probability of detection by anti poaching staff. As the 'distance to a road within a property' calculation is related to road density within the property, increased road network makes it easier for a poacher to access rhino habitat. As anti poaching resources also use these routes for patrols, 'distance to roads within a property could be a proxy for patrol effectiveness or increased traffic might be seen as an impediment to criminal activity.	As distance to roads within a property decreases (higher road density) the likelihood of poaching increases.	Nawaz (2007) Liu et al (2009) Wato (2006)
Roads Through/Around Property	Public road networks are related to the accessibility and 'escape' routes for a poacher to a particular property. Formalised public road networks (blacktop and concrete) that are situated through a protected area or on a property boundary are more accessible to poachers or increased traffic might be seen as an impediment to criminal activity.	Presence of a main public access road located on a boundary or through a property increases the likelihood of a poaching incident	Nawaz (2007) Liu et al (2009) Wato (2006)
Terrain	Mobility and accessibility due to the type of terrain within a property is related to poacher 'catch per unit effort' and also the probability of detection by anti poaching staff. Flatter terrain increases accessibility for a poacher but is also easier to patrol, therefore terrain could be a proxy for patrol effectiveness.	Flat properties are easier to access are more likely to experience a poaching incident	Sanchez-Mercado et al (2008)
Housing Density	High-density housing is related to human population density. If adequate resources are available to close to home, a poacher is less likely to travel long distances to poach. High human populations within close proximity to a protected area might increase the poaching pressure within that property or increased community presence might be seen as in impediment to criminal activity.	As housing density increases the likelihood of a poaching incident will increase.	Jachmann (2008) Nawaz (2007) Ogutu (2009) Metzger (2009)

Table 3.1 Description of variables in the study, rationale for inclusion and predicted effect of variables

3.1.1 Rhino poaching data/Poaching status

Rhino poaching data was supplied by Ezemvelo KZN Wildlife (EKZNW) and gathered from internal poaching reports. A poaching incident was included in the study if (a) it had been reported to EKZNW and (b) was accompanied by a Police Incident Report reference. The total numbers of rhino poaching incidents for State and P/C properties were recorded for each year between 2004 and 2010 and cross referenced against the South African National Parks (SAN Parks) published records.

There was a limitation in the 2010 data, which showed a discrepancy, whereby KZN had reported 39 rhino poached and SAN Parks had published a total of 38. It was revealed that a rhino carcass had been discovered after the 2010 totals had been published and had not been included by SAN Parks (Pers. comm. Rod Potter); therefore the verified total of 39 poaching incidents was used in this study.

Each property's 'Poaching Status', based on reported poaching incidents between 2004 and 2010, was categorised as 'Poached' or 'Not Poached' and included in the study as the binomial dependent variable.

3.1.2 Rhino population data

Rhino population data were supplied by EKZNW and gathered from wildlife management reports submitted annually by State and P/C owned properties.

For each property, the population counts for black and white rhino were recorded for each year between 2004 and 2010. As another minor limitation,

Black rhino population data were not available for 2010 (due to internal processing issues at EKZNW). As the black rhino population has little variation from one year to the next, the 2009 population records were entered as 2010.

Population density was calculated for each property by dividing population by area of the property in Km^2.

As the dependent variable in this study is poaching status over a 7-year period and due to the study's small sample size, it was felt that a mean value for population density taken over the same time period would be appropriate to minimise sampling error within each property. The mean Rhino Population Density was included in the study as a continuous explanatory variable.

Graphic analysis revealed an outlier in the dataset, whereby one private property had twice the number of rhino per Km^2 than the second highest property (2.53 and 4.78 respectively) and was skewing the data. The property in question had not been poached and therefore was deemed safe to remove from further analysis.

3.1.3 Property size

Property size was supplied by EKZNW gathered from management reports and personal communication with landowners. Area was recorded in Km^2 and included in the study as a continuous explanatory variable.

3.1.4 Land management

The categorisation of land management for each rhino property was supplied by EKZNW and disseminated as a shapefile for analysis in GIS. All property names

were substituted with a coded reference. Land management was categorised as 'State' and 'Private/Communal' and were included in the study as a binomial categorical explanatory variable.

3.1.5 Infrastructure/Road Networks

Road Infrastructure Strategic Framework for South Africa (RIFSA) road network data was supplied by EKZNW as a shapefile for analysis in GIS. 7 categories of roads were available with categories 1-4 extrapolated and analysed as formal infrastructure (blacktop, concrete and gravel) and categories 5-7 as low-grade informal roads.

The 'RIFSA' and 'Land management' shapefiles were entered as layers into GIS for analysis using the following processes:

- **Distance to roads outside properties** - The 'Distance' function in the Spatial Analyst extension was used to produce a raster output showing the distance of each cell to the nearest road outside of each property and the 'Zonal Statistics' function was used to calculate the mean distance of each property. The result, measured in metres, was included in the study as a continuous explanatory variable.

- **Distance to roads inside properties** - The 'Distance' and 'Zonal Statistics' functions was repeated, as above, to calculate the mean distance to a road within each property. The result, measured in metres, was included in the study as a continuous explanatory variable.

- **Roads through/around a property** - Analysis was performed by systematically examining the presence/absence of a 'Black top' and/or 'Concrete road' located through or around the perimeter of each property. As the boundaries for each property and them major roads were clearly defined, this was performed with a simple visual inspection. The presence/absence of roads was included as a binomial variable.

3.1.6 Terrain

An elevation shapefile was supplied by EKZNW for analysis in GIS. The shapefile was created by EKZNW utilising satellite imagery (at 90 metre resolution) with a two dimensional hill shade colouring to indicate changes in elevation. The 'Rhino property' and 'Terrain' shapefiles were entered as layers into GIS. A visual analysis was performed by systematically examining the elevation fluctuations within each property boundary. In the majority of cases, the categorisation between 'Flat' and 'Hilly' was easily assessed, as elevation variation was minimal although 10 properties had a mixture of flat and hilly terrain. Categorisation was then recorded if that property contained more than 50% of that category. The results were included as a binomial variable.

3.1.7 Housing density

A rural household shapefile was supplied by EKZNW. This was created by state-owned ESKOM, the largest electricity company in South Africa, whereby the data would be used for future electrical infrastructure expansion to rural communities. A buffer zone of 5km was created around each property and the 'density function' was performed in GIS to count the number of households.

These results were then divided by the buffer area to calculate a housing density (number of houses per Km^2) and included as a continuous variable.

3.2 Correlation analysis

Each variable was visually explored using a combination of scatter plots, box and whisker graphs, histograms and bar graphs. Possible correlations between all variables were explored using the following statistical tests:

- **Pearson's Product-Moment Correlation (Pearson's)** between all continuous variables.
- **Analysis of Variance (ANOVA)** between all continuous and categorical variables.
- **Chi-square for Association (x^2)** between categorical variables or **Fisher's Exact Test (Fisher)** between categorical variables with observed cell counts <5.

The results were placed into a Correlation Table (Table 3.3) where variables with significant correlations ($p<0.05$) were highlighted for further investigation before inclusion in the GLM.

3.3 Variable selection process

The variables that did not reveal any correlations with each other were automatically included. These were 'Housing Density', 'Roads Through Around' and 'Terrain'. The remaining variables were all found to have significant correlations ($p<0.05$) between each other.

The correlated variables were examined in more detail to ensure that the variables included in the GLM analysis would yield as reliable results as possible.

If the correlated variables were too related, they were excluded from further analysis.

Distance Roads In	**0.000[1]**						
Housing Density	0.247[1]	0.300[1]					
Rhino Population Density	0.517[1]	**0.023[1]**	0.841[1]				
Roads Through Around	0.179[2]	0.955[2]	0.753[2]	0.968[2]			
Area (Km²)	**0.006[1]**	**0.000[1]**	0.516[1]	**0.017[1]**	0.200[2]		
Management	**0.000[2]**	**0.000[2]**	0.508[2]	**0.009[2]**	0.512[4]	**0.000[2]**	
Terrain	0.403[2]	0.311[2]	0.103[2]	0.575[2]	0.087[3]	0.163[2]	0.200[4]
	Distance Roads Out	**Distance Roads In**	**Housing Density**	**Rhino Population Density**	**Roads Through Around**	**Area (Km²)**	**Management**

Table 3.3 Correlation table showing relationships between all variables. (Key=1 Pearson's, 2 ANOVA, 3 X^2, 4 Fisher, **BOLD** Significant p<0.05)

The significant correlation between the 'Area' and 'Rhino Population Density' suggests that the size of the property is positively related to the number of rhino contained within each property. These two variables were also correlated with 'Management', as state run reserves are the largest in size and are the government custodians of the largest proportion of rhino. Therefore 'Area' and 'Rhino Population Density' were flagged for exclusion from the model in favour for 'Management'.

The two 'Distance to Roads' variables ('outside a property' and 'within a property') were highly correlated with each other and with 'Area', suggesting that the area of a property increases, so do the distances to roads outside and

within the property. Because 'Area' is also highly correlated with 'Management', 'Distance Roads Out' and 'Distance Roads In' were flagged for exclusion from the model in favour for 'Management'.

The final variables included in the model were 'Management', 'Terrain', 'Roads Through Around' and 'Housing Density'.

3.4 Generalised linear model

A GLM was used to calculate a best-fit model. A full model was built and processed with the following variables with poached status (Yes/No) as the dependent variable.

Presence/Absence of poaching ~ Management + Terrain +
Housing Density + Roads Through Around

This was executed using the 'dredge' function from Multimodel Inference (MuMIn) in R (Burnham and Anderson, 2002). This programme runs all possible model combinations and ranks the best-fit models by the corrected Akaike Information Criterion (AICc), where the model with the lowest AICc value explained the most variance (Akaike, 1973). The results from this analysis revealed a 'Top Model' and the list of variables that best explain the presence of poaching. In order to further investigate the model variables, 'Average Model Parameters' and 'Relative Variable Importance' were calculated through the 'Top Model' function in MuMIn.

3.5 Questionnaire

The second part of this research employed an open-ended scenario-based questionnaire to investigate P/C landowner and state reserve manager attitudes

and opinions regarding rhino poaching and rhino protection costs, and their views on the future for rhino conservation in KZN (See Appendix 7.1 and 7.2)

3.5.1 Questionnaire design

Due to the sensitivity of rhino poaching, compromises were made on some issues. Questions regarding past, present and future security measures along with reserve income and enforcement costs were considered to be unsuitable and could potentially reduce a respondent's willingness to participate, particularly as the questionnaire was not going to be conducted face-to-face with a known and trusted researcher (Castley and Hall-Martin, 2003). Therefore the questionnaire was designed using a Likert scale, whereby respondents could answer sensitive questions on a scale from 'Significantly Decreased' to 'Significantly Increased' without revealing specific details. Open-ended questions (in self-administered questionnaires) are more likely to highlight socially undesirable issues (Bernard, 2006), therefore these were included to encourage open dialogue that individuals would feel comfortable answering. The questionnaire was designed to be quick and simple, containing 14 questions that were estimated to take approximately 20-30 minutes to complete.

3.5.2 Pilot study

The questionnaire was reviewed and checked by my project supervisors, the head of biodiversity research at EKZNW and a small pilot study was conducted with three EKZNW reserve managers. A number of questions were modified to reduce potential sensitivity issues along with minor wording and grammatical changes.

3.5.3 Respondents

EKZNW supplied the database for all state and P/C owned property managers/owners, although due to security issues I was unable to have access to this. Therefore an EKZNW staff member, who had regular working relationships with respondents, sent out the 58 questionnaires via email. The respondents were to return their completed forms via email to the EKZNW staff member, which were then forwarded to me anonymously.

3.5.4 Analysis

Only 11 participants out of 58 responded to my questionnaire, and the low response rate has limited the degree to which quantitative analysis can be preformed. Therefore the results will be discussed in broader detail through summarised response tables and a selection of respondent quotations, gathered from the open-ended questions. From this dataset small inferences can be made towards the attitudes of respondents regarding rhino poaching and associated issues, although due to the small sample size, it would be inappropriate to draw any large conclusions that can be regarded as definite or beyond dispute from this part of the study. However, it is the aim that these findings may form the basis for future researches an analysis.

4 Results

4.1 Rhino poaching incidents

South Africa has experienced a dramatic increase in the number of rhino poaching incidents over the past 4 years (see Table 7.3 and Figure 7.3) and equally similar poaching patters have been experienced in KZN (See Figure 4.1).

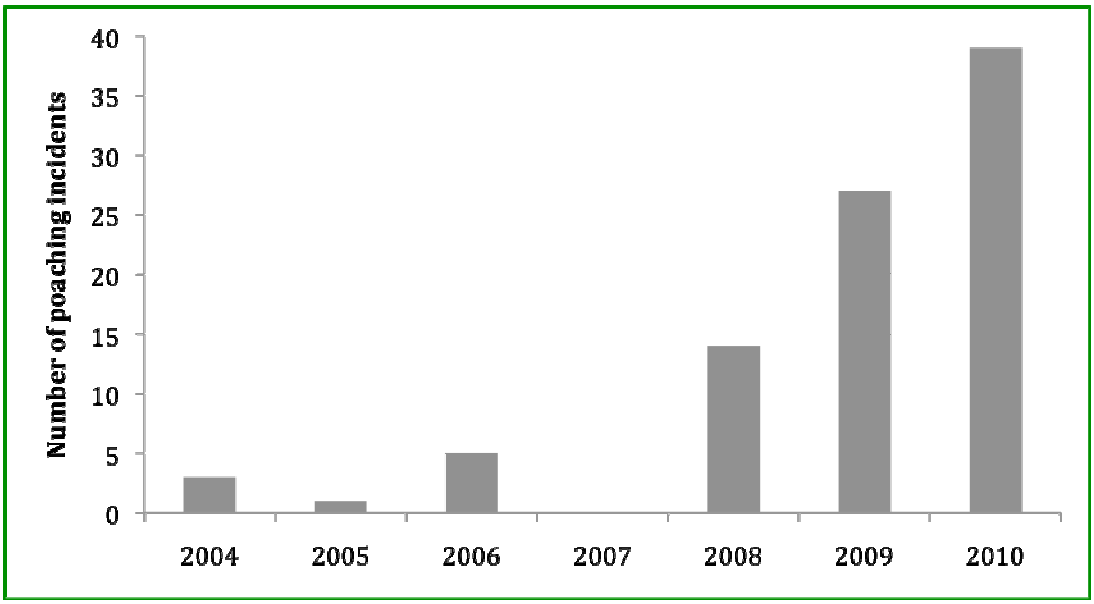

Figure 4.1 Bar graph of KZN rhino poaching incidents between 2004 and 2010

In KZN there are 63 properties that contain rhino, divided into 12 State run and 51 P/C owned reserves. In comparison to the P/C owned reserves, State run properties are larger by area (State Mean = 216 Km^2, P/C Mean = 40 Km^2) and rhino population (State Mean=240, P/C=10), although the mean rhino population density is similar with 0.79 and 0.45 rhino per Km^2 respectively (See Table 4.1).

	State	P/C
Number of properties	12	51
Area (Km²)	2593	2056
Mean rhino population per property	240	10
Mean rhino population density (Km²) per property	0.79	0.45
Number of properties poached	7	9
% Properties poached	58%	17%
Number of poaching incidents	78	11

Table 4.1 Summary of property details and rhino poaching incidents in KZN from 2004 2010 by land management

While both land management categories have reported similar numbers of poached properties (State=7, P/C=9) the level of poaching intensity has hit State run properties the hardest (88% of all recorded poaching incidents occurring between 2004 and 2010).

4.2 GLM analysis

The 'Dredge' results showed a best-fit model of:

Poached Status ~ Management +Housing Density + Roads Through Around

Whereby the state land management, plus high density housing surrounding a property with the presence of a black top/concrete road running through or around a property are the explanatory variables from this stud, that best explain the pattern of poaching present in KZN. Table 4.2a show summary statistics for the top models ranked by AICc value.

Variables	Deviance	AICc	Delta	Weight
Housing Density + Management + Roads Through Around	57.56	66.25	0.00	0.23
Management + Roads Through Around	60.65	67.05	0.81	0.16
Housing Density + Management	61.33	67.73	1.49	0.11
Management + Roads Through Around + Terrain	59.06	67.75	1.51	0.11
Management + Terrain	61.39	67.80	1.56	0.11
Housing Density + Management + Roads Through Around + Terrain	56.82	67.88	1.63	0.10
Management	63.83	68.03	1.79	0.10
Housing Density + Management +Terrain	59.74	68.43	2.18	0.08

Table 4.2a Model summary Best-Fit Model

State land management appear in 8 out of the 10 models and scores the highest for 'Relative Variable Importance' with the most explanatory power (Table 4.2b). This is followed by the presence of a main road running though and/or around a property (0.61), and while Housing Density appears in 6 out of the 10 models, it does not appear to hold as much statistical power as the Road variable with a 'Relative Variable Importance' of (0.53). Hilly terrain was the variable with the least explanatory power and only appears in 4 models.

Management	Roads Through Around	Housing Density	Terrain
1.00	0.61	0.53	0.40

Table 4.2b Relative variable importance

The GLM summary (Table 4.2c) reveals that while all the variables in the GLM contribute to the explanation of poaching patterns, State Management is the only highly significant variable ($p<0.01$), reinforcing a hypothesis that State managed properties are more likely to experience a poaching incident.

	Estimate	Standard Error	Z Value	P Value
Intercept	-1.765	0.790	-2.234	0.025 *
Housing Density	0.069	0.045	1.521	0.128
Management (State)	2.427	0.840	2.889	0.004 **
Roads Through Around (Yes)	-1.207	0.733	-1.645	0.100
Terrain (Hilly)	0.656	0.783	0.838	0.402
Significance p<0.05* and p<0.001**				
Null deviance 71.4, 62 df				
Residual deviance 56.8, 58 df				

Table 4.2c GLM summary

The negative relationship for 'Roads Through Around' indicates that the presence of a black top or concrete road decreases the likelihood of a poaching incident, which seems counterintuitive, but it is possible that the highly significant relationships between 'Management', the two 'Distance to Road' variables and 'Area' are confounding the results. Even though 72 out of the 89 rhino poached between 2004 and 2010 did occur within properties that had a major road running through or around its boundary, 63 of these incidents occurred within a state run property. One could hypothesise that increased roads around State run properties infers high tourist activity and a disturbance for poachers, but further investigation into these relationships will be required in order to tease out the meaning out these multiple relationships.

4.3 Questionnaire

11 participants from a possible 58 responded to the questionnaire. While a 20% response rate from a self-administered questionnaire is considered within the acceptable range (20-30%) (Bernard, 2006), it is at the lower end of this scale.

Although this is disappointing in terms of the amount of qualitative analysis, those who did reply were very candid with their responses to the open-ended question and a wide variety of insightful opinions were expressed.

Potentially, face-to-face interviews may have resulted in more responses, but budgetary and time constraints required to gain the trust of participants would have made this methodology difficult to implement.

The variety of responses and the number of times each was mentioned indicate the strength of that response amongst the respondents.

Out of the 11 respondents, 4 were from private/communally owned rhino properties and 7 from EKZNW state properties.

4.3.1 Revenues, costs & profits

Respondents generally reported 'Nil' to 'Low' revenue gains from having rhino on their property during the last financial year (7 out of 11 respondents). 'Moderate' to 'High' cost increases over the past 5 years (7 of 11) have been reported with Net Profits ranging between 'Costs greatly exceeding benefits' to 'Costs slightly exceeding benefits' (5 out of 8) although the overall Net Profit trend, during the past 5 years showed very little change. The reasons given for the increases in rhino protection costs are summarised in Table 4.3.1.

Issue	Number of mentions
Property security - fences	2
Security personnel – additional guards, salary, overtime	4
General costs – fuel	3

Table 4.3.1 Summary of responses for changes in property profits.

4.3.2 Rhino poaching

Of the 11 respondents, only 3 had experienced a poaching incident during the past 12 months and only 1 had experienced poaching during the previous 5 years. 4 respondents reported that a neighbouring property had been poached in the past 12 months and 2 during the previous 5 years. Despite a low reported rate of poaching amongst the respondents, in comparison to known provincial poaching rates, this did not change their attitude towards the current poaching problem with 100% feeling 'Very Concerned' about the current rate of poaching in KZN and South Africa. A variety of opinions regarding drivers of current poaching trends are summarised in Table 4.3.2.

Issue	Number of times mentioned
Demand from Asian countries	8
Societal issues – Greed, general lawlessness, lack of public awareness, poverty, unemployment	8
Wildlife conservation authority – lack of funding, corruption, decreased staff capacity, lack of control of neighbouring countries and rural communities entering protected areas	6
Legal system/Police – poor law enforcement, poor legal system, corruption	5
Government – lack of input into solving the problem and lack of funding	2
Involvement of organised criminals	2
Rhino – high rhino population density	1
Lack of a legal horn trade	1

Table 4.3.2 Summary of respondent opinions regarding drivers of poaching

4.3.3 Rhino protection

The vast majority of respondents (8 of 11) reported 'Moderate' to 'Significantly' increased levels of rhino protection effort with almost all reporting 'Moderate' to

'Significantly' increased levels in rhino protection costs (10 of 11). The main factor in the change in effort and costs appears to be staff related, and are summarised together in Table 4.3.3.

Issue	Number of times mentioned
Additional staff	5
Overtime	4
Staff equipment	3
Fear of being poached	3
Salary	2
Training	2
Reporting	1
Neutralise criminal sophistication	1
Electronic surveillance	1
Living expenses for staff	1

Table 4.3.3 Summary of factors that have influenced changes in rhino protection costs and effort

4.3.4 Scenario questions

A Pre-2007 Scenario - In 2010 the number of rhino poaching incidents for South Africa was 334, if poaching incidents were to return to pre-2007 levels (average of 3 per annum in KZN and 15 in South Africa) 6 respondents indicated that their rhino protection effort would remain the same, 3 would 'Moderately Decrease' effort and 2 would 'Moderately' to 'Significantly' increase effort. The differences in opinions are summarised by the range of open-ended responses below:

"Because our rhino protection is being applied at the same level prior to the increased poaching and this level will not change" (Respondent 6 – State)

"Guards would remain on property but spend less time with rhino"
(Respondent 1 - Private/Communal)

"With the current state of policing, there will be no guarantee of safety for the animals"
(Respondent 4 – Private/Communal)

A Third Poaching Scenario - Should rhino poaching increase by a third from the 2010 level to 450 (the estimated number of poaching for 2011 (www.gov.za)) respondents reported that 'Increased Security' would be the most likely management decision (6 out of 11).

"We are here to conserve the rhino in its full beauty. Why should they suffer due to poor protection" (Respondent 4 – Private/Communal)

"No matter how one reduces rhinos, the threat will not go away. The only thing is to strengthen security measures to discourage rhino poaching and impose harsh sentences"
(Respondent 5 – State)

The next most likely decision would be to remote track rhino utilising Global Positioning System (GPS) or similar technology, although this decision was very weak, with only 3 out 11 choosing this method due to the costs involved and perceived effectiveness.

"Current technology is very cost inhibitive and I don't really feel it can prevent the loss of rhino…possibly if technology and costs improve" (Respondent 3 – Private/Communal)

The decisions to dehorning rhino, reduce rhino populations via auction or hunting were not selected as by any of the respondents, with 3 respondents indicating the following opinions:

"Our organisation is seen as one of the primary rhino conservation agencies in Africa, essentially dehorning or removing rhino would be admitting defeat and where would be send them?"
(Respondent 6 – State)

"Dehorning is not an option as the animal looses tourism value"
(Respondent 3 – Private/Communal)

"Selling (rhino) to other people would be transferring the problem"
(Respondent 8 – State)

A Double Poaching Scenario - If rhino poaching incidents were to double from the 2010 level to 660 incidents per year, a similar number of respondents selected 'Increased Security' as the most likely decision (7 out of 11).

"The long term solution is to train our law enforcement staff to a level that will match poachers in terms of skill and equipment" (Respondent 11 – State)

There was an increase in GPS or similar "Remote Tracking" technology being considered, with 7 out of 11 indicating this choice as "Moderately" to "Highly Likely", although cost and technology are still issues.

"Remote tracking would depend on cost and technology"
(Respondent 3 – Private/Communal)

2 respondents indicated that reducing numbers by hunting would be "Moderately Likely" with 1 respondent indicating it as a source of conservation funds.

"More revenue will be required to buy (remote) transmission equipment"
(Respondent 8 – State)

1 respondent reported that they would be "Moderately Likely" to reduce their rhino population by selling at auction, but dehorning and removing all rhinos from a property were both scored as "Highly Unlikely" and "Not an Option".

Triple Poaching Scenario - Should rhino poaching incidents triple to 1000 rhino per year, the likelihood of choosing 'Increased security' as a management decisions remained the same at 6 out of 11 respondents.

"(I) hope (the) mentioned figures will never accrue. Drastic measures all over the country should be in place before this happens" (Respondent 2 – Private/Communal)

"Reducing rhino numbers to discourage poaching will not work, because on one hand rhino populations need to be increased but security measures should be increased, while applying sustainable utilisation" (Respondent 5 – State)

Selling rhino via auction increased from 1 (in the previous question) to 7 out of 11 respondents selecting this option as "Moderately" or a "Highly Likely. Remote tracking would be "Moderately" to "Highly Likely" for 7 out of 11 respondents, although 1 respondent indicated that group consensus might be required.

"Dehorning rhino might have to be looked at as an option, only if other reserves or organisations start to feel it's necessary as an option" (Respondent 3 – Private/Communal)

Only 1 respondent would consider dehorning or reducing numbers via hunting, although another respondent is not convinced of the merits of making this decision.

"Increase protection, get more resources from hunting quota revenue" (Respondent 8 – State)

"Hunting may have a role but at the same time it will also decrease your rhino population. It is arguable how hunting would protect the rhino population" (Respondent 7 – State)

Only under the "Triple Poaching Scenario" did 1 respondent indicated that removing rhino from the property would be a "Highly Likely" decision but possibly only as a short-term measure.

"In my opinion it will show that all efforts in term of security have failed, therefore, instead of leaving the population to extinction, perhaps it's better to relocate to another property where security is not a problem for a while" (Respondent 11 – State)

3 respondents stated the same answer across all three scenarios.

"If poaching increased we would be more alert in general, but considering that the poaching of rhino does not correlate to law enforcement effort, it is largely beyond your control unless huge amounts of money and effort are poured in. The normal practical law enforcement measures will not stop poaching" (Respondent 10 – State)

"Relatively large populations of rhino make most of these (options) completely unfeasible. But desperate times do call for desperate measures. It would also depend on whether poaching started happening here. It may increase nationally but in other areas, and we would then probably continue as per normal. But obviously be aware of the potential for increased poaching at any stage" (Respondent 7 – State)

"Decisions are made centrally by the organisation and little influence can be exerted by field managers" (Respondent 9 – State)

4.3.5 Help and by Whom?

Respondents gave a wide variety of opinions regarding what should be done and by whom to help solve the rhino-poaching problem. The responses for both questions are grouped and summarised in Table 4.3.5. Government support for an improved judicial system regarding rhino related crimes and a legalised rhino horn market, were the two highest suggestions from the 11 respondents.

"The solution to the problem does not lie in the protection of rhino, this has failed throughout Africa. The solution lies in making available rhino horns to the users by auctioning annual quotes of the over 40 Tonnes of legal horn in the country. In parallel to this alternative medication in whatever form should be marketed aggressively to the users"
(Respondent 1 – Private/Communal)

"Sentencing should be increased – we have to as a country, make rhino poaching an activity which is too risky to undertake; consider death sentence/shoot to kill. Diplomatic relations with countries known to be involved i.e. Vietnam and China should be severed. Flood the market with current horn stocks to detract from exclusivity, break the cycle of criminal activity and control the market" (Respondent 6 – State)

"Public prosecutors to become more familiar with wildlife crime and increase the sentences for rhino poaching. Increased fines/(prison) terms for snaring of rhino and greater resources to rhino poaching cases. Take more consideration into idea of legalising sale of rhino horn"
(Respondent 3 – Private/Communal)

Suggested support	**Number of times mentioned**
Government support for an improved judicial system - increased bail & fines, increased prosecution and convictions, longer prison sentences, high quality legal staff, death sentence/shoot to kill	10
Government, CITES, IUCN and NGO's - support for creation of legalised rhino horn market, understanding of supply chain for market regulation	10

Police –better trained police force, informants, surveillance, identify corruption	8
Government/State Wildlife Authorities – consolidate rhino population for enhanced protection, more resources (funding and highly trained staff) better recruiting standards, reduce unnecessary administration, improved firearm licensing process and screening of staff	8
Government – military support and funding for anti poaching resources	4
Government – diplomatic pressure on countries implicated in horn trade	2
State Wildlife Authorities/Rhino Organisations – creation of specialised law enforcement and intelligence gathering authority.	1
State Wildlife Authorities/Rhino Organisations – sharing of information and increased networking between organisations	1
Alternative source of 'rhino horn' medication - aggressively marketed in Asia	1
Private Landowners – take responsibility for their rhino populations	1
Corporate Finance – for alternative source of funding	1

Table 4.3.5 Summary of suggested support for rhino poaching incidents

Improved policing along with support from and for, conservation agencies was the next favoured solution. The reduced capacity (human resources and funding) within the state run wildlife authorities was noted, and the need for additional support requested.

"Government financial support for anti-poaching measures. Better policing and better trained policeman that actually know what they're doing"
(Respondent 4 – Private/Communal)

"In many cases, there is a shortage of staff and no intelligence network in place. Improvement of the budget for security of rhino specifically could make a huge difference"
(Respondent 11 – State)

"Adequate resources, budgets, information sharing and networking is required"
(Respondent 8 – State)

"Conservation agencies are understaffed, under resourced and having enough difficulty managing their own reserves…Private security to focus specifically on rhino safety would be the ultimate answer but at whose and what cost " (Respondent 6 – State)

The results gathered from this study, even with a small sample size has revealed a series of complex poaching drivers and interactions, and the complex nature of poaching is reflected in the wide variety of opinions expressed by the conservation practitioners represented in this study. And while it is inappropriate to extrapolate the results into the wider context of South African rhino poaching, it does highlight interesting and important concepts that warrant further discussion and future research.

5 Discussion

This study investigated a variety of spatial and management-related variables to best explain the distribution of rhino poaching patterns in KZN South Africa, complemented with an exploratory analysis of property managers' and owners' attitudes of attitudes and opinions regarding rhino poaching.

The findings from the quantitative analysis highlighted the need for additional research within State run parks to obtain a clearer understanding of the poaching patterns.

5.1 Spatial and reserve management related variables

The best-fit GLM model points to the management of the reserve, housing density surrounding the property and the presence of a main road through or around, as the variables that best explain the rhino poaching incidents between 2004 and 2007, with State management having the highest explanatory power for poaching activity. These findings may be an oversimplification of the issue, as highly correlated variables may be confounding the results, with the actual institutional structure of the property potentially not the variable of most concern. This is due to the highly significant relationships that exist between Management, Area, Roads outside/inside and Rhino Population Density.

The correlation analyses show that as the area of the property increases, the rhino population density increases and distance to roads inside and outside of the property increases with these factors all interlinked with management. These relationships can be explained by the fact that state run properties within

KZN are the custodians of South Africa's wildlife and natural habitats and as the land is owned by the state, is it normally always larger in size and wildlife numbers and density. Therefore when analysing the results of the model, it is difficult to tease apart if one of the management-related variables is in fact influencing the results. A finer scale quantitative analysis within each state run property could indicate more accurately the variables influencing property vulnerability, and could be utilised more efficiently by reserve management.

'Roads through and around a property' was the second most important spatial variable of the best-fit GLM model, although the negative relationship obtained from the analysis was unexpected. Again, this could be due to the highly correlated relationships explained above or other factors could be in play. For example, main roads are also access points for heavy tourism and the presence of tourist and the associated security measures that accompany tourist management could be acting as a deterrent to poachers. If finer scale data such as GPS points of rhino poaching incidents, tourist routes within the park and ranger patrol information were to be made available, a repeat of this analysis may reveal more significant results.

Housing density and therefore human population density was the third most important variable. Population density and the proximity to protected areas are frequently cited as drivers of poaching and species declines (Nawaz, 2007, Jachmann, 2008; Ogutu, 2009; Metzger, 2010). Restricted access to protected areas does not preclude illegal resources extraction by local communities (Hayward & Kerley, 2008). Although the presence of rhinos is not generally seen by local communities as an imposition or threat, the presence of human settlements nearby can influence the incidence of poaching through their

willingness or non-willingness to be complicit or 'turn a blind eye' when poaching occurs.

The rural population of KZN is higher than the national average (www.statssa.gov.za) and as the rural population growth rates on the boarders of protected areas are nearly double the average rural growth rate (Metzger, 2010) these pressures are expected to increase over time, placing more and more pressure on reserves, therefore the poaching pressures from local encroachment on protected areas does not appear to be improving over time.

The inter-related nature of the all variables are probably masking the true pattern of poaching and further research into this phenomenon would be required to obtain a more a definitive answer.

Effectiveness of anti-poaching patrols would be an interesting variable to test and may unlock the interactions, in particular; GPS points of rhino poaching incidents, patrol routes, numbers of rangers, hours of spent patrolling, level of training and the standard of equipment. Should these be made available, a very detailed analysis could be conducted identifying the exact locations of illegal activity and highlight areas of vulnerability where redirected resources could be deployed. Numerous studies in the past have found that the variability of poaching incidents are attributed to patrol efficiency, resources and funding (Leader-Williams and Albon, 1988, Milner-Gulland and Leader-Williams, 1992; Jachmann, 2008)

5.2 Land owner/reserve manager attitudes & opinions

The questionnaire responses, although gathered from a small sample size, provided an insightful array of opinions and attitudes from conservation

practitioners. Although it is inappropriate to make broad conclusions, the results can be useful in creating discourse regarding a highly sensitive topic. For further research, it would be interesting to repeat a similar study in other regions of South Africa to determine if there are differences in opinion due to property location. As KZN have a proud history of rhino conservation, do the landowners and managers have a more intrinsic view of rhino conservation, versus a purely economic incentive attitude? Other areas may yield different results and therefore further inferences could be made regarding the future of rhino conservation on private land on a countrywide scale.

5.2.1 Costs, profits & revenues

The majority of respondents reported low levels of revenue gained and moderate to high costs incurred from having rhino on their property. However, as they reported only minimum changes over 5 years in their overall profits, it appears that these respondents might not yet have reached a critical financial 'tipping point', whereby rhino conservation moves from becoming a previously profitable business to an unprofitable venture.

The additional costs that were incurred appear to be due to the increased investments in security; these including personnel (and associated salary costs), equipment, property security and additional expenditure on fuel. While these costs will increase naturally over time, due to inflation and other economic factors, should the poaching incidents continue to increase and more security measure are implemented, then the costs for protecting rhino could soon escalate higher, bringing us closer to the aforementioned theoretical tipping point. Should the switch from profitability to unprofitability in private

investment in rhino conservation ensue, South Africa could run the risk of landowners reverting to a non-wildlife based form of land use management for reasons relating to finance, security risks and effort. As South Africa has been viewed as successful and innovative with their approach to wildlife conservation and management, particularly with rhino, the knock-on consequences could well jeopardise the future of international rhino conservation outside and inside state-run protected areas.

In September of 2011, the South African government recently announced they are considering a moratorium on rhino hunting in order to review the existing legislation and regulations, due in part to alleged corruption amongst some hunting organisations (www.gov.za). While this is welcome news to anti-hunting and animal welfare campaigners, a move such as this could potentially decrease private landowner revenue and associated profits even further. Should the moratorium be only be enforced during the regulatory review, then benefits from such improvements could help long term rhino security, although a long term hunting ban could put the law abiding private landowners, who rely on rhino trophy hunting for income at a financial disadvantage. Elsewhere in Africa, moratoriums on hunting and problem animal control (e.g., lion in Botswana) have had mixed results in terms of their conservation efficacy and have been viewed as politically contentious on both sides (del Valle, 2004).

The balance between costs and profits for landowners should therefore be closely monitored to ensure this risk is minimised and future research targeted appropriately.

5.2.2 Drivers of poaching and what can be done to help

The respondents indicated the main factors they believe to be influencing the increase in rhino poaching were (a) demand from Asian countries, (b) societal/development deficiencies, (c) institutional issues or inefficiencies within the government and regulatory agencies, and (d) inefficient legal framework or law enforcement. Demand from Asian countries aside, the three other categories are domestic in origin, potentially suggesting that conservation gains could be achieved through improved governance in these sectors.

Inadequate law enforcement, poverty and civil unrest have often been cited as factors contributing to increased illegal resource consumption (Grey-Ross et al, 2010), and while these examples are usually quoted when discussing issues like civil war and a breakdown in government, an overall lack of investment into these important sectors.

Law enforcement, in terms of anti poaching effectiveness was described by Milner-Gulland and Leader-Williams in 1992 as being influenced by probability of detection, likelihood of capture (once detected) and the level of prosecution. It has been noted in mainstream press (www.bbc.co.uk) and reinforced via the questionnaire respondents, that gangs of organised criminals are the suspects behind the poaching incidents of late, with the probable employment of locals as guides and on the ground resources. Local poachers have been shown to show positive behavioural changes regarding poaching behaviour when offered an alternative income in place of poaching and are more easily deterred with the probability of capture. While gangs require penalties that are comparative to the crime committed and are deterred by improved law enforcement (Milner-

Gulland and Leader-Williams, 1992). It could be argued that under the current economic conditions surrounding the high price rhino horn, the benefits associated with poaching greatly outweigh the probability of being caught, and any fine that may be issued is inconsequential, potentially rending law enforcement ineffective. Incentive structures that are effective at creating support from local people for EKZN's anti-poaching efforts could produce results by reducing local communities' complicity or acceptance of poaching. An understanding of how, or even if, benefits from rhino poaching are shared by local populations living near reserves would be beneficial to efforts to structure such incentives. As the Wildlife Authorities (in this case EKZNW) are faced with having to neutralise the poaching pressure, or maintain vigilance against a poaching incident with an ever-decreasing budgets and resources, local community support and assistance is critical for success.

This lack of government management and investment is reflected in the strength of responses when asked 'What support is needed, and by whom' with 7 out of the 11 response categories citing some form of government investment, improvement in legal systems/law enforcement and more funding and resources for Wildlife Authorities as sources of assistance towards rhino poaching.

Respondents also suggested that Government support initiatives which address the demand of rhino horn. The historic use of rhino horn, as a Chinese herbal medicine, decorative carvings and Yemini dagger handles (Janbiya) are well known (Ellis, 2005) The South African police have been making inroads into the criminal networks and investigations of the supply chain traders are yielding positive arrest rates (www.gov.za) and diplomatic pressure has been suggested

as an additional trajectory for rhino conservation. Although political will is required to make any headway towards solving any domestic or international issue, wildlife resources important to the national or provincial economy and society need to be valued and managed in the same manner as any other natural resource if conservation is to succeed (such a gold, coal or other minerals). It was also recently reported that museums and auction houses across Europe are targeted specifically for antique rhino horn (www.bbc.co.uk), proving that this is not just a problem in Africa; this is an international issue that requires international collaboration.

Suggestions have been made with South African conservationists and also suggested by questionnaire respondents, to investigate a legalised rhino horn market to eliminate the need to for poaching. As rhino horn does grow back and there are reportedly substantial stockpiles of horn held by state in private reserves, a legal horn market is an attractive solution to sourcing much needed conservation funding. Although this solution may not be as simple as it appears. Blute (2005) looked into this very idea and concluded that a basic supply side approach could result in either more poaching or no net decrease in poaching under certain market conditions. His reasoning deduced that the supply side market assumption of 'perfect competition' is violated in an illegal black market. Whereby in reality, the criminal gangs are acting as 'traders' in an 'imperfect competition' environment supplying a large proportion of the rhino horn stock under almost monopolistic conditions, manipulating the market price by either altering the supply and the price 'mark up'. It was posed as a possibility that if a sustainable horn supply was made available on a controlled basis (from un-

poached sources) disreputable or criminal elements active today may simply alter the mark-up cost to aggressively manipulate the market in their favour. Hence, they could still maintain market control and the threat of poaching could remain. Alternatively, if sustainable horn quotas were to be introduced under a strictly controlled and regulated market (after rigorous market research) a sustainable supply could potentially match current demands, the gang 'traders' could be bypassed via legal channels, decreasing the need to poach with the proceeds funnelled back into rhino conservation. This does sound attractive on paper, but the underlying assumptions in this discussion is the requirement of transparent market conditions, strict governance and a corruption free environment, which is often lacking in African countries ('t Sas-Rolfes, 1994). A legalised trade may also open the market to consumers, whom would not have previously purchased rhino horn due to its illegal status and could be a 'backdoor' entrance for illegal horn to make it's way on to the legal market. This option may not be the silver bullet solution to rhino poaching, as some believe it is.

The CITES ban has proven to be ineffective in decreasing demand and going forward, with an ever increasing human population in the East, changing consumer habits could prove costly or perhaps even impossible ('t Sas-Rolfes, 1994). Therefore for this reason alone, all options should remain open for consideration, and further innovation, political will and funding are required.

Rhino poaching is a multi dimensional issue involving international sovereign governments, local communities, international criminal organisations, regional wildlife authorities and landowners. Perhaps the answer to the current rhino

poaching threat is no longer just about reinforcing protected areas and employing tried and tested game management approaches. With a new paradigm that sees rhino horn trading at unprecedented prices, some economists have suggested that the effects of the global recession have rhino horn is being utilised in the same way as gold, as an alternative repository of value (www.freakonomics.com).

5.3 Strengths and limitations

The strength of this study is the combination of both quantitative and qualitative analysis. While the results from the spatial and management related variable analysis were inconclusive in terms of highlighting specific variables that preclude a property to a poaching incident, it did confirm that valuable resources held within state managed reserves are under significant pressure from poachers. Very little research has utilised quantitative approach to park vulnerability and similar methodology could prove to be useful, by combining previously collected data and accompany this with specific on site information. The analytical methodology is relatively straightforward and quick, with the potential for results to assist reserve managers in a timely manner.

Therefore the results from this portion of the study can be utilised towards building a finer scale analysis methodology.

The attitude and opinion results gathered via qualitative questionnaire analysis again cannot be extrapolated to all property owners, but they did give landowners and reserve managers the opportunity to voice their opinions and suggestions; in an attempt to begin a meaningful dialogue amongst conservation

practitioners. The wide variety of responses highlight that rhino poaching is not a single faceted issue, it is complex and interacts with all sectors of society – from local communities, through to high level government policy and beyond the shores of South Africa.

The availability and access to data was an issue during the data collection phase. The importance of working collaboratively and protection of resources due the understandable security issues played off on one another. Should data become more freely accessible to registered researches and the results disseminated amongst rhino stakeholders, the benchmark of open discourse and open exchange of information will only enhance the strength of the individuals and organisations working towards the same end goal. Property managers should welcome the opportunity for the chance to explore the vulnerabilities of their reserves; this information could be used to better deploy the limited conservation resources in the most efficient and effective manner. The stronger relationships between conservations, researchers and practitioners, the stronger the trust and the louder your collective voice will be heard. Just as in protected area management, corridors can increase the viability and functions of ecosystem and constituent species; conservation organisations work in the same manner with open communication, exchange of data and networking create a stronger and more robust collective front.

5.4 Conclusion

While the combined results of this study have not pinpointed conclusively the contributing property related factors influencing rhino poaching patterns in KZN, they have highlighted spatial concepts worthy of a finer scale examination

and a wide selection of social, institutional and economic factors that should be open for discourse and future research.

The stakes are high. The urgent requirement going forward is to ensure the long-term survival of the species, in an ever-increasing resource consumption-driven world, not only for the species intrinsic value, but also for the continued livelihood of South African people.

Future analysis of conservation inputs and management strategies must be conducted in relation to a rapidly evolving and transformative set of drivers relating to demand-influenced factors (in the case of South Africa's rhinos) that exist far out of reach for local land managers. A fuller understanding of such drivers, their interplay, and how they impact the attitudes of local stakeholders (communities and land owners), as well as the creation of incentives to align interests of as many actors as is possible could help enable the continuation of South Africa and KZN conservation successes. (Milner-Gulland and Leader-Williams, 1992).

6 References

't Sas-Rolfes, M. (2000) Assessing CITES: Four case studies. In J. Hutton and B Dickson (eds), *Endangered Species Threatened Convention: The Past, Present and Future of CITES*. London: Earthscan, pp. 69-87

't Sas-Rolfes, M. (1994) Trade in Endangered Species: Is it an Option? *Economic Affairs,* April 10-12

2010 *Rhino Horn Trade Management in VietNam, Including Legally Aquired Horns from Trophy Hunts* Convention on International Trade in Endangered Species of Wild Fauna and Flora. CoP 15

Adams, W. M. (1998) Conservation and Development. In W. J. Sutherland (ed.) *Conservation Science and Action.* Oxford, UK: Blackwell Science, pp. 286-315

Akaike, H. (1973) *Information Theory and an Extension of the Maximum Likelihood Principle.* Akademiai Kiado, Budapest, Hungary pp. 267-268.

Amin, R., Thomas, K., Emslie, R. H., Foose, T. J., & Van Strien. N. (2006) An overview of the conservation status of and threats to rhinoceros species in the wild. International Zoo Yearbook, 40: 96-117

Arnzten, J. W. An Economic View on Wildlife Management Areas in Botswana (2003) Gabarone, IUCN. CBNRM Support Programme Occasional Paper No. 10.

Attwell, C. A. M. and Cotterill, F. P. D (2000) Postmodernism and Africa Conservation Science. *Biodiversity and Conservation* 9, 559-577

Barnes, J. I. (2001) Economic Returns and Allocation of Resources in the Wildlife Sector of Botswana. *South African Journal of Wildlife Research,* 31, 141-153

BBC Science & Environment (2011) *UK to Lead International Rhino Horn Clampdown* [Online] Available from: http://www.bbc.co.uk/news/science-environment [Accessed 20th August 2011]

Bernard, H., R. (2006) *Research Methods in Anthropology: Qualitative and Quantitative Approaches.* 4th ed. AltaMira Press 2006 Oxford, UK

Boynton, G. (2010) *Safari: Are too many tourists killing Africa's Wildlife?* [Online] Available at: http://www.telegraph.co.uk/travel [Accessedd 11th September 2011]

Bulte, E. H. & Damania, R. (2005) An Economic Assessment of Wildlife Farming and Conservation. *Conservation Biology* 19(4) 1222-1233

Burnham, K. P. and Anderson, D. R (2002) *Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach.* 2nd ed.

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

CITES n.d. *CITES Species Database* [Online] Available from: http://www.cites.org/

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(2):43

Cowlishaw, G., Meldelson, S. & Rowcliffe, J.M, 2005. Evidence for post-depletion sustainability in a mature bushmeat market. J. Appl. Ecol. 42: 460 - 468

De Alessi, M (2000) Private Conservation and Black Rhinos in Zimbabwe: The Save Valley and Bubiana Conservancies. *Centre for Private Conservation.*

del Valle, G. C. (2004) Predator Conservation in a World of Human Use: Socio-economic, Ecological and Policy Aspects of Conflict Between Humas and Lions *Panthera leo* in the Okavango Delta, Botswana. MSc Thesis, University of Kent at Canterbury (DICE) (Unpublished)

Ellis, R. (2005) *Tiger Bone & Rhino Horn: The Destruction of Wildlife for Traditional Chinese Medicine.* Washington, DC, Shearwater Books

Fischer, C., Muchapondwa, E. and Sterner, T. (2011) *Environ Resource Econ*. 48, 303-319

Goodman, P. S., James, B. & Carlisle, L. (2002). Wildlife utilisation: It's role in fostering biodiversity conservation in KwaZulu-Natal. In: Pierce, S. M.,

Cowling, R. M., Sandwith, T. & MacKinnon, K. (eds.) *Mainstreaming biodiversity in development. Case studies from South Africa*. Washington, D.C, The International Bank for Reconstruction and Development/THE WORLD BANK. pp. 21-31.

Grey-Ross, R., Downs, C. T. & Kirkman, K. (2010) An Assessment of Illegal Hunting on Farmland in KwaZulu-Natal, South Africa: Implications for Oribi *(Ourebia ourchi)* Conservation. *BioOne*. 40(1) 43-52

Hall, R. J., Milner-Gulland, E. J., & Courchamp, F. (2008) Endangering the endangered: The effects of perceived rarity on species exploration. *Conservation Letters,* 1, 75-81

Hartter, J. and Goldman, A. (2011) Local responsible to a forest park in western Uganda: alternative narratives on fortress conservation. *Oryx.* 45(1), 60-68

Hayward, M. W. and Kerley, G. I. H (2008) Fencing for Conservation: Restriction of Evolutionary Potential of a Riposte to Threatening Processes? *Biological Conservation*. 142, 1-13

Hutton, J.M. & Leader-Williams (2003) Sustainable Use and Incentive-Driven Conservation: Realigning human and conservation interests. *Oryx,* 37, 215-224

Jachmann, H. (2008) Illegal Wildlife Use and Protected Area Management in Ghana. *Biological Conservation.* 141, 1906-1918

Jick, T. D., (1979) Mixing qualitative and quantitative methods: Triangulating in Action. *Administrative Science Quarterly,* 24 (4), 602-611

Karsten, M., Jansen van Vuuren, B., Gooman, P. & Barnaud, A. (2011) The History and Management of Black Rhino in KwaZulu-Natal: A Population Genetic Approach to Assess the Past and Guide the Future. *Animal Conservation.* 14, 363-370

Kiss, A. Is Community-based Ecotourism a Good Use of Biodiversity Consevation Funds? Trends in Ecology and Evolution. 2004.

Kiss, A. Principles and Issess. Kiss, A. Living with Wildlife: Wildlife Resource Management with Local Participation in Africa. 1990. World Bank Technical Paper No. 130

Knight, M.H., (2009) Black rhino translocations within Africa. *Africa Insight*, 39: 70-83

Kock, R. A., (1995) Wildlife Utilisation: Use it or Lose it – a Kenyan Perspective. *Biodiversity and Conservation*. 4, 241-256

Leader-Williams, N. & 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

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

Lindsey, P. A., Romanach, S. S., Tambling, C. J., Chartier, K. & Groom, R. (2011) Ecological and Financial Impacts of Illegal Bushmeat Trade in Zimbabwe. *Oryx,* 45(1), 97-111

Liu, F., McShea, W., Garshelis, D., Zhu, X., Wang, D., & Chen, Y. (2009) Spatial Distribution as a Measure of Conservation Needs: An Example with Asiatic Black Bears in South-Western China. *Diversity and Distribution.* 15, 649-659

Metzger, K. L., Sinclair, A. R. E., Hilborn, R., Grant, J., Hopcraft, C., Simon, & Mduma, A. R. (2010) Evaluating the Protection of Wildlife in Parks: The Case of African Buffalo in Serengeti. *Biodiversity Conservation*. 19, 3431-3444

Millner-Gulland, E. J. & Leader-Williams, N. (1994) 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

Nawaz, M. A. (2007) Status of the Brown Bear in Pakistan. *BioOne*. 18(1) 89-100

Nelson, F. (2006) Black Rhinoceros Conservation and Trophy Hunting in Southern Africa: Implications of Recent Policy Changes. Endangered Species Update, April-June 2006 *Rhinoceros Resource Centre*

Norton, D. A. (2000) Conservation Biology and Private Land: Shifting the Focus. *Conservation Biology*. 14(5), 1221-1223

Ogutu, J.O., Piepho, H. P., Dublin, H. T., Bhola, N. & Reid, R. S. (2009) Dynamics of Mara-Serengeti Ungulates in Relation to Land use Changes. *Journal of Zoology.* 278, 1-14

Pires, S. F & Moreto, W. D. Preventing Wildlife Crimes: Solutions That Can Overcome the "Tragedy of the Commons" *Eur J Crim Policy Res* 17, 101-123

Potter, Rod. Wildlife Investigator Ezemvelo KZN Wildlife (Personal communication, 25th May 2011).

Provide Project (2005) *A profile of KwaZulu-Natal: Demographics, Poverty, Inequality and Unemployment.* Background Paper 2005:1(5)

R Development Core Team. (2010) R: A language and environment for statistical computing. [Version 2.11.1] R Foundation for Statistical Computing Vienna, Austria.

Redford, K. H. & Richter, B. D (1999) Conservation of Biodiversity in a World of Use. *Conservation Biology.* 13(6) 1246-1256

Rhino Resource Centre. Rhinos Seeing Unprecedented Slaughter. [Online] Available from: www.rhinoresourcecenter.com [Accessed 4th April 2011]

Rosser, AM and Leader-Williams, N (2010) Protection or use: a case of nuanced trade-offs? In *Trade-offs in Conservation: deciding what to save*, edited by N Leader-Williams, WM Adams and RJ Smith, pp.135-156. Oxford: Wiley-Blackwell.

Rowcliffe, J. M., de Merode, E. & Cowlishaw, G. (2004) Do Wildlife Laws Work? Species Protection and the application of a prey choice model to poaching decisions. *The Royal Society*. 271, 2631-2636

Sanches-Mercado, A., Ferrer-Paris, J. R., Yerena, E., Garcia-Rangel, S. &Rodriquez-Clarke, K. M. (2008) *Oryx*. 42(3) 437- 447

Seidensticker, J. (2010) Saving Wild Tigers: A Case Study in Biodiversity Loss and Challenges to be Met for Recovery Beyond 2010. *Integrative Zoology.* 5, 285-299

Smith R. J., Muir, R. D. J, Walpole, M. J., Balmord, A. (2003) Governance and the Loss of Biodiversity. *Nature.* 426, 67-70

Southafrica.info (2011) *South Africa's Tourism Industry* [Online] Available at: www.southafrica.info/business/economy/sectors/tourism-overview.htm [Assessed 11th September 2011].

Spenceley, A. (2005) Nature-based Tourism and Environmental Sustainability in South Africa. *Journal of Sustainable Tourism.* 13(2) 136-170

Spenceley, A. & Barnes, J. (2005) *Economic Analysis of Rhino Conservation in a Land-Use Context within the SADC*. SADC RPRC Task 6.3-1.2 (Phase II)

Spiteri. A. and Nepalz, S. K (2006) Incentive-based conservation programs in Developing Countries: A Review of Some Key Issues and Suggestions for Improvements. *Environmental Management,* 37(1) 1-14

Statement by Minister Edna Molewa on the ongoing scourge of rhino poaching (2011) *South African Government Online* [Online] Available from: http://www.gov.za/speech [Accessed 29th August 2011]

Statistics South Africa (2011) *Mid-Year Population Estimates* [Online] Available from: www.statssa.gov.za/publications [Accessed 18th August 2011]

The IUCN Red List of Threatened Species. [Online] Available from: www.iucnredlist.org [Accessed 4th April 2011]

Walker, C. H. (1994) Black Rhino on Private Land – The Experience of Lapalala Wilderness, South Africa. Proceedings of a Symposium. In: *Rhinos as*

Game Range Animals. Bedfordview, South Africa. Rhino and Elephant Foundation pp 108-110

Walpole, M., Karanga, G. G., Sitait, N. W. and Leader-Williams. Wildlife and People: Conflict and Conservation in Masai Mara, Kenya. (2003) London. Wildlife and Development Series No.14. International Institute for Environmental and Development.

Watkin, J. R. (2003) *The Evolution of Ecotourism in East Africa: From an idea to an industry.* IIED Widlife and Development: 15.

Wato, Y. A., Wahungu, G. M. & Okello, M. M. (2006) Correlates of Wildlife Snaring Patterns in Tsavo West National Park, Kenya. *Biological Conservation.* 132, 500-509

7 Appendix

7.1 Questionnaire cover letter

EZEMVELO KZN WILDLIFE
Conservation, Partnerships & Ecotourism

23 June 2011

Dear

Ezemvelo KZN Wildlife is supporting a research study exploring landowner and manager attitudes towards rhino conservation within KZN and South Africa.

The purpose of this project is to explore your opinions concerning rhino poaching, the costs and benefits involved with maintaining rhino populations, along with your thoughts about the future of rhino conservation. It is our intention that the information gathered from this study will be used to identify areas of concern, potential future management decisions and assist us in our efforts to support rhino conservation within KZN.

We request your participation in this study by completing the short and simple questionnaire attached. Your participation is entirely voluntary. Please however be assured that all information supplied by you on the questionnaire will be completely confidential and all results will remain entirely anonymous and not linked to any property or owner.

Should you wish to participate in the study, please complete the attached questionnaire, and return via email or fax to John Cragie (jcraigie@kznwildlife.com or fax: 033 845 1226).

Should you have any questions or concerns about this project, please feel free to contact either myself or John Cragie; we will be happy to discuss this project further.

Your support and participation would be greatly appreciated.

The results of the study will be available from October 2011. We will forward these to all those that participated in the study.

Yours sincerely,

Dr. Peter Goodman
Coordinator Biodiversity Research

P O Box 13053,Cascades. 3202. Pietermaritzburg. KwaZulu-Natal, South Africa.
Tel: +27 33 845 1999.Fax: +27 33 845 1699.
Reservations:Tel: +27 33 845 1000. Fax: +27 33 845 1001. Information: +27 33 845 1002.
E-mail bookings: bookings@kznwildlife.com. Website: www.kznwildlife.com

7.2 Questionnaire form

Landowner Attitudes Questionnaire

Date	

Area of Property (ha)	

Private/Communal Run Game Ranch	State Run Protected Area

Question 1:
Please indicate from the list below, which sources of REVENUE your property receives from rhino.
(Please X appropriate box/boxes)

Rhino Tourism (Game viewing, photography etc)	
Rhino Trophy Hunting	
Auction/Selling Live Rhino	
Others (Please state)	

Question 2:
A) How would you describe the REVENUE that was gained from the rhino on your property in the last financial year?

Nil	Low	Moderate	High	Very High

B) How has this REVENUE changed over the past 5 years?

Significantly Decreased	Moderately Decreased	Small Change	Moderately Increased	Significantly Increased
More than 10%	Between -10% and -5%	Between -5% and 5%	Between 5% and 10%	Greater than 10%

Question 3:
A) How would you describe the financial COST from having rhino on your property in the last financial year?

Nil	Low	Moderate	High	Very High

B) How has this financial COST of keeping rhino changed over the past 5 years?

Significantly Decreased	Moderately Decreased	Small Change	Moderately Increased	Significantly Increased
More than 10%	Between -10% and -5%	Between -5% and 5%	Between 5% and 10%	Greater than 10%

Question 4:

A) How would you describe the NET PROFIT made from having rhino on your property for the last financial year?

Costs greatly exceed benefits	Costs slightly exceed benefits	Costs similar to Benefits	Benefits slightly exceed costs	Benefits greatly exceed costs

B) How has this NET PROFIT changed over the past 5 years?

Significantly Decreased	Moderately Decreased	Small Change	Moderately Increased	Significantly Increased
More than 10%	Between -5% and -10%	Between -5% and 5%	Between 5% and 10%	Greater than 10%

C) If there has been a change; please describe which factors have contributed MOST to the increase or decrease in NET PROFITS.

Question 5:

A) Has your property experienced poaching of rhino during the past 12 months?

Yes	No

B) Has your property experienced poaching of rhino during the previous 5 years?

Yes	No

C) Has a neighbouring property experienced poaching of rhino during the past 12 months?

Yes	No

D) Has a neighbouring property experienced poaching of rhino during the previous 5 years?

Yes	No

Question 6:

A) How would you describe your attitude towards the rhino poaching incidents in South Africa over the past 5 years?

Not Concerned	Moderately Unconcerned	Neutral	Moderately Concerned	Very Concerned

B) How would you describe your attitude towards the rhino poaching incidents in KZN over the past 5 years?

Not Concerned	Moderately Unconcerned	Neutral	Moderately Concerned	Very Concerned

C) In your opinion, what factors have caused the increase in rhino poaching incidents in South Africa?

Question 7:

A) How has your properties level of rhino protection EFFORT changed over the past 5 years?

Significantly Decreased	Moderately Decreased	No Change	Moderately Increased	Significantly Increased

B) What can the change in EFFORT be ascribed to?

Question 8:

A) How has your properties level of rhino protection COSTS changed over the past 5 years?

Significantly Decreased	Moderately Decreased	No Change	Moderately Increased	Significantly Increased

B) What can the change in COSTS be ascribed to?

Question 9:

A) If rhino poaching incidents were to return to pre-2007 levels (average of 3 rhino per year in KZN and 15 rhino per year for South Africa), how would your properties level of rhino protection EFFORT change?

Significantly Decrease	Moderately Decrease	No Change	Moderately Increase	Significantly Increase

B) Please explain why you would make this management decision?

Question 10:

The number of rhino poaching incidents recorded in South Africa for 2010 was 333.

A) Should the yearly rhino poaching incidents increase from the current level by a third to 450 incidents, please indicate below the likelihood of you choosing to make the following decisions.

Increase property security measures					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Dehorn rhino					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Reduce rhino population through increased hunting quotas					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Reduce rhino population by selling more rhino at auction					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Remote tracking transmitters on all rhino					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely

Remove all rhino from property					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely

B) Please explain why you would choose to make these management decisions.

Question 11:

A) Should the yearly rhino poaching incidents double to 660 incidents, please indicate below the likelihood of you property choosing to make the following decisions.

Increase property security measures					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Dehorn rhino					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Reduce rhino population through increased hunting quotas					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Reduce rhino population by selling more rhino at auction					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Remote tracking transmitters on all rhino					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely

Remove all rhino from property					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely

B) Please explain why you would make these management decisions.

Question 12:

A) Should the yearly rhino poaching incidents triple to 1000 incidents, please indicate below the likelihood of you choosing to make the following decisions.

Increase property security measures					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Dehorn Rhino					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Reduce rhino population through increased hunting quotas					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Reduce rhino population by selling more rhino at auction					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely
Remote tracking transmitters on all rhino					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely

Remove all rhino from property					
Not an option	Don't know	Highly Unlikely	Moderately Unlikely	Moderately Likely	Highly Likely

B) Please explain why you would make these management decisions.

Question 13:
In your opinion, what should be done to help rhino property owners and managers improve the current rhino poaching problem?

Question 14:
In your opinion, which organisations should be providing property owners and managers with assistance towards improving the current rhino poaching problem?

Thank you for your participation.

7.3 South African rhino poaching data

	2007	2008	2009	2010	TOTAL
Kruger	10	36	50	146	**242**
Limpopo	0	23	16	52	**91**
KwaZulu-Natal	0	14	28	39	**81**
North West	0	7	10	57	**74**
Mpumalanga	3	2	6	17	**28**
Gauteng	3	2	6	17	**28**
Eastern Cape	0	1	3	4	**8**
Free State	0	0	2	3	**5**
Northern Cape	0	0	0	1	**1**
Western Cape	0	0	0	1	**0**
TOTAL	**13**	**83**	**122**	**334**	**552**

Table 7.3 Correlation table showing relationships between all variables

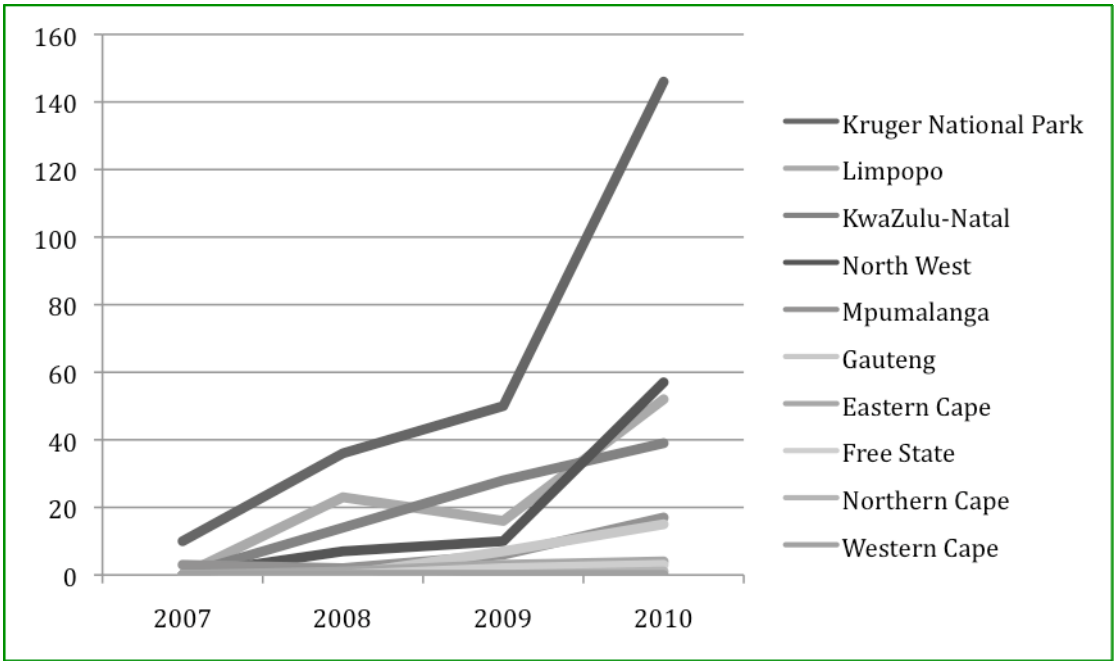

Figure 7.3 Line graph showing rhino poaching incidents for

7.4 Mode of kill data

	Shot	Snare	TOTAL
2004	2	1	**3**
2005	0	1	**1**
2006	4	1	**5**
2007	0	0	**0**
2008	13	1	**14**
2009	24	3	**27**
2010	36	3	**39**
TOTAL	**79**	**10**	**89**

Table 7.4 Rhino poaching incidents in KZN by mode of Kill