Development of a Rhino Anti-Poaching Model for Game Farms and Nature Reserves in the Free State Province of South Africa

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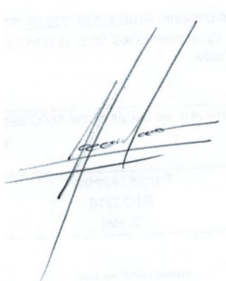
DECLARATION OF INDEPENDENT WORK

I, H.L. Jordaan, do hereby declare that this research project submitted for the degree Doctor of Technology in Agriculture, is my own independent work and has to the best of my knowledge not been submitted before to any institution by me or anyone else as part of any qualification.



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ABSTRACT

During the last ten years, the rhino populations of South Africa have suffered under an intense poaching onslaught. This onslaught has moved to the Free State Province of South Africa and there is a justified concern that its rhino populations are at risk. To protect the rhinos in the Province a need exists to manage the risk of poaching through a practical rhino anti-poaching model, which can assist to protect them effectively. This Rhino Anti-Poaching Model can determine and predict a poaching risk, can identify weaknesses, can assist to address problem areas, and will enable efficient monitoring.

It is imperative to know which rhino species occurred in the Free State Province in historical times, to ensure that the correct rhino species is protected against the risk of poaching and that they be kept in a suitable habitat. Nine farms in the Free Sate have rhino as a prefix in their names, which may be an indication that rhino did occur in the Province. Various historical photos and literature give a retrospective view, and show that there was insufficient browsing vegetation for black rhinos to survive. The occurrence of open grassland however suggests that white rhinos did occur in those specific areas during the time of the first pioneers. During this study period a count of rhinos was done, and currently there are 669 white rhinos and 11 black rhinos in the Province, thus a total of 680 rhinos in the Free State Province.

The South African Constitution mandated the State to enforce measures that will ensure adequate environmental protection for the benefit of future generations. The South African government promulgated a myriad of new environmental legislation. Several international agreements were also introduced as enforcement tools to regulate rhinos. The enforcement measures are noble, but out of balance, with many inspectors, but too few law enforcement officials. It also over-regulates and ensnare officials in minor issues.

A brief discussion on the latest technological innovations gives insight to the purpose of its development and effectiveness in combating rhino poaching. There are currently no technical or strategic solutions to save rhinos from poaching, therefore a combination of

techniques is needed. Although self-manufactured unconventional devices seem to be more efficient to deceive poachers, a combination with the latest technological equipment and conventional strategies might be the best solution to counter rhino poaching.

Free State rhino farmers own 90% of the Province's rhinos. However, these rhino farmers lack the appropriate security measures required to adequately protect their rhinos. A questionnaire was developed and data were collected, providing statistics on the current stance of security measures on rhino sites in the Province. It showed that 80% of rhino poaching occurs in rhino camps bordering public roads, 69% of the rhino sites located within 20km from the nearest town reported poaching, and 77% of large rhino camps are prone to poaching incidents. 57% of the respondents experienced rhino poaching on their sites. Through the questionnaire, it was gathered that rhino farmers in the Province are not vested in the concept of using trained rhino security.

A Production Loss Formula was constructed that calculates the production loss of a poached rhino. This formula reflects the reality experienced by the breeder. It indicated that the Province lost almost R300 million due to the poaching of 60 rhinos and that a poached breeding bull scores a higher production loss than all other gender groups. The Production Loss Formula also indicated that the State had a larger mean amount of loss compared to the rhino farmers, despite the lower bull per cow ratio owned by the State.

As part of the Rhino Anti-Poaching Model, a spreadsheet Formula was developed to calculate the total poaching risk percentage of each rhino site in the Province. Subsequently, an average rhino-poaching risk of almost 65% was obtained. After a rectification of the risks, the average poaching risk was reduced to nine percent and 10 sites scored below 50% (versus the current four). The statistical analysis indicates that the most important predictors for number of rhinos poached in the Free State Province were the Rhino Camp and Rhino Population categories.

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LIST OF ABBREVIATIONS

AIS	Alien Invasive Species
ANOVA	Analysis of Variance
BABS	Bioprospecting, Access and Benefit Sharing
CBD	Convention on Biological Diversity
CCTV	Closed-Circuit Television
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COP	Conference of the Parties
CPA	Criminal Procedure Act
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DESTEA	Department of Economic, Small Business Development, Tourism and Environmental Affairs
DNA	Deoxyribonucleic Acid
FLIR	Forward-looking Infrared Radiometer
GLM	Generalised Linear Model
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GTA	Game Theft Act
INTERPOL	International Police
EMI	Environmental Management Inspectors
MCDA	Multi-Criteria Decision Analysis
NEMA	National Environmental Management Act
NEMBA	National Environmental Management Biodiversity Act
NEMPAA	National Environmental Management Protected Areas Act
NPA	National Prosecuting Authority
NWCRU	National Wildlife Crime Reaction Unit
PAWS	Protection Against Wildlife Security
Pers. Comm.	Personal Communication

PROA	Private Rhino Owners Association
PRP	Poaching Risk Percentage
RPRP	Rectified Poaching Risk Percentage
RAPID	Real-time Anti-Poaching Intelligence Device
RAPM	Rhino Anti-Poaching Model
RhoDIS	Rhino DNA Index System
PLF	Production Loss Formula
SACTA	South African Cellular Communication Association
SADC	Southern African Development Community
SEMAs	Specific Environmental Management Acts
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAPS	South African Police Service
TOPS	Threatened or Protected Species
UAV	Unmanned Aerial Vehicle
UMTS	Universal Mobile Telephone Service
UNEP	United Nations Environment Program
WRSA	Wildlife Ranching South Africa
ZAR	Zuid Afrikaanse Rand

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CHAPTER 1

GENERAL INTRODUCTION AND RATIONALE

1.1 INTRODUCTION AND RATIONALE

1.1.1 History of rhino conservation in SA

Several records indicate that, historically, white rhinos (*Ceratotherium simum*) occurred in the southern African sub-region (Kruger 1902; Player and Feely 1960; Selous 1969; Pringle 1982). Unfortunately, the two species of African rhino, the white rhino and the black rhino (Diceros bicornis), were driven to near extinction by the year 1900. As an example, Balfour and Balfour (1991) wrote about a hunting party whose members shot six white rhinos near the confluence of the Black and White Umfolozi Rivers in 1895. This kind of hunting excursions led to the shooting of the last rhino at Renosterkop near Kroonstad in the Free State (Giliomee, 1989). The Zululand nature reserves of Umfolozi and Hluhluwe were proclaimed by the Natal Government in 1897 to save the black and, particularly, the white rhino (Balfour and Balfour 1991). Great effort was made by the then Natal Parks Board to save the white rhino in the Umfolozi-Hluhluwe corridor (Player 1972).

In 1962 the Natal Parks Board donated the first white rhino to the Free State Provincial Department of Nature Conservation, and it was relocated to the Willem Pretorius Game Reserve (Jordaan 2010). In South Africa, conservation-minded pioneer game farmers played an important role in conserving animal species, including the rhino species (Young 1984). These initial efforts by game farmers grew progressively into commercial production of wildlife (Bothma and Van Rooyen 2005).

The commercialising of wildlife allowed the southern white rhino numbers to grow exponentially from 5 000 twenty years ago, to more than 20 000 rhinos, with an additional 704 animals in captive breeding institutions world-wide (Knight 2016). With this success, the International Union for Conservation of Nature (IUCN) was obliged to reclassify in their Red List of Threatened Species the white rhino from Vulnerable to Near Threatened (IUCN 2012).

The IUCN classifies, in their Red List of Threatened Species, the black rhino as Critically Endangered (Emslie 2012b). Black rhino numbers have declined by an estimated 97.6% since 1960, with global numbers as low as 2 410 in 1995, mainly due to poaching. Since 1995 numbers have steadily increased, with numbers doubling to 4 880 for the continent by the end of 2010. There are currently 235 black rhinos in captivity (Emslie 2016). By 2016 there were 1 893 black rhinos in South Africa.

South Africa has a proud history of white rhino conservation, with significant proportions of rhino populations protected on State-run and privately owned land. The South African concept of protectionism was successful, and the southern white rhino (*C. s. simum*) multiplied from 10 in 1904 (Furstenburg 2004) to approximately 20 375 in 2015 for all countries with southern white rhinos (Emslie Milliken Talukdar Ellis Adcock and Knight 2016; Knight 2016), whilst black rhino numbers increased from 630 to 1893 (Emslie and Adcock 2016). The proud history of rhino conservation is, however, fading with the current onslaught of illegal wildlife trading.

1.1.2 The current threat of poaching

Lately, locally and internationally, well-structured crime syndicates got involved in rhino poaching and smuggling of rhino horn as part of a profitable international enterprise, creating pressure on rhino numbers in Southern Africa and in the Free State (Ayling 2012). These syndicates serve various markets in the East, such as the medicine industry.

According to Holt-Biddle (1995), powdered rhino horn has been used in traditional oriental medicine for at least 3 600 years. Rhino horn was not a cure-all, but rather had some specific uses (Milliken and Shaw 2012). Their firm belief in the efficacy of animal products as medical cure-alls was established from the earliest times. Vegter (2015:2) states the following: “a billion and a half Asians add a patronizing, neo-colonialist attitude to the poaching problem, no matter how right Western environmentalists think they are.” These millions of people believe in traditional remedies, and according to Vegter, it is hard to shake that belief. The exponential increase of rhino killings over the last five years reveal a staggering growth in incidents, which may indicate a potential danger for the species (Eloff 2012).

The illegal trade in wild animal products is controlled by groups of criminal networks specialising in trafficking illegal commodities across borders (Avis 2017). These traders have a substantial hold on the wildlife market, and earn high profits by exercising control over supply and demand (Bulte and Damania 2005). This leads to an increase in especially rhino horn prices, which is currently estimated currently at $60 000/kg (Austin 2015). This increase results from a high demand for rhino horn, which can be obtained either legally or illegally (Economist at Large 2013). The South African government, and the public and private sectors are becoming increasingly concerned about this matter, and have initiated efforts to counter illegal rhino poaching. The involvement of the private sector, especially rhino farmers, is particularly important for rhino conservation.

Rhino farmers operate as managers of fragmented rhino populations to secure the heterozygosity of the rhino meta population, and are a safe source from which surplus individuals can be transferred to other rhino farms and nature reserves. This can increase rhino population numbers in nature reserves, and can demonstrate a sustainable conservation finance solution (Goodman James and Carlisle 2002). As part of their management practices, rhino farmers select certain genetic traits and are prepared to pay huge amounts of money to upgrade their rhino population breeding values. This practice of successful breeding is in danger due to the uncontrollable spiral of rhino poaching. Poachers rise from a marginal economy, while farmers are losing valuable animals, bred for specific traits. Therefore, the question arises: What will be the effect of rhino poaching on the production loss of rhinos? Understandably, rhino owners are concerned about the Government's commitment to protect their rhino breeding projects against the rhino-poaching onslaught. Inadequate law enforcement, poverty and civil unrest have often been cited as factors contributing to increased illegal resource consumption (Grey-Ross Downs and Kirkman 2010). Whether the current legislation is adequate to combat the rhino-poaching onslaught, which causes ecological degradation, is of concern to both the public and private sector.

Meanwhile, South Africa changed politically and business opportunities opened for a number of countries to exploit South Africa's natural resources as a new market to provide products for their ancient beliefs (Shah 2010). One of the unfortunate consequences was a severe increase in rhino-poaching numbers.

1.1.3 What has been done to reduce the threat of poaching?

To counter the poaching problem, the Department of Environmental Affairs proclaimed a national regulatory framework regarding (a) the hunting, (b) sale, (c) issuing of various permits related to animal products, and (d) the dehorning of rhinos (Molewa 2011).

Van der Linde and Feris (2010) state that the inclusion of section 24 (on environmental rights) into the South African Constitution (Act 109 of 1996) created a constitutional right to protect the environment through legislative measures that will prevent ecological degradation, and promote conservation. Consequently, the Constitution places custodianship of our natural resources on the shoulders of the State. The State is tasked to provide enforcement and prosecution. Although the State must provide protection, every rhino owner also has the responsibility to secure his own assets against rhino poaching by employing security measures effectively to maximise the stoppage of poaching (Department of Environmental Affairs 2013). Security can only be possible if the farmers receive revenue from their rhinos to protect them on a sustainable basis.

This newly implemented initiatives aimed at stopping the poaching onslaught on rhinos are now a relief, as it seems to be significant when viewing at the successes given by DEA for 2017. This study will also investigate the effectiveness of all relevant legislation applicable to restrict rhino poaching, trade and protection.

1.1.4 What this thesis will address

There is uncertainty whether rhino breeders are alert to the safety of the rhino populations in the Free State Province of South Africa. This study hopes to contribute to the fight against rhino poaching by highlighting and testing several factors that could indicate the vulnerability of a rhino farm or nature reserve. By doing this, the results might be useful to help inform rhino farmers and conservation authorities on where to allocate conservation funding and anti-poaching resources to yield maximum protection, and to increase the probability of success (Lockwood 2010).

This study will also investigate the effectiveness of all relevant legislation applicable to restrict rhino poaching, trade and protection.

A production loss formula should give an insight into the actual production loss of an individual rhino when poached. It is important to consider the novel security approaches and technologies currently on the market, and to share this knowledge with rhino owners. The investigation into innovative security approaches to protect rhino populations is vital. Old and new technical applications will be evaluated and discussed in an attempt to counter rhino poaching. With the above-mentioned in mind, this study will develop a rhino anti-poaching model for the rhino species existing on rhino farms and nature reserves in the Free State.

With the above-mentioned in mind, this study aimed to develop a five-step Rhino Anti-Poaching Model (RAPM) that measures a rhino poaching risk on existing rhino farms and nature reserves in the Free State. A RAPM was developed through the identification of five expert-defined factors that may determine poaching. It provides a scoring system that evaluates the five factors which then identifies weaknesses on the rhino site. The model also addresses the rectification of the risks. The aforementioned enable continued monitoring of various security aspects on a rhino premises. By predicting future poaching, the rhino owner may now counter an attack ahead of time.

1.1.5 What is being done in the Free State to stop poaching?

Several security measures such as anti-poaching patrols, technology and risk implementation plans have been tried and tested to protect the rhinos in Africa. However, the poaching is ever increasing, and very little has been achieved in combating rhino poaching (Cheteni 2014). The level of preparedness of rhino breeders in the Province is of concern and will be investigated. Security measures are valuable and helpful resources that can assist in creating safe and secure environments (Van Jaarsveld 2011).

White rhino numbers increased successfully in provincial nature reserves and national parks over the past decades due to satisfactory rhino breeding programs by early conservation-minded protectionists. Nature conservation district officials promoted this successful pioneer concept of protectionism to farmers and they accepted the challenge. Large portions of farms were fenced off in the Free State to protect various antelope and rhino species. Lately, this concept of enclosures evolved into the erecting of smaller camps to breed these scarce species more intensively for both conservation and profit.

1.2 OBJECTIVES OF THE STUDY

The objective of this study is to develop a pro-active Rhino Anti-Poaching Model that might assist rhino owners in protecting rhino effectively in the Free State. To address this aim, the following objectives will be investigated:

- to present an historical overview of the prevalence of rhino in the Free State Province;
- to provide a synopsis of legislation that regulate rhinos in the Province;
- to examine the latest technologies and methods available for rhino owners to counter rhino poaching;
- to assess the security measures pertaining to rhino sites in the Free State;

- to develop a Production Loss Formula to determine a poached rhino’s value.
- to develop a Rhino Anti-Poaching Model.

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CHAPTER 2

PREVALENCE OF RHINO IN THE FREE STATE: A REVIEW

2.1 INTRODUCTION

Historically there was doubt regarding the exact number of species of rhino that occurred in southern Africa. By the turn of the previous century it was widely accepted that there were only two species occurring in South Africa, namely the white and the black rhino (Rookmaaker 2007). This study will attempt to give clarity on which of the two rhino species occurred historically in the Free State Province of South Africa. Nature conservationists and rhino farmers in the Province need to know which species should be conserved and for which species the habitat of the Province is suitable.

Numerous authors argued either in favour or opposed the idea of rhinos occurring in the Province (Bryden 1899; Bigalke 1963; Selous 1969; Gilliomee 1989). According to Brink (1987) physical evidence of white rhino were excavated at Florisbad in the central Free State, which indicates that the species could have occupied the Province about 100 000 years ago. Lynch (1991) believed that, based on ecological grounds, white rhinos could have roamed the Province in historical times.

Confusion also developed as to the origin of the words “white” and “black” rhino. Earlier records do not distinguish between the black and the white rhino species. The early inhabitants of the Free State Province, moving from the Cape Colony, recognised only the Cape or Common Rhino. Moving into the interior of South Africa, the pioneers came across an unknown rhino, and referred to it only as rhino. The differences between the two species were described scientifically in 1758 and 1812, but took some decades to establish in popular parlance as the white and black rhino (Burchell 1817; Linnaeus 1758).

The mid nineteenth century was characterised by the eradication of various antelope species, and both the rhino species were not exempted from this onslaught (Somerset Playne 1912; Botha 1979). The last rhino is believed to have been shot at Renosterkop near Kroonstad in the Free State Province in 1842 (Gilliomee 1989). Nine farms in the Free Sate have rhino as a prefix in their names, which may indicate that rhino occurred in that specific area. These farms were visited to collect colloquial information of rhinos, if any.

2.2 METHODOLOGY

A literature study was conducted to determine the presence of rhinos in the Free State in historical times. Various related articles were collected from the internet, and studied, while the National Museum in Bloemfontein and the old Nature Conservation Library of the current Department of Environment, Small Business, Tourism and Economic Affairs (DESTEA) were visited to gather information on this subject. Besides these mentioned state-owned identities, the local libraries of small towns in Bultfontein, Hoopstad, Theunissen, Kroonstad, Koppies, Vredefort, Parys, Viljoenskroon, Lindley, Frankfort, Vrede, Cornelia, Memel and Sasolburg were visited to gather information regarding the historical incidence of rhino and other wildlife in the Free State.

The Department of Agriculture was visited to obtain the latest data, maps and lists of registered title deed farms in the Province. After receiving this information all farms with “Rhenoster” as a prefix were located, and a historical rhino farm map was drawn with ArcGIS version 9.2. To achieve consistency, all these Rhenoster-prefix farms in the Free State were visited, and an interview with each owner was held to gather unrecorded information regarding the name, colloquial history of rhinos, ecological change and pictures of the specific farm.

Boshoff and Kerley (2010) proved how the usefulness of written historical records can be enhanced if they are combined with other information, particularly the known ecological requirements of the species concerned. Therefore, the ecological aspect was brought into consideration for this study. To determine if rhino could have occurred in the Free State, the vegetation of each site was described. These vegetation descriptions were confirmed by a photo of the rhino site, and confirmation was sought through historical photos of the same area, if possible. Pictures were gathered from the farmers, local libraries and the internet. Pictures of the Anglo Boer War were of importance, as it gave an indication of the vegetation of the Free State in recent historical times.

Various historical photos and old literature were examined to obtain a retrospective view of historical times, to determine whether there was insufficient browsing vegetation for black rhino to survive, and whether there was sufficient habitat for white rhinos to survive. The reintroduction of rhinos into the Province were examined, and current numbers of rhinos in the Province are given.

2.3 THE PREHISTORIC OCCURRENCE AND STATUS OF RHINOS IN THE FREE STATE

Rhino belong to the mammalian order *Perissodoctyla*, a group of odd-toed ungulates that has its origins in the Eocene Period some fifty million years ago. The only surviving members of this order comprise of the tapirs, the horse family and five rhinos' species (Prothero 1991; Tougard Delefosse Hänni and Montgelard 2001). Fossil records suggest that as many as 170 rhino species may have become extinct over the past fifty million years (Balfour and Balfour 1991). Skinner and Chimimba (2005) name four genera of fossil rhino, namely *Brachypotherium, Acerathherium, Dicerorhinus and Chilotherium.* The *Baluchitherium* is an extinct member of the rhino family, and stood 5.5 metres high, which makes it the largest land mammal that ever lived. According to Brink (1987), physical evidence of white rhino indicates that they inhabited the Free State in prehistoric times some 100 000 years ago. Mills and Hes (1997) state that the white rhino derive from those early periods when very large mammals flourished the world in prehistoric times. Dakes (1961) refers to those early periods when these, now extinct, rhino roamed the world as the Pre-Adamite-World. Lynch (1991) points out that bone and tooth fragments of rhinos from historical times are still lacking rhino evidence in the Free State.

The Indian rhino, or greater one-horned rhino, (*Rhino unicornis*) occurs in southern Asia on the northern margin of the Indian subcontinent, and adjacent to the southern slope of the Himalayas. The Javan rhino, or lesser one-horned rhino (*Rhino sondaicus)*, occurs in western Indonesia, eastern Indochina and Java. The Sumatran rhino, or lesser two-horned rhino (also called hairy rhino) (*Rhino sumatrensis*), occurs in the Peninsular of Malaysia, Sumatra and northern Borneo. On the African continent, two species of rhino occur: the white rhino (*C. s. simum* and *C. s. cottoni*) (*Ceratotherium simum*) and black rhino (*Diceros bicornis*). According to Emslie (2012b) there are three subspecies of black rhino: the eastern black rhino (*Diceros bicornis michaeli*), the desert black rhino (*Diceros bicornis bicornis*) and the south-central black rhino (*Diceros bicornis minor*). There are currently 20 378 southern white rhinos, 5 250 black rhinos, 3 264 greater one-horned rhinos, 76 Sumatran rhinos and 63 lesser one-horned rhinos in existence (Emslie Milliken Talukdar Ellis Adcock and Knight 2016). There are also two subspecies of white rhinos recognised: the southern white rhino (*Ceratotherium simum simum*) in southern Africa, and northern white rhino (*Ceratotherium simum cottoni*) in central Africa. The latter are critically endangered, with only two individuals alive (Gibbons 2018). Both African rhino species occur in eastern, central, western and southern Africa.

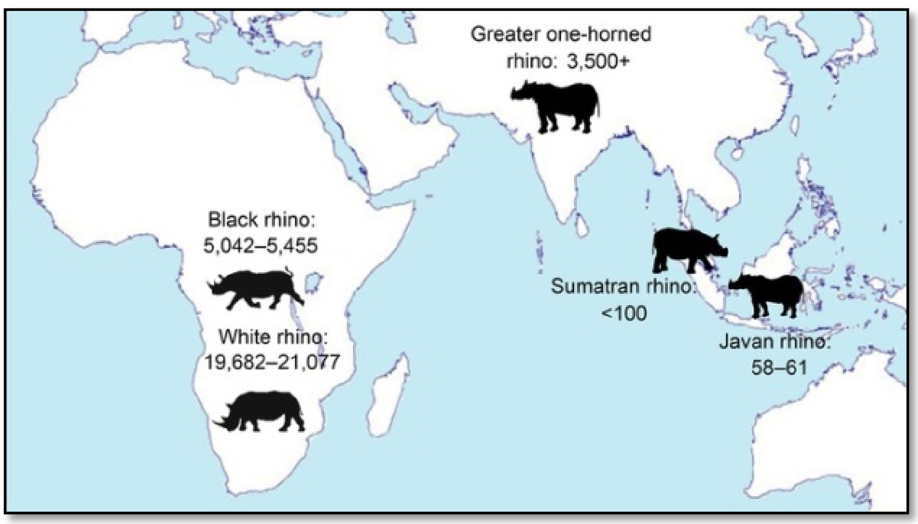

Figure 2.1: Distribution of the five rhino species with their total numbers for 2016 (From: https://www.savetherhino.org. Accessed on 24 September 2016).

Today, three of the remaining five species in existence are found on the Asian continent, and two in Africa (Figure 2.1).

2.4 PERSPECTIVES OF RHINO SPECIES OCCURING HISTORICALLY IN THE FREE STATE PROVINCE

2.4.1 Literature as confirmation of rhino occurrences in the Province

2.4.1.1 Historical occurrence of rhinos in the Free State

In a few articles and books, place names are mentioned with direct reference to the presence of rhino in the Free State Province. Unfortunately, these sources do not contain information that enables us to determine to which of the species they were referring.

Boshoff and Kearly (2013) gave 3 miles (4,8 km) south of Scandinavia Drift (Vaal River crossing between Potchefstroom and Viljoenskroon) as the place where Captain William Cornwallis Harris shot one of the last rhinos in the Free State. Harris (1852:233) in Boshoff and Kearly (2013) wrote: “We had not advanced more than three miles before our progress was opposed by a furious storm of hail and thunder … To me it is remarkable from the circumstance of my having there, for the last time, seen and destroyed the rhino.” He did not give a clear indication of which species he hunted, though he knew a “zwart rhinoster” as he describes them as having “existed in considerable numbers on the present site at Cape Town” (Harris 1840:XVI). During the period June to August 1843, a Reverend John Bennie from the Glasgow Missionary Society travelled through the Transorangia (Free State) and the Potchefstroom-Winburg Republic, and provides evidence of rhinos formerly occurring in the northern Free State near the Vaal River (Boshoff and Kearly 2013).

2.4.1.2 Evidence of white rhino occurrences in the Free State

Bryden (1899) believed that white rhino occurred in the Free State, since similar grassy plains occur in the Free State as in the Southern Transvaal, where they usually occur. Vaughan-Kirby (1920) speculates that white rhino also occurred south of the Vaal River.

2.4.1.3 Evidence of black rhino occurrences in the Free State

Skinner and Chimimba (2005) state that the white rhino was generally absent from the Free State, and that the black rhino had a wider distribution and occurred throughout most of South Africa. Various authors (Hall 1857; Sclater 1900; Gilliomee 1989) assumed the mystery 1842 record as the date when the last black rhino was shot in the Free State. Skead (1987) doubted Sclater's (1900) remarks on the 1842 date and Rhenosterkop as the place when the last black rhino was shot in the Province. Brand (1964) quoted Lydekker (1926) as 1853 when the last black rhino was shot in the Free State. Boshof and Kearly (2013) stated that the date and the source of the 1842 record have not been found and that Shortridge (1934) obviously follow Hall's (1857) date of "1842".

Boshoff and Kerley (2013) also added further that there would have been suitable habitat for black rhino along the course of the Valsch River and on the rocky hills (koppies) in the general area.

2.4.1.4 Possible historical evidence that rhinos did not occur in the Free State

Both Bigalke (1963) and Du Plessis (1969) doubt the occurrence of rhino species in the Free State Province. Lynch (1991) indicates that definite accounts of white rhinos in the Free State appear to be lacking. Maps provided by Du Plessis (1969) point out that black rhinos did not occur historically in the Free State, but they did occur in the rest of the southern African sub region.

Boshof and Kearly (2013) comment that several missionaries and explorers travelled the Free State during the period 1830 to 1840, without any notes in their diaries on observing some rhinos. Steytler (1932) pointed out that the Free State was treeless, and therefore no elephants and rhino occurred in the Province.

2.4.2 Registered farms as evidence of rhino occurrence in the Province

It is possible that the first pioneers in the Free State only knew a rhino, a common (black) rhino, which they encountered in the Cape Colony from where they originated. After they came across the Orange River, they probably named their farms to the nearest geographical landsite where rhinos subsequently occurred, to the common rhino, for example "Rhenosterdraai".

The first registered rhino farms in the Free State were spelled in Dutch with a "Rhe", as in Rhenoster, and not with a "Rhi", as in "rhino" in English (Annexure A). The Afrikaans language evolved from Dutch. The "H" faded away and is nowadays spelled as "renoster" in Afrikaans.

Registered "Rhenoster-prefix" farms occurred in six locations in the Province. The southernmost "Rhenoster" farm location was near Bloemfontein; whilst the westernmost farm was near Hoopstad. One rhino location was centred in the Province near Theunissen. The most prominent rhino farms were near Kroonstad. Another location was near Koppies, and the northernmost location was in the Vredefort district towards Viljoenskroon. No records could be found of registered "Rhenoster" farms that occurred in the eastern Free State.

The Department of Agriculture was visited to retrieve all farms in the Free State that occurred with the prefix "Rhenoster" on their system. It was also followed up by a Windeed (Deeds Office Property) search with the same results. According to ArcGIS version 9.2, the following nine farms with the prefix "Rhenoster" were historically registered after rhino occurring in the Province: two "Rhenosterspruit" farms in the Bloemfontein district (probably the same farm), "Rhenosterkop" in the Hoopstad district, "Rhenosterfontein" in the Theunissen district, "Rhenosterkop", "Rhenosterhoek", "Rhenostervlei" and "Rhenosterspruit" in the Kroonstad district, "Rhenosterdraai" in the Koppies district, and "Rhenosterpoort" in the Vredefort district (Table 2.1).

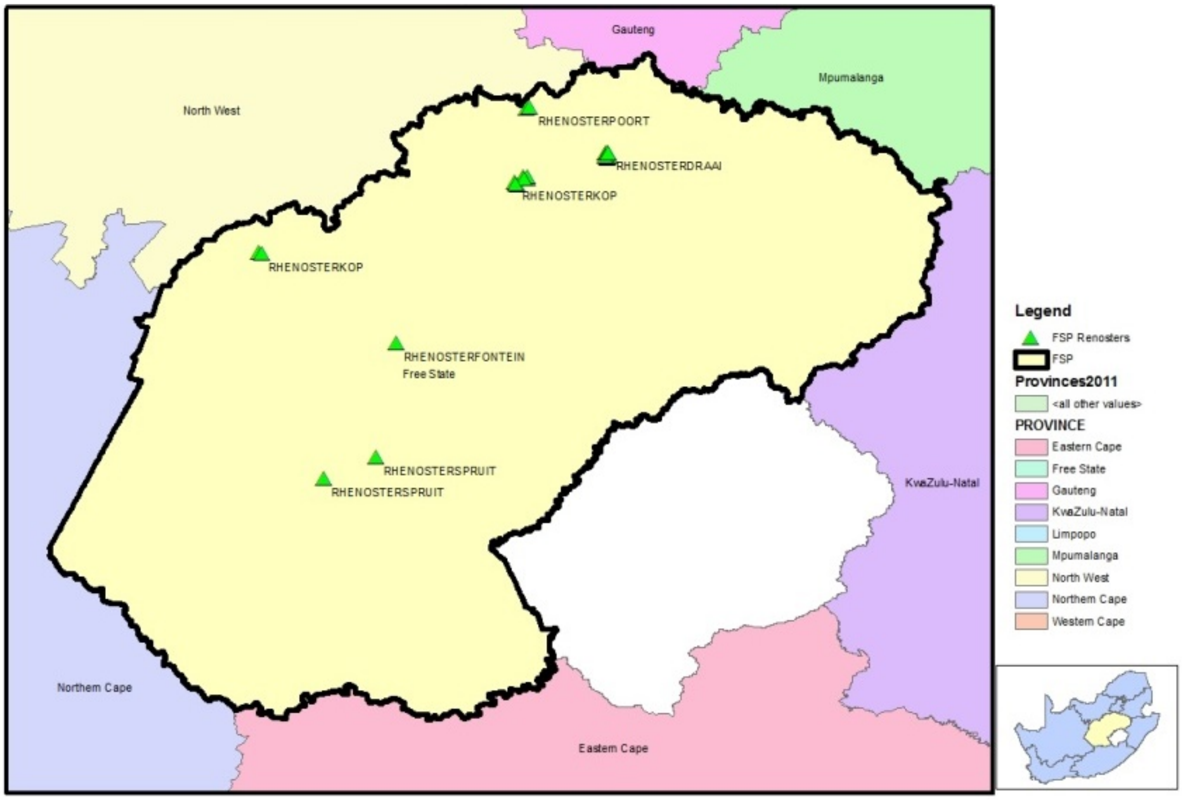

Figure 2.2: Map of the Free State indicating all the registered farms with "rhenoster" as a prefix to their name. (Map courtesy of Mr W van Zyl, Department of Agriculture).

When looking at the current map (Figure 2.2) of farm names in the Free State with rhino as a prefix, it seems that rhinos occurred in small populations in the south, central, western and northern half of the Province. It might also be possible that rhinos occurred in other areas but that farm owners did not name their farms after rhinos.

Table 2.1: The original farms (with subdivisions) in the Free State with "Rhenoster" as a prefix.

NO.	FARM NUMBER	PORTION	TOWN NAME	EXTENT	FARM NAME
1	1434	0	HOOPSTAD RD	462.9 ha	RHENOSTERKOP
	1434	1	HOOPSTAD RD	428.2 ha	RHENOSTERKOP
2	443	0	KOPPIES RD	190.8 ha	RHENOSTERDRAAI
	443	1	KOPPIES RD	572.3 ha	RHENOSTERDRAAI
	443	2	KOPPIES RD	561.5 ha	RHENOSTERDRAAI
	443	3	KOPPIES RD	800 DUM	RHENOSTERDRAAI
	443	4	KOPPIES RD	11.2 ha	RHENOSTERDRAAI
	443	5	KOPPIES RD	381.5 ha	RHENOSTERDRAAI
	443	6	KOPPIES RD	267.8 ha	RHENOSTERDRAAI
3	347	0	KROONSTAD RD	845.9 ha	RHENOSTERKOP
4	632	0	KROONSTAD RD	640.3 ha	RHENOSTERSPRUIT
5	1291	0	KROONSTAD RD	462.8 ha	RHENOSTERHOEK
	1291	1	KROONSTAD RD	256.9 ha	RHENOSTERHOEK
	1291	3	KROONSTAD RD	428.2 ha	RHENOSTERHOEK
	1291	4	KROONSTAD RD	312.5 ha	RHENOSTERHOEK
6	1352		KROONSTAD RD	1113.8 ha	RHENOSTERVLEI
7	26	0	THEUNISSEN RD	381.8 ha	RHENOSTERFONTEIN
8	108	0	VREDEFORT RD	262.2 ha	RHENOSTERPOORT
	108	1	VREDEFORT RD	256.9 ha	RHENOSTERPOORT
9	2631		BLOEMFONTEIN RD		RHENOSTERSPRUIT
	320		BLOEMFONTEIN RD		RHENOSTERSPRUIT

2.4.2.1 Rhenosterspruit no. 2631 and 320 (Bloemfontein)

These two farms should not be confused with the registered farm "Rhenosterspruit", as described by Grobler (2004:89): "De Wet and his convoy proceeded in a northerly direction and tonight reached the farm Renosterspruit near the Vaal River". This farm probably refers to the farm that currently borders Rhenosterkop, in the Kroonstad district. Van der Merwe (1921) mentions "Renosterspruit", in the vicinity of Maselspoort at Bloemfontein, as the place from where the father of president MT Steyn often appears to inspect the farm orders at Suurfontein, where his two sons were farming. No evidence could be found of the origin of the creek with the name “Rhenosterspruit”, or the farm “Rhenosterspruit”. The farm owner and the farm “Rhenosterspruit no. 2631 & 320” in the Bloemfontein district could not be located, as it does not appear on the ArcGIS system or Windeed. It was probably re-registered with another name, as is the case with “Rhenostervlei” (Renostervlei). A search was done on Windeed, which states that the two farms “Rhenosterspruit 2631 & 320” no longer exists. According the Windeed, it seems that the farm “Rhenosterspruit’ was re-registered under the name “Midway”, as it is currently registered in the company name of “Rhenosterspruit Plase CC”, and belongs to a Mr Lu. The owner of the present farm Mazelspoort (not the resort) is a great granddaughter of president MT Steyn’s brother (Hillegard Muller Steyn). She stated that they were not aware of the farm by the name “Rhenosterspruit”. According to her, the farm was possibly situated east of the upper course of the Rhenosterspruit, and is perhaps part of the current Midway, Roodewal and Vallombroosa small holdings, which stretches downstream towards the confluence of the Modder River. Some of the old inhabitants of the mentioned small holdings near Maselspoort (the resort) were visited (such as the retired Director of the Department of Nature Conservation). Nobody could be found with information regarding the origin of the “Rhenosterspruit” farms outside of Bloemfontein.

2.4.2.2 Rhenosterkop no. 1434 & 277 (Hoopstad)

Rhenosterkop is situated approximately 10 km from the Northwest Province’s border. The farm was visited and the owner’s wife was interviewed. All that she could recall was that the adjacent farm, “Graspan”, was initially part of ‘Rhenosterkop”, and that “Graspan” historically had thousands of springbucks on the grassy plains. The “kop” (hill) of “Rhenosterkop” was inspected, and it was found to have a slight rocky elevation from the surrounding sandy, grassy plains, with less trees and shrubs to the eastern side of the hill. The hill is currently characterised with trees and shrubs such as: *Searsia lancea, Ziziphus mucronata, Ehretia rigida, Grewia flava, Acacia karroo, Vachellia hebeclada, Acacia erioloba* and *Asparagus laricinus*. The habitat with trees and shrubs suggests possible rhino occurrence of both species.

2.4.2.3 Rhenosterfontein no. 267 (Theunissen)

An interview was held with a farmer who currently rents this farm. He mentioned that the previous owner (Sophia le Roux) had told him that her great grandmother was nine years old when she made sketches of the rhinos when they came in the late afternoon to drink water near the “fontein” (fountain). Her great grandmother must have made these drawings around the 1850s. It is not known what happened to the rhino population or the drawings. Some older farmers around Rhenosterfontein were consulted, but could not confirm the existence of the rhinos. On the “Amended Survey” of the farm Rhenosterfontein dated 23 December 1897, the surveyor made sketches of trees along the “spruit” near the “fontein”, indicating possible habitat for rhino (note Annexure A for an old “Amended Survey” of the farm “Rhenosterfontein”). The vegetation surrounding the fountain is currently dominated by exotic trees, dating back to the early nineteenth century when it was promoted by government to plant exotic trees, and 2 574 000 exotic trees were planted in 1911 in the Free State (Bennett 2010). Some of the exotic trees around the “Rhenosterfontein” perhaps dated back to this period, and include the weeping willow (*Salix babylonica*), sering (*Melia azedarach*), silver poplar (*Populus alba*) and cypress tree (*Cupressus sempervirens*). Now also occurring is indigenous trees such as *Searsia lancea*, *Searsia pyroides*, *Diospyros lycioides*, *Acacia karroo* and *Ziziphus mucronate*. These species are ideal for browsing rhinos as well as shade for grazing rhinos.

2.4.2.4 Rhenosterkop no. 347 (Kroonstad)

The owner of this farm was also the owner of the farm “Rhenostervlei” adjacent to “Rhenosterskop”. He said that his father had told him that the Renosterkop (the hill) was originally divided in 12 farms, starting from the highest point of the “kop” and portioned outward. This was done as to give each farmer a portion of the hill, so that everybody may have some firewood and wild olive tree poles (*Olea earopea africana*) to use for anchor poles to fence off their farms. His father also told him that Renosterkop was the only place in the vicinity that has trees such as "olienhout" (wild olive) and sweethorn trees (*Acacia karroo*). He also added that there are rock paintings on Renosterkop, with rhinos dotted on a rock. All the neighbouring farmers camped every year from Christmas to New Year in tents at Renosterkop, as it was the only place in the district with worthwhile shadowing trees. A photo taken in 2017 of the approximate site indicate a vegetation change some 94 years later (Figure 2.3). Indefinite vegetation dispersion probably causes the settling of mentioned plant species.

Figure 2.3: This picture (left) was taken of farmers neighbouring Renosterkop in 1922/23 and script: "RENOSTERKOP PIC-NIC DEC 29TH 1922 – JAY 2 TH 1923". Picture courtesy from J.P.S. Geldenhuys. Picture (right) taken in 2017 of the approximate site at Renosterkop.

On the "Amended Survey" of the farm Rhenosterkop dated 26 September 1879, the surveyor made sketches of trees of Rhenosterkop from the top to the foothill, indicating possible habitat for rhino.

Note Annexure A for the "Amended Survey" of Rhenosterkop.

2.4.2.5 Rhenostervlei no. 2132 (Kroonstad)

The previous owner of the farm “Rhenostervlei” changed its name to “Môregroet no. 2474” in 1966. No reason for this change could be found by the new owner. The four farms bordering Renosterkop are currently characterised by plant vegetation such as bushveld asparagus (*Asparagus laricinus*), camphor bush (*Tarchonantus camphoratus*), sweet thorn trees (*Acacia karroo*), mountain karee (*Searsia leptodictya*), karee (*Searsia lancea*), wild olive (*Olea europaea),* cross-berry (*Grewia occidentalis*), puzzle bush (*Ehretia rigida*), bush guarri (*Diospyros lycioides*), mountain sage (*Buddleja dalviifolia*) and common spike-thorn (*Maytenus heterophylla).*

2.4.2.6 Rhenosterhoek no. 1291 (Kroonstad)

The owner does not know where the farm got its name from. He added that his father-in-law had told him that the camphor bush (*Tarchonantus camphoratus*) was introduced to Rhenosterkop by the previous owner, who bought cattle from Vryburg and released them on Rhenosterkop. Since then this farm’s portion of Rhenosterkop is dominated by this plant community. The owner also said that the famous Anglo Boer War hero, Captain Danie Theron, hid at Rhenosterkop for a few weeks because of the availability of trees and shrubs. Lord Roberts labelled Theron "the chief thorn in the side of the British". He put a bounty on his head for £1,000 if he was captured. The legend is confirmed in the book by Serfontein (1990). This anecdote confirms the presence of trees and shrubs as possible habitat during historic times.

According to Owen-Smith (1988) and Jordaan (2010), white rhinos prefer open grassland with scattered trees, which might have been the type of vegetation that occurred at Rhenosterkop during historical times.

2.4.2.7 Rhenosterspruit no. 632 (Kroonstad)

The current owner believes that this farm received its name from the "Rhenoster Spruit" (creek) that originates on the farm Vista some 3 km upstream, which runs through his farm and confluences into the Valsch River some 15 km downstream. The "Rhenoster Spruit" should not be confused with the "Rhenoster River" that flows some 25 km north and converges with the "Vaal River", at Renovaal. The owner had discovered an old track on his farm. He asked some elderly farmers about the track, and it was revealed that it was the old coach route which initially transported merchandise between the towns of Winburg, Kroonstad and Potchefstroom, during the time of the Republic of Potchefstroom-Winburg (Williams 1956). Later it mainly conveyed "Witblits" (home-distilled brandy) in a "karba" (like a wine barrel), and then became known as the "Witblitspad" (Witblits road). Transport-riders with coaches and early Boers with ox wagons conveyed their goods along this route to its destinations (Raath, Van den Berg and Hayes 2002). This route is probably also the route that Boshoff and Kearly (2013) described that wagon travellers utilised when they carried horns and hides to traders. The road passed right under Rhenosterkop on its way between Winburg and Potchefstroom, and it was probably done to give the horses a rest under the trees before travelling to the next destination, as Rhenosterkop was almost halfway between the two settlements.

2.4.2.8 Rhenosterdraai no. 443 (Koppies)

According to two registered owners of the farm "Rhenosterdraai" (Rhino bend), it was probably named after the Rhenoster River, which makes an oval bend just before it enters the Koppiesdam Nature Reserve. They could not recall any anecdotes of rhinos in the vicinity.

2.4.2.9 Rhenosterpoort no 108 (Vredefort)

In an interview with a renowned farmer of the Vredefort Dome, he stated that his great grandfather produced “witblitz” on his farm, which was probably transported on the “Witblitz road” to Kroonstad and Winburg. A few older inhabitants of the Vredefort district were interviewed, but they could not recall any anecdotes of rhinos.

2.4.3 Pictorial and literature evidence of historical vegetation in the Province

The vegetation types in the early eighteenth century, when rhinos roamed the Province, are of importance when discerning which rhino occurred in the Province. No proper historical plant description of these areas exists, and the only means to observe the vegetation types of a century ago, are the photos taken before and during the Anglo Boer War by war journalists as well as private family photos. According to Somerset Playne (1912) no recognized botanical investigation has ever been made of the flora of the Free State Province. These photos and amended surveys of registered farms give insight into the environment in late historical times. Although the war pictures were taken approximately 60 years after the last rhino was hunted, it still provides an indication of the surroundings in the time of the living rhinos. The provided old photographs (Figure 2.4 & 2.6) are compared to up-to-date images of areas surrounding the specific sites where rhinos probably occurred. The comparison shows the contrast between the same sites more than a hundred years apart. The only available old picture of Renosterkop is provided, and is compared with a 2017 picture of Renosterkop, which indicate a vegetation change over time (Figure 2.3).

2.4.3.1 The Rhenoster and Valsch River railway bridge vegetation at Koppies and Kroonstad

During the Anglo Boer War, it seems that very few, if any, trees or shrubs occurred along the Rhenoster River, and specifically near the Koppies railway bridge.

Grobler (2004) also showed a photo of the Rhenoster River Railway bridge after it was destroyed by the Boers. On this photo, barely any shrubs could be seen on the one flank of the Rhenoster River bank, while the rest of the surrounding is undulating grassy plains.

Today, dense indigenous trees such as white stinkwood (*Celtis Africana*), sweet thorn (*Acacia karroo*), buffalo thorn (*Ziziphus mucronata*), blue bush (*Diospyros lycioides*), wild currant (*Searsia pyroides*) and bushveld asparagus (*Asparagus laricinus*) characterise the banks of the Renoster River, while exotic invaders such as *Eucaliptus spp.*, weeping willow (*Salix babylonica*), syringa (*Melia azedarach*), Spanish cane (*Arundo donax*) and wild peach trees (*Prunus persica*) dominate the vegetation near the bridge along the Rhenoster River (Figure 2.4). The treeless river probably did not provide food for black rhinos but perhaps grass for white rhinos.

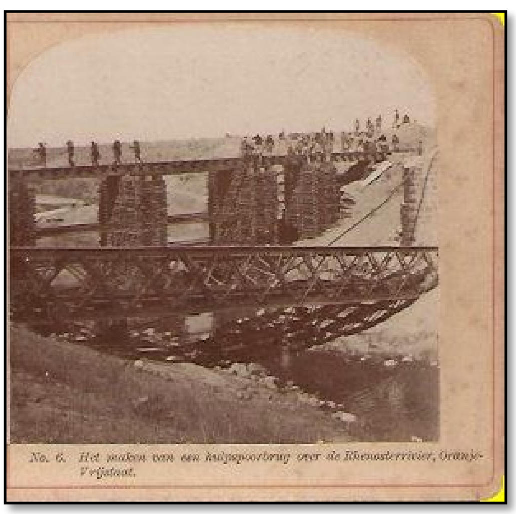

Figure 2.4: A stereo view image on the left (with no trees and shrubs) reading: "The construction of an improvised bridge over the Rhenoster River, Orange Free State." Picture right, the same site, 117 years later.

Approximately one hundred years ago, the Valsch River showed signs of sweet thorn trees (*Acacia karroo)* growing on the banks of the river. Currently the area around the same railway bridge is also covered with almost identical indigenous trees, found at the Rhenoster Railway bridge, with white stinkwood (*Celtis africana*), sweet thorn (*Acacia karroo*), buffalo thorn (*Ziziphus mucronata*), blue bush (*Diospyros lycioides*), wild currant (*Searsia pyroides*) and bushveld asparagus (*Asparagus laricinus*); and with exotic invaders such as *Eucaliptus* spp, weeping willow (*Salix babylonica*), syringa (*Melia azedarach*) and common reed (*Phragmites australis*). Today (2017), the banks of the Valsch River near Kroonstad are characterised with the above-mentioned vegetation. It was evident that the sweet thorn trees (*Acacia karroo*) occurred on the banks of the Valsch River, on the photo in Figure 2.5, whilst the absence of sweet thorn trees on the banks of the Valsch River near Kroonstad is also evident. It refers to two different places along the Valsch River near Kroonstad, affirming an area with trees and an area without trees.

Figure 2.5: Subscript of the photo left read: "Lord Roberts ride arch into Kroonstad through the Valsch River". The subscript of the photo to the right read: "Robert's ride into Kroonstad with his camera's poised to capture occasion".

Figure 2.6: The railway bridge at Kroonstad (1899 – 1902) and the railway bridge in 2016 (to the right). Note the tree density of the 2016 photo.

The railway bridge at Kroonstad indicate vegetation changes over time (Figure 2.6).

The comparative pictures of the Rhenoster and Valsch Rivers from the Boer War and today show some major differences in plant vegetation. Rivers historically seems to be grassy dongas while presently riverines are vegetated with woody plants of which some are exotics while other are invaded with shrubs such as *Asparagus* and *Acacia* trees.

2.4.3.2 Vegetation description by early inhabitants

Early inhabitants occupied the Province since the early 1800's until the Boer War in 1899. Gerdener (1924) wrote how Sarel Cilliers lost an eye when he chopped wood near the Vaal River after leaving his farm in the Kroonstad district where there was not sufficient wood. He had to travel 100km to collect wood. This indicates how rare trees were in the interior of the Free State in the mid-eighteenth century. Today the farm of Sarel Cilliers is called Doornkloof, and it is dominated by sweet thorn trees (*Acacia karroo*). Gerdener (1924) also described the battle of "Vechtkop" (battle hill), and explained why the "Boers" used thorn tree branches (probably *Acacia karroo*) to interweave it around the ox wagons to protect them against the Matabele warriors. He also painted "Vechtkop" as a scene of a thorny hill in a sea of grassy plains near 'n creek of the "Rhenoster River", which Sarel Cilliers (the leader of the "Boers") chose as a safeguard against the Matebele onslaught. A British Soldier (Reckitt 1972) in the Anglo Boer War comments in his dairy, as he awoke next to the Sands River (probably near Willem Pretorius Game Reserve, as they slept next to the Sand River coming from Bloemfontein on their way to Kroonstad) on the morning of 25th May 1900: "The scenery was not interesting – an expanse of grass veldt from one horizon to the other, slightly undulated and only relieved by the railway." Raath *et al.* (2002) stated that a Mr Tom Bourke established a nursery at Viljoenskroon to break the monotonous treeless environment surrounding Viljoenskroon, approximately 13 km from the Rhenoster River. Somerset Playne (1912:499) described the Free State as: "virtually a grass steppe, which is interspersed with small shrublets". In addition, Hattersley (1969) mentions that the Free State had huge stretches of grassland, overrun with game of every description.

According to these descriptions from early inhabitants it is clear that browsing black rhinos would have found it difficult to roam in a grassy steppe while white rhinos could have settled in an open grassland with nearby shrublets.

2.4.3.3 Ecological requirements of white and black rhino

White rhinos prefer savannah areas and open grassland (White Swaisgood and Czekala 2007; Thompson Avent and Doughty 2016). Several studies confirm that white rhinos are predominantly short grass feeders and live in groups (Player and Feely 1960; Owen-Smith 1988; Shrader *et al*. 2006; Jordaan *et al.* 2010), with the exceptional utilization of medium and tall grass (Owen-Smith 1988; Mills and Hes 1997). A previous study done by Jordaan, Brown and Slater (2015) suggest that the ecology of the Free State Province are suitable for white rhinos if there are sufficient palatable short grass, water and suitable protection from extreme cold and heat in the form of woody species.

On the other hand, several researchers regard black rhinos as selective browsers (Oloo Brett and Young 1994; Muya and Oguge 2000). Ganqa, Scogings and Raats (2005) found that black rhinos select only highly preferred plant species when there is an abundance of available forage. Morgan Mackey and Slotow (2009) argue that black rhinos are driven by resource availability and individuals will therefore select habitats with a higher quality and abundance. Kotze and Zacharias (1993) found that tall grass detracts from browse value, while gentle slopes enhance habitat suitability and conclude that forest verges provide important black rhino feeding areas. Black rhinos are solitary animals and visually impaired (Plotz 2014).

The Mucina, Rutherford and Powry (2005) vegetation map of South Africa, Swaziland and Lesotho provide a broad plant classification. The two existing plant regions, where rhinos most probably occurred in the Province, will briefly be described:

- GH 6 Central Free State Grassland (Rhenosterfontein at Theunissen and the four Rhenosterkop farms near Kroonstad): "Undulating plains supporting short grassland, in natural condition dominated by *Themeda triandra* and *Eragrostis* grass in degraded habitats. Dwarf karoo bushes establish in several degraded clayey bottomlands. Overgrazed and trampled low-lying areas with heavy clayey soils are prone to *Acacia karoo* encroachment".
- GH 11 Vredefort Dome Granite Grassland (Rhenosterhoek at Vredefort): "Dominated grassland on granite".

Pictures, literature and maps are the only resources available to study historical times in the Province. The on-site visits to the Rhenoster farms confirm the presence of limited trees as indicated on the two survey maps of Rhenosterfontein and Rhenosterkop. These visits, pictures of the Boer War and literature proves that the Free State Province was open grassland even along rivers and creeks, except for occasionally encroached *Acacia* trees and small shrubs. The present habitat of the "Rhenoster" farms in the Free State Province shows mainly open grassland. Thus, the open grassland of the Province was suitable for the occurrence of white rhinos in the Province.

If abundant woody vegetation occurred in historical times (at mentioned farms) more trees would have been present today and the region would have been described as a type of bushveld. If this was the case the habitat would have been suitable for black rhinos at the time of the first pioneers and therefore the possibility of the permanent occurrence of black rhinos was likely. A comparison between the present and historical ecological requirement in Table 2.2 indicate that the Free State had more suitable habitat for white rhinos to live in than black rhinos.

Table 2.2: Present versus historical occurrence of ecological requirements at the five Rhenoster farms in the Province.

	WHITE RHINO				BLACK RHINO			
FARM NAME	OPEN GRASS LAND		SAVANNAH		BUSHVELD		FOREST	
	PRESENT	HISTORICAL	PRESENT	HISTORICAL	PRESENT	HISTORICAL	PRESENT	HISTORICAL
Renostersspruit	x	x	x					
Renosterkop	x	x	x	X				
Renosterfontein	x	x						
Renosterhoek	x	x	x					
Renosterpoort	x	x	x	X	x			

If black rhinos occurred in the Province, it would have been difficult for the first pioneers to regularly observe them due to their solitary behaviour. On the other hand, white rhinos are territorial and roam in groups and could have been easily and more frequently observed. Therefore, it is believed that the pioneers named their farms after the only rhino they knew and observed, namely the white rhino. It is believed that the pioneers in the Free State Provinces did not know of the existence of the black rhino that occurred naturally to the north of South Africa.

2.4.4 Rock Art

Moodley and Kriek (2005) investigated rock art on the farm Rooihoogte in the Kroonstad district. They examined a rock engraving of a rhino, and confirmed that the engraved rhino with microdots and pecks clearly indicate an image of a rhino. The engraved rhino at Renosterkop (mentioned earlier) is 14 km east of the engraved rhino at Rooihoogte (Figure 2.7). Although early San artists draw paintings on rocks, these engravings are different. At this site, an engraved Marabaraba game-board was also discovered. This game is a prominent Sotho board game which is still played today. It seems that Sotho dwellers roamed the interior of the Free State and made these engravings. This image with its hump, heavy shoulders and large head appeared to be a white rhino. According to Willcox (1966) rock paintings (petro graphs) were mostly done by San people, however petroglyphs could also have been done by other indigenous people. Petroglyphs was only limited to the western Free State, south west Transvaal and northern Cape.

Figure 2.7: Image of a rhino engraved with microdots which was discovered on a boulder at the farm Rooihoogte in 2005.

Boshoff and Kearly (2013) stated that the San artist drawings of black rhinos near Reddersburg were not necessarily conclusive evidence that rhinos occurred in that specific area, as the rhinos may have been observed elsewhere.

2.5 THE ERADICATION OF RHINOS IN SOUTH AFRICA AND THE FREE STATE

While rhino' numbers are decreasing, an exponential growth in the world population of more than 7 billion people has taken place (Gerland Raftery Ševcíková Li Gu Spoorenberg Alkema Fosdick Chunn Lalic Bay Buettner Heilig and Wilmoth 2014). Since 2003, the earth's carrying capacity or "ecological footprint" has annually been exceeding its natural resources by 25% (Bonthuys in *Die Burger* 3 October 2006). Thus, a new expected onslaught on animal species and their habitat is inevitable. When the southern white rhino was first described by Burchell in 1817, individuals were reportedly found in great abundance (Lang 1924).

Von Molkte (2003) described how legendary "Dorslandtrekker olifantjagters" (thirstland pioneer elephant hunters) such as Hendrik van Zyl hunted between 150 to 200 rhinos during the years 1874 to 1877. The reason for this was money, as they made sjamboks out of the animal skins for an income. These elephant and rhino hunters received a fixed price of 2 shillings per sjambok. They cut 100 sjamboks from a rhino, and received up to £30 per rhino skin. The last white rhino in Zimbabwe was shot in 1895, while Selous shot one in 1874 in Botswana near the Zimbabwe border, and Sir Hugh Beadle shot another in Mozambique in 1935 (Skinner and Chimimba 2005). In the Cape Province, the last rhino was shot near Port Elizabeth in 1853, and in 1836 in the Orange Free State (Harris 1840). Both the last black and white rhino in the Transvaal were killed between 1872 and 1890 (Balfour and Balfour 1991). Balfour and Balfour (1991:175) wrote about a hunter, William Cotton Oswell, who "shot no fewer than 89 rhinos (both black and white)" in one season. He led 5 hunting expeditions between 1844 and 1853. Reports of 90 rhino individuals killed in a single hunting trip, and 60 being killed by a hunter in one season, exist (Lang 1924). In a monograph by Rookmaaker (2008), he identified 58 persons or groups who had rhino events in Southern Africa from 1795 to 1875. He gave the following statistics on the historical events of rhino in southern Africa: There were 575 events, which included 272 cases where rhinos were killed (102 black rhinoceros, 97 white rhinoceros and 73 unidentified). These events were recorded by 12 collectors, 10 missionaries, nine traders, seven military officers, and five hunters. Amongst them only three could be classified as trained zoologists.

In 1895, according to Haasbroek (2016), there were approximately 100 white rhinos left in king Shaka's old hunting fields near today's well known Hluhluwe-iMfolozi Park. He also states that Boers and other ivory hunters avoided these areas due to the high occurrences of the tsetse fly. Renshaw (1904) compared the rapid eradication of white rhino with the American bison and the true quagga. He states further: "According to a more recent estimate, there are, however, about ten white rhinoceros still in Zululand". Skinner and Chimimba (2005) pin their numbers down to a single remnant population of 10 to 20 individuals, while black rhino numbers were reduced to between 100 and 150 individuals. There is little consensus in the literature regarding the actual number of surviving southern white rhino, with various references stipulating either just a few, 20 or 50 individuals, or even as many as a hundred. The years 1895, 1900, 1910 and 1920 have all been proposed as the date when the population reached its lowest number (Rookmaaker 2000). Rookmaaker (2000) suggested that a highly exaggerated low population size estimate was publicised to motivate public support for the conservation effort, and that there were probably at least 200 individuals at that time. Somerset Playne (1912) wrote how the settlers ruthlessly shot several species to extinction, which included lions, hyenas, buffaloes and rhinos - species that earlier inhabited the vast plains of the Free State. This eradication of the rhino species also occurred for other species. Botha (1979) wrote that in 1870, 311 446 blesbuck hides where shipped from Durban, and all of these originated from the northeast Free State. According to Raath *et al*. (2002), more than 4 000 "trekbokke" (migrating antelope) were shot near Kroonstad in one day. Cape and Natal trade dealers bought these antelope hides, and in 1870 a total of 174 340 hides were exported from Kroonstad. By 1881 species numbers declined drastically, and game became a scarcity. The famous Swede hunter, Johan August Wahlberg, wrote that he spent six days along the Rhenoster River without seeing any rhinos in early November 1841 (Boshoff and Kerley 2013).

2.6 ALLEGED BLACK RHINO SKULLS DISCOVERED AT LETITIA AND TELEGRAAFSFONTEIN

Several authors (Skead 1987; Lynch 1991; Rookmaaker 2008; Boshoff and Kearly 2013) claim that two black rhino skulls were discovered in the Free State Province. Allegedly one was found in 1958 in the Vals River on the farm Letitia and another was discovered on the farm Telegraafsfontein. Both these black rhino skulls were donated to the National Museum in Bloemfontein.

Letitia

The farm Letitia, in the Kroonstad district, borders the Vals River and has a creek (spruit) with the name of Liebenbergspruit that confluence into the Vals River just west of the farmstead. The previous owner of the farm Letitia was interviewed regarding the black rhino skull. The owner stated that her brother discovered a skull of a hippopotamus in 1958 at the confluence, after it was flushed open by heavy rains. They donated the hippopotamus skull to the National Museum in Bloemfontein. In 1956 the brother of the owner also discovered a tooth of a hippopotamus in the Vals River not far from the hippo skull (Figure 2.8). The discovery of the complete hippo skull was published in the local newspaper – Northern Times ([1]Archer *pers comm*, 2016). A similar incident happened earlier in 1953 when Mr. Daniel Serfontein of the farm Erfdeel discovered a “giant lower jaw fossil mandible of a very large hippopotamus” (Anon, 1955) in the Vals river, 15 km downstream from Letitia.

[1] Christa Archer, sister of Hennie Bester (who discovered the skull) mentioned that the newspaper article published in the Northern Times is in her sister-in-law’s possession after it was inherited from the late Mr. Hennie Bester.

Figure 2.8: The tooth of the hippopotamus that the brother of the previous owner of Letitia discovered in 1956.

<u>Telegraafsfontein</u>

In a conversation with the owner of the farm Telegraafsfontein, he stated that his family have occupied the farm since 1862 ([2]Van der Merwe *pers comm,* 2017). He was raised on the farm and he could not recall that there was ever a black rhino skull discovered on their farm. A fossil mandible was however donated to the National Museum in Bloemfontein and they received feedback that it was a mandible of an unknown predator.

According to the abovementioned, there is reasonable doubt that it was black rhino skulls that were discovered at Letitia and Telegraafsfontein. These skulls can therefore not be used as evidence that black rhinos occurred in the Province.

2.7 THE RE-ESTABLISHMENT, ORIGIN AND CURRENT NUMBER OF RHINO IN THE FREE STATE

To protect the onslaught on several game species, numerous people and governments attempted to preserve species, including the rhinoceros. President Paul Kruger proclaimed Africa's first game reserve, the Pongola Game Reserve, on 13 June 1894, to

[2] Mr. Scholtz van der Merwe is the owner of the farm Telegraafsfontein.

preserve wild game species (Pringle 1982). Zululand reserves of Umfolozi and Hluhluwe were proclaimed by the Natal Government in 1897 to save the black, and particularly the white, rhino (Balfour and Balfour 1991). The Free State government proclaimed the Sommerville Game Reserve near Bultfontein in 1926 to preserve wildlife in the Free State (Jordaan Van Zyl and Lotze 2014). This game reserve was found to be of high agricultural value, and was exchanged in 1956 for the farm Allemanskraal and other farms in the Winburg district to develop a new game reserve. In 1971 these farms were consolidated and was proclaimed as the Willem Pretorius Game Reserve, where the first white rhino since 1836 was relocated in 1962 (Bourquin 1973). The hunting of game in southern Africa in late historical times led to the annihilation - not only of the white rhino - but of other game species as well. Only a few antelope species (game) were left after the Anglo Boer War, and the early farmers regarded game as a nuisance, as they competed with their cattle for grazing. Furthermore, a great number of their cattle died in the Free State because of a disease transported from the black wildebeests (Somerset Playne 1912).

The disease is probably better known as “snotsiekte” (Malignant Catarrhal Fever). These events caused conservation-minded farmers to protect game in small numbers on their farms for sentimental reasons, and for personal use. These pioneer game farmers played an important role in conserving game species. The Terblanche, Delport and Du Plessis families rescued the black wildebeest (*Connochaetes gnou*) in the Free State, the Van der Byls, Van Bredas and Albertyns rescued the bontebok (*Damaliscus pygargus pygargus*), and Hans Lombaard saved the Cape mountain zebra (*Equus zebra zebra*), (Young 1984). These initial efforts grew progressively into commercial production of wildlife, for example the sustainable utilisation of ostrich (*Struthio camelus*) and crocodile skins (*Crocodylus niloticus*) for the fashion industry (Bothma and Van Rooyen 2005).

Since the 1990’s the private sector in Southern Africa has invested a great deal in endangered wildlife species as an alternative to marginal game species. The rhino species was targeted as a safe, high value and good investment species, and this helped to increase their numbers in South Africa. By the 1960s, there were no records of white rhinos occurring in the Free State, and on 14 March 1962, the first white rhino, named

Ondini, was relocated to the Free State Province by the Natal Parks Board as part of their translocation program (Player 1972).

Figure 2.9: “Ondini” in the boma before being released into the Willem Pretorius Game Reserve. Subscript read: “Ondini, the first of the white rhino to arrive at the Willem Pretorius Game Reserve in a “Boma” 1962/3/14.”

Dr JG van der Merwe from Heilbron in the northern Free State was the first farmer that introduced white rhino to the Free State in 1969. He had five white rhinos in a 250-ha rhino camp on his farm Weltevreden, which he bought from the Umfolozi Game Reserve for R500 (Anon in *Die Volksblad* 29 April 1971). Although he camped them off with three steel cables, a bull and a cow managed to break out, and the one cow ended up in a swimming pool in the town of Koppies (Figure 2.10). The article stated that they had run between 120 to 160 km before the bull was captured on the farm Swellendam near Kroonstad, and both were successfully relocated back to the camp.

Die Volksblad

Op eie stoom kon sy dit nie maak

Inspuiting in boud

„SWAAR SWEMMER" OM TE RED

Figure 2.10: Editorial published as the main article in "Die Volksblad" of 29 April 1971, describing the outbreak of the white rhinos of Dr JG van der Merwe of Heilbron.

During 1980, only 34 white rhinos occurred in the Free State. A follow-up survey indicated that in 1985 there were 49 white rhinos in the Province, of which 15 were privately owned, and 34 owned by the State (Terblanche 1988). Another census in 1990 showed a decrease in rhinos to 37, of which farmers owned 15, whilst the State owned 22. No black rhinos occurred in the Province in 1990 (Jordaan 1990). In 2010 the Province had a total of 214 white rhinos, of which 153 occurred on private land, and 61 on State-owned land. In 2010 the State had four black rhino bulls, whilst private farmers had three black rhino bulls (Jordaan 2010).

During this study period, a count was done by the researcher that revealed that there are currently 599 white rhinos on private land, and 70 in government nature reserves, which totals to 669 white rhinos for the Free State Province. There are 10 black rhinos on private land, and one in a nature reserve, totalling 11 black rhinos. Thus, 680 rhinos in the

Province. New private rhino owners bought many rhinos due to poaching elsewhere in the country and were responsible for the sudden increase in numbers.

2.8 CONCLUSION

There is physical evidence that white rhinos inhabited the Free State in prehistoric times, but material evidence from the late historic period are still lacking. From literature, rock engravings, a narrative and rhino farms with a “Rhenoster” prefix, it appears likely that rhinos did occur in the Free State Province during late historical times.

Nine farms in the Province were named after rhino, which indicate that they may have roamed in that region. The occurrence of rhinos at Rhenosterspruit near Bloemfontein could not be substantiated. Rhenosterkop near Hoopstad was probably named after rhinos observed in the eastern Kalahari region of the Northern Cape Province where they roamed in savannah veld. Rhenosterdraai was probably named after the river’s bend, and not to the occurrence of rhinos. The narrative of Sophia le Roux could be accepted, as she made drawings of a single population of rhinos that came to drink in the afternoon at the “fontein” of Rhenosterfontein near Theunissen. Rhenosterpoort was probably named after this rhino population which roamed along the Vaal River. This population probably originated from the “southern Transvaal” side of the Vaal River. Thus, only three locations in the Free State might have had rhino populations that were observed by early Boers and explorers. The last rhino in the Free State was hunted 4.8 km from the Vaal River near Scandinavia Drift by Captain W. Cornwallis Harris in mid-December 1836. The mystery date of the 1842 record and place of Rhenosterkop where the last rhino was shot, as suggested by various authors, could not be substantiated.

The limited availability of suitable habitat would therefore have been probably the reason for their low numbers and perhaps the reason why explorers did not find them abundantly in the Free State.

The present and historical ecological habitat indicate that the Free State had more suitable habitat for white rhinos than black rhinos. From an ecological perspective, it is doubtful that black rhino would have survived in the treeless Province, as they are browsers. The tree (browse) line of the rivers and creeks in the natural distribution areas of historical rhinos was limited to absent. Pictures taken during the Anglo Boer War (60 years after the last observation of a rhino), indicate zero to limited tree densities in the mentioned areas. Only two of the nine Rhenoster farm maps show limited trees on the surveyed maps. The few trees and shrubs that might have occurred, although in limited numbers, could have been the *Acacia karroo, Searsia lancea* and *Olea eauropea*, as seen on provided pictures.

There are two rock engravings with microdots on boulders of rhinos near Renosterkop. These petroglyphs indicate the presence of early inhabitants near Renosterkop. Although early San people drew paintings on rocks, these engravings might be different and it is uncertain if they saw the dotted rhinos at Rhenosterkop. The paintings of the San artists were probably not painted of an animal in the vicinity, because they were wonderers and could have seen the rhinos in another Province. On the site discovered at Rooihoogte, an engraved Marabaraba game-board was also discovered, probably indicating the presence of Sotho artists, who were more territorial. They probably made the engravings of the white rhinos that they observed regularly near Renosterkop.

New information gathered from the previous and current landowners of the farms Letitia and Telegraafsfontein stated that they are not aware of any black rhino skulls discovered on their farms. The fossil skull at Telegraafsfontein is a lower mandible of a predator and the skull discovered at Letitia was that of a hippopotamus.

Although the Summerville Game Reserve was founded in 1925, the State only managed to re-introduce the first white rhino in 1962. Private enterprise managed to re-introduce the first white rhino on private land in 1969. Today, there are 680 rhinos occurring in the Free State Province.

The aim of the study was to collect evidence of which rhino species occurred historically in the Province. After assessing this evidence through “Rhenoster” farm visits, literature, ecological requirements and old photographs it is believed that the white rhino roamed the Province during historical times.

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CHAPTER 3

THE IMPACT OF CURRENT LEGISLATION, POLICIES AND SUPPORTIVE GOVERNANCE TO REDUCE RHINO POACHING

3.1 INTRODUCTION

South Africa, custodian of the world's largest white rhino population, was awakened by a series of rhino-poaching incidents some ten years ago, as well as an exponential increase in rhino poaching over the last five years. Previously secure populations are now being targeted by sophisticated poaching operations, apparently backed by international organized crime syndicates (Ayling 2012). To understand rhino poaching, one must examine trends in the market for rhino horn, which is the main drive for poaching (Messer, 2000).

Since 1977, world governments have progressively attempted to shut down the rhino horn market globally via the mechanism of an international trade ban (under the banner of CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora).

To counter the threat of poaching and subsequent illegal trade, the South African government has introduced several statutes to combat the illegal trade of wild species, the most distinctive being the National Environmental Management Act (Act 107 of 1998) (NEMA), together with its SEMAs (Specific Environmental Management Acts), such as the National Environmental Management Biodiversity Act (Act 10 of 2004) (NEMBA), and the National Environmental Management Protected Areas Act (Act 57 of 2003) (NEMPAA).

The South African Government have also signed and ratified a few international treaties such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the Convention on Biological Diversity (CBD), which focus on the conservation of biological diversity as well as the sustainable use of genetic resources (Kidd 2000).

Environmental protection became a fundamental right, guaranteed and protected under the Constitution of the Republic of South Africa (1996). In Section 24, it specifically states that: “everyone has the right to an environment that is not harmful to their health or wellbeing and to have the environment protected through reasonable legislative measures”. The responsibility rests upon the State to ensure the realisation thereof through reasonable legislation and other measures.

Even though the above-mentioned is entrenched in the South African Constitution, some wildlife resources, more than ever before, are faced with the threat of extinction. South Africa's wildlife resources are threatened by poaching and products that are traded across the world. Trade can take place either on a legal basis, or it can be done illegally. In the environmental context, and more specifically, trade in endangered species and by-products, such as rhino horn, is done illegally (De Wet 2014).

Considering the foregoing, this chapter addresses the following question: does South African law, within the context of the international and regional legal orders, provide the means to eradicate or reduce rhino poaching and the illegal trade in rhino horn? The possibility of claiming financial losses from poachers after they are found guilty will be examined. The relevance of legislation can serve as a deterrent for poachers and serve accordingly as a rhino security measure for rhino owners.

The study included a focus on the international, African and South African laws regulating trade, as they provide a regional context and framework within which South African law is meant to be understood, as well as the terms within which South African law functions. In the subsequent study, a brief description of relevant environmental acts will be given to assist in providing the context to rhino poaching.

Thereafter, measures currently implemented preventing non-compliance and effective law enforcement capacity in the Free State are investigated. It will be followed by an analysis of the current legislation effectiveness. Finally, a conclusion will be formulated, with recommendations based on the content of the study.

3.2 METHODOLOGY

A literature study formed the basis of this chapter, and includes a focus on the international legislation, African treaties and South African laws that regulate rhino poaching and horn trade. This study is based on a review of relevant textbooks, the nature conservation ordinance, legislation, law journals, case law and other sources relating to the illegal poaching of rhinos from a Free State prospective. The focus will be on the critical evaluation of the influence of legislation, to establish whether the key issue is with the legislation or the enforcement thereof.

A purposive sampling approach was used in this study, and a qualitative approach was followed. Unstructured interviews were conducted with representatives of rhino breeders, government Environmental Management Inspectors (EMI's), lawyers, and with members of the South African Police Service, to obtain perspectives on the interpretation of possible controversial sections in the various acts.

Only acts, regulations, moratoriums, agreements, ordinances and policies relevant to rhino poaching will be summarised and discussed. Although 13 legislative tools are described, another six acts can be used for prosecution against rhino poachers. These other acts include the National Environmental Management Laws Amendment Bill (the NEMLA Bill, Gazette 40733, Notice Number 245 of 31 March 2017), the Animal Protection Act (Act No. 71 of 1962), Animal Health Act (Act No. 7 of 2002), Animals Diseases Act (Act No. 35 of 1984), Medicines and Related Control Substances Act (Act No. 90 of 1997), and the Animal Matters Amendment Act (Act No. 42 of 1993).

The latter is under the jurisdiction of the Department of Agriculture, Forestry and Fisheries, and may be relevant to rhino conservation, as it plays a significant role in veterinary care of animals. These acts are not described in detail, as they fall outside the enforcement powers of EMIs. The following table gives a brief description of the main acts relevant to the study (Table 3.1).

Table 3.1: Relevant legislation that addresses rhino poaching

NO. AND YEAR OF LAW	SHORT TITLE	COMMENCEMENT	OBJECTIVE	MAXIMUM PENALTY
108 of 1996	Constitution of the Republic of South Africa	4 February 1997	The RSA Constitution is the supreme law of the country	None
107 of 1998	National Environmental Management Act (NEMA)	29 January 1999	Creates the fundamental legal framework that gives effect to the environmental right guaranteed in the Constitution	None
10 of 2004	National Environmental Management Biodiversity Act (NEMBA)	7 June 2004	Management and conservation of biological diversity within the Republic, and of the components of such biological diversity	R10 million/ 10 years' imprisonment
57 of 2003	National Environmental Management: Protected Areas Act (NEMPAA)	18 February 2004	To provide protection for the conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes	R10 million/ 10 years' imprisonment
105 of 1991	The Game Theft Act (GTA)	5 July 1991	To regulate ownership of game; to combat the theft and unlawful hunting, catching and taking into possession of game.	R40 000/ 10 years' imprisonment
8 of 1969	Free State Ordinance on Nature Conservation	1 January 1970	To provide for the conservation of fauna and flora for the Orange Free State Province.	R100 000/ 10 years' imprisonment

The above-mentioned legislations will be briefly summarised and then discussed. The following hierarchical display presents an overview of the South African national environmental legislation framework, as well as another act and an ordinance applicable in the Free State that addresses rhino poaching and illegal trading in rhino horn (Figure 3.1).

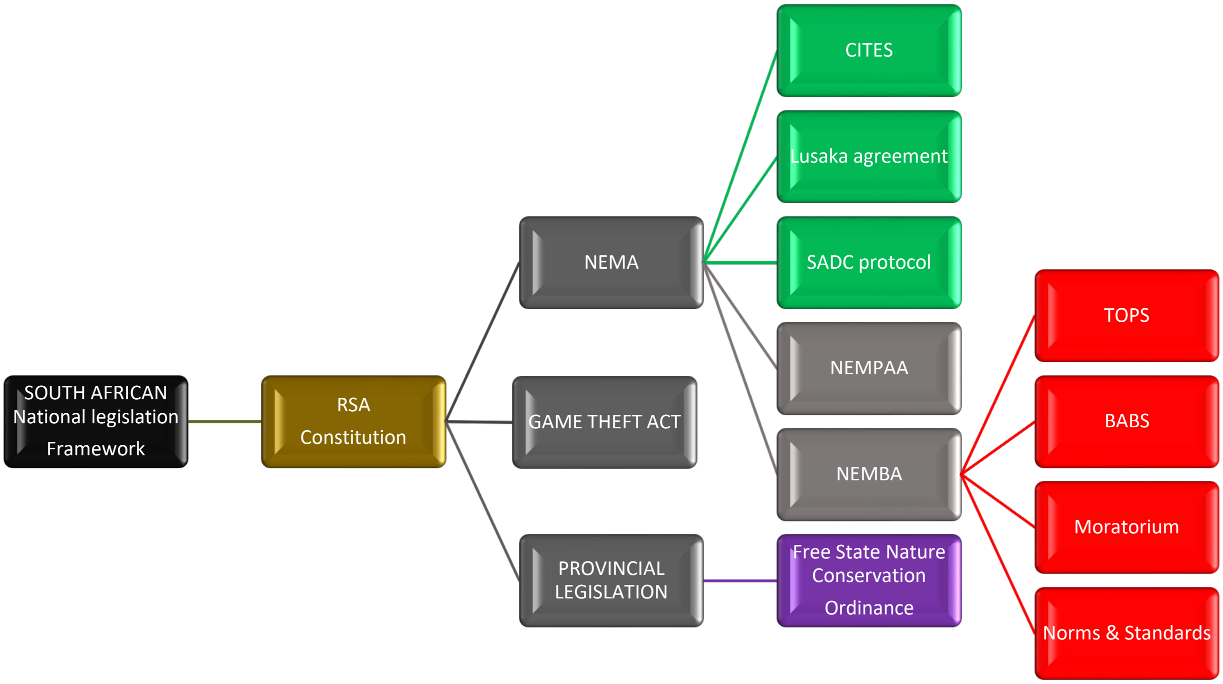

Figure 3.1: Relevant national environmental and provincial legislation currently enforced by EMIs for rhino-based offences in South Africa.

3.3 AN EXPOSÉ OF RELEVANT LEGISLATION APPLICABLE TO RESTRICT RHINO POACHING, TRADE AND PROTECTION IN THE FREE STATE PROVINCE

A short preamble allowing insight into the development of the new environmental legislation framework of South Africa will be provided in this Section.

A new national environmental legislation framework based on the philosophy of sustainable development, driven under UNEP's expert guidance, was developed (Rouwenhorst 2007; Van der Linde and Feris 2010). To understand the influence of environmental supportive governance, it is of importance to evaluate the frameworks of various proclaimed legislation which ensures that environmental degradation is counteracted, especially regarding rhino poaching.

3.3.1 National Environmental Management Act (Act 107 of 1998 - NEMA)

The prelude of NEMA repeats Article 24 of the South African Constitution, which states that everyone has a right to an environment that is protected. This environmental right, and other rights relevant to environmental concerns, ought to be seen against the backdrop of international trends and developments (Glazewski 2005). The main goal of NEMA is to regulate functions of national departments possibly affecting the environment, and as such, form the principal environmental framework act in South Africa (Kotze and Du Plessis 2006). Section 2 stipulates that “the actions of all organs of State that may significantly affect the environment” (RSA 1998:16) apply throughout the Republic. Chapter 6 deals with provisions on international obligations and agreements, and set guidelines to obtain these. Chapter 9 deals with the administration of the Specific Environmental Acts (SEMAs), such as NEMBA and NEMPAA. Section 2(2) of NEMA states that environmental management must place people and their needs at the forefront of its concern. Simultaneously, this includes that the State, in terms of Section 2(4)(b)(viii) of NEMA, must anticipate and prevent negative impacts on the environment and environmental rights. The South African Constitution has delivered a clear mandate to the State to deliver, by way of laws and regulations, as well as measures ensuring adequate environmental protection. NEMA empowered Environmental Management Inspectors (EMIs) with various functions and powers to enforce compliance and monitoring. EMIs, through their mandate, may also include seizing and investigating evidence when searching premises where criminal activity, such as possession of rhino products, has taken place (NEMA s 31H, 31J, 31L). In addition, members of the South African Police Service (SAPS) also enjoy all the enforcement powers conferred on the EMIs, with two notable exceptions: the power to conduct routine inspections, and the power to issue compliance notices (NEMA s 31O).

3.3.2 National Environmental Management: Biodiversity Act (NEMBA Act No. 10 of 2004)

NEMBA provides for the management and protection of South Africa's biodiversity within the framework established by NEMA (Chapter 9). The act protects species and ecosystems in need of protection; the sustainable use of indigenous biological resources; equity in bioprospecting; and the establishment of a regulatory body on biodiversity, namely the South African Biodiversity Institute (SANBI). The act includes two important definitions, namely "restricted activity" and "sustainable development", on which the act pivots. Of importance in this act is chapter 4 that provides guidelines for the protection of Threatened or Protected Species (TOPS). In Addition, Section 56 authorises the Minister to publish, by notice in the Gazette, a list of critically endangered, vulnerable or protected species. Section 57 regulates the carrying out of restricted activities involving a listed threatened or protected species (TOPS). Both African rhino species are listed as TOPS species. The essence of the act is Section 57, and it states, in short, that a person may not carry out a restricted activity involving a TOPS specimen without a permit. These defined restricted activities (Section 1) include hunting, capturing, killing, cutting parts off, importing or exporting into or from South Africa, having in possession of exercising physical control (over any rhino), breeding, translocating, moving, selling, donating or accepting (any rhino) or any of its products or derivatives as a gift. Knight, Emslie, Smart and Balfour (2015) summarise NEMBA as a constitutional commitment to take reasonable legislative measures that promote conservation by providing for the management and conservation of biological diversity, and the sustainable use of indigenous biological resources. According to Crouch, Douwes, Wolfson, Smith and Edwards (2008), NEMBA takes over the role of provincial legislation only if the latter is in conflict.

3.3.2.1 National Environmental Management: Biodiversity Act (Act No. 10 of 2004): Threatened or Protected Species (TOPS) Regulations (No. R. 152 of 2007)

The Threatened or Protected Species (TOPS) Regulations are proclaimed under Section 97 of the South African National Environment Management: Biodiversity Act (NEMBA) in effect as of 1June 2007. The TOPS Regulations 24(1) (a–i) and (2)(a–b) prohibit the hunting activities of large predators, including white rhino and black rhino, in the following manners: put and take (offload and hunt), hunting of captive-bred white rhino in a controlled environment, and if the rhino is under the influence of a tranquilizing, narcotic, immobilising or similar agent. Knight *et al.* (2015) stated that the TOPS Regulations prohibit the hunting of white rhino by means of darting it by a hunter; it does not prohibit the darting of white rhino by a veterinarian for management purposes, disease control procedures or scientific research, veterinary treatment, or for translocation. Regulation 26(1)(8) stated that no white rhino, black rhino, savannah elephant (*Loxodonta africana africana*) or crocodile (*Crocodylus niloticus*) may be hunted with a bow and arrow. Regulation 70 of TOPS also regulates the provisions relating to the marking of elephant ivory and rhino horn. The sub-regulations provide details of the protocols to mark and register these products. All rhino horns in the Province are marked, micro-chipped and registered on the rhino DNA Index System (RhoDis n.d.). Boshoff and Carroll (2007) concluded that the principles of the TOPS Regulations apply only to those species that are listed as threatened or protected in terms of the Biodiversity Act, and stated that provincial legislation still applies to all species not listed as threatened or protected. According to Goitom (2013), the TOPS Regulations have been amended five times since its promulgation in 2007 until 2013 and since then it remains unchanged.

3.3.2.2 Norms and Standards for the Marking of Rhino and Rhino Horn and for the hunting of Rhino for Trophy Hunting Purposes (Notice No. 35248, No. 304 on 10 April 2012)

The TOPS Regulations, the National Norms and Standards for the marking of rhino and rhino horn and the hunting of rhino for trophies, as well as the CITES Regulations, are promulgated legislative tools that regulate restricted activities involving white and black rhinos, particularly the hunting of white rhinos and the legal export of the hunting trophies, according to Section 9 of NEMBA. NEMBA and its subsidiary legislation provide the authority for consolidating fragmented biodiversity legislation in the country through the establishment of national norms and standards, specific to certain particularly vulnerable animals (Goitom 2013). Under the guise of trophy hunting, TOPS hunting permits were issued, but it was suspected that the true intention was to sell rhino horns on the black market in Asia. This deception has been termed "pseudo-hunting" and occurred between 2003 and 2010 (Cota 2013). Allegedly, there have been cases of pseudo-hunters killing multiple rhinos and exporting the trophies illegally on a single permit (Milliken Emslie Richard and Talukdar 2009; Taylor Brebner Coetzee Davies-Mostert Lindsey Shaw and 't Sas-Rolfes 2014). The norms and standards were amended (Government Gazette No. 35248, Notice No. 304, 10 April 2012) when the exploitation of the system was detected, placing stricter control on hunting, and making it obligatory that a conservation official be present at every rhino hunt. It is also now a requirement that the hunting clients prove their legitimacy as hunters by proof of membership of a hunting association in the country of normal residence, or proof of previous African species hunting experience, or a Curriculum Vitae (CV) indicating hunting experience. In addition, the permit issuing authority must also consider whether the country of usual residence of the hunting client has adequate legislation to ensure the rhino horns will be used for the purpose as indicated by CITES export (Heitmann 2014; Knight *et al.* 2015). Milliken *et al.* (2009) point out in their report that it is prohibited to export trophies in hand luggage, and that individual hunters are limited to one white rhino hunt per year. These regulations also require national approval before provincial hunting permits can be issued. Part four of the norms and standards require that samples of the horns and blood be collected by using the DNA kits, as provided by the Veterinary Genetics Laboratory of the University of Pretoria. RhoDIS (Rhino DNA Index System) is a project that was initiated by the Veterinary Genetics Laboratory of the University of Pretoria. They use the unique DNA profile of individual rhinos to prevent poaching and assist in forensic prosecutions (RhoDis n.d.).

3.3.2.3 The National Moratorium on Trade on Rhino Horn (Government Gazette No. 31899, Notice No. 148, 13 February 2009)

International trade in rhino horn has been prohibited under CITES regulations since 1977 (Taylor *et al.* 2014). It was legal for South African citizens to sell and exchange rhino horn within South Africa if permits were acquired. In the early 2000s, this legal trade began to be exploited for illegal purposes. The South African Government decided in 2009 to place a national moratorium on the sale of individual rhino horns and any derivatives or products within South Africa, to ensure that no legally obtained horns end up in illegal trade (De Beer 2016). However, the rhino-poaching surge that started in South Africa during 2008 has continued to escalate despite the moratorium, and there have been concerns that the local trade ban has aggravated the poaching crisis rather than alleviated it (Taylor *et al.* 2014). Meanwhile, two rhino owners (Johan Kruger and John Hume) registered an application in 2012 challenging the moratorium on the domestic trade in rhino horn. A judgment in 2015 lifting the 2009 moratorium on domestic rhino horn trade was made in the Pretoria High Court (Crone 2015). In 2016, the Minister filed an application for leave to appeal to the High Court, which was dismissed. On 5 April 2017, the Constitutional Court dismissed an application by the Department of Environmental Affairs aimed at maintaining a ban on domestic rhino horn trade (Bale 2017).

3.3.2.4 The Bioprospecting, Access and Benefit Sharing (BABS) Regulations of 2008 Amendment Regulations of 2015 (Government Gazette No. 38809, Notice No. 447, 19 May 2015)

The Bioprospecting, Access and Benefit Sharing (BABS) Regulations of 2008 were issued under chapter 6 of NEMBA, and was amended under General Notice

447 in Government Gazette 38809, dated 19 May 2015. The BABS Regulations promote conservation of indigenous biological resources and sustainable utilisation of its components, whilst ensuring fair and equitable sharing of benefits derived from their commercialisation in the nutraceutical, pharmaceutical, cosmeceutical, agricultural and other relevant industrial sectors. The use of rhino horn or rhino genetic material (cloning) for bio-prospecting purposes such as intellectual property rights arising from research will be directed by the BABS Regulations (General Notice: NOTICE 269 OF 2015). Ngwenya (2014) gives bio-piracy as the reason for the promulgation of BABS under NEMBA, to ensure that indigenous communities share equally in the benefits flowing from bio-prospecting and indigenous knowledge. Crouch *et al.* (2008:355) concluded that, "though well-intentioned, these non-facilitative regulations have placed a dead hand on value-addition to South Africa's biodiversity."

3.3.3 National Environmental Management: Protected Areas Act, 2003 (Act 57 of 2003 NEMPAA)

NEMPAA provides for the protection and conservation of ecologically viable areas representative of South Africa's biodiversity, natural landscapes and seascapes in protected areas (NEMPAA 2003). Protected areas in South Africa offer a viable tool for habitat protection and the protection and maintenance of ecologically viable numbers of the white rhino and their associated species and habitats (Van der Linde and Feris 2010).

According to De Wet (2014), one of the main objectives of this act, as stated in Section 2(a), is to provide, within the framework of national legislation, for the declaration and management of protected areas. The constitutional right contained in Section 24 is echoed in Section 2(e) of NEMPAA, which further emphasises the importance of sustainable utilisation and the protection of the environment, for the benefit of the people. He stated further that the Minister, in terms of Section 38(a), in writing, assigned the management of these nature reserves to a suitable organ of State or organisation. SANParks is an example hereof, as it was established in terms of the NEMPAA specifically to serve this function. Arguably, the most important section in this act is Section 17(e), which states that the purpose of declaring such areas as protected is to safeguard threatened and rare species (Strydom and King 2009). Amongst others, it does so by means of environmental management agreements as referred to in Section 41(1) of the Act. Section 17(e) is further supplemented by the provisions made in Section 45(1) and 46(1) of the Act. In short, the main purpose of these provisions is to limit the access of the public to special nature reserves or protected areas for safeguarding, amongst others, endangered species such as rhinos.

3.3.4 The Game Theft Act (GTA) 105 of 1991 (Government Gazette No. 133552, 5 July 1991)

In 1982, the National Game Committee of the South African Agricultural Union requested The Department of Justice to be decisive on the ownership of game. In 1988, the Minister of Justice requested the South African Law Commission to investigate the ownership of game to protect game farmers who, at the time, had experienced theft of game without compensation. The game farmers invested at large in the establishment of game on their farms (Die Suid-Afrikaanse Regskommissie 1989). The GTA was then promulgated on 5 July 1991 to protect the lucrative fledging industry of game farming. According to Van der Merwe (in Zimmerman and Visser 1996), the act regulates the ownership of certain classes of wild animals referred to as "game". It comprises all game kept or held for commercial or hunting purposes, including meat, skin, carcass, or any portion of the carcass (such as rhino horn), of that game (Section 1).

The aim of the GTA is "to regulate the ownership of game in certain instances; to combat the theft and wrongful and unlawful hunting, catching and taking into possession of game; and to provide for matters connected therewith" (Game Theft Act, 1991:2). The first part of Section 2 of the Act provides that if game escapes from sufficient enclosed camp, open area, a kraal, or a vehicle, then the owner shall retain ownership of the game. Freedman (2000) pointed out that both Section 2(1)(a) and Section 2(1)(b) of the Game Theft Act has abolished several common-law rules relating to the acquisition and loss of ownership of wild animals. The GTA was also, according to Bürgener, Snyman and Hauck (2001), used to determine and protect the rights of the landowner, especially when game was lured away from a property, or when they have escaped. According to Jansen (1993, *pers. comm.*), the Free State Department of Nature Conservation (and currently DESTEA) enforces this act to the extent of game theft in both cases of poaching or escaping of live game from a farmer's property. He states further that this act vested ownership of game when a camp is adequately enclosed, according to specific fencing policy guidelines provided by the Department. At present DESTEA issues a fence certificate to provide evidence of ownership, which may assist in a court case when rhino poachers are prosecuted for "game" theft. Historically, all wildlife was regarded by law as *res nullius* or un-owned property (Fuggle and Rabie 1983). Anybody could kill, capture or domesticate wild animals to reap the benefits of ownership of such an animal. Obviously, an incentive to harvest was created and not to protect a valuable wild species. When game ranchers invested in a rhino which escapes from the farm or is killed by poachers, he could not claim compensation ('t Sas-Rolfes 2011:3).

Section 300 of the Criminal Procedure Act (CPA) (Act 51 of 1977:156) states that the "court may award compensation where offence causes damage to or loss of property." An award made under Section (3)(a) of the CPA by a regional court, shall have the effect of a civil judgment of the magistrate's court of the district in which the relevant trial took place (also Section 7 of the GTA). Thus, a rhino owner may claim from a rhino poacher "R1 000 000 in respect of a regional court, and R300 000 in respect of a magistrates' court - GN R62 in GG 36111 of 30 January 2013" (CPA 1977:156)". The concept of ownership of game was debated decades ago, and the aim was to give a farmer the right to gain income from game as an asset or livestock on his farm. In this regard, a new Free State environmental legislation was proposed by [3]Jansen (1998) to categorise all game under livestock once it is fenced off for game-farming purposes, and is therefore to be regulated under agricultural laws, and no longer regarded as wild animals. Rhino poachers could then be charged under the Stock Theft Act (Act 57 of 1959), though the GTA also makes provision for it, if game (such as rhinos) could be proven stock (s 8). Twenty years later, Wildlife Ranching South Africa (WRSA) is currently running a similar proposal to the Agricultural Department, in an attempt to place game under the Department of Agriculture (Raats 2016).

3.3.5 The Free State Ordinance on Nature Conservation (Ordinance 8 of 1969)

The autonomous Ordinance on Nature Conservation was uniquely developed for the needs of the Free State Province's people and its species, and has its own unique Sections to protect fauna and flora. It was also the first legislation that controlled rhinos and their products in the Province, since the promulgation of the first Orange Free State Game Conservation Act in 1858 (Lategan and Potgieter 1981). The Ordinance makes the following provisions under Section 2(1): "The species of wild animals specified in Schedule 1 to this Ordinance are hereby declared protected game. (3) No person shall hunt protected game, except under authority of a permit which may be issued by the Administrator". The Schedule 1 Protected Game includes both black and white rhino. Under Section 14 (2), the following is stated: "Except under authority of a permit which may be issued by the Administrator, no person shall (b) sell any such processed part or product; or (c) possess any processed part or product of a rhino horn". Six persons were convicted under the Nature Conservation Ordinance for the dealing in rhino horns from 1968 to 2008 ([4]Boing, 2016, *pers. comm.*). In the Free State Province, no one was prosecuted for illegal hunting of rhinos, as it did not occur in the Province during that period. The ordinance is still valid and functional, with monthly successes for ordinary contraventions. It is still a handy alternative tool when all other legislation fails.

[3] Willem Jansen, Director of the Department of Nature and Environmental Conservation in 1998.

[4] Werner Boing, Deputy Director of the Compliance and Law Enforcement Section of the DESTEA.

3.3.6 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Government Gazette No. 33002, Notice No. R173, 5 March 2010)

On 15 July 1975, South Africa became a founding member of the Convention on International Trade in Endangered Species in Wild Fauna and Flora, known as the CITES Treaty. The objective of this treaty was to protect endangered species against over-exploitation by prescribing import and export regulations, and in some cases, prohibiting trade (Kidd 2000). South Africa is a party to CITES, and aims to ensure that international trade in specimens of wild plants and animals does not threaten their survival. Except for South Africa's and Swaziland's populations of the southern white rhino, the white rhino is listed in Appendix I of CITES, which requires strict international trade control. South Africa's white rhino population was included in CITES Appendix II in 1994, but only for international trade in live animals to appropriate and acceptable destinations, and for the export of hunting trophies, which hunters must retain as mementoes of their hunts. All other specimens of this species are deemed included in Appendix I, which means that international trade for commercial purposes is prohibited (Knight *et al*. 2015). The Minister responsible for Environmental Affairs has an obligation in terms of Section 59(a)(ii) of NEMBA to monitor compliance in South Africa with the provisions of CITES, and to consult the Scientific Authority on issues relating to trade involving specimens of, among others, CITES-listed species such as rhinos.

3.3.7 Convention on Biological Diversity (CBD)

Signed by 150 government leaders at the 1992 Rio Earth Summit, the Convention on Biological Diversity is dedicated to promote sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality. Agenda 21 is a non-binding action plan of the United Nations about sustainable development. The Convention recognises that biological diversity is about more than plants, animals and micro-organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live (CBD n.d.). The South African Legislator developed a wide definition of bioprospecting in contrast to the narrow definition of genetic resources embraced by the CBD. Parties are required to promote the protection of ecosystems, natural habitats and the maintenance of viable populations of threatened species in natural surroundings through development and implementation of plans and other management strategies (De Wet 2014). One of the reasons why rhino populations have not only increased, but flourished in South Africa, is because of its adherence to this requirement of implementing conservation and sustainable plans or strategies. One of the most successful of these plans was the publishing of the Regional Rhino Conservation Plan and the Conservation for Black Rhino Plan (Knight Balfour and Emslie 2010).

3.3.8 SADC Protocol on Wildlife Conservation and Law Enforcement

The Protocol on Wildlife Conservation and Law Enforcement to the SADC Treaty introduced in 2003 were approved by Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Tanzania and Zambia. The Protocol recognises states' sovereign rights to manage their wildlife resources, with a corresponding responsibility to sustainable use and to conserve these resources (Morgera and Cirelli 2010). The SADC Protocol on Wildlife Conservation and Law Enforcement provides a clear rationale for ensuring that any national or regional goals for rhino conservation refers to the interdependency between human welfare and sustainable management of wildlife resources, within which the "flagship" role of rhinos is highlighted. Rhinos are particularly appropriate as "flagships" for regional cooperation in resource management, since the decline of many of the subcontinent's rhino populations was due to cross-border poaching and illegal trading networks that extended through several countries (Du Toit 2006). Showing a reversal of this trend, through regional cooperation in law-enforcement, sharing of rhino management expertise, and sharing of rhinos through meta-population management, would be a very graphic demonstration of SADC's effectiveness. South Africa, as the major white rhino range state, can continue to play the major role to re-establish the species in the SADC Region (SADC 1999).

3.3.9 Lusaka Agreement

The Lusaka Agreement on co-operative enforcement operations are directed at illegal trade in wild fauna, and was founded by wildlife law enforcement officers from eight eastern and southern African countries who met in Lusaka in December 1992. There are currently seven parties to the Agreement: Republic of the Congo, Kenya, Liberia, Tanzania, Uganda, Zambia and Lesotho. The Republic of South Africa, Ethiopia and Swaziland are also signatories to the agreement (Faure De Smedt and Stas 2015). A country may become a party to a treaty by accepting the treaty. A country becomes a signatory to a treaty when it makes the terms of the treaty legally binding on itself. The Lusaka Agreement is a treaty between many African nations that seeks to reduce and eliminate illegal trade in fauna and flora and to establish a permanent Task Force for this purpose (Lusakaagreement 2013). The Lusaka Agreement Task Force (LATF), are charged with the task to investigate violations of relevant national laws and providing evidence to the member countries (Lusakaagreement 2013).

3.4 MEASURES CURRENTLY IMPLEMENTED THAT PREVENT NON-COMPLIANCE AND EFFECTIVE LAW ENFORCEMENT CAPACITY IN THE FREE STATE

The following section will give an overview of the enforcement measures available for EMIs to protect rhinos in the Province.

3.4.1 Compliance

Permits of private rhino owners may be cancelled when they are suspected of permit irregularities, or when they have been charged with wildlife-related offenses. The permits of private rhino owners may also be cancelled when they do not comply with the requirements set in the various relevant acts and regulations (NEMBAs 93).

3.4.2 Monitoring

All rhino owners and their horn stock piles are currently registered on the national DNA database. Both horn stockpiles in privately and State-owned possession are being audited on an annual basis by the national Department of Environmental Affairs (DEA). A provincial secure, electronic permitting system and database was developed to maintain up to date data on who owns rhinos, where and how many? An EMI of the provincial Department of Economical, Small Business, Tourism and Environmental Affairs (DESTEA) in the Free State was screened and allowed access to the database, ensuring reduced risk of corruption.

3.4.3 Law enforcement

Environmental Management Inspectors (EMIs) are designated according to NEMA to fulfil their mandated duties professionally. Training courses are held from time to time, which include understanding organised crime, fraud and corruption, and the consequences of legally traded horn entering the black markets. Environmental legislation guidelines were written for several magistrates and State prosecutors with environmental expertise (Snijman n.d). A close relation exists between EMIs and police experts. A Free State Rhino Anti-Poaching Unit was established, and is operational monthly at specific rhino locations in the Free State. It consists of EMI officials of DESTEA and of SAPS members ([5]Col. Botha, 2014, *pers. comm.*). A South African law-enforcement structure was established in early 2010 with the formation of an interim National Wildlife Crime Reaction Unit in the Department of Environmental Affairs (NWCRU) consisting of representatives from SAPS, SANParks, national and provincial nature conservation officials (EMIs), the National

[5] Col. Hendrik Botha, (apart from his official duties) also Operation Commander of the Free State Rhino Anti-poaching Unit.

Prosecuting Authority (NPA), the Asset Forfeiture Unit, and INTERPOL. This expansion recognised the marked escalation in rhino security threats throughout the country, and moved quickly to develop a national crime investigation mechanism that linked all components of the law-enforcement community through local, provincial and national scales (Milliken and Shaw 2012).

3.5 A CRITICAL ANALYSIS OF THE EFFECTIVENESS OF CURRENT LEGISLATION

3.5.1 Analysis from literature

Aucamp (2016:25), in a lecture to the SADC Law Association, stated that: "from a legislative perspective South Africa is equipped to successfully combat rhino poaching". Aucamp identified a lack of knowledge and experience from many SAPS members of environmental crime, and that the investigation units sometimes do not regard the crime of rhino poaching as serious.

In accordance with Aucamp (2016), De Wet (2014:64) agrees as follows in his conclusion of the current environmental legislation: "…the South African legal framework certainly does have the means to preventing illegal trade in rhino horn…". De Wet (2014:iv) reasons further that its current failure is attributable to a lack of enforcement of these measures because of a "lack of provisions holding entities accountable". A study done by Cronin (2015) indicates that there is a lack of clarity of the regulations, lack of enforcement and weak top-down communication from Government regarding NEMBA regulations.

Strydom (2017) confirmed that there is a broad legislative framework, but the lack of enforcement thereof seems to be the reason why South African rhinos are facing destruction. The continuous amendments on the various acts are an indication of the lack of extensive deliberation and consideration prior to the proclamation of the acts (Goitom 2013). De Wet (2014:iv) further states the following: "To combat and eradicate the illegal trade in wild species and parts therein, South Africa has enacted numerous laws and it has ratified various international conservation Conventions". Snijman (n.d.) provided further guidance to State prosecutors, and stated that a myriad of new South African environmental legislation was created to form an effective environmental enforcement network to combat environmental crimes such as rhino poaching. He emphasised the importance of the Constitution as the basis for the protection of the environment. When found guilty, the South African courts are bold in sentencing poachers (DEA 2016). See Annexure C for poachers sentenced.

Strydom (2017) indicates that the problem does not lie in weak legislation, or in a lack of suitable provisions with respect to rhino poaching, but rather with the implementation thereof; hence exposing the shortcomings of the enforcement framework. Rhino-poaching statistics confirm that the current regulatory regime governing trade and preservation of this species is not able to counter the effects of a growing illegal trade involving organised criminal syndicates (Heitmann 2014). He also stated that the domestic measures implemented to restrict supply have simply caused prices on the illegal market to escalate, and may prove unsustainable in the long term.

't Sas-Rolfes (2012:16) is of the opinion that: "the law enforcement approach decreed through CITES, and progressively implemented by various nations over the last 35 years, has failed to protect rhinos from the threat of poaching." Taylor, Balfour, Brebner, Coetzee, Davies-Mostert, Lindsay, Shaw and t- Sas-Rolfes (2017) pointed out that the conventional legal protection and law enforcement are insufficient at current levels of efficiency.

3.5.2 Analysis from rhino owner surveys

It is evident from De Beer's (2016) study that the CITES ban on international trade in rhino horn has failed to stop or limit rhino poaching. He stated that under the trade ban, the poachers and criminal syndicates are taking all the profits, while the rhino owners and custodians carry all the costs of keeping and protecting rhinos. Therefore, the rhino owners regard the breeding of rhinos as a liability instead of an asset. This attitude causes a disinvestment in rhinos by the private sector. Although results from the questionnaire show that rhino farmers do not believe that they are protected by legislation, it is believed that through a better understanding of the available regulations and legislation, rhino farmers can be convinced of the value of these regulations and legislation to assist in improving security measures.

Two rhino farmers in the Free State believe that the regulations control rhinos unnecessary while another owner stated that the regulations do not protect rhino owners (See Table 5.1 in chapter 5). Rhino farmers are apprehensive about the Department's policy on providing coordinates of their rhino farm's location when applying for translocation permits, because they believe that the Department is leaking confidential information, which is obtained from applications. These applications require the rhino farm coordinates and if they are not provided, the application is not considered ([6]Den Houting, 2017, *pers. comm.*).

3.5.3 Analysis from EMI surveys

Any decision made by the DEA has an impact on the workload of provincial EMIs ([7]Schlemmer, 2017, *pers. comm.*). When there are new promulgated regulations, such as Alien Invasive Species (AIS) and BABS, new national departmental sections are being created with newly appointed national EMIs to handle these issues, but within the Provinces, the present provincial EMIs must do their work too. EMIs are currently involved in minor monitoring issues, such as attending sampling of DNA of various species, attending rhino loading and offloading, taking DNA samples of lion bones and numerous general inspections.

[6] Koos den Houting, EMI responsible for law enforcement in the eastern Free State region.

[7] Andre Schlemmer, EMI Grade 2 responsible for special investigations in the Free State Province.

The DEA provided statistics for 2015/2016 for National Environmental Compliance and Enforcement which include data of the Free State. According to the report there were 2 647 Environmental Management Inspectors designated across the country of which the Free State have only 41 EMIs. They registered 1 261 criminal dockets issued 1 145 admission of guilt fines (J534s), and inspected 3 687 facilities for compliance monitoring (DEA 2016). The provided statistics perhaps presented a distorted image of law enforcement actions, and indicate that the 2 647 EMIs inspected only 3 687 facilities, which means 1,4 inspections carried out per EMI annually. A large number of EMIs were trained, and only approximately 10% are executing their powers (Schlemmer, 2017, *pers. comm.*). The largest contingent is Grade 5, based in protected areas, and they do not have powers for compliance inspections. Powers in terms of Section 31D(3) of the act stretches from Grade 1 – 5. Grade 1 have all the powers in the act. Grade 2 have all the powers except for Section 31 L. Grade 3 have powers except for 31 L and 31 h (5). Grade 4 do not have powers for Sections 31H(1)(b), 31H(5), 31I(3) 31J, 31L and 34G(2) of the Act. Grade 5 have only powers for section 31H, section 31I(3) and section 31J of the Act. Only Grade 2 EMIs may prosecute, and approximately 265 Grade 2 EMIs (10% of the 2 647 EMIs) in South Africa are responsible for enforcing the national environmental framework, of which the 13 mentioned acts are only a fraction. This compares poorly with the State of Virginia (110 785 km²) in the United States, where 180 Game Wardens (Conservation Police) are appointed in a State almost the size of the Free State Province (129 825 km²). They do no operate on tax payer's money ([8]Hull, 1999, *pers. comm.*; Cochran 2015). The Free State have only 12 active Grade 2 EMIs in the Province mandated to enforce the described legislation (Schlemmer, 2017, *pers. comm.*). As a solution to the problem the Department need to appoint more EMIs, have a better cooperation with the SAPS and implement specialised units that can regulate more effectively.

[8] Mike Hull, Chief Game Warden (law enforcement officer) in the State of Virginia, U.S.A.

NEMBA boasts two important definitions, namely “Restricted Activities” and “Sustainability”. “Restricted Activity” is widely defined, which makes management of the act impractical, and leads to the over-regulating of minor contraventions, such as having a possession permit for a silver fox (*Vulpes chama*) hide (Section 57(1) of NEMBA). These minor contraventions may lead to the criminalising of ordinary citizens. The intention of the concept of sustainability is to ensure continued use of biological resources (such as rhinos), so that there will be no long-term decline. The current rhino-poaching rate; rhino farmers’ concern of the numerous regulations; and the government’s over-regulating of rhino farmers by requiring permits for each action (according to norms and standards) taken during the handling of rhinos, confirm that the act’s objective of “sustainable development” is in jeopardy. It has been revealed that the act challenges too many penalty areas and becomes expansive, which makes execution impractical, according to a few anonymous Free State rhino farmers (note comments in Table 5.2 of Chapter 5). The NEMBA act lends itself to misinterpretation by officials to enforce internal policy as promulgated, b acts. Section 88(2)(b) of NEMBA is such an example, which states the following: “require the applicant to comply with such reasonable conditions as it may impose before it grants the application”. Reasonable conditions should be directly related to a specific section in an act, as a support to clarify such a section, and not for any other intention ([9]Swanepoel, 2008, *pers. comm.*).

EMIs should be made aware of the Latin principle of “de minimis non curat lex” (“The law does not concern itself with trifles”) as stated by Burchell, Milton, Hunt and Burchell (1983), so that emphasis can be placed on major conservation contraventions. The purpose of the “de minimis” rule is to avoid the burdening of the courts with minimal complaints, which will only incur unnecessary expenses and waste ([10]Snyman, 2017, *pers. comm.*).

[9] Danie Swanepoel, from Du Rand & Louw, a criminal lawyer from Kroonstad.

[10] Cathy Snyman, State Prosecutor, Kroonstad.

The National Wildlife Crime Reaction Unit (NWCRU) was an effective specialised unit consisting of the Asset Forfeiture Unit, SARS, Interpol, a designated prosecutor, DEA & provincial EMIs and SAPS special support, but was unfortunately disbanded. The interim unit evolve due to its effectiveness into a permanent structure with support from all stakeholders. The seconded officials took part in joint operations, shared information and coordinated conservation initiatives.

3.6 CONCLUSION

- The South African Constitution has provided a clear mandate to the State to enforce measures that will ensure adequate environmental protection for the benefit of future generations.
- Much of South Africa's environmental legislation is based on the sustainable development principles of Agenda 21, derived from The United Nations Environmental Program (UNEP), to form an environmental enforcement network to combat environmental crimes such as rhino poaching.
- The former provincial nature conservation ordinances and environmental acts were kept as alternative prosecution tools. The newly proclaimed NEMA and SEMAs legislation established a modern approach to environmental crime prevention, especially in relation to the protection of endangered species such as rhinos. For the first time, South African environmental officers were confronted with new modern legislative tools such as Compliance Notices, Directives, Moratoriums and Norms and Standards, to assist with crime prevention.
- Several international agreements such as CITES, CBD, SADC Protocol and the Lusaka Agreement were also introduced as enforcement tools to control rhino, in addition to various other agreements that control other wildlife. Except for CITES, the other three agreements are not very active.
- The continuation of amendments on all environmental legislation indicates that the acts were not well considered before promulgation.
- Unfortunately, all these newly adopted laws, regulations and agreements place a heavy burden on the public and Environmental Management Inspectors (EMIs) who

must respectively obey and enforce it. In their eagerness to enforce these environmental acts, EMIs may fall into a trap of spending valuable time prosecuting citizens for not complying in minor issues, while major conservation contraventions such as rhino poaching receive limited to zero attention.

- The South African environmental regulatory framework involves 13 regulatory tools to combat the illegal trade in rhino horn as well as rhino poaching. The enforcement measures are noble, but unfortunately out of balance and perhaps too theoretical, with too many Grade 1,3,4, & 5 EMIs, and too little Grade 2 EMIs. The EMIs are further preoccupied by numerous policies, unnecessary trivial cases and restricted budgets.
- A shortage of Grade 2 EMI's in the Province are perhaps the reason why effective law enforcement could not be done. Limitations on monthly kilometres and shortage of vehicles are some of the problems that EMI's are facing. In addition, these EMIs are currently also involved in minor compliance and monitoring. Monitoring the loading and offloading of rhinos are unnecessary and is a waste of valuable kilometres that could have been used for law enforcement.
- The dedicated National Wildlife Crime Reaction Initiative (NWCRU) responsible for coordinating rhino-related crimes in South Africa was dissolved in 2015, leaving no specialised unit in the country to combat environmental crimes.

This chapter addressed the question whether South African environmental legislation can assist in reducing rhino poaching and the illegal trade in rhino horn. The possibility of receiving lifetime sentences for poaching, claiming financial losses from poachers and the danger of being killed by armed rhino guards or policemen can assist to discourage poachers.

Solutions to challenges in environmental law enforcement:

- The appointment of more EMI's would render law enforcement more sufficient.
- More regular training for EMIs to keep up with the latest amendments in acts as well as the strategies used by poachers.

- Guidelines to prioritise contraventions should be introduced to make sure all serious environmental offences are dealt with first.
- Reshuffling of the Grade System to ensure that Grade 2 EMIs do not become entangled with trivial matters but stay focused on law enforcement.
- The specialised anti-poaching unit must be reinstated to investigate wildlife crime.
- Regular wildlife operations to prevent environmental crime.

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CHAPTER 4

AN OVERVIEW OF TECHNOLOGIES AND METHODOLOGIES TO FACILITATE RHINO SECURITY

4.1 INTRODUCTION

The ability of technological equipment as a tool to combat criminals in general will be discussed in this chapter. Lately, numerous new technologies have been tested to also combat wildlife crime. Drones, hidden cameras, satellite imagery, DNA analysis, predictive analysis, GPS location devices and various apps are all being implemented in an attempt to predict, locate, track and apprehend suspected poachers. Although there are several types of technical equipment available on the commercial market, the question remains whether they are proactive enough to protect rhinos from being poached. Several new modernised apparatuses were developed over the last ten years, and may be of assistance in rhino protection services. The drone, shot detectors, the Meerkat radar, laser beams and FLIR cameras are some of the equipment that can be used to protect wildlife (Stones 2016). A few mathematical specialists also ventured the field of poaching prediction through data collection and developed intelligent devices (Nguyen Sinha Gholami Plumptre Joppa Tambe Driciru Wanyama Rwetsiba Critchlow and Beale 2016). Whether these complicated devices are capable of apprehending intruders in time needs further investigation.

Former established technologies such as night vision and CCTV cameras are not discussed, as they already proved their effectiveness in anti-poaching operations, and only a few of the "hundreds" of newly technological apparatuses available for anti-poaching will be described. Except for the robotic rhino, no futuristic methods such as the 3D synthetic rhino horn will be described (McGrath 2016). Baffled by the technological time that we live in, modernised apparatuses seem to be the appropriate action to take to combat rhino poaching, but the one element that may jeopardise the success of technology is the human factor (Vincente 2008).

A rhino farmer may implement the latest technical equipment with success, and might find it the ultimate solution, until it becomes a hassle or fails after the first poaching incident. The importance of the human factor and its relation to sophisticated technology cannot be ignored, and is briefly discussed. Some rhino farmers simply do not trust technology and rely on old conventional methods, and even apply their own unconventional methods to counter rhino poaching.

Ultimately, rhino poaching is based on a military offense. To understand the poaching attacks, one must understand the basics of conflict, which is based on conventional and unconventional methods (Serena 2011). Currently, State-owned anti-poaching strategies rely on a conventional defensive mechanism to prevent poaching, and not on an offensive mechanism to confront poachers (Brener 1998). This study will briefly expose the various latest technologies, conventional and unconventional methods with their capabilities, successes and failures for rhino security.

4.2 METHODOLOGY

In order to collect adequate information regarding the different rhino anti-poaching methods and the various technological apparatuses used to deter poachers, or protect rhinos, various literature sources were counselled. A purposive sampling methodology was used targeting specific sources, publications and experts in the field to provide extensive sources of information. The information was mainly gathered from authoritative internet articles; local media; personal communications (*pers. comms*) from experienced rhino farmers; retired Special Forces soldiers; nature conservators; and experts from the security industry. Information was further based on websites advertising different technological apparatuses. Some books, journals and various articles were also used to obtain adequate information regarding rhino anti-poaching methods.

This chapter regard rhino poaching as a form of warfare. Historically, battles were either fought in a conventional or unconventional manner. In modern times, technology is an integral part of any warfare. Therefore, this study accentuates a threefold approach.

Each method will be described in terms of its description, practicality, effectiveness and whether it is a proactive or reactive method. The cost will not be provided as prices fluctuate continuously.

The latest technological apparatus, conventional and unconventional methods as categorised in Table 4.1, will be discussed, evaluated and compared to other methods of protecting rhinos.

Table 4.1: A survey of the various rhino anti-poaching methods described

METHODS OF PROTECTING RHINO			
	TECHNOLOGY	**CONVENTIONAL**	**UNCONVENTIONAL**
1	RAPID	Foot patrols	Rhino horn dye
2	Drone	Horse patrols	Rhino decoy
3	Gunshot detector	Vehicle patrols	Mannequin
4	Seismic sensor	Patrol reports	Ucaller
5	The Meerkat radar	Tactical tracking	Fake equipment
6	The Roboguard	Dehorning	Motion sensor spotlight
7	The invisible fence	Observation post	Old caravan
8	The FLIR camera	Shoot to kill	Crushed stone
9	The TrailGuard	Trip-wire “Bang”	Small intensive camps
10	Cellular GPS Collar	Trip Siren	
11	The long-range jammer	Trip Flare	
12	The anti-drone jammer	Shoot to kill	
13	Cmore		
14	Cyber tracker		
15	Google Glass		

4.3 RHINO ANTI-POACHING METHODOLOGIES

4.3.1 Conventional methods utilised in rhino anti-poaching

4.3.1.1 Daily foot patrols

Description: Daily foot patrols are for appointed guards that patrol perimeters and rhino camps.

Practicality: Greeff (2013b:6) states that if no late afternoon or night patrols are done, and no rangers patrol over weekends, "the routines will obviously suit the criminal ideally and they have the reserve to themselves at certain times with absolutely no risk of getting caught". According to Greeff (2013b:6), conservation organisations "have established a deadly routine in their method of operations".
Effectiveness: The conventional daily foot patrol concept, as a method, is still irreplaceable. Foot patrols have the advantage of binding a relationship between the rhino guard and his rhinos.
Proactive or reactive: It is a proactive measure that keep poachers at bay.

4.3.1.2 Horse patrols

Description: Since the early days of game parks, game wardens used horses as a tool in protecting wildlife against threats especially poaching.
Practicality: Horses move silently and is useful as a surprising element. When reading books of famous game wardens, horses played a vital role in wildlife protection and anti-poaching operations (Kinloch 1972; Player 1972; Du Preez 2009; Stark 2010). It has been decades since the last horses were used in the Kruger National Park, as they have been replaced by motorised vehicles. In 2017, the park has reinstated the horses by deploying them for anti-poaching patrols as a pilot project, to test the effectiveness of mounted horses (Parker 2017). Rhino farmers indicate in the questionnaire that they use horses to protect their rhinos with success.
Effectiveness: Several stories were told by game wardens on how they had successes with horses on anti-poaching patrols ([11]Coetzee, 1989, *pers. comm.*; [12]Langman, 1992, *pers. comm.*; [13]Du Preez, 2004, *pers. comm.*).
Proactive or reactive: Horse patrols are proactive in rhino poaching prevention.

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11 Daan Coetzee, retired Nature Conservator from Etosha National Park.

12 Derek Langman, retired Game Warden and part of a rhino anti-poaching team in the former Wankie (Hwange) National Park, Rhodesia (Zimbabwe).

13 Kallie du Preez, retired Chief Nature Conservator from Etosha National Park.

4.3.1.3 Vehicle patrols

Description: Vehicle patrols cover large areas in a relatively short amount of time, and can simultaneously do a perimeter fence patrol. It also provides observation posts and foot patrols with food, water and ammunition.

Practicality: In emergency cases, it can pick up game scouts on foot patrol, and can also play the casevac role. Unfortunately, vehicle patrols are noisy and can be heard from a long way off by poachers. Greeff (2013a) states that motorbikes are noisy, not sustainable and only a method of transport, and that battery driven quad bikes are preferred. Helicopters and micro lights are noisy and expensive to maintain, yet effective.

Effectiveness: Vehicles carry heavy loads, and can be used for extended patrols in remote areas with very little water. It remains an effective method to in the case of an emergency.

Proactive or reactive: It is a reactive method and is used after a poaching incident occurs.

4.3.1.4 Patrol reports

Description: Rhino guards traditionally write daily reports with feedback on human tracks found, rhinos seen or rhino tracks found, damage to perimeter fence, solar panels and batteries tested, waterholes and troughs visited, unfamiliar tracks found at waterholes, aircraft seen or heard, suspect vehicles seen or heard, flood damage, grid references at start of patrol, end of patrol, vegetation disturbance in area patrolled, carcasses found, gunshots heard and date of patrol start and finish. Modern field managers rely on high-tech reports such as Cybertracker, Cmore and Google Glass as a replacement for traditional booklet reports.

Practicality: One downside is that the information is not real-time, and only gets passed on to security managers later, often too late.

Effectiveness: These reports are useful in providing information to managers about animal movement patterns and patterns of poachers, amongst other things, both of which can be used to improve future anti-poaching patrol effectiveness.
Proactive or reactive: It can be both. Proactive to determine trends and to predict a poaching incident and it is a reactive method once the poaching incident occurred and details are written down.

4.3.1.5 Tracking

Description: Tactical tracking skills were initially developed by Allan Savory, a former game warden and ecologist from Rhodesia (Zimbabwe), who hunted down elephant and especially rhino poachers in the late 1960s (Scott-Donelan, 1989, *pers. comm.*).
Practicality: The skill of tactical tracking is a tool, all over the world, to hunt fugitives ([14]Scott-Donelan, 1989, *pers. comm.*).
Effectiveness: The ability to track and arrest fugitives through all types of terrain is a component of effective enforcement, and the only way of accomplishing this is via tactical tracking. To be effective, all rhino guards in the Province need to be trained in tactical tracking abilities, as none of them are properly trained in this field, according to the 2017 rhino owner questionnaire.
Proactive or reactive: It is a proactive measure to pick up tracks of poachers before they hunt a rhino. It may also assist to track poachers and fugitives after a poaching incident occurred.

4.3.1.6 Dehorning practices

Description: Around 2005 it was debatable whether rhino owners should dehorn their rhinos, or not. Since 2009 rhino poaching increased rapidly, and out of desperation dehorning practices were implemented, and it became the norm.

[14] David Scott-Donelan (Captain), former Commander of 5 Reconnaissance Regiment at Phalaborwa, and former Training Officer for the Rhodesian Selous Scouts.

Only exceptional cases occur where rhino owners keep rhinos for the trophy market.

Practicality: Rhinos should ideally be dehorned every 24-36 months but under conditions of high poaching intensity every 12-24 months.

Effectiveness: According to Lindsey and Taylor (2011) dehorning is only effective if poachers are aware that the rhinos on a farm is dehorned. Publicizing the dehorning is important and will minimize poaching incidents. Dehorned horns should also be removed from the property for security purposes. Dehorning practices help to reduce poaching, is sometimes effective in small rhino camps, easy to manage small populations, is a security measure, assist as a crisis management tool and makes poaching less profitable (Lindsay and Taylor 2011).

Proactive or reactive: It is a proactive method and may serve as a prevention.

4.3.1.7 Observation posts

Description: Observation posts are structures from which soldiers observe for enemy activity, and are situated in critical areas from where the company commander directs (Globalsecurity 2005). A raised platform that would serve as an observation post could be erected close to areas that are suitable for poachers.

Practicality: Rhino guards in observation posts can be in constant radio contact with controllers, and could make hourly reports.

Effectiveness: Guards manning observation posts should be equipped with binoculars and night-vision equipment to be more effective. This observation post can be decoyed by mannequins, radios and human voices. It might only be successful in smaller open grassy rhino camps.

Proactive or reactive: It is a proactive method and may make poachers aware of their presence.

4.3.1.8 Shoot to kill

Description: Another conventional strategy is to implement the shoot-to-kill policy. Several strategies have been established to protect the rhinos in Africa, but very little has been achieved in combating rhino poaching. In a literature study done by Cheteni (2014), he questioned the current conservation methods. His research reveals that most methods have failed to protect rhinos. He suggests that "forensic tests, shoot to kill policy and new strategies may be the only way to avoid rhino extinction" (Cheteni 2014:17).
Practicality: Long extensive court cases or judicial investigations may evolve from a shoot-to-kill incident which may incriminate a rhino guard or a rhino owner.
Effectiveness: In the Free State, three incidents occurred where poachers were shot, and those rhino owners have not yet reported another poaching incident.
Proactive or reactive: It is a reactive method once a poacher was detected or already hunted a rhino.

4.3.1.9 Various Tripwire Devices

4.3.1.9.1 Tripwire Bang ("potjie fakkel")

Description: It can be constructed with a thin line between two points at about 30cm height above the ground. When kicked with one foot, it will pull on a mechanism, which will set off the detonator with an overwhelming noise. This device is designed to alert residents and scare intruders. When activated the unit will go off loudly.
Practicality: This conventional gadget can be installed in a few minutes. It can be armed or disarmed quickly. This gadget must preferably be set outside the rhino camp to not disturb the rhinos.
Effectiveness: It is a flexible design that can be used to protect any opening. The device's advantage is that it can be re-used indefinitely, and it is an affordable means of protection (Intelligencebureau 2017).

Proactive or reactive: It is a reactive method to alarm rhino guards of an incident.

4.3.1.9.2 Trip Siren

Description: It can be made at home, with mirrors, a laser point and a few electrical parts, and it can cover an area with an array of light beams (Instructables 2013).

Practicality: A laser tripwire alarm could be used to let the ranger know when a trespasser is in a rhino camp or restricted area.

Effectiveness: It is effective once the siren went off. Tripwire sirens could also be purchased online.

Proactive or reactive: It is a reactive method to alarm rhino guards of an incident.

4.3.1.9.3 Trip flares

Description: A trip flare is a device traditionally used by military forces to secure an area and to guard against infiltration. A model M49-A1 Surface Trip Flare can be used as a booby trap signal. The flare fires after releasing the trigger or removing a pull pin. Upon activation, it burns for a minimum of 55 seconds, with an average luminosity of 35,000 candlepower (Pyrotechnicspecialties 2017). When something triggers the tripwire, the activated flare begins to burn.

Practicality: In dense vegetation and on extensive farms guards may not be able to see the trip flare during daytime.

Effectiveness: It is an effective manner if it be monitored and managed by guards on duty.

Proactive or reactive: It is a reactive method to alarm rhino guards of an incident.

4.3.2 Novel technological equipment

4.3.2.1 Real-time Anti-Poaching Intelligence Device (RAPID)

Description: According to Mok (2015) the RAPID system consists of a camera implanted in the rhino's horn, a GPS tracking collar around the animal's neck, and a heart rate monitor to keep tabs on its pulse. The hope is that poachers might eventually view rhinos wearing the radio collar, which has a distinctive bright turquoise colour for maximum sight, as not worth the risk to poach (Mok 2015).
Practicality: Assisted with Wi-Fi connected tablets, rangers are able to respond to alerts anywhere in a nature reserve, and a helicopter may reach targets within 10 minutes, which might be fast enough to prevent a rhino's death, or to catch a poacher.
Effectiveness: The system broadcasts continuous information to a control centre, where anti-poaching teams monitor the information. It may serve as a deterrent for poachers.
Proactive or reactive: It is a reactive method to alarm rhino guards of an incident, often too late to prevent a rhino death.

4.3.2.2 Drone

Description: A drone is an unmanned aircraft, or branded as an Unmanned Aerial Vehicle (UAV), and its origins can be traced to the military (Hyde 2014). Drones used for conservation solutions are much smaller and more limited. They have a flight time of 30 minutes to over an hour; a range of 30 km; can acquire high-resolution photographs; high-definition video footage; and produce 3D maps of surveyed areas.
Practicality: It can do a quick reconnaissance over the rhinos but its limited battery life makes the drone impractical for long periods. They can be equipped with ordinary cameras/videos, night-vision or thermal-imaging cameras (Salmon 2015).

Effectiveness: Its effectiveness depends on the battery pack. Drones have been receiving media attention as a “silver bullet” to end the rhino-poaching crisis (Willems 2016).
Proactive or reactive: It is a reactive method to detect the position of a poached rhino.

4.3.2.3 Gunshot detectors

Description: ShotSpotter Flex is a product developed by a privately-held Californian company, which they were introduced in crime-ridden urban United States neighbourhoods, to alert police to weapons fired. Weller (2017) explains how the microphones are placed strategically around high-crime areas to pick up the sounds of gun-fire, and to alert police to the shooting locations via dots on a city map.
Practicality: Williams (2014 in *Herald Live* 27 July 2017) reports in a local newspaper how ShotSpotter detect gunshots in the Kruger Park up to three kilometres away. Furthermore, he reports that when a shot is fired, the origin of the sound is triangulated and sent to the service provider in the United States. Coordinates of the gun shot are then relayed to a Kruger Park operations centre within 30 seconds, making it possible to deploy rangers and helicopters with precision.
Effectiveness: In one case, police followed the coordinates to the designated dot and found the casings, 11 feet from where the dot was.
Proactive or reactive: It is a reactive method that alarms when a shot is fired, often too late. However, it could activate an anti-poaching team to do a follow-up operation.

4.3.2.4 Seismic sensor

Description: The Seismic Underground Security Sensors System consists of seismic sensors installed 50cm underground. The seismic perimeter security system creates a virtual fence with a width of 6 meters. The system detects and classifies footsteps and vehicles.

Practicality: It can be configured with different sensitivity levels. Alerts can be monitored in the command and control system (CandC). The CandC software shows the alarms of the system with map indication of the specific location of intrusion to the protected area.

Effectiveness: For effectiveness, the system can be integrated with CCTV cameras for alarm verification and recording (Applied-infrared 2015:1).

Proactive or reactive: A proactive method to alarm rhino guards of intruders.

4.3.2.5 The Meerkat Radar

Description: Developed by South Africa's Council for Scientific and Industrial Research (CSIR), the Meerkat Radar System comprises of a set of radar and electro-optic sensors that detect, classify, monitor and track humans moving in the Kruger Park over a wide area.

Practicality: The mobile system can be rapidly deployed to prevent poaching (Tsedu 2016). “Clever thinking” of the Meerkat allows it to differentiate between humans and animals, and its application can guarantee early warning and improve the abilities of rapid response. The Meerkat system is designed to fold up and fit in the back of a truck, and can be unpacked by a small team.

Effectiveness: In De Villiers’ (2017) article, he explains that an electronic optical surveillance system of the Meerkat is used to identify the exact location of potential poachers, and to plot the movement on a map. De Villiers (2017) reports further that two weeks after introducing the Meerkat Radar System, it stopped five out of nine detected poaching incidents.

Proactive or reactive: It is a proactive method to detect poachers on time.

4.3.2.6 The RoboGuard

Description: The RoboGuard Outdoor Perimeter Security Solution is wireless, can be set up in a matter of minutes, and is completely portable. Each RoboGuard covers 110 degrees for up to 20 meters (400 square meters per RoboGuard), and sends an instant warning to a portable HQ receiver in the event of a breach of up to eight zones per portable HQ receiver.

Practicality: The system uses top and bottom dual-beam technology (RoboGuardOnline 2017) and can be placed in tree branches or fences. Unfortunately, it must be placed close to the rhino guards as it has a limited reach. Its mobility is an advantage for rhino guards as they can carry it with them.

Effectiveness: The South African manufactured device is an instant, wireless, outdoor portable perimeter security solution, capable of monitoring rhino camp perimeters if situated at strategic points. It is only effective for short distances.

Proactive or reactive: It is a proactive method to alarm rhino guards of poachers.

4.3.2.7 The invisible fence

Description: The Selectable Beam Frequency Long Range Photoelectric Detector (Model AX-350/650TF) by Optex is designed with dual photo beam sensors that create an invisible barrier, and offer four site-selectable frequencies that create a wall of coverage when stacked one on top of another.

Practicality: Its photo beam sensors create an invisible fence, and will trigger an alarm in the event of a breach. The system can also send trouble signals when the beam strength drops. The anti-frost structure prevents fog and heavy condensation from blocking the beams. (Optex 2017). It can be differentiated from the RoboGuard due to its long-range capability.

Effectiveness: Another feature of the model is its dual beam with long-range sensors of up to 200m. The beams can be adjusted to differentiate between a falling leaf and a person climbing over a fence.

Proactive or reactive: It is a reactive method to alarm rhino guards of intruders.

4.3.2.8 FLIR Camera

Description: The Forward Looking Infrared Radiometer (FLIR) is an infrared camera with a non-contact device that detects infrared heat, and converts it into an electronic signal, which is then processed to produce a thermal image on a video monitor and perform temperature calculations.

Practicality: Heat sensed by an infrared camera can be quantified, or measured, allowing to not only monitor thermal performance, but also identify and evaluate the relative severity of heat-related problems (FLIR 2017). It has an effective range of approximately 500m.

Effectiveness: Farrel (2016) described how Kenyan rangers tested the FLIR camera at an outpost. The outpost rangers radioed the location of poachers, after determining their position by use of the FLIR camera, to the foot patrol units who surreptitiously arrested the intruders.

Proactive or reactive: It is a proactive method that can pick up an intruder at night as it climbs over a fence and could be arrested before poaching a rhino.

4.3.2.9 The TrailGuard System

Description: The TrailGuard system guard trails and lines of access through surveillance. Obviously, poachers must sometimes use certain choke points, ridge lines, river crossings, or dense forest with prominent trails. The system consists of electronic sensors, principally cameras that have “invisible sentries” that are concealed along trails. The TrailGuard system is an electronic trap line set for poachers (Wildland Security 2011).

Practicality: Each camera is triggered by the motion. The image is transmitted to the internet and then back to the ground forces responsible for dispatching response teams to intercept the poacher before he kills.

Effectiveness: These camera traps have the “smarts” to “phone home” when they see an event they are programmed to classify as a possible poacher.

Proactive or reactive: It is a proactive method to alarm rhino guards of poachers.

4.3.2.10 Cellular GPS Collars (GSM)

Description: Locates rhinos on the farm at any time, thus providing anti-poaching units' critical information on where to send patrols. The Cellular GPS Collar can be used on rhinos. The cellular collars contain a Hawk105 (GPS–GSM) device that analyses the animal's coordinates by means of a GPS. This data can be sent via the Global System for Mobile communications (GSM) network as a text message (SMS), that can be downloaded through HAWK software. The device has a data logger that can be attached to the unit, so that readings can be taken even when there is no cellular coverage. The Collar data indicates the exact position of the rhino, which can be viewed with high resolution satellite imaginary on Google Earth (Haupt & Haupt 2017).

Practicality: A well-established method, moderately practical but requires a veterinarian to check the collars regularly. By knowing the exact position of the rhino, the rhino guards can arrange their foot patrols according to the rhino's movement.

Effectiveness: Provides accurate information of rhino location when functioning well, but is prone to problems such as breakage of the collar, causing abrasions on the neck and a short battery life.

Proactive or reactive: A reactive method useful for ensuring guards to know where rhinos are, but does not stop a poacher from killing a rhino if no guards are present to defend it.

4.3.2.11 Long-range jammer for mobile phones

Description: This jammer for mobile phones has an operating range of up to 500 meters. Its function is to scramble cellular networks. The rapid development of cellular networks was described by Dutta (2015), where people can now access information at any time, and anywhere, through a cellular network. According to the South African Cellular Telecommunication Association (SACTA), the possession and use of cellular phone jamming devices is illegal in South Africa (SACTA 2017).

Practicality: The jammer illuminates' signals of the first three generations up to the Universal Mobile Telephone Service (UMTS) (Endoacustica 2017).

Effectiveness: It is uncertain as it is illegal to use.

Proactive or reactive: If a permit could be obtained this device would be a proactive method to use for officials during anti-poaching operations.

4.3.2.12 The anti-drone jammer

Description: This jammer lowers the signal of many UAV aircrafts and drones, and operates with a normal DC 12V battery. The anti-drone jammer, such as the CPB-DRONE1, is a professional defence system that is effective against UAVs.

Practicality: By pointing the antenna towards the flying drone, the jammer releases radio waves that disconnect the input signal used to drive the aircraft, and land it.

Effectiveness: This anti-drone signal breaker can find application in the prevention of poaching. It works in a range of between 400 and 1000 meters (Endoacustica 2017).

Proactive or reactive: A proactive method to prevent poachers from locating a rhino's position.

4.3.2.13 Cmore

Description: Cmore is an advanced web-based collaboration technology developed by CSIR and ArM.Sc.or that integrates different sensors, distribute information, has a situation awareness display, capture information in a database, and has decision support. It also enables the distribution of integrated information and supporting analysis to enable better control during operations, as well as proactive performances (Oosthuizen 2015). Cmore notifies events, tracks discovered, comments, images and videos received in real-time (Cmore 2017).

Practicality: Rhino guards may capture events such as animal sightings, poacher tracks, evidence of incursions, etc. on the Cmore App on a smart phone, which can be viewed in real time by anyone with access rights on the system.
Effectiveness: Though Cmore is effective, without trained and authorised manpower operating the system it becomes ineffective. It works well in full time rhino anti-poaching operations.
Proactive or reactive: Cmore is a proactive method to detect poachers early enough to send armed forces in for arrests.

4.3.2.14 Cybertracker

Description: The Cybertracker is a modern software application that acts like a patrol report. It was designed to assist trackers in the field to record all significant observations, such as the drinking and sleeping places of rhinos. This software generates a large quantity of very detailed geo-referenced data at a level of detail not possible before (Liebenberg Stevenson Benade and Minye 1999).
Practicality: The Free State provincial nature reserves use the Cybertracker for their rhino guards to collect GPS Field Data of their rhinos and other game, while a combined force Rhino Anti-Poaching Team prefers to fill in conventional patrol reports after each shift worked. The Cybertracker can also map poacher movements. Patterns can be established and plotted on maps and by doing this it can help to plan preventative operations.
Effectiveness: Currently it does not contribute in the Province.
Proactive or reactive: A proactive tool to use, when used correctly.

4.3.2.15 Google Glass

Description: The Google Glass follows voice commands to document the location of the animals through GPS, and captures their movements and individual characteristics on camera. This information, along with details about the surrounding habitat, is uploaded to a database known as Monitoring Information System Technology (Esterman 2016).

Practicality: It is a handy device to gather information while on horseback, quad bike or foot patrols.

Effectiveness: During this survey, nobody indicated the usage of this technology for anti-poaching.

Proactive or reactive: It is a proactive method to determine trends in the rhino camps or nature reserve.

4.3.3 Unconventional methods that may assist in rhino anti-poaching

4.3.3.1 Rhino horn dye

Description: The Rhino Rescue Project members developed a technique where they capture a live rhino and painlessly inject an anti-parasitic drug and a dye into the horn. The chemicals, which are harmless to the animal, disfigure the horn, rendering it useless as an ornament or as traditional medicine. This injected drug can be harmful for humans, since it can cause nausea, vomiting and convulsions in people, which makes it unfavourable to use in traditional medicine (Rhinorescueproject 2017).

Practicality: The infusion of rhino horns was visually examined and it was established that the assumptions were weak and refuted claims that discolouring horns is a viable method (Ferreira Hofmeyr Pienaar and Cooper 2014).

Effectiveness: This method was introduced on a rhino farm which hasn't reported any poaching incident. The farmer sold all the rhinos in 2017 and its effectiveness was not really tested over a long period.

Proactive or reactive: It is a proactive method.

4.3.3.2 Rhino decoy

Description: Fullmount fibreglass rhinos might be specially built at taxidermists to serve as decoys. The management of the decoy(s) is essential for the success of the strategy. It must be placed at tactical spots, such as the drinking hole or near a place where a territorial bull tends to roam.
Practicality: It would be preferable if more than one decoy could be placed at specific sites to confuse the poacher, and to keep rhinos alive that might have been shot otherwise.
Effectiveness: It was not tested yet and its effectiveness remains uncertain.
Proactive or reactive: It will serve as a proactive method to deter poachers.

4.3.3.3 Mannequins mimic rhino guards

Description: The use of mannequins dressed as rhino guards could be positioned at strategic places in a rhino camp. They can be dressed with camouflaged uniform and be equipped with replicas of military assault rifles that can be purchased at toyshops. Together with the rifle, a two-way radio with a fake light inside could be placed in the hand of a mannequin.
Practicality: These mannequins must be removed frequently and replaced with other unconventional methods.
Effectiveness: The mannequins can be placed for a few days next to the rhino camp before introducing them into the camp. Rhinos easily accept the mannequins as part of the camp's features (Jordaan 2010).
Proactive or reactive: It is a proactive method to confuse poachers.

4.3.3.4 Ucaller Remote Animal Caller

Description: The Ucaller is a compact electronic animal caller. Wildhunter has a library of sounds online, where all the sounds are free to download. The sounds from animals in distress to people calling can be downloaded. The built-in speaker is very loud, and will amplify sounds up to 110dB. It can control sound and change the volume if needed. The device can add weatherproof mega speakers as well, and has a three-meter cable. It is powered by 3AA batteries, and has about 20 hours' life (Wildhunter 2016).

Practicality: A remote control may control the caller from up to 100 meters. This device can occasionally be implemented by rhino guards on duty to play unfamiliar sounds in the veld that may deter poachers. These unfamiliar sounds might discourage poachers as it may be feared and regarded as a possible ambush.

Effectiveness: Not tested and its effectiveness is uncertain.

Proactive or reactive: It is a proactive method to distract poachers.

4.3.3.5 Fake equipment

Description: Several types of fake equipment could be used to deter poachers. Dummy cameras, infra-red lights and equipment such as CCTV cameras with flickering dummy red lights could be placed at strategic places to discourage poachers from entering a rhino camp.

Practicality: Some farmers tried this option by placing fake equipment at strategic points where poachers can observe them.

Effectiveness: Since implementing this option no rhino poaching occurred.

Proactive or reactive: It is a proactive method to give the impression to poachers that they might be spotted.

4.3.3.6 Motion sensor spotlight

Description: The solar powered MAXSA Innovations Motion-Activated Dual Head LED Security Spotlight can detect motion from up to 12 meters away, and comes with four very bright 0.5 watt LED lights that give off 160 Lumens. This product's dual adjustable light heads allow it to secure two areas at once. Its dual head has two lights instead of one, so it can detect motion for nearly 360 degrees.

Practicality: A feature of this product is its long range. This spotlight can be powered by solar energy. When fully charged, it will give light for one minute, 90 times (Safewise 2017). Motion sensor lights could be placed at strategic points in the rhino camps, for example, the perimeter and possible entry points for poachers.

Effectiveness: Not been tested yet.

Proactive or reactive: It is a proactive method to disturb poachers.

4.3.3.7 Old caravan

Description: An old caravan could be placed in the middle of the rhino camp as a deterrent for poachers. Some rhino owners use this method with success. It can be controlled with mannequins, music and lights on a timer during other phases of the moon to leave the impression that somebody is on guard.

Practicality: They use it during the full moon phase and feed the rhinos near the caravan.

Effectiveness: It seems to be effective as the rhino owners have not reported any poaching since they introduced this method.

Proactive or reactive: Proactive – it gives the impression that somebody is on guard.

4.3.3.8 Crushed stone

Description: To walk on crushed stone makes noise which criminals do not like ([15]Coetzee *pers comm,* 2013). Tree branches could be placed at strategic points, in a small rhino camp, close to the crushed stones, to act as a funnel to drive the poachers towards the trap, where they would chase the rhinos away or leave tracks, in a special made sandpit. Rhinos can hear, on an average, 455 meters on windless days (Jordaan 2010).

[15] Warrant Officer Coetzee from the SAPS Crime Prevention Unit at Welkom.

Practicality: The idea is to awake the rhino when they hear somebody walk on the crushed stone, and that might chase them away from the poachers. This method could be used in small and large camps if it is placed strategically.
Effectiveness: In large camps this method could be constructed close to the rhino's home range and in small camps it could be placed at possible points of entry. Its effectiveness is unsure.
Proactive or reactive: Proactive – it might alert rhino guards and rhinos and prevent poachers of shooting a rhino.

4.3.3.9 Intensive rhino camps

Description: A few rhino farmers succeeded in erecting small rhino camps of less than 500ha for better control over their guards and rhinos. The DESTEA implemented a policy that prohibits rhino breeders to keep rhinos in a camp of less than 100ha. The policy stated that rhinos must be kept at a ratio of 50ha per rhino. Some rhino farmers erected small camps of less than 100 ha with up to 10 rhinos in it.
Practicality: If small camps are situated close to the farmer's house it may veer off intruders, while abundant activity around the farmstead may allow the poacher to shoot a rhino during daytime, since the sounds of tractors and various other activities would mask the sound of gunshots. The cost of erecting a small camp is cheaper than a large camp and justifies the appointment of a full-time rhino guard and implementation of high tech appliances as means to protect the rhinos effectively. Any noticeable uncharacteristic behaviour of rhinos in a small camp will be noticed immediately by the owner, while in extensive areas he might not be able to pick up any abnormalities amongst his population.
Effectiveness: In the Free State, 23% poaching incidents occurred in small camps, and 77% poaching incidents occurred in large extensive rhino camps and nature reserves (See chapter 5).
Proactive or reactive: Proactive – small camps are a proactive method to protect rhinos.

4.4 THE ROLE OF THE HUMAN FACTOR IN APPLYING SECURITY TECHNOLOGY AND METHODOLOGIES

Innovators have introduced several high-tech devices intended to deter rhino poachers. Despite the technology flash, some of it may not quite live up to expectations, and rhino owners are cautious and do not believe that these high-tech solutions are cures to the poaching problem.

The human factor is integral to technology in the age of globalisation. According to Hale (2010), one can take the best, state-of-the-art security technology, but if you do not have people understanding the key components thereof, they are of no use. Vincente (2008) blames most designers of technological systems, saying that they do not pay enough attention to human needs and capabilities. He further states that human factors lead to errors, alienation from technology, and, eventually, a failure. Helander, Landauer and Prabhu (1997) state that typical users of Information Technology (IT) do not enjoy the process of learning a new technology, and may experience “phobic reactions”. People often employ technology differently than intended (Ankeney Del Rio Nash and Vigilante 2011).

The human factor remains a problem, as officials tend to sleep on duty, or are under the influence of alcohol. Greeff (2017, *pers. comm.*) stated that there is no alternative to hard discipline, willingness to shoot to kill, and seven-days-a-week foot patrols to guard rhinos. A rhino farmer from the eastern Free State said they got tired of “checking trial cameras daily”; that it became a nuisance; and that they had sold the cameras with the rhinos ([16]Marais, 2016, *pers. comm.*). It must be kept in mind that the daily maintenance on technology seems to be tiresome, but it must still be executed with strict discipline, as criminals are aware of their existence, and the chance of being caught or shot remains a fearful factor for them.

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[16] Awie Marais, former rhino farmer from the eastern Free State.

The human factor also plays a role in the mind of prospective criminals, with specific manifestations into the manner that they utilise technology - for example their fear of being caught by camera or voice recorder, as well as a general lack of training (Greeff 2013b). In an article, Acorn (2009) described how criminals rated fear as their main concern, and not violence. The thought that one is being watched is more frightening to criminals than the punishment itself.

4.5 A CRITICAL ANALYSIS OF THE METHODOLOGIES THAT FACILITATE RHINO SECURITY

Conventional, unconventional and technological methods will be discussed to emphasize its abilities and effectiveness in rhino poaching operations. Horn implant transmitters have limited operational lives, because their antennae become damaged due to the combination of horn growth and horn wear (Pienaar and Hall-Martin 1991). Telemetry is a reactionary technique which indicates the movement and location of a rhino but does not prevent it from poaching. It supports the rhino guard, the farmer and control room of the rhino's position and help to plan hourly adjustments of patrols. Du Toit (1996) summarised the problems with technology by explaining the problems experienced some 20 years ago. As an example, he mentioned that ear-tag transmitters have inadequate signal range and soon tear out. Surgically implanted transmitters are too risky for use in rhinos, as they may be disposed to subcutaneous abscesses. The main problems with neck collars are the rhinos' wedge-shaped neck, which pushes a collar down onto its ears, where the collar can cause serious abrasion. Various designs of radio collars have been tested in Zimbabwe, but none has proved to be entirely suitable. Although some collars have stayed on for over two years, the loss rate within the first month of fitting has remained over 20% (Du Toit 1996).

There was a 96 % reduction in rhino poaching in a certain game reserve near the Kruger National Park, after technology, such as RAPID, thermal imaging, CCTV, biometric scanning, analysis of real-time data, drone cameras in the sky and seismic sensors were implemented around the perimeter (Braithwaite 2016).

After having an interview with a Kruger Park Director, Venter (2013) stated that the GPS tracking solution for rhinos remains a problem because of its battery life. According to a tracker consultant ([17]Desmond Tracking, 2017, *pers. comm.*), after experimenting with 23 rhinos, the lifespan of GPS tracking devices has been determined to seldom be longer than four months effectively. One rhino farmer in the Free State applied a GPS collar on some of his rhinos' legs, only to discover it as a pick-up in the veld after a few weeks ([18]Louw, 2017, *pers. comm.*). The rumen bolus or ceramic pill might be the solution, in future, to monitor rhinos, as the current collar around a rhino's neck is impractical due to the prismatic head and neck shape. Although these electronic ceramic pills are in practise in cattle feedlots it has not been tested for the use of wild animals such as rhinos.

The popular media have heralded drones as amazing tools that can solve poaching problems through their ability to fly high above a target. However, Tenenbaum (2017) points out the weaknesses of drones by stating its limited battery life, range limitations, possible malfunction that can lead to an expensive crash, and the fact that the heavy thermal-imaging equipment, gusty winds and mountainous terrains make it difficult to operate. Several articles have been published about the potential for using drones for anti-poaching purposes; most of these articles did not mirror any actual performance in the field. To date, no drone solution has been applied successfully to direct anti-poaching activities (Tenenbaum 2015). Drones can cause challenges, such as incorrect attacks on non-poachers, and the consequential breach of human rights (Mukwazvure and Tirivangani 2012). Another problem with drones and infrared cameras has been found in hot areas, where the cameras cannot differentiate anything because everything on the ground, including rocks, is hot. FLIR cameras proved their effectiveness during poaching operations in Kenyan game parks. Farrel (2016) stated that 26 snare poachers were arrested directly after the FLIR cameras were introduced.

[16] Desmond Tracking is a private consultant from Bethlehem, specialising in TRACKER devices for farm animals.

[18] Chris Louw, Environmental Management Inspector (EMI) responsible for rhino coordination in the Free State.

The field test trial done by Watkins, Mazerolle, Rogan and Frank (2002) shows that the Shotspotter System has a high degree of accuracy in terms of detection and margin of error if the system malfunctions. The ShotSpotter is being piloted in the Kruger National Park, and it already yielded the arrests of an undisclosed number of poachers (Reuters 2014). Although effective, this system at a cost of R32 million, is too expensive for the Free State rhino farmer, and is of a reactive nature. Harvey (in *The Washington Post* 31 July 2015) quoted the opinions of conservationists such as Du Toit and Emslie on technology as a tool to guard rhinos. Their opinions are outspoken against drones and the Real-time Anti-Poaching Intelligence Device (RAPID). Every time technocrats develop a new strategy; the criminals simply circumvent it. Unfortunately, there is no single or simple IT solution to prevent rhino poaching. Numerous technologies must be integrated to create a protective shield against poachers with an arsenal of sophisticated deadly equipment (Stones 2016).

Conventional warfare has been a strategy developed over centuries to defend an attack on livestock, a country or in modern times, computer networks. Conventional strategies as a basic warfare tool were enforced over centuries as the only solution to overcome, and sometimes resist, unconventional attacks. For example, General Staff Officers, such as Lord Kitchener, believed in physical combat in trenches as the way to counter enemies. He opposed enlightened technologists who were searching for unconventional solutions to combat the enemy with armoured vehicles (Macksey 2013). In recent times, conventional war principles are still applicable with the attack on the South African rhino populations. Rhino poaching is based on military principles, and must be combated accordingly ([19]Fourie, 2016, *pers. comm.*). Conventional methods of protecting rhinos are electric fences and alarm systems, but these are prone to false alarms and need to be backed by response teams (Greeff 2013a). The stereotypical daily horse patrols can be predicted by poachers, and an alternative strategy for rhino owners will be the implementation of night horse patrols as a deterrent against poachers. According to Greeff (2013a), air support such as aircrafts, drones, fixed wing and choppers, is primarily

[19] Theo Fourie (Commandant), former Commander of 5 Reconnaissance Regiment of Special Forces at Phalaborwa.

a means of transport and surveillance, and cannot catch a poacher. He emphasises that their role is just an aid for the ranger force, and they can only be a detector but not a “destroyer”. On the question whether conventional methods of warfare are effective against unconventional forms, Bercovitch and Fretter (2004) stated that it becomes difficult to counter unconventional attacks with conventional methods.

Strategies are needed to oppose attacks in an unconventional way. Greeff (2013a:6) describes the use of conventional reaction forces as “exactly that, reactive Not pro-active”. Adams (1998) describes the unconventional model as an array of poorly defined conflicts that do not follow the conventional model. The US Special Forces used an unconventional warfare method of making their goals and the goals of the local people the same, rather than the conventional counter terrorism methods, to overthrow the Taliban in the Pech Valley, Afghanistan (Fry 2016). A modern approach with its technologies should be considered to circumvent poachers, with the understanding that they also utilise modern technology as a strategy to attack rhinos. Rowlette (2015) explains how the misuse of technology can lead to defeat rather than victory, and suggests that technology strategies should be developed for irregular warfare that are based on tailored capabilities. Therefore, the description of available modern technology, to get a better understanding of its capabilities.

4.6 CONCLUSION

Based on the literature provided on the use of technology, there are currently no technical or strategic solutions to save rhinos from poaching. The conventional principles coupled with unconventional strategies, technology and governmental commitment might be the answer to the rhino-poaching problem.

Although several methods were described only a few will be recommended for rhino anti-poaching in the Province. Some of the methods are too expensive, such as the Gunshot Detector, others have battery limitations, such as the drone, while other unconventional methods have not been tested.

Recommended methods:

- The conventional method of foot and horse patrols applied in rhino anti-poaching operations proved to be effective, if repetitive and monotonous routines are avoided.
- The structured collection of data from anti-poaching patrols. This can be done using CyberTracker, SMART or Cmore, but the data must be examined regularly by the anti-poaching manager or farmer to keep track of trends and high risk areas. The deployment of anti-poaching patrols is much more effective if you know the most likely places of poacher incursions and attacks, but without regular data collection, a land owner will not know where these high-risk areas are.
- Tactical tracking is an effective method to detect tracks of intruding poachers.
- All committed rhino guards in the Province must be trained in tactical tracking.
- The dehorning practise is effective if used in conjunction with conventional anti-poaching tactics (such as foot patrols) and should be included in management strategies.
- The unconventional methods and devices created by Free State rhino owners to prevent poaching are recommended which include fake equipment, the tripwire bang and the strategic placement of an old caravan.
- The method of keeping rhinos in intensive rhino camps rather than extensive rhino camps, proved successful and can be considered after consulting with DESTEA regarding their policy of keeping 50ha/rhino.
- Installation of the TrialGuard System with its ability to identify a potential poacher and to telephonically notify the rhino farmers, is recommended.
- The FLIR camera have been tested in the Province with success and is recommended as a technological solution.

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CHAPTER 5

AN ASSESSMENT OF SECURITY MEASURES ON RHINO SITES IN THE FREE STATE PROVINCE

5.1 INTRODUCTION

There are reasons for concern about the escalation of rhino poaching and related crime in South Africa. The poaching onslaught on white rhino (*Ceratotherium simum simum*) in the Free State Province over the last five years, reveals a staggering growth in incidents, which may indicate a potential danger for the meta population. With the poaching onslaught, security measures have become an integral part of new rhino conservation plans, to ensure a safe and secure rhino environment (Emslie and Brooks 1999; Taylor Balfour Brebner Coetze Davies-Mostert Lindsay Shaw and 't Sas-Rolfes 2017). The question arises: What kind of security measures have the rhino breeders ready for this offense?

Although a multi-disciplinary law enforcement approach, using a variety of different methods has been adopted to prevent the effects of poaching, these efforts have made little progress, possibly due to the complex nature of the problem. These methods include increased levels of security and specialised equipment, as well as the use of intelligence and informer networks (Duffy Emslie and Knight 2013). The Save the Rhino International Organization, with its partners and several European zoos, provides funding and technical support for the ongoing running costs of approximately 15 field programmes in Africa and Asia (Dean 2011). In contrast, Els, Van Zyl and Kilian (2014) reported shortcomings at Free State nature reserves when protecting rhinos. These shortcomings include funding, personnel shortages, support, communication, motivation, priority, trustworthiness and nature reserve location. The lack of funding for reserve personnel to run anti-poaching operations on the provincial nature reserves is a challenge. Ngubane (2012), in a report to the DEA, stated that the cost of security, and the emotional trauma of the poaching situation, have caused the rhino to become a liability rather than an asset to the rhino owner.

The objective of this chapter is to assess the existing rhino breeders' levels of preparedness against the rhino-poaching onslaught; to examine security measures (or lack thereof) currently in place at the various rhino sites and to identify weaknesses of certain components on a rhino site. Results from this chapter will be used to develop a Rhino Anti-Poaching Model for rhino breeders.

5.2 METHODOLOGY

5.2.1 Research design and area

The research was conducted from July 2016 until August 2017, at the various nature reserves and rhino farms in the Free State Province of South Africa (Figure 5.1). A mixed-method approach was used to achieve an understanding of possible problem areas and the weaknesses in security methods in the Province. Once the problem areas were identified, the questionnaire was compiled. Information gathered from the questionnaire was used to develop a Rhino Anti-Poaching Model.

Figure 5.1: Map of the Free State Province of South Africa, the study area.

5.2.2 Sampling and data collection

There is a total of forty-seven (47) rhino breeders in the Free State Province. The various nature conservation district officials were contacted to provide the names of all the rhino breeders in their designated areas. Only one rhino farmer was reluctant to be interviewed, and data was collected from the forty-six (46) remaining respondents. The forty-six (46) respondents included five provincial nature reserve managers and forty-one (41) rhino farmers.

A personal, structured interview was conducted with each rhino farmer and nature reserve manager. This was done in private to ensure confidentiality. Detailed questions regarding specific security measures, and the keeping of rhino horn, were beyond the aim of the study, and could have potentially reduced a respondent's willingness to participate. Hence, this was ignored for purposes of this study. Views and experiences on security measures, and the shortcomings thereof on farms or nature reserves, were the focus of the study.

Information was also gathered from the rhino owners' managers, partners and family members if the farmers were not available. Rhino poaching data was supplied by internal poaching reports from the Department of Economic Small Business Tourism and Environmental Affairs (DESTEA). Poaching incidents were included in the study if (a) these have been reported to DESTEA, and (b) were accompanied by a Police Crime Administration System number (or "CAS Number").

5.2.3 Observation

Observation was done to undertake a basic site survey of existing security measures at the various farms and nature reserves. This method was used to get an idea of the types and variety of different security measures that were in place. It also allowed the researcher to observe how the access/egress control of the rhino camps and nature reserves operated, and to determine the level of sophistication of each system in place; as well as to provide a better overall picture of the first line of security.

5.2.4 Pilot study

To test whether the questionnaires addressed all the relevant areas and that the questions were asked in the correct manner, a pilot study was conducted with three former rhino farmers and three nature conservators (that are currently not working full time in nature reserves). Thus, the pre-testing of the questionnaire on a small number of individuals who had the same or similar characteristics as the ones of the target population was conducted, prior to administering the questionnaires to the selected target group. Apart from minor issues, no major changes were made to the original questionnaire.

5.2.5 Questionnaires

The questionnaire consisted of both closed-ended questions (where participants were given a few choices to choose from) and open-ended questions (which allowed the participants to provide their own answers, ideas and ways of thinking in the open space provided). The questionnaire consisted of six sections, sections A to F, which covered all the relevant information that was needed for this study. The sections comprised the following:

- Section A: Rhino camp data regarding its location.
- Section B: Habitat information regarding the habitat of each rhino camp.
- Section C: Confidentiality.
- Section D: Rhino population management.
- Section E: Security measures implemented.
- Section F: Rhino-poaching incidents.

A total of 49 questions were formulated to use in the administered questionnaires which, on average, took the participants about thirty to forty minutes to complete. All questionnaires were completed by the researcher, and then coded to protect the rhino owner from identification. Note Annexure B for the relevant questionnaire.

5.2.6 Data analysis

Data was collated, ordered, processed and interpreted. A master code sheet was developed containing all the responses from the participants to all the questions (both closed and open-ended). The Statistical Package of Social Science (SPSS) version 17 was used for the statistical analysis of this research study. The frequency distributions that were calculated in this study are displayed in table form or in various graphic forms; namely histograms, bar graphs and pie charts. Frequency distributions illustrate the summarised data that was grouped into different categories/groups, where after it shows the number of occurrences in each group. A basic Chi squared test was used to compare the impact of camp size on poaching as well as the impact of poaching on distances from nearest town.

5.2.7 Validity and reliability

The same set of questions were asked to all respondents. Leading, ambiguous and biased questions were avoided in the questionnaires. Rhino poaching was defined as a direct poaching incident with a firearm, as well as poaching attempts where a rhino was successfully illegally darted and horns removed, animals wounded or killed. Rhino sites refer to a proclaimed private nature reserve, proclaimed provincial nature reserve, and a rhino farm. Some of the farms have a designated camp where rhinos occur, and it is therefore generally referred to as a rhino camp.

5.3 RESULTS

5.3.1 Rhino poaching statistics

A total of 46 rhino sites in the Free State Province of South Africa were evaluated by means of a questionnaire. A total of 26 (57 %) of the 46 respondents reported poaching incidents since the first poaching incident, which occurred in 2009. From 2009 to 2017, the Free State Province experienced a 1 500% increase in rhino poaching (Figure 5.2). A total of 75 rhinos were poached during this period, of which 64 were dead, six were wounded and five darted.

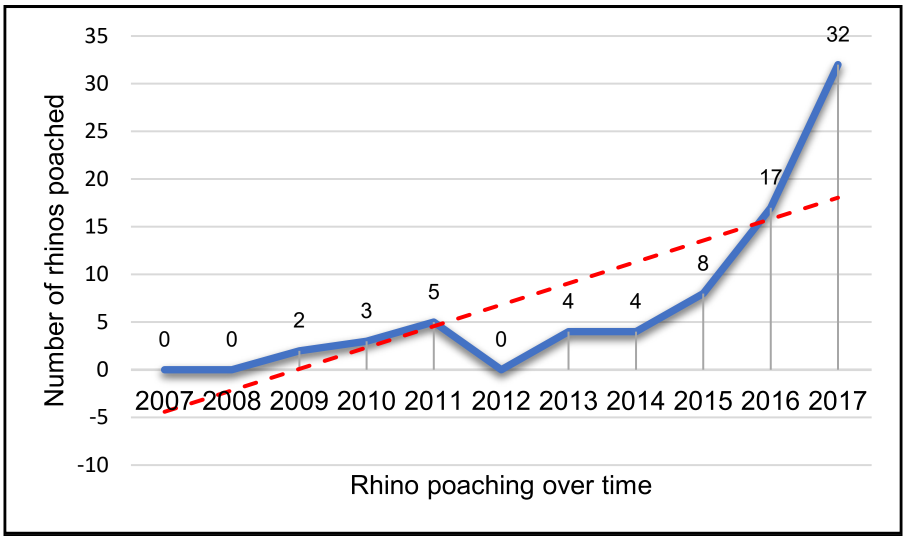

Figure 5.2: Rhino-poaching statistics for the Free State Province, South Africa from 2007 - 2017

Poaching occurred on 26 (57%) of the 46 rhino farms during the last eight years, while no poaching occurred on 20 (43%) of the farms. Poaching occurred on 24 of the 26 rhino farms that are situated nearer than a 1000 meters from a public road. Two other farms where poaching occurred are further than 1000 meters from a public road.

On average, the 46 rhino farms and nature reserves are situated 18.04 km (range from 1 to 45 km) from the nearest town. Of the 46 respondents, 29 (63%) are within a 20 km range from the nearest town, whilst 17 (37%) are situated beyond 20 km from the nearest town. Four (9%) farms were situated <5km from town, eight (17%) of the farms were located 5 – 10 km from town, 14 (30%) of the farms were placed between 11 – 20 km from town and 20 (44%) of the farms were >20km from town. The four (100%)

farms situated close to town were all poached. From the eight farms located 5-10 km from town, five (63%) reported poaching. Of the 14 farms, nine (64%) reported poaching while eight (40%) of the 20 farms situated further than 20 km from town, reported poaching incidents. A significant relationship between actual poaching rates and observed poaching rates occurred (P = 0.45; P > 0.05) and confirm that the distance to the nearest town does have an impact on poaching.

5.3.2 Experience of rhino owners

In the Free State, 47 sites exist that have rhinos, of which the State owns five provincial nature reserves, and the rhino farmers 42. The mean age of the 46 respondents were 52 years (range 28-77). They have an average of nine years' experience with breeding and farming with rhinos. Sixteen (33%) of the respondents have five years and less experience with rhino breeding, which demonstrates that there continue to be new entrants into the rhino farming sector, despite the poaching (Figure 5.3).

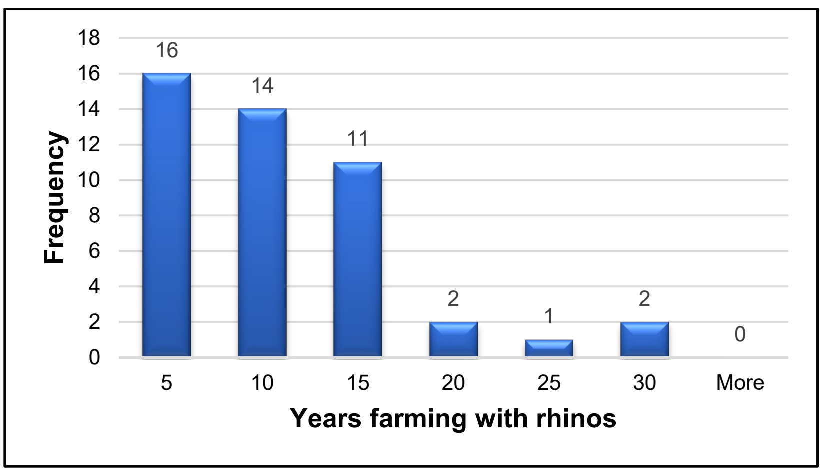

Figure 5.3: Rhino breeders' experience with rhino farming.

5.3.3 Rhino farm sizes

The farm sizes that were provided by the respondents as indicated in Figure 5.4, were categorised into 10 categories to show the frequency of farms, and the sizes of nature reserves that keep rhinos in the Free State. Most of the farms were placed in the 301 to 750 ha group with 10 farms. The smallest farm was 105 ha, and the largest was a nature reserve of 23 000 ha (Figure 5.4).

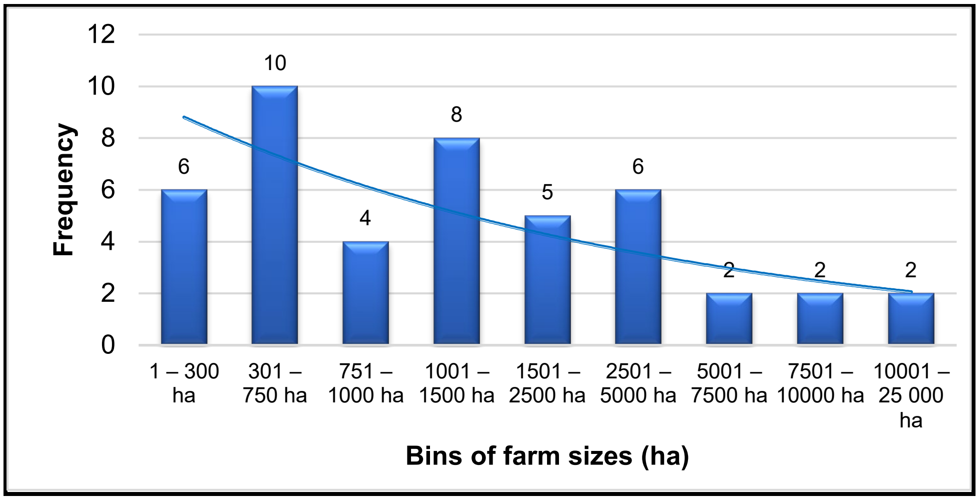

Figure 5.4: The frequency of farms indicating the various rhino farms' sizes.

5.3.4 Rhino numbers

From the 46 respondents visited in the Free State Province, a total of 680 rhinos were counted, of which 669 were white rhinos, and 11 were black rhinos. The rhino farmers have 599 white rhinos, while the provincial government has 70 white rhinos. A total of 375 (56%) white rhinos occur in the northern Free State; 152 (23%) in the western Free State; 87 (13%) in the southern Free State; and 55 (8%) occur in the eastern Free State (Figure 5.5). There were 11 black rhinos in the Free State at the beginning of the research project (2016), which comprised of nine males and two females. Only one black rhino belongs to the State, while the other 10 belong to three rhino farmers. Of the 11 black rhinos, six were sold, four were poached (including the two females), and only one black rhino survived at the end of the project in 2017. Black rhinos occurred mainly in the southern Free State, while most of the white rhinos occur in the northern Free State. Changes in white rhino numbers fluctuate monthly as they calf and be traded with. By the end of the study period there were 680 white rhinos. There are 26 (57%) rhino owners who have rhinos with home ranges that occur close to the rhino camp fences, and 20 (43%) of the rhino home ranges are situated far from the rhino camp's fence.

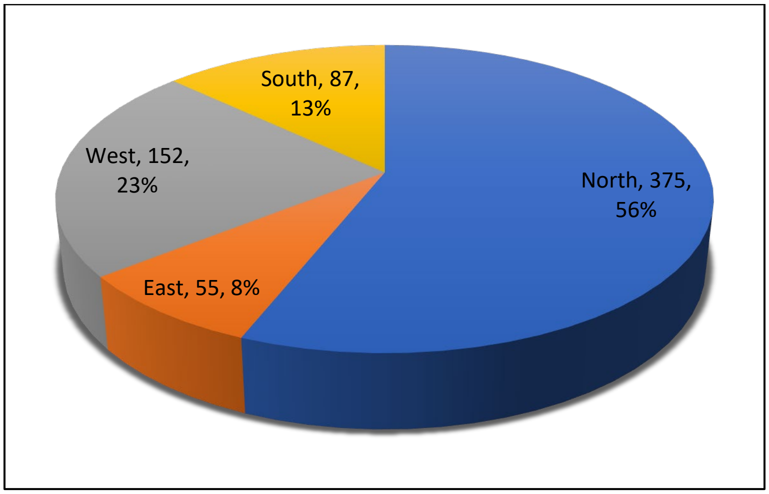

Figure 5.5: Distribution of white rhinos in the Free State Province (*n* = 669).

5.3.5 Dehorning of rhinos

Most respondents in the Province primarily dehorn their rhinos as a poaching prevention method. A total of 34 (74%) owners dehorn, while 12 (26%) prefer not to dehorn. From the 34 owners that dehorned 20 (59%) reported poaching incidents and six (50%), of the 12 owners that do not dehorn, reported poaching.

5.3.6 Rhino Farm security guards

A total of 24 (52%) respondents make use of internal security guards; while 10 (22%) use external guards to protect their rhinos; and 12 (26%) respondents do not make use of any guards to protect their rhinos. Guards used at 13 (28%) rhino sites have official training in rhino anti-poaching operations.

5.3.7 Rhino farm workers

Only six (13%) of the respondents use temporary workers on the rhino premises; while 38 (83%) do not use temporary or foreign workers; and two (4%) use no workers. A total of 20 (59%) their rhino anti-poaching staff reside with the workforce; and 14 (41%) do not stay with the workforce. The main problems with the workforce at rhino sites are alcohol 28 (61%), theft 14 (30%) and domestic violence 12 (26%) (note Figure 5.6 below).

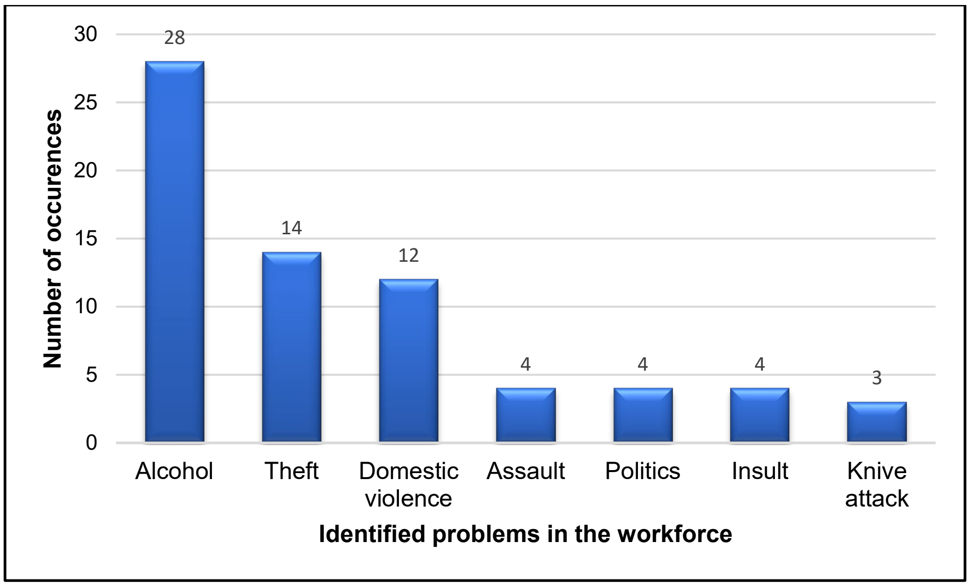

Figure 5.6: Main workforce problems experienced on rhino sites.

5.3.8 Rhino farm security devices

On the question whether their rhinos have been implanted with satellite devices as a security measure, only three (7%) respondents confirmed that their rhinos have been implanted with satellite devices, whilst 43 (93%) of the respondents did not consider the idea. The following frequency table indicate that most respondents (96%) make use of security equipment such as two-way radios, while trial cameras (52%) are the second largest security measure implemented, followed by night-vision binoculars (39%) (Table 5.1). Of the 21 options for security equipment provided in the questionnaire, nine (such as a mobile radar, metal detector or “seismopen”) were not chosen as a security option.

Table 5.1: Respondents’ indication of the types of security measures in place at their rhino camps and nature reserves (*n* = 46).

SECURITY MEASURES	FREQUENCY (46 respondents)	PERCENT (%)
Two-way radios	44	96%
Trial cameras	24	52%
Night vision binoculars	18	39%
Air supply (Chopper)	15	32%
Assault weapons	10	22%
FLIR Thermal Camera	8	17%
Alarm system on fences	6	13%
Pseudo operations	6	13%
Patrol drone	5	11%
Polygraph	3	7%
Tracker system on rhinos	3	7%
CCTV cameras	2	4%

5.3.9 Rhino farm security patrols

Of the 46 respondents, the majority - 43 (93%) - do security patrols on their farms and nature reserves, while three (7%) do not. In addition to the security patrols, 34 (74%) do daily patrols, nine (20%) do weekly patrols, and three (6%) neglect to do any patrols. Over the weekends, 41 (89%) of the respondents do patrols, but five (11%) do not patrol over weekends. The findings show that 20 (43%) of the respondents patrol the perimeter, and 26 (57%) do not patrol the perimeter.

5.3.10 Rhino farm security control measures

None of the respondents conduct weapon searches on their properties. Approximately one third (30, 65%) do not require visitors to sign in at their sites, while 16 (35%) do control entrances to their sites. The majority of 40 (87%) respondents do not have a Manned Control Room with 24-hour operators, while six (13%) rhino farms do make use of Manned Control Rooms. A total of 10 (22%) of the respondents consulted rhino-poaching experts to assist them with security measures, while 36 (78%) do not make use of any expertise. Only eight (17%) of the respondents have a written security plan, while 38 (83%) do not have any written security plans. The eight written security plans were read by the owners, and the plans have all the sections as needed in a security plan.

5.3.11 Rhino farm habitat security

The findings show that 37 (80%) of the rhino sites do not provide entrance into rhino areas through rivers or dams, while nine (20%) of the sites do provide entrance through water bodies for poachers. The habitat on the various rhino premises in the Free State provide hiding places for poachers, as follows: dense bush 30 (26%), remote camp 25 (21%), rocky hills 24 (20%), dongas 17 (15%), riverine 9 (8%) and other 12 (10%).

Of the 26 respondents that encountered poaching incidents, a total of four were poached in a habitat with dense bush, six in a remote camp, five in rocky hills, two in rhino camps with several dongas, eight in other (such as grassy plains), and one in a riverine habitat. Thirty (65%) of the farms have high ground, and 16 (35%) have other habitat such as savannah or grassy plains.

5.3.12 Rhino farm management security

On the question if the owners move water and feeding points, 44 of the owners (96%) indicated that they do not move their drinking troughs. Only two (4%) indicated that they change water troughs occasionally, while 10 (22%) of the owners move their feeding buckets frequently, and 36 (78%) have fixed feeding sites. Respondents also indicated that 11 (24%) drinking sites are close to roads (within 1 km), and 35 (76%) are situated away from roads, while 23 (50%) indicated that their rhinos' feeding sites are close to roads. The other half stated that their feeding sites are away from any roads. Note Table 5.2 for management of water and feeding points.

Table 5.2: Respondents' management of water troughs and feeding points

Do you move the water and feeding points often on the farm? (*n* = 46)		
	Yes	**No**
Water troughs/cribs	2 (4%)	44 (98%)
Feeding buckets/tyres	10 (22%)	36 (78%)
Are your water and feeding sites close to any roads? (*n* = 46)		
	Yes	**No**
Dams/rivers/water troughs	11 (24%)	35 (76%)
Feeding buckets/core grazing area	23 (50%)	23 (50%)

5.3.13 Rhino camps

On the question, did you erect small or large camps, 14 (30%) of the respondents indicated that they have erected small camps, while 32 (70%) have large rhino camps. Of the 26 poaching reports, six (23%) incidents occurred in small camps, and 20 (77%) poaching incidents occurred in the large rhino camps and nature reserves (Table 5.3). The small rhino camps are on average 185 ha, while the large camps have an average of 1 861 ha on farm land (3 909 ha with nature reserves included). The demarcation was set at <300 ha and >300 ha for small and large camps. A significant relationship between actual camp sizes and observed poaching rates occur ($P < 0.05$) and confirm that there is a larger probability of poaching occurring in larger camps than smaller camps.

Table 5.3: Poaching incidents per rhino camp size category.

Camp size	Total number of properties in size category (n=46)	Frequency of poaching in size category	Percentage of poaching per category
< 300 ha	8	2	25%
301 – 750 ha	8	5	63%
751 – 1 000 ha	4	3	75%
1001 – 5 000 ha	19	11	58%
5001 – 10 000 ha	4	3	75%
> 10 000 ha	3	2	67%

The main reason why respondents erected small camps was for security purposes (79%), while the rest indicated reasons such as establishment of a zoo, speculation with rhinos and pasture rotation. The respondents with smaller camps had two rhino camps on average. Although 46 rhino sites were investigated, a total of 72 rhino camps exist.

Nineteen (19) of the 41 rhino farmers subdivided their original rhino camps into 26 additional smaller camps (range; 2 - 4 camps/farm and camps range from 30 ha - 762 ha). The occurrence of small camps, namely 35, is situated in a bin between 1 – 300ha; 17 camps are situated between 301 – 1000ha; and the other 20 are large camps situated >1000 ha.

5.3.14 Location of rhino camps

Eighty percent (37) of the respondent's rhino camps and nature reserves in the Province border public roads (within 1km, as asked on the questionnaire) and twenty percent (9) do not border or are close to any roads. Public roads were regarded as any road that a poacher may use (as a member of the public) and includes all types of dirt and tar roads which have a National-, Secondary- or Tertiary number. The occurrence Table 5.4 shows the occurrence of rhino camps bordering roads in the Province.

Table 5.4: Occurrence of rhino camps next to public roads (*n* = 46).

DISTANCE FROM ROAD	OCCURRENCE	PERCENTAGE (%)
0 - 100 m	23	50 %
101 - 1 000 m	14	30 %
1 001 - 1 500 m	4	9 %
1 501 - 2 500 m	3	7 %
2 501 - 4 000 m	2	4 %

Results show that 29 (28%) of the respondents' rhino camps are situated near a house; 28 (27%) close to a public road; 24 (23%) are isolated; 11 (11%) are not far from towns; and 11 (11%) are near a neighbour. Near and far was a respondent's perspective of the visual distance from neighbours, houses, roads and towns.

5.3.15 Suggestions by rhino owners to prevent poaching

A total of 7 options were given to the respondents on the question: what should you do when poaching increases? In response, 30 (65%) owners indicated that they will dehorn; 22 (48%) will increase their security measures; 15 (33%) specified that they will sell all the rhinos or stop the project; 12 (26%) said that they will hunt their remaining rhinos; 11 (24%) will translocate their rhinos to other sites; two (4%) stated they will add transmitters on their rhinos; while two (4%) indicated other options. These other options included poisoning of rhino horns and refusing to ever sell rhinos, and one rhino farmer stated that he keeps his rhino for conservation purposes.

A total of 37 respondents supported a legalised rhino horn market. It was the single highest suggestion from the 46 respondents. Other suggestions were repeated between two to six times. The responses are grouped and summarised in Table 5.5.

Table 5.5 Proposed suggestions from the 46 respondents to stop rhino poaching

SUGGESTED SUPPORT FROM RESPONDENTS	Number of mentions	%
LEGAL CONCERNS		
Legalising the selling of rhino horns in South Africa will reduce poaching	37	80
Proclaim stricter laws with longer prison sentences	5	4
Stop the policy of not allowing small rhino camps in the Province	5	4
Implement the shoot-to-kill policy	4	3
Bring back the death penalty	2	2
Poor investigations, with no arrests made in the Province regarding rhino poaching	2	2
Minimise the permit system, as it is problematic for confidentiality	2	2
There are too many regulations controlling rhinos unnecessarily	2	2
There are no regulations that protect the rhino owner	1	1
Polygraph tests must be done on government officials working with applications	1	1
SECURITY MEASURES		
Better equipment will counter rhino poaching	6	5
Increase security measures by respondents	6	5
Rhino guards must receive advanced skills training	5	4
Around-the-clock reaction forces	4	3
Infiltration of poachers through pseudo operations	4	3
Appoint more guards and select them strictly	3	3
Implement unconventional security methods	2	2
More police presence on farms	1	1
Increase discipline of rhino guards	1	1
Breeders must have a military approach in protecting their rhinos	1	1
MANAGEMENT OF RHINO POPULATIONS		
Keep rhinos in smaller rhino camps for better control and effective security	6	5
Keep rhino populations away from public places	3	3
Stop dehorning of rhinos	2	2
Attach GPS devices on rhinos for tracking purposes	2	2
Keep workers and public away from the rhino camp	1	1
OTHER PROPOSALS and COMMENTS		
Set an export quota for selling of rhino horns from South Africa to other countries	2	2
CITES, IUCN and WWF must compensate respondents for protecting the species	2	2
The “why pay me, while I can steal and get a better price” idea, must be countered	1	1
Environmental activists create a market with their rhino awareness programmes, and it should be stopped	1	1
Donate private horns to the East initially, and thereafter allow farmers to farm sustainable with rhino for their horns	1	1
Total	**115**	**100%**

5.3.16 Safety of rhinos on rhino farms

The respondents were asked to rate themselves to the statement: "My farm is a safe place for rhinos". The results indicate that 13 (28%) strongly agreed, 20 (44%) agreed, 11 (24%) were neutral, and two (4%) disagreed, while nobody strongly disagreed (Figure 5.7). Of the 13 strongly agreeing respondents, five experienced poaching, 12 of the 20 agreeing respondents experienced poaching, eight of the 11 neutral respondents experienced poaching, and one of the two disagreeing respondents experienced poaching.

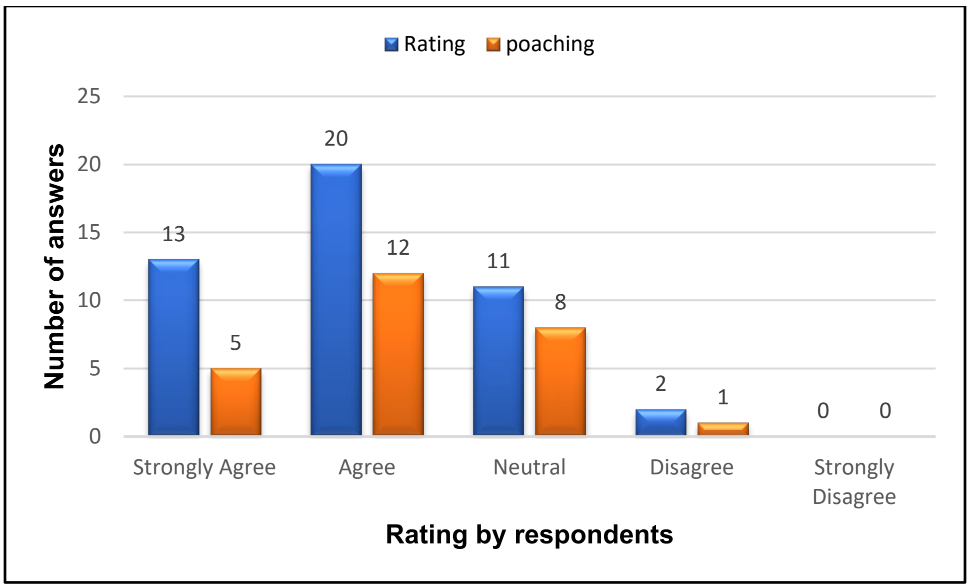

Figure 5.7: The clustered column shows respondents' reply on the question whether their farm is a safe place for rhinos comparing to poaching incidents on their farm.

When the respondents were asked whether they found the security measures to be effective on their farms, 18 (39%) indicated that their security measures are very effective, while another 18 (39%) indicated that they are effective. Six (13%) of the respondents stated that they are somewhat effective; 2 (5%) declared that they are somewhat ineffective; while two (4%) indicated that they are very ineffective. Poaching occurred on 10 of the 18 respondents' sites, which is an indication that their security is very effective. Nine of the 18 who stated that their security measures are effective, had poaching incidents (Figure 5.8).

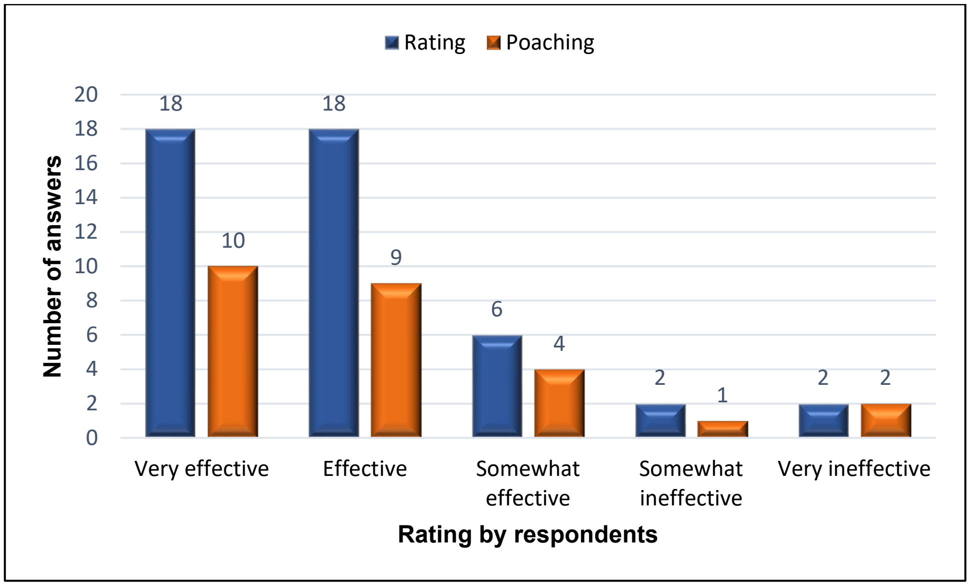

Figure 5.8: The clustered column shows respondents' reply on the question whether they found the security measures to be effective.

Four of the six who indicated that their security measures are somewhat effective, had poaching incidents, whilst one of the two respondents who claimed that their security is somewhat ineffective, had poaching incidents. Both of the respondents who had indicated that their security measures are very ineffective, had poaching incidents.

5.3.17 Rhino farms versus nature reserves

In comparison to the farm land, State-run nature reserves are larger by area (State mean = 11 940ha, farm land mean = 1 861ha), but not to rhino population (State mean = 14, farm land mean = 15). The State reserves have on average 14 rhinos per reserve comparing to the rhino farmers 15 rhinos per farm. Both land management categories have reported similar numbers of poached properties (State=3/5, P/C=23/41). Hence, the level of poaching intensity is even between State-run properties and private land (Table 5.6).

Table 5.6: Similarities and differences between provincial nature reserves and rhino farmers.

DETAILS OF RHINO FARMERS	NATURE RESERVES	RHINO FARMERS
Number of properties	5	41 (26 additional small rhino camps)
Average rhino property	11 940 ha	1 861 ha
Area under rhino conservation	59 700 ha	76 305 ha
Mean rhino per property	14	15
Percentage of properties poached	60%	61%
Rhinos poached	13	62
White rhinos	70	599
Black rhinos	1	10
Years rhino experience (average)	20	8
Age of respondents	46	53
Average distance from town	19 km	18 km

South Africa has experienced a significant increase in the number of rhino-poaching incidents since 2007 (Figure 5.8) and equally similar poaching patterns have been experienced in the Free State Province.

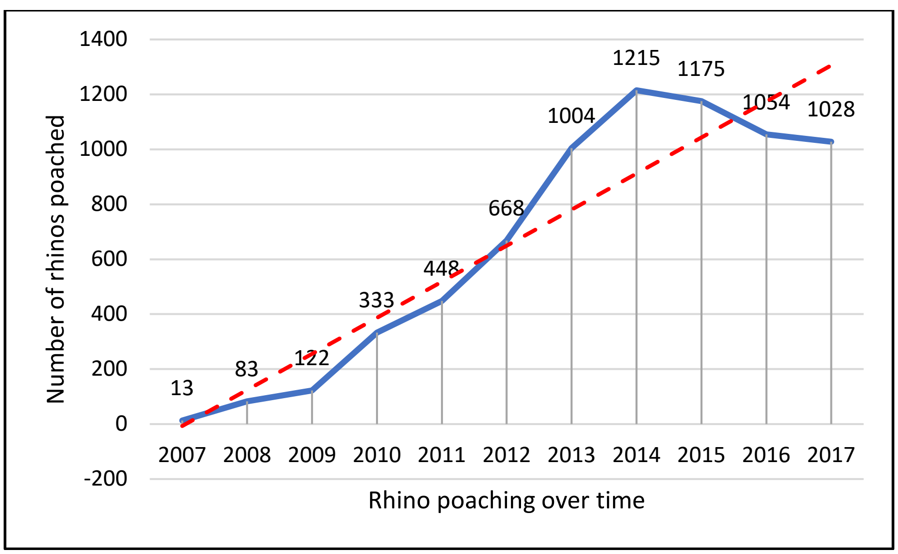

Figure 5.8: Rhino-poaching statistics for South Africa from 2007 – 2017

5.3.18 A Confidentiality Diagram

A Confidentiality Diagram based on a hypothetical example was constructed to illustrate all the role players during a rhino translocation process, which includes both the buyer and seller, as well as other participants. It was not part of the questionnaire. A total of up to 74 contributors are possibly involved during a rhino translocation process (Annexure D).

5.4 DISCUSSION

The type of security measures existing at the various rhino sites were investigated to determine the level of preparedness of rhino owners. Results obtained through this study showed an alarming low level of preparedness amongst rhino owners due to a lack of proactive security measures.

Since 2009, 75 rhinos were poached in the Free State Province which amounted to a 1 500% increase in rhino-poaching, compared to the 400% in KwaZulu-Natal over five years (Carnie 2016). The poaching statistics of the Province compared well with other rhino breeders in South Africa. Other rhino breeders had an 80% poaching rate, compared to the 57% of the Free State Province (Jones 2014). It seems that the Province was initially not targeted by poachers, but this is rapidly changing. One of the measures that could be taken to prevent further poaching incidents, is an increase in coordinated law enforcement patrols on rhino farms.

A total of 47 rhino breeders were assessed for security measures and only one owner was reluctant to provide information. Thus, information was gathered from 46 breeders. The study showed that rhino breeders are not well experienced, with only two breeders having more than 30 years' experience. The increase in rhino farmers can be ascribed to farmers who recognise rhino breeding as a profitable farming practise, with the added value of sustainable harvesting of rhino horn.

An alarming 80% of the respondents' rhino premises in the Province border within one (1) km from public roads. Rhino poaching occurred on 24 of the 26 rhino premises that were situated <1000m from a public road. According to a report by Treasury (Anon 2015), the Free State Province has a total of 48 356 km roads (6 310 km paved roads, 22 046 gravel roads and 20 000 km tertiary roads). The Province also has 507 938 cars, which indicate a road density of 17.8 vehicles per km. This data indicates a network of roads throughout the Province, which makes it easier for poachers to access rhino sites. Greeff and Von Tichelin (2014) gave the average rhino-poaching incursion as 2.5 – 3.5 km, and stated that it will take an average of 25 minutes to exit a rhino premises. A statistical test indicated that the distance to the nearest town does have an impact on poaching. Rhino owners need to erect their rhino camps at least 5 km away from the nearest road to reduce the possibility of poaching.

Presently the 680 rhinos in the Free State is the highest number of rhinos ever recorded in the Province. The 599 white rhinos in private possession compare fairly with the 691 white rhinos on private land in Kwazulu-Natal. This is however not the case with State owned land, where the Free State falls well short with their total of 70 white rhinos, compared to the 3 210 white rhinos (Greeff and Von Tichelin 2014) in Kwazulu-Natal. Of concern is the 90% decline of black rhino numbers in the Province due to poaching and live selling during 2016 and 2017. No similar data exists for white rhinos as their numbers fluctuate continuously due to breeding and trade. It is noteworthy that there is only one black rhino left in the Free State, compared to the 496 black rhinos of Kwazulu-Natal. According to Jones (2014), the Private Rhino Owners Association (PROA) own 27% of the country's white rhinos, and Knight (2017) stated that private enterprises own just over 30% of both black and white rhinos. The Free State rhino farmers own 90% of the white rhinos in the Province, indicating that the farmers of the Free State play a vital role in the conservation of rhinos in the Province. Most of the rhinos' home ranges are situated close to fences and roads, which increase the possibility of poaching. This makes it easier for poachers to enter the rhino camps, and definitely contributed to the 1 500% increase in rhino poaching in the Free State Province since 2009. It seems that small camps restrict the rhino's home range and that their natural behaviour might be altered. These changes need to be studied further.

Almost three-quarters of rhino breeders in the Free State Province dehorn all their rhinos, which is like the practice in Namibia, where an entire rhino population was dehorned in the Karas section of the Etosha National Park (Lindsay and Taylor 2011). The farmers that dehorned still had a 59% poaching occurrence compared to the 50% of farmers that did not dehorn. The six farmers that do not dehorn, and which reported poaching, keep their rhinos for international hunters while the other six farmers, who keep their rhinos for tourism and conservation, did not report any poaching. Thus, 100% of the trophy hunting farms were poached probably because of their position next to public roads while conservation farms were more isolated. From the 20 farmers with dehorned rhinos, 13 (65%) reported poaching in their large camps while only 7 (35%) reported poaching in their small camps. This result shows that poachers prefer to target large camps.

Only a small portion of the rhino farmers are using security guards. Approximately only 15 external trained security guards are used to protect rhinos. This is a very low employment rate compared to the 16 077 employed security guards in the 229 registered security companies in the Free State, as stated by Badenhorst (2014). Rhino owners need to increase the use of security guards and to continuously send their rhino guards for relevant training. The option of using internal versus external guards needs to be further investigated.

The high alcohol usage (41%) of the workforce on a rhino premises is of concern, as it often results in the failure to control impulses, and can raise questions about an individual's reliability and trustworthiness (Henderson 2010). The fact that theft is the second highest problem, with 20% of cases of theft reported, is also of concern, and indicates disloyalty towards the respondents, which might evolve into poaching. To counter this problem, it is recommended that the workforce undergo a full range of Voice Stress and Polygraph testing.

A few private rhino owners in the Free State made use of satellite devices, which were attached to their rhinos, with limited success, mainly because of practical problems regarding the device. Venter (2013) acknowledges these practical problems, stating that some of the problems can be due to the limited battery life of GPS devices. In Zimbabwe, these satellite devices were also attached to rhinos, which resulted in difficulties, namely losing 20% of the devices within the first month of fitting (Du Toit 1996). A total of seven out of the eleven rhino farmers from KwaZulu-Natal indicated that they would consider the GPS option, depending on the cost (Lockwood 2010). Some parks in the North-West Province have initiated the use of these satellite devices, but there has not been any feedback regarding its efficiency, to determine whether this technology is better equipped for the protection of rhinos (Gill 2010). Most respondents make use of equipment such as two-way radios, trail cameras and night-vision binoculars. One of the few benefits of satellite trackers is that it makes it easier to manage foot patrols of the rhino guards. Unfortunately, usage of these GPS devices is reactive and not proactive.

Though the overwhelming majority do perform security patrols on their farms, a few believe that to not patrol is a security measure, reasoning that if fewer people know about the rhinos, the possibility of rhino poaching decreases. Interestingly, up to date, none of these respondents had poaching incidents. Those maintaining this philosophy have remote rhino camps, with only the owner visiting these camps over weekends. Weapon searches and entrance control are of low priority for all respondents. The majority (87%) of rhino owners do not have a Manned Control Room with 24-hour operators. The findings indicated that a low 43% of the respondents patrol the perimeter. To protect rhinos, full time rhino security guards must be on continuous security patrols to prevent poaching and trespassing.

Rhino breeders do not rotate their water cribs, and only a few rhino farmers rotate rhino feeding points as a strategy to counter poaching. Respondents indicated that drinking cribs are away from roads, while feeding sites are close to roads. Practical solutions must be introduced by the breeders to regulate their rhinos in camps with water point distribution.

Data from this chapter revealed that rhino camps that are situated within 20 km from the nearest town have a 69% chance of being poached. Most of the poaching incidents occurred in large rhino camps, and only a small portion occurred in small rhino camps. Respondents erected smaller camps mainly for security reasons. The Chi-square test confirmed that there is a larger probability of poaching occurring in larger camps than smaller camps. The Provincial Department may investigate the option of registering rhino farmers as intensive breeding operations or extensive breeding operations. These two options must then be managed differently per guidelines stated by the aim of the breeding program.

A few opinionated questions were asked to retrieve respondent's overview of rhino breeding and related issues. Most (72%) of the respondents strongly agreed or agreed that their farms are a safe place for rhinos. More than half (52%) of the respondents that believe their farms are a safe place, experienced poaching. During the interview in 2016, most of the farmers did not experience any poaching. Since the interviews, a drastic increase in poaching in 2017 occurred which was unpredicted. The rest of the respondents either already experienced poaching or could not do anything more to protect their populations and therefore indicated a neutral or disagreed answer. On the question, what should be done to prevent rhino poaching in the Province, respondents gave 35 suggestions, of which several were repeated (n = 115). The majority of respondents' regard legalising of rhino horn, selling and changing of regulations as a prevention to rhino poaching. According to Taylor *et al*. (2017), the country is capable of producing up to 13 356 kg rhino horn per year. This amount of rhino horn could generate a substantial amount for the farmers, which incites them to vote for the legalisation of rhino-horn commerce. Only a limited number of respondents gave practical solutions to the poaching problem, e.g. to set an export quota for selling of rhino horns from South Africa to other countries. It was hoped that the opinion questions would provide more practical answers to the questions, which unfortunately did not happen.

As indicated on the confidentiality diagram (Annexure D), a high number of participants are involved in the translocation of rhinos. Therefore, it is almost impossible to prevent information leaking about the location of rhinos. Further study towards practical solutions to increase confidentiality during translocation should be undertaken.

5.5 CONCLUSION

The Province experienced a drastic increase in poaching during the last eight years which resulted in a high production and financial loss for breeders. Although the poaching level in the Free State Province is still lower than the rest of the country, a sudden rhino-poaching increase of almost 100% in 2017 remains a major concern for the future of rhino breeding in the Province.

The Province has an extensive network of roads which assist the poachers in their endeavours. Rhino properties adjacent to public roads are vulnerable and statistics indicated a significant relationship between the distance to the nearest town and poaching incidents.

The Free State rhino farmer deserves to be applauded for breeding rhinos up to numbers never known to the Province before, as well as for their ownership of 90% of the Province's rhinos. The 680 rhinos in the Free State is the highest number of rhinos ever recorded in the Province. Where the home ranges of rhinos are situated close to public roads, there is a higher risk of poaching. Although results showed that there were fewer poaching incidents where rhinos were kept in smaller camps, it remains a concern that the rhino's natural movement is restricted in small rhino camps.

Most rhino owners dehorn their rhinos to prevent the risk of poaching, although the dehorned populations still experienced a 59% poaching rate. The farmers that dehorn had a high poaching rate compared to the farmers that do not dehorn. Results showed that dehorned rhinos that are kept in large camps were targeted more than those kept in small camps. It is evident that poachers are not deterred by dehorning.

Rhino farmers use a limited number of trained security guards for rhino protection. Rhino farmers do not seem convinced of the advantages of using trained security guards. Rhino farmers are also not vested in the usage of technological devices. Respondents indicated the use of two way radios, trail cameras and night vision equipment. The implementation of satellite devices at three rhino farms were unsuccessful as they are not in use anymore. Apart from the few mentioned devices, rhino premises lack the appropriate technical security measures required to adequately protect their rhinos.

Security patrols on farms exist and are mostly performed by the farmers and nature conservators. Only a limited number of owners do not allow security patrols and they believe that this maintains their low poaching rate. Control measures on the premises such as entrance control and weapon searches are of low priority for owners. Less than half the owners patrol the perimeters of fences.

A lack of management of water cribs and feeding buckets occur. Only a few farmers rotate feeding buckets while no one controls water points. Most of the water cribs are situated away from public places. There was no indication that feeding sites bordering fences and roads are monitored.

Most rhino breeders believe that legalising the trade of rhino horn will reduce and even prevent poaching. A few other proposed the changing of legislation and a limited number provided practical solutions. These solutions included that the State allow the keeping of rhino in smaller camps and that law enforcement should infiltrate poaching syndicates.

Confidentiality is a controversial issue amongst rhino farmers and many blame the State of leaking information. Reducing the number of people involved when translocating rhino as well as the vetting of all employees may reduce the breach of trust.

Rhino camps situated closer to towns have a 69% chance of being poached. Most of the poaching incidents occurred in large rhino camps, and only a small portion occurred in small rhino camps. Respondents erected smaller camps mainly for security reasons. It is also concerning to note that the various rhino camps and nature reserves border public roads. Most of the rhino sites in the Province are located close to public places, which increases the risk of poaching and impede investigations.

Based on the data provided by the respondents, the Free State rhino breeders have a low level of preparedness to counter the rhino-poaching onslaught. Early warning signs of approaching poachers cannot be detected due to the lack of proper security measures. The fact that large rhino camps are situated for long distances along public roads, makes it difficult to manage rhino anti-poaching strategies.

Further research on rhino security measures throughout South Africa will provide a better perspective on the preparedness of all rhino breeders to reduce and prevent rhino poaching. Keeping rhinos in smaller camps proves to be an efficient security measure, but further research on the influence of small rhino camps on the home range of rhinos are needed.

The following solutions are proposed:

- Rhino owners need to introduce the latest technology available to proactively monitor the possible presence of intruding poachers.
- Although this study showed that poachers were not deterred by dehorning, the harvesting of horn remains a financial gain for the rhino farmer. Dehorning should still be encouraged and made mandatory for rhino owners to protect the species.
- New rhino owners must provide the Department with a proper security and management plan before permits are approved. This can prevent approval of rhino breeding sites near public places and where little to no security measures occur.
- Amended legislation must prohibit the keeping of rhinos close to public places and roads.
- It is recommended that the State engage in pseudo operations to infiltrate rhino poaching syndicates.

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CHAPTER 6

A PRODUCTION LOSS FORMULA FOR POACHED RHINOS

6.1 INTRODUCTION

Due to the severe hunting of the white rhino population in South Africa, less than 50 white rhinos were left by 1895, with obvious restricted genetic variation, of which all occurred in Natal (Anderson and James 2001). It is also feared that the population reduction through hunting of white rhino in the late eighteenth century created a “bottleneck effect”, reducing heterozygosity among populations (Coutts 2009). Great effort was initiated by the then Natal Parks Board not only to save white rhino, but also to multiply and distribute them all over the world (Player 1972). White rhino numbers increased to approximately 20 375 in 2015 for all countries with white rhinos (Emslie Milliken Talukdar Ellis Adcock and Knight 2016), whilst black rhino numbers in South Africa increased to 1 893 (Emslie and Adcock 2016).

Since 1962, when the first white rhino was relocated to the Free State Province, sustainable rhino farming developed which helped the species to recover from low numbers (Leader-Williams Milledge Adcock Brooks Conway Knight Mainka Martin and Teferi 2005). An increased illegal demand for rhino horn were responsible for a steep increase in rhino-poaching and 6 102 rhinos were poached between 2008 and 2016 (Rubino and Pienaar 2017). Since the drastic increase in poaching, rhino farming no longer makes economic sense due to the increased risk (Hall 2012). The question that arises from the poaching risk is what the production loss will be, should the current poaching situation continue? Production loss is defined as the rhino owner’s direct loss of his poached rhino as well as his indirect loss of potential calves and horn regrowth.

White rhino breeders from the Province select animals for certain traits, such as; horn length, shoulder height and body weight and register their rhino populations at Wildlife Stud Services in an event to counter inbreeding and breeders pay high prices for animals with these exceptional genetic traits. ([20]Crous brothers, *pers. comm.,* 2017). Rhino farmers further benefit from rhino farming through tourism, hunting and live sales (Child

[20] Crous brothers, the largest rhino farmers in the Free State.

2012). To ensure effective management of rhino breeding programs it is essential for the rhino breeder to know the production loss once an animal is poached.

The aim of this chapter is to develop a Production Loss Formula (PLF) to delineate the immediate and potential future production loss of a poached rhino. The production loss for the rhino owner include the direct or immediate loss of the actual poached rhino as well as the indirect or potential future loss when a rhino is poached. The production loss of poached rhinos in the Free State Province will be determined in this study after collecting data of rhinos poached from private land owners and the provincial nature reserves.

This study will also assess the age of poached animals, as well as gender, and compare to determine differences. Other factors such as the total loss of income for the Province will also be calculated.

6.2 METHODOLOGY

The focus of this chapter was to determine the production loss due to rhino poaching. The methods used to investigate was by means of research, interviews, a questionnaire and data analysis.

6.2.1 General research design

6.2.1.1 Literature

Published prices of rhinos and rhino horn are not easily available. Hence, this study relied on the day-to-day prices available on the internet. Consequently, the prices mentioned in this study were retrieved from internet resources. Data on rhino horn trade, horn growth rates, dehorning, feeding and security costs were sourced through scientific literature and online searches.

6.2.1.2 Interviews

From the start of the project, key stakeholders in the field of rhino farming and wildlife management were consulted. These stakeholders included Environmental Management Inspectors (EMIs), rhino farmers with intensive rhino farming projects, wildlife veterinarians farming with rhinos and wildlife consultants. Face-to-face formal and informal interviews were carried out to assist and support. Information gathered from the interviews were related to feeding of rhinos, horn regrowth rates, various financial and biological implications such as maintenance cost and calving intervals.

6.2.1.3 Questionnaires

A questionnaire was completed with 41 rhino farmers and five nature reserve managers. The questionnaire intended for the developing of a Rhino Anti-Poaching Model had a section included for the poaching incidents on each rhino farm. Pertinent questions in the structured questionnaire were asked to either the landowner or manager regarding the age of the poached individual, horn length, horn circumference and the number of productive females and males in the herd. No questions related to dehorning practises were asked.

If the respondents did not have data available, the rhino-poaching data were confirmed by the Free State Department of Economic Small Business Tourism and Environmental Affair's (the Department of Economic Small Business Tourism and Environmental Affair's (DESTEA)) internal poaching reports, and officials responsible for rhino farmers. This data was used in the formula to determine production loss for each rhino farmer's poached rhino.

6.2.1.4 Data analysis

Although 75 rhinos (71 white and four black rhinos) were poached in the Province since 2009, the production loss was calculated for only 60 dead rhinos. Sixtyfour were dead, six were wounded and five darted. The five darted rhinos survived the darted-poaching attempts. The gender and age of four decomposed carcasses could not be determined, and their production loss was therefore not calculated. Two of them were black rhino carcasses.

Since the homogeneity of variance assumption was violated, a Welch F test was run. The Welch F test is a robust test that do not assume homogeneity of variance (Field 2009). Due to the result of the Welch test which indicated that no significant differences exist between the four age groups, no post-hoc tests were performed.

6.2.2 The identification of potential Production Loss Formula (PLF) factors

This Formula includes the direct and indirect loss of a poached rhino. The direct loss is the monetary value of the poached individual. The indirect loss includes the potential value of future calves as well as the value of horn regrowth which can be potentially harvested every two years.

The full equation and Formula factors set out as follows:

$$\text{Production Loss Formula (FLF)} = \Big(\overbrace{g}^{\text{Individual value}} + \overbrace{\Big[a \text{ x } c \text{ x } \big(\tfrac{30-s}{r}\big)\Big]}^{\text{Potential calf value}} + \overbrace{\Big[(P \text{ x } d) + \big(\tfrac{30-s}{q} \text{ x } P\big)}^{\text{Horn(s) value}}\ \Big]\Big) - \overbrace{\textstyle\sum_1^{30-s} j\,(1+0.06)^i}^{\text{Care value}}$$

g	=	Monetary value of the poached individual (purchase price or current market value)
a	=	Total number of breeding females that can never again breed with the poached breeding bull.
c	=	Average price per calf (the average price of both sexes is set: R267 604)
s	=	Age of poached individual rhino
r	=	Calving intervals (every 3 years)
P	=	Current price per kg of total horn
d	=	The actual kg horn on day of poaching

q	=	Harvesting intervals of rhino horn (every 2 years)
$35 - s$	=	Production years for females (for males it is $30 - s$)
$30 - s$	=	Harvesting years for horns
i	=	Production years lost
j	=	Future maintenance cost
$\sum_{1}^{30\text{-s}}$	=	Remaining time of maintenance/care for all poached animals
$(1 + 0.06)^{i}$	=	Compound interest set at 6 % inflation for the remaining production years for a poached individual (maintenance cost for future calves not included)

- All females and heifers will equal one (*a*=1). Additional bulls and bull calves will also only have a value of one, as they have the potential to breed with at least one other.
- There are two *P* factors in the equation stating the actual value of the stolen horn on the carcass and the potential harvesting stump of horn to be harvested every two years. This amount to ZAR 210 000/kg for the formula. A constant regrowth rate of 1 kg/two-years was set to compensate for slow female and age regrowth rate.
- The PLF is used to determine the production loss of only one rhino, therefore if more than one rhino has been poached on a farm, separate formulas will be used for each rhino. The formula can be adjusted for certain scenarios, for example (see Table 6.2):
  - When one breeding bull has been poached and the bull is not substituted.
  - When one breeding bull has been poached, and is substituted.
  - When one breeding female has been poached, with a breeding bull still alive and available in the herd.

6.2.3 Financial factors in the Production Loss Formula

The focus of the formula will mainly be on the direct and indirect cost factors of the poached rhino. This cost mentioned is only an estimate. Rhino breeders can calculate their own unique production loss and compare it with the benchmark provided by other Free State breeders. Although this formula was developed from data collected mainly from private landowners, the Formula stays the same, even when a rhino was poached on a proclaimed nature reserve or national park.

6.2.3.1 Rhino live trade

Legal buying and selling of live wildlife mostly takes place at accredited game auctions, wildlife agents and private sales. According to the website *wildgameauctions*, there are presently two types of game auctions in South Africa: centralised auctions - where game is darted and taken to a central game auction boma where the animals are auctioned off; and catalogue auctions – where the buyer buys the game through a catalogue and receives the game directly from the seller farm. Annual figures for the average wildlife auction prices (Table 6.2) are made available to the public on the website *Auctionready* (Auctionready 2016).

Table 6.1: Average prices for live white rhinos in 2016 (Auctionready 2016:13).

AGE GROUP	NUMBER	AVERAGE PRICE (ZAR)
Adult w/r bull	4	317 500
Sub-adult w/r bull	8	166 875
Adult w/r cow	1	600 000
Adult w/r cow in calf	3	535 000
Adult w/r cow in calf with a bull calf	1	750 000
Adult w/r cow in calf with a heifer calf	1	700 000
Sub-adult w/r heifer	9	368 333
W/r Heifer in calf	3	480 000

The prices of rhino calves vary depending on market trends. Thus, the price of the calves will be fixed at an average of 267 604 ZAR. The average auction price of a white rhino bull (four) for 2016 (R317 500.00) will be used as an input for the Formula. Different prices for females were used as per Table 6.1.

6.2.3.2 **Rhino horn trade** (Legal domestic market price)

The Constitutional Court formally dismissed the appeal by the Department of Environmental Affairs, to keep a moratorium on the domestic trade in rhino horn; therefore, rhino horn can now be legally traded in South Africa ([21]Schlemmer *pers comm*, 2018). The national price for selling rhino horn is currently not stable, and is between ZAR 200 000 – 300 000 per kg (Murphree 2017). According to an anonymous Free State rhino farmer, some other rhino farmers are legally advertising their rhino horn (2017) at R120 000/kg on the domestic market. The average of the lowest and the highest price will be used in the formula as (300 000+120 000)/2 = ZAR 210 000 per kg.

6.2.3.3 Maintenance cost

6.2.3.3.1 Insurance

According to Dugmore (in *Farmer's Weekly* 25 November 2010), a white rhino valued at R300 000 would attract a premium of anything from R3 000/year for limited fire, storm and lightning cover to R27 000/year (11% for full comprehensive cover). Hall (2012) gave the annual cost of insuring a rhino for 365 days as ZAR 9 070/rhino, which includes limited cover for animal loss due to fire, lightning, storm and flooding. According to a game stud risk insurance broker from PSG Consult ([22]Linde *pers comm,* 2017), they insured rhino between 4 – 6% of the animal's live value from the moment of darting, transportation and offloading for one year. The insurance can then be renewed for another one year. Each rhino farmer could calculate his cost at present values. For the basic formulation, the calculation will be set at five per cent for the adult rhino bull: ZAR 317 500.00 x 0.05 = ZAR 15 875/year.

[21] Andre Schlemmer, EMI Grade 2 responsible for special investigations in the Free State Province.

[22] Mr Linde, game stud Risk Insurance Broker from PSG Consult, Pretoria.

6.2.3.3.2 Veterinarian

According to Hall (2012), the annual average veterinary cost includes annual de-worming and vaccinations, which would amount to ZAR 1 200/rhino. Independent interviews with the three largest rhino farmers and two rhino veterinarians were conducted. According to them they do not immobilize each rhino annually but at least once in two to three years when they dehorn and vaccinate their rhinos. Other farmers immobilise rhino once in five years while others never make use of veterinarians. The consulted farmers stated that the figure of ZAR 1 500/year/rhino might be more appropriate for 2018.

6.2.3.3.3 Feeding

For the nutrition requirements of the enclosed rhino, the biggest rhino farmer in the Free State formulated a diet which he daily provides to his rhinos at 30kg/rhino. An all-in-one feed is required, and roughage such as teff bales (*Eragrostis tef)* is made available to the animals ([23]Crous *pers comm,* 2011). The weight of an adult white rhino bull is 2 400kg, and that of an adult white rhino cow is 1 600kg (Skinner and Chimimba, 2005). The current market value (May 2017) for Standard Game Cubes is set at ZAR 200/40kg bag as quoted by Senwes Cooperation (2017) in Kroonstad, Free State. Thus:

$$\text{Standard Game Cubes } = \frac{ZAR\ 200}{40kg} = \text{ZAR 5/kg}$$

Shepstone (2017) advises that large animals, such as rhinos, consume 1,5% of its live body mass every day. It is recommended not to give additional feed to animals year-round, but only in the drier season (Smith 2017). Thus, the required daily feed for an adult white rhino bull with an

[23] Riaan Crous, (with his two brothers) are currently the largest rhino farmers in the Free State.

average body weight of 2 400kg x 1,5% = 36kg feed/day. Annual expense of feed for an adult bull:

- $36kg \text{ x } \frac{ZAR\ 5}{kg} = \frac{ZAR\ 180}{day}$
- $\frac{ZAR\ 180}{day} \text{ x } \frac{365\ (Days\ of\ the\ year)}{6\ (Feeding\ only\ 2\ months\ or\ 61\ days)}$
- = ZAR 10 980/year/rhino.

6.2.3.3.4 Dehorning

The approximate cost for the entire dehorning procedure of rhinos is ZAR 9 000.00/rhino ([24] van der Walt *pers comm,* 2018,). The three rhino farmers that were consulted for prices, stated that they sometimes use only vehicles to immobilise but most of the time they use a helicopter when they must immobilise great numbers per day. The helicopter increases the dehorning cost up to ZAR 9 000/rhino/year. Thus, the amount of ZAR 9 000 was used for the Formula and divided by two, as rhinos are dehorned every two years: = ZAR 4 500/rhino/year. Dehorning operations require a special TOPS permit which must be applied for in advance.

6.2.3.3.5 Security cost

Bothma and Du Toit (2010) give the preferred labourer:rhino ratio as 0.33 labourers. According to two consulted rhino farmers some breeders do not use any rhino guards while others pay ZAR 6000/month for external guards. The South African Department of Labour's website (Labour 2016) proclaimed that a fixed minimum wage of ZAR 3 001.13/month (from 1 March 2017 to 28 February 2018) should be paid to a farm worker

[24] Dr. Chris van der Walt, wildlife veterinarian and rhino farmer from Kroonstad.

in the agricultural sector. The figure of 0.33 labourer:rhino from Bothma and Du Toit (2010) will be used.

Thus, the annual security expenses:

- $\text{Rhino guard} = \frac{\text{ZAR 3001}}{\text{Month}}$ x 12 months = ZAR 36 013
- $\frac{\text{0.33 Labourer}}{\text{Rhino}}$ x $\frac{\text{ZAR 36 013}}{\text{Labourer}}$
- = ZAR 11 884/rhino guard/year.

6.2.3.3.6 Total maintenance cost

The total maintenance cost for a rhino per annum:

Insurance	= ZAR 15 875/year
Veterinarian costs	= ZAR 1500/year
Feeding	= ZAR 10 980/year
Dehorning	= ZAR 4 500/rhino/year
Security	= ZAR 11 884/rhino guard/year
TOTAL	= ZAR 44 739/rhino/year/rhino farmer

This amount is similar to Warren (2015), who gave the same cost as ZAR 41 250/rhino annually. Consulted Free State rhino farmers gave this figure as between ZAR 35 000 and ZAR 50 000. The total maintenance cost for a rhino was set at ZAR 44 739 annually.

6.2.3.3.7 Inflation

The Reserve Bank of South Africa calculates the inflation rate monthly. Currently, the inflation rate is set at an average of 6% for 2017 (South African Reserve Bank 2017). This rate will be used in the formula.

6.2.4 Biological factors in the Production Loss Formula

6.2.4.1 Production years

A white rhino cow may breed from the age of four years (Owen-Smith 1988). White rhino cows reach sexual maturity at the age of seven, and can reproduce up to the life expectancy age of 40 years (Skinner, Dott, Matthee and Hunt 2006). For the formula, the age of conception will be set at five years for a breeding cow.

Through experimental research, it has been established that a white rhino cow on average can produce up to 14 calves in her expected lifespan (Bothma and Van Rooyen 2005). A white rhino bull may be sexually mature at the age of six years, but mark territories in their home range only from 10 to 12 years of age (Condy 1973).

The following diagram illustrates the production consequences if a rhino is poached from a productive population (Figure 6.1).

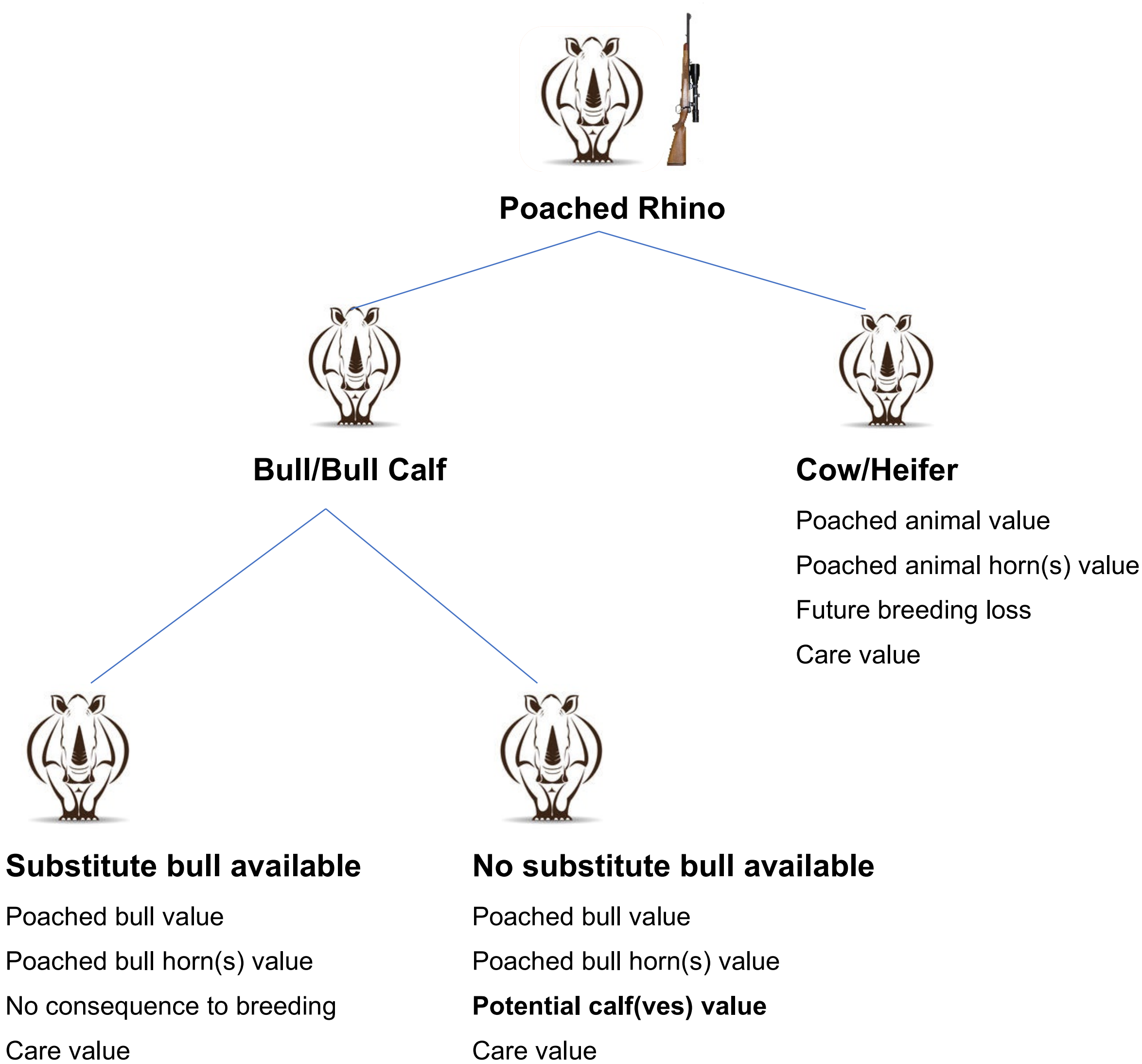

Figure 6.1: Production loss consequences of a poached rhino

For the Production Loss Formula, the age of 10 years will be regarded as an adult breeding bull. Production years for an adult cow will be regarded as 35 years, and for a bull it is set at 30 years.

6.2.4.2 Years it takes to generate offspring

Gestation period for a white rhino cow is 16 months (Owen-Smith 1988). Bothma and van Rooyen (2005) give an inter-calving period of two years for white rhinos.

A well-known rhino farmer (Warren 2015) gives the inter-calving period as three years. Du Toit (1998) proof calving intervals of 2.63, 2.7, 2.85 and 3,45 years. For the Formula, a calving-interval of 3 years will be set.

6.2.4.3 The age of an animal

Hillman-Smith, Owen-Smith, Anderson, Hall-Martin and Selaledi (1986) determined age classes of white rhinos up to the age of 15 years. Rhinos can be grouped according to their body size, tooth growth or anterior horns. Beyond 15 years, an individual can be regarded as an adult. The oldest white rhino ever recorded was 40 years and 8 months (Skinner and Chimimba 2005). On 19 March 2018, the world's oldest northern white rhino, Sudan, died at the age of 45 years (Berlinger 2018). Rhino breeders keep data of individual animals, and it will be easy to determine the age of the animal from its birth date.

6.2.4.4 Horn regrowth abilities

If the horn is cut too close to the germinal layer, this could damage the horn base and lead to deformed horn re-growth (Lindsay and Taylor 2011). An approximate 10cm horn is therefore left on the rhino to protect the germinal layer. Lindsay and Taylor (2011) advise 12 to 24 months' dehorning intervals in poaching hotspot areas, and up to 36 months in low risk areas. According to Rachlow & Berger (1997) the rates of horn regrowth after dehorning appear to decrease slowly between 10 and 30 years where after it approaches a slow asymptote. They stated further that the re-growth of dehorned rhinos appears to be slightly faster than horn growth in non-dehorned rhinos. Hall (2012) quote Hume (2012) which estimated the re-growth rate of white rhino bulls as 1kg/annum and white rhino cows 0.6kg/annum. This confirms Rachlow and Berger's (1997) study that male white rhino's re-growth horn mass is almost twice that of females. An official from DESTEA gave the figure of 1kg/15-18months of regrowth and added that the repetitive dehorning over time deteriorated the horn quality and it became brittle.

([25]Louw *pers comm,* 2018). Taylor *et al.* (2017) states that white rhino bulls have an increase growth rate of 1.6 kg/annum up to the age of seven years after which growth rate levelled off, and white rhino cows 1.1 kg/annum to the age of six years before levelling off. Harvesting intervals was set at two years with an accompanying constant average factor of 1 kg per two-year regrowth as a compensation for the slower regrowth rate of an animal of both sexes towards it's >30 years of age. Although a rhino may become 40 – 45 years of age its last 10 -15 years will be incorporated in the 1 kg/two-year ratio. Shortened telomeres with each cell division causes cellular aging (Gomes Ryder Houck Charter Walker Forsyth Austad Venditti Pagel Shay and Wright 2011) and may be the reason for a slower rhino horn regrowth towards the end of a rhino's lifespan.

6.2.5 Three different scenarios calculated

An example on which three scenarios are based;
A 10-year adult breeding bull was poached a week after it was dehorned, leaving the original 1 kg horn on its head with 0 kg regrowth. The price for a rhino horn averages at ZAR 210 000/kg. The harvesting interval for rhino horns are 2 years. He was accompanied by five adult cows. There is no substitute bull. The farmer paid ZAR 317 500 for the bull in 2016 at an auction. The average price for a calf is ZAR 267 604. The maintenance cost per rhino is ZAR 43 739.

[25] Chris Louw, Environmental Management Inspector (EMI) responsible for rhino coordination and dehorning in the Free State.

Table 6.2 Production loss calculated for three different scenarios

FLF	SCENARIO 1 Breeding bull poached and not substituted	SCENARIO 2 Poached breeding bull, substituted	SCENARIO 3 Breeding cow poached
g	ZAR 317 500	ZAR 317 500	ZAR 600 000
a	5 cows left in herd	5 cows left in herd	*a* = 1
c	ZAR 267 604	Calf value removed	ZAR 267 604
s	10 years old	10 years old	10 years old
r	3-year calving interval	3-year calving interval	3-year calving interval
p	ZAR 210 00/kg/horn	ZAR 210 000/kg/horn	ZAR 210 000/kg/horn
d	1 kg (actual horn mass on day of poaching)	1 kg (actual horn mass on day of poaching)	1 kg (actual horn mass on day of poaching)
q	2-year horn harvesting	2-year horn harvesting	2-year horn harvesting
30-s	20 years lost	20 years lost	25 years lost
$\sum_{1}^{30-s} j\,(1 + 0.06)^{i}$	2 791 720	2 791 720	2 531 174
Cost	**ZAR 8 666 712.00**	**ZAR -164 220.00**	**ZAR 2 599 939.20**

<u>Breeding bull has been poached and is not substituted</u>

The Formula will not be adjusted in Scenario 1, since all factors determine the production loss.

Production Loss Formula (PLF) = $\left(g + \left[a \text{ x } c \text{ x } (\frac{30-s}{r})\right] + \left[(P \text{ x } d) + (\frac{30-s}{q} \text{ x } P)\right]\right) - \sum_{1}^{30-s} j\,(1 + 0.06)^{i}$

= 317 500 + $[5 \text{ x } 267\ 604 \text{ x } 6.6] + [210\ 000 + (10 \text{ x } 210\ 000)] - 2\ 791\ 720$

= 317 500 + 8 830 932 + 2 310 000 – 2 791 720

= 11 458 432 – 2 791 720

= 8 666 712

Production Loss (PL) = ZAR 8 666 712.00

Breeding bull has been poached and is substituted

In Scenario 2, the potential calf value will be removed, since a new rhino bull will be purchased, eliminating the need to determine the potential calf loss. Using the same example as before, the production loss will be determined as follows:

Production Loss Formula (PLF) = $\left(g + \left[(P \text{ x } d) + (\frac{30-s}{q} \text{ x } P)\right]\right) - \sum_{1}^{30-s} j\,(1+0.06)^{i}$

= 317 500 + $[210\,000 + (10 \text{ x } 210\,000)]$ – 2 791 720

= 317 500 + 2 310 000 – 2 791 720

= -164 220

Production Loss (PL) = ZAR -164 220.00 (A new breeding bull of ZAR 400 000 could also be added to the sum as a further loss)

Breeding cow has been poached, a breeding bull is still available in the herd

In Scenario 3, the number of cows left will be adjusted, as well as the age. the production loss will be determined as follows:

Production Loss Formula (PLF) = $\left(g + \left[a \text{ x } c \text{ x } (\frac{35-s}{r})\right] + \left[(P \text{ x } d) + (\frac{30-s}{q} \text{ x } P)\right]\right) - \sum_{1}^{30-s} j\,(1+0.06)^{i}$

= 600 000 + $[1 \text{ x } 267\,604 \text{ x } 8.3\,] + [210\,000 + (10 \text{ x } 210\,000)] - 2\,531\,174$

= 600 000 + 2 221 113.20 + 2 310 000 – 2 531 174

= 5 131 113.20 – 2 531 174

= 2 599 939.20

Production Loss (PL) = ZAR 2 599 939.20

Potential loss of future calves:

The indirect potential loss of future calves can be calculated independently by using the following extract of the formula: *a* x $\left(\frac{30-s}{r}\right)$. For example, the potential loss of future calves for a 10-year bull with 5 cows will be calculated as follows:

a x $(\frac{30-s}{r})$ = 5 x 6.3

= 33 rhinos' calves' loss

6.3 RESULTS

Seventy-five rhinos were poached in the Free State from 2009 to 2017, of which 64 died, six were wounded and five darted and survived. The production loss of 60 poached rhinos was calculated, of which 58 were white rhinos and two were black rhinos. The average ages of the poached rhinos were: 12.9 years for adult bulls (42%), 2.4 years for bull calves (8%), 13.7 years for adult cows (44%) and 2 years for heifers (6%). The gender distribution of the poached rhinos was: 15 adult bulls (25%), seven bull calves (12%), 32 adult cows (53%) and six (10%) heifers (Figure 6.2).

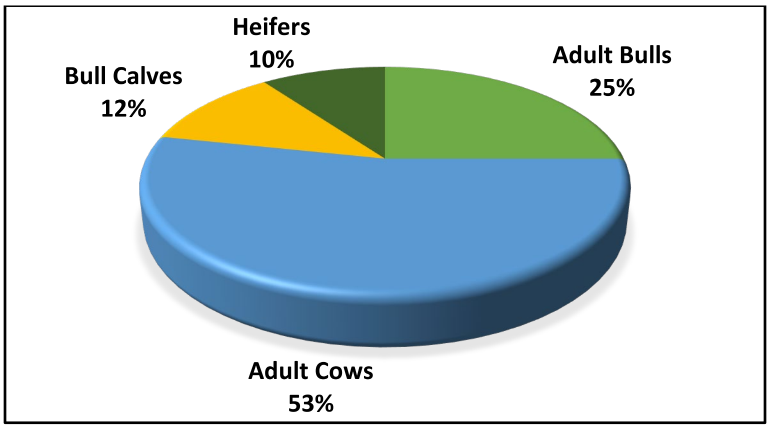

Figure 6.2: Percentage of age groups of rhinos poached in the Free State

The average actual production loss of the bulls is higher than the rest of the gender groups. The mean actual production loss of the bulls was R9 447 432.13 compared to the R3 522 640.50 of the cows, R3 429 309.67 of the heifers and R3 412 675.14 of the bull calves (Figure 6.3).

The highest production loss was a young breeding bull with 10 cows, with a calculated production loss of R21 019 890.00 (Range for breeding bulls = R1 343 663 - R21 019 890. The loss might be limited as soon as the owner replace the poached breeding bull with another purchased breeding bull reducing further loss. The lowest was a 34-year-old cow worth her own value of R783 066.00 (Range for cows = R783 066 – R4 386 923).

When calculating the production loss of all the poached rhinos in the Province, it adds up to a total loss of R298 900 562.00 for the 60 rhinos, for the period 2009 to 2017.

The production loss for private owner's total R219 629 262.00, and R79 271 300.00 for State-owned poached rhinos. It is important to note that the mean production loss for the private rhino owners was R4 482 229.84, while the mean production loss for State-owned rhinos were R7 206 481.82.

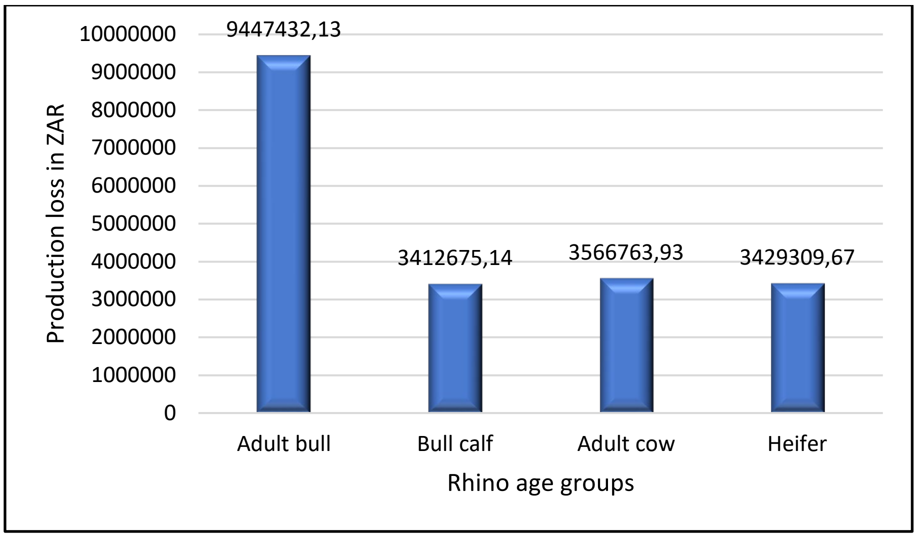

Figure 6.3: Average of the production loss (ZAR) calculated from poached rhinos in the Free State

To determine if there was a production loss difference between the genders, it was decided to categorise the genders. This categorisation can be used to determine what the tendency is of poaching when it comes to productive or unproductive animals. The bull and cow was categorised as productive animals, while the heifer and bull calves were categorised as unproductive animals.

In order to determine if there was a statistically significant difference in the production loss between the four gender groups namely bull, cow, heifer and bull calf, a Welch F test was conducted. This test was selected because a Levene's homogeneity of variance test indicated that the data did not have equal variance." The descriptive table for the production loss for the different gender groups is shown in Table 6.3.

Table 6.3: Descriptive table of production loss for different gender groups

GENDER	*N*	MEAN	STD. DEVIATION	STD. ERROR	95% CONFIDENCE INTERVAL FOR MEAN		MINIMUM	MAXIMUM
					Lower Bound	Upper Bound		
Bull	15	94 47432	672 9166	173 7463	5720943	131 73920	134 3663	210 19890
Cow	32	35 22640	68 1473	120 468	327 6943	376 8337	783 066	438 6923
Heifer	6	34 29309	90 228	368 35	333 4620	352 3998	335 4661	356 1249
Bull calf	7	34 12675	11 160	4 218	340 2353	342 2996	339 6930	342 2968
Total	60	498 1676	421 3253	54 3928	389 3277	607 0074	783 066	210 19890

The Levene's homogeneity of variance test was first conducted in order to assess the assumption of homogeneity of variance between the four gender groups. The Levene's test ($p <0.001$) indicated that homogeneity of variance could not be assumed. Due to the fact that the homogeneity of variance assumption was violated, a Welch F test was run. The Welch F test is a robust test that does not assume homogeneity of variance (Field 2009). The result of the Welch test ($F\ (3,14) = 4.04$, $p = .025$, $\eta_p^2 =0.38$) indicated that the there was a statistically significant difference in the production loss between the four gender groups.

The η_p^2 value of 0.38 indicated a medium-effect size based on the scale proposed by Wilson, Robertson, Burnham, Yonz, Ireland and Noehren (2017): strong relationship ($0.50 \leq r \leq 1.0$); moderate relationship ($0.3 \leq r < 0.5$); weak relationship ($r < 0.3$). A total of 38% in the variability of the production loss of a rhino can therefore be predicted by its gender group.

Games-Howell post-hoc tests were used due to the fact that homogeneity of variance could not be assumed (Field 2009). Table 6.4 provides a summary of the post-hoc comparisons between the various gender groups. The post-hoc tests indicated that there was a statistically significant difference between the production loss of bulls and females (p = 0.02, d = 1.56). The effect size for this analysis (d = 1.56) was found to exceed Cohen's (1988) convention for a large effect (d = .80). There was also a statistically significant difference between the production loss of bulls and heifers (p = 0.018, d = 1.04). The effect size for this analysis (d = 1.04) also exceeded Cohen's (1988) convention for a large effect. Moreover, a statistically significant difference between the production loss of bulls and bull calves were observed (p = 0.018, d = 1.07), with the effect size also exceeding a large effect size (Cohen 1988). No statistically significant differences in production loss were observed between cow and heifers (p = .880, d = .15), cow and bull calves (p = .798, d = .18) and heifers and bull calves (p = .967, d = .27).

Table 6.4: Games-Howell post-hoc comparisons of production loss between various gender groups

(I) GENDER GROUPS	(J) GENDER GROUPS	MEAN DIFFE-RENCE (I-J)	STD. ERROR	SIG.	Cohen's d	95% CONFIDENCE INTERVAL Lower Bound	Upper Bound
Bull	Cow	592 4791	174 1634	.020	1.56	868 727	109 80855
	Heifer	601 8122	173 7853	.018	1.04	967 508	110 68736
	Bull calf	603 4756	173 7468	.017	1.07	984 695	110 84818
Cow	Heifer	933 30	125 974	.880	.15	-246 333	432 994
	Bull calf	109 965	120 542	.798	.18	-217 151	437 081
Heifer	Bull calf	16 634	37 076	.967	.27	-1188 28	152 097

To determine the production loss difference between age groups, it was decided to classify poached rhinos in four age classes as described by Owen-Smith (1988), namely calves, adolescents, sub-adult and adult animals. This classification can be used to determine if a poacher has the intention to hunt adult or sub-adult rhinos when poaching a rhino.

In order to determine if there was a statistically significant difference in the production loss between different age groups, four age groups were created based on the classification of Owen-Smith (1988). The age groups are as follows: calves (0-2 years), adolescents (3 - 6 years), sub-adults (7 - 10 years) and adults (11 - 40 years). The descriptive table for the production loss for the different age groups is shown in Table 6.5.

Table 6.5: Descriptive table for production loss for different age groups.

AGE GROUP	N	MEAN	STD. DEVIATION	STD. ERROR	95% CONFIDENCE INTERVAL FOR MEAN		MINIMUM	MAXIMUM
					LOWER BOUND	UPPER BOUND		
Calves	9	342 8485	97 796	32 598	335 3312	350 3658	335 4661	367 2717
Adolescents	5	345 6186	75 010	33 545	336 3048	354 9324	339 6930	356 1249
Sub-adults	13	608 8574	628 2021	174 2319	229 2386	988 4761	142 0397	2101 9890
Adults	33	520 0357	404 2048	703 630	376 7109	663 3605	783 066	1586 2284
Total	60	498 1676	421 3253	543 928	389 3277	607 0074	783 066	2101 9890

The Levene's homogeneity of variance test was first conducted in order to assess the assumption of homogeneity of variance between the four age groups. The Levene's test ($p = 0.002$) indicated that homogeneity of variance could not be assumed. Due to the fact that the homogeneity of variance assumption was violated, a Welch F test was run. The Welch F test is a robust test that do not assume homogeneity of variance (Field 2009). The result of the Welch test ($F\,(3,23) = 2.807$, $p = .061$, $\eta_p^2 = 0.049$) indicated that there was no statistically significant difference in the production loss between the four age groups. The η_p^2 value of 0.049 indicated a very weak effect size based on the scale proposed by Wilson *et al.* (2017): strong relationship ($0.50 \leq r \leq 1.0$); moderate relationship ($0.3 \leq r < 0.5$); weak relationship ($r < 0.3$). Less than 5% in the variability of the production loss of a rhino can therefore be predicted by its age group. Due to the result of the Welch test which indicated that no significant differences exist between the four age groups, no post-hoc tests were performed.

6.4 DISCUSSION

A minimum ten years' age difference exists between the age groups of rhinos being poached. It is evident that poachers are in search of adult animals, because they have bigger horns and will therefore earn more money. From personal experience when dehorning rhino cows with calves, it was found that calves tend to charge the people around the sedated cow. This might be the reason why poachers shoot the calves when removing the horn from the cows. The poaching of young rhinos with smaller horns is, however, on the increase, as it still has value for the poachers (Trendler 2014). Some researchers (Owen-Smith 1972; Pienaar 1994; Jordaan 2010) stated that rhinos group in cow-calf pairs, solitary bulls, sub-adults and adults. Solitary adult bulls and cow-calf pairs may also be an allurement for poachers, especially if they were informed of the specific locality of a territorial bull or a cow-calf pair.

The Production Loss Formula shows promise, as it gave the production loss of the 34-year-old white rhino cow as R783 066.00, which is approximately the value of an adult productive rhino cow. The biggest loss, from recorded poaching in the Free State, was an eight-year white rhino bull, with a loss of R21 019 890, who accompanied 10 adult productive cows in a nature reserve. It was the offspring of an exceptional bull introduced from KwaZulu-Natal to breed specific genetic traits, such as large body size and big horn circumference. Some unique traits considered by game breeders are genetic variation, inter-calf period, structural soundness, horn traits and live body weights (Josling 2017). The 15-year black rhino bull did not have a high production loss, only R3 314 183, as it only accompanied one black rhino cow. The 15-year old black rhino cow had the highest production loss of R4 386 923, and this may be due to its high live value. Poaching an individual selected rhino, especially a bull, from a breeding herd has consequences, as such an individual with its unique phenotypical characteristics cannot be replaced. The Free State Province introduces new breeding bulls from KwaZulu-Natal every ten years to replace older bulls in the various reserves to counter inbreeding ([26]Lawrence *pers comm,* 2016).

Thus, rhino owners' attempts to breed quality animals are being jeopardised by the poaching onslaught. The effect of poaching on the heterozygosity of the rhino population is yet to be determined. The total production loss for the 60 poached rhinos in the Province, excluding the ones that were darted, wounded and who have died afterwards, amounted to a loss of almost R300 000 000. The State had a larger mean loss, with R7 206 481 compared to the R4 482 229 of rhino farmers. The difference may be due to the lower bull-per-cow ratio kept by the State.

Statistical tests proved that animal gender has a greater significance on the production loss ($P<0,05$) than the age of the animal ($P>0,05$). There is no statistically significant evidence to show that there is a difference in mean production loss between certain age groups. There is statistically significant evidence to show that there is a difference in mean production loss among the four animal genders. Poachers tend to hunt productive adult animals because of their weightier horns.

Due to the three-year gestation intervals of white rhino cows, as given in the study, the age of the animal does not have a significant effect on production. A rhino bull can father 20 calves annually, in contrast with the cow, which can only deliver once every three years. A bull may deliver multiple calves from various cows annually, which confirm the statistical significance of gender.

6.5 CONCLUSION

The Production Loss Formula is a valuable tool to calculate the production loss of a poached rhino. Its results reflect the reality as experienced by the breeder. The Formula

[26] Kees Lawrence, Chief Game Capturer of the Free State's Department of Economic, Small Business Development, Tourism and Environmental Affairs (DESTEA).

is not restricted to rhino breeders, but may also be used for other animals with similar contributing factors.

The potential loss of R300 million for the 60 poached rhinos is damaging to the rhino breeding projects of the Free State Province. Income generated by illegal poaching is spent in the informal economy and in foreign countries, with no gain for the South African formal economy. The high production loss of the State's rhinos is alarming. It can result in investigations by the State Treasury, and calls for accountability.

The high percentage of adult rhinos poached indicate the poachers' aim to gain the highest possible revenue. The statistics show that age does not have a significant influence, but gender does. This is confirmed by the higher breeding bull value compared to other lower-scoring gender groups. The Formula accentuates the value of a breeding bull.

The protection of certain individual rhinos, with scarce genetic traits, is a necessity to ensure that adequate genetic traits and species are not lost. Except for six exported black rhinos, the loss of all the black rhinos to poaching in the Province is alarming, and must be regarded as a warning for the Free State white rhino breeders to take the necessary pro-active measures to prevent the same from happening with white rhinos.

The production loss formula form the basis for further calculations. Other variables can be incorporated. The potential loss of horns that could be harvested from future calves could be added to the formula as well as the potential care of future calves.

Genetic studies proved the restricted genetic diversity of white rhinos due to historic hunting. It is recommended that future genetic studies examine the influence of rhino poaching on the genetic cost of rhinos. The current high number of animals poached will result in an increased lack of heterozygosity. To prevent this, white rhino breeding projects should be required to register, in order to secure the protection of genetic diversity.

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CHAPTER 7

THE DEVELOPMENT OF A PROPOSED RHINO ANTI-POACHING MODEL FOR RHINOS SITES IN THE FREE STATE PROVINCE

7.1 INTRODUCTION

Recently, rhino poaching and related crimes have escalated in South Africa, which raises concern among rhino breeders and environmentalists in South Africa. Furthermore, the approaches adopted to combat poaching up to now have not been successful. Therefore, a Rhino Anti-Poaching Model (RAPM), which identifies the poaching risk in a specific area, may reduce the vulnerability of rhinos, and will introduce techniques and measures for the Province's rhino breeders.

Watson (2017) stated that millions of Rands (ZAR), countless man hours and some of the best technology were combined to reduce the number of rhinos poached, but still 2.93 rhinos are killed daily. The study of Gyimah (2016) indicates that there is currently a lack of trust in the Department of Environmental Affairs (DEA) for handling the national poaching problem. The investigation of these different approaches, which have been tried and tested elsewhere, and the Free State's and other department's shortcomings, were factors that incited the development of a practical rhino anti-poaching model, designed specifically for the Free State rhino sites.

This Model differs from the African Rhino Conservation Action Plan and the Biodiversity Management Plan as far as practicality and level of operation is concerned. The African Rhino Conservation Action Plan provides a reassessment of the status of Africa's rhino populations and emphasize changing priorities for rhino conservation. It highlights specific actions that have been taken and forms part of rhino conservation strategies and policies (Emslie and Brooks 1999). The Biodiversity Management Plan sets out actions and strategies needed to ensure that monitoring, protection, conservation and sustainable management of the species will contribute to meeting conservation goals and contribute towards meeting the long-term vision for conservation of the species in question. These mentioned plans are used at government level, while the RAPM addresses actual rhino poaching risks in a private domain. Greeff (2015) discusses an Eight-Step Anti-Poaching Model which emphasises the importance of perimeter defence, internal defence, and rapid response as security measures for reserves. In addition to Greeff's model, a similar counter poaching model is serving as the protocol for the Ezemvello KZN Wildlife (2014) to act proactively, by means of planning and training. A Generalized Linear Model (GLM) developed by Lockwood (2010) revealed a series of complex poaching drivers such as State Management, Housing Density and Presence of a Road Through Property. A small sample size was however used in developing this model.

Throughout the development of the Rhino Anti-Poaching Model the target group, namely the rhino farmers, were kept in mind. The aim was to develop a practical, user friendly model which can form part of the daily management on a rhino farm. This Model is currently the only Rhino Anti-Poaching Model that measures a rhinos' poaching risk. It differs from the other models in its practicality, measurements and continual assessment. The RAPM was based on rhino poaching expert's opinions in the identification of critical factors that may influence poaching. It uses a scoring system that evaluates the five expert-defined factors, which identify weaknesses on the rhino farm. The Model also addresses the rectification of the risk factors. This enables continued monitoring of various security aspects. By predicting future poaching, the rhino owner may now counter an attack ahead of time.

During this study, details will be provided for the new proactive anti-poaching model, with specific emphasis on the five main factors that influence rhino poaching. The five expert-defined factors are the Rhino Camp, Population, Confidentiality, Habitat and Security Measures. The objective of this study is to develop a practical product for the rhino breeders of the Province that will determine their level of preparedness against the rhino-poaching onslaught.

To conclude, the model can help to identify weaknesses on a rhino property, which is unknown to the rhino breeders, and it will be referred to as the Poaching Risk.

7.2 METHODOLOGY

A pro-active five-step Rhino Anti-Poaching Model (RAPM) was constructed for the Free State Province as a guide for the existing and future rhino breeders to consider, through an objective analysis and evaluation.

The RAPM consists of the following five components:

1. Determine the current poaching risk of a rhino farm by calculating a Poaching Risk Percentage (PRP), using the five expert-defined factors, namely; Rhino Camp features, Rhino Population size, Confidentiality of the rhino project, Habitat and Security Measures on site (to be explained later in further detail).
2. Evaluate weaknesses identified through the five factors.
3. Address the problem areas by implementing precautionary measures.
4. Daily monitoring of implemented protocols.
5. Predict future poaching by gathering continual data from internal and external resources.

The following schematic model shows the working of the Rhino Anti-Poaching Model (Figure 7.1).

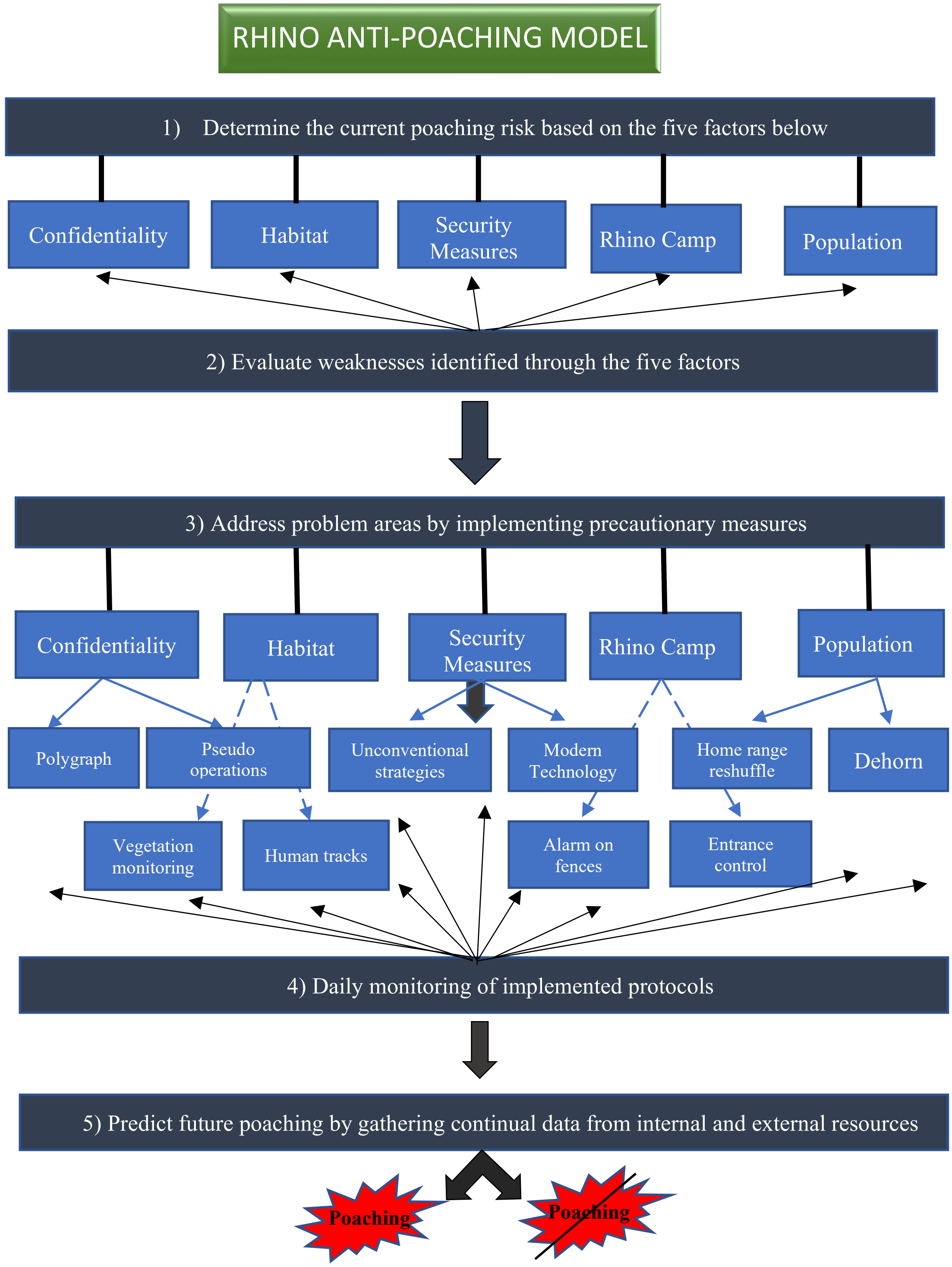

Figure 7.1: The Rhino Anti-Poaching Model for Free State rhino owners.

7.2.1 Determine the poaching risk

The poaching risk of a rhino farm is determined by calculating a Poaching Risk Percentage (PRP), using the five expert-defined factors, namely; Rhino Camp, Rhino Population, Confidentiality, Habitat and Security Measures.

7.2.1.1 Identification of factors contributing to poaching

To identify factors contributing to poaching, a complex scientific or mathematical approach was avoided. This Model does not use a factor analysis based on data but rather an expert-defined factor analysis based on the Multi-Criteria Decision Analysis (MCDA), as described by Mabin and Beattie (2006). Analysis of factors were done through brainstorming with experts, which included conservationists, rhino security experts, members of the SAPS endangered species task force and rhino farmers and an intuitive approach was followed. During brainstorming sessions focusing questions were asked to define which factors contribute to poaching from the poacher's perspective. Factors most mentioned by the experts were chosen. Through these sessions the following five main contributing factors were identified:

- Rhino Camp Factor: The ease of which the poacher can enter and exit the rhino camp.
- Rhino Population Factor: The rhino population as an allurement with their accessibility, numbers and horn qualities.
- Confidentiality Factor: The ease of which the poacher can infiltrate a rhino owner's management strategies, for example by befriending the labour force.
- Habitat Factor: The difficulty of the terrain, for poachers to stalk rhinos.
- Security Measure Factor: The degree of security measures implemented by the farmer or management authority that will reduce a poacher's risk of being killed or captured.

7.2.1.2 Determining the weighting of factors to calculate PRP

According to Monat (2009) the decision-maker's perception of how important a Factor is, will determine the weight of each factor relative to the other factors that are also taken into consideration. The criteria given by Pauw and Wolvaart (2009), where a weight is allocated to a criterion indicating its contribution to the overall objective, were also taken into consideration to determine factor weights. A similar allocating of weights contributing to criteria was given by Kruger (1983) where a score out of a 100 was given for certain criteria to determine veld condition.

The same expert-defined factor analysis used to identify the five main poaching contributing factors (as described in 7.2.1.1) was used to determine the different weights for the five factors:

- RHINO CAMP; with regard to its location near or far from towns and roads were regarded by the experts as the most important contributor to poaching, was given a weight of 35%.
- RHINO POPULATION; as an important attraction or allurement on any rhino site for the poachers, were given a weight of 20%.
- CONFIDENTIALITY; leaking of information by employees or role players on rhino farms attract poachers, therefore a weight of 30% was allocated.
- HABITAT; may hinder or benefit the poacher or the rhino farmer, and 5% was allocated to the factor.
- SECURITY MEASURES; implemented to guard and protect rhino as an asset was allocated a 10% weight (Table 7.3).

Literature (as indicated in Table 7.1) was also used to gather more information on the expert-defined factors as well as the five respective weights allocated to ~~to~~ each factor (Dean 2011; Venter 2013; Greeff and Von Tichelin 2014; Greeff 2015).

Table 7.1: Description of factors, rationale for inclusion, effect of factor, literature assistance and weights allocated for each factor.

FACTORS	DRIVE FOR POACHING	HYPOTHESIS	LITERATURE	WEIGHT
Rhino camp features	The sizes of rhino camps, distance from roads and easy entrances makes accessibility easier for a poacher.	Speedy accessibility reduces chance of arrest or killed	Lockwood (2010) Greeff (2015)	35%
Rhino population	A larger population attracts poachers because it is easy to find a rhino, for example the KNP	Rhino population serves as an allurement	Metzger (2010) Ferreira *et al.* (2015)	20%
Confidentiality in and around rhino sites	The flow of people on and adjacent to rhino sites, as well as a lack of covert operations	More people on a rhino site increases risk of poaching.	Vigne (1998) Steele (1989) Dean (2011)	30%
Habitat availability	Water bodies, bushes, drinking and feeding spots are resources for poachers' advantage.	Habitat features assist poachers in poaching events	Lockwood (2010) Greeff (2015) Jordaan *et al.* (2015)	5%
Security measures implemented	Non-existent, stereotypical to limited security measures will drive poachers to rhino sites	Insufficient security measures will attract poachers	Bewick (2017) Venter (2013) Van Jaarsveld (2011)	10%

7.2.1.3 Assignment of attribute questions to each factor.

A Scoresheet (Table 7.2) was developed with five attribute questions categorised under each of the five above-mentioned Factors. Attribute questions are supportive questions that explain and enlightens each Factor. These questions were taken from a rhino farmer's or nature conservator's perspective, as they would be the users of the Scoresheet. The attribute questions under each factor measures the possible impact of the Factor, and these questions were aimed to be as quantitative as possible.

7.2.1.4 Formula for the PRP and RPRP

Poaching Risk Percentage (PRP):

A formula was developed to calculate the Poaching Risk Percentage (PRP) per rhino site. To understand the extent of the potential rhino-poaching risk, the five expert-defined factors had to be brought into account to determine the specific poaching risk on each farm. Based on the above-mentioned factors, the equation for determining PRP is as follows:

$$\text{Poaching Risk Percentage (PRP)} = R_c \sum_{i=p}^{n} + P_o \sum_{i=c}^{n} + C_o \sum_{i=s}^{n} + H_a \sum_{i=r}^{n} + S_e \sum_{i=h}^{n}$$

<u>Where:</u>

R_c = Rhino Camp

P_0 = Population

C_o = Confidentiality

H_a = Habitat

S_e = Security Measures

To test the formula, the following hypothetical example will be described, after which the PRP will be computed:

A 1000 ha rhino camp is situated adjacent to a tar road, with 50 rhinos, which were never dehorned. Daily horse patrols occur, a helicopter is available and intern rhino guards perform stereotype patrols. The camp has a river as one border, with high ground and a locked gate. Up to 120 seasonal labourers worked on the farm during the winter. There are no alarms on the fences, and the farm has a savannah habitat with thickets alongside the river. The farm, with a guest house, is located 5 km from town.

The attribute questions (as described in 7.2.1.3) are scored 1, 2, 3 or 4; a higher risk having a higher value. The attribute questions scores add up to a maximum of 20. The total of the five attribute scores for each factor, multiplied by five, gives a maximum Factor score out of 100.–This example given was scored according to the Scoresheet (Table 7.2) and the results (86.25% & 61.75% for PRP and RPRP) are reflected in both the scoresheet, spreadsheet and equation.

Based on the above criteria:

R_c	= Rhino Camp	(90 x 35%	= 31.5)
P_0	= Population	(90 x 20%	= 18)
C_o	= Confidentiality	(80 x 30%	= 24)
H_a	= Habitat	(85 x 5%	= 4)
S_e	= Security Measures	(85 x 10%	= 8.5)

= $(R_c \text{ x } 0.35) + (P_o \text{ x } 0.2) + (C_o \text{ x } 0.3) + (H_a \text{ x } 0.05) + (S_e \text{ x } 0.1)$

= (90 x 0.35) + (90 x 0.2) + (80 x 0.3) + (85 x 0.05) + (85 x 0,1)

= 31.5 + 18 + 24 + 4.25 + 8.5

= 86.25%

<u>The Rectification Risk (RPRP):</u>

The Rectification Risk is the re-evaluated PRP. If weaknesses were identified through the RAPM and rectified, then the poaching risk can be re-evaluated and scored to obtain a Rectified Poaching Risk Percentage.

In the hypothetical examples (Table 7.2), on the right-handed column, the Rectified Risk was calculated to determine the new Factor Score for each of the five Factors. This can be done to determine whether the rhino premise was suitable to continue keeping rhinos or whether to discard the rhino project. By re-evaluating a premise, it can be determined if major management adjustments are necessary or not. As an example; In the Scoresheet, Question 2 of Security Measures was initially given a score of 4, because stereotypical patrols exist, but was adjusted after unconventional night patrols were introduced and the score changed to 1.

The same set of attribute questions were asked but instead of scoring on the left column, the re-evaluated scores were written in the right “Rectified Risk” column next to each attribute question. The following Rectified Risk example is reflected in the Scoresheet:

$$= (R_c \text{ x } 0.35) + (P_o \text{ x } 0.2) + (C_o \text{ x } 0.3) + (H_a \text{ x } 0.05) + (S_e \text{ x } 0.1)$$

= (70 x 0.35) + (70 x 0.2) + (55 x 0.3) + (65 x 0.05) + (35 x 0,1)

= 24.5 + 14 + 16.5 + 3.25 + 3.5

= 61.75%

Table 7.2: A Scoresheet to evaluate the risk of rhino poaching.

POACHING RISK	**SCORESHEET** **Attribute questions scored 1 – 4.** **Factor score = Total attribute score x 5**	**RECTIFIED RISK**
	R_c = RHINO CAMP FACTOR	
Attribute score	**Attribute questions**	**Attribute score**
4	1) Is the rhino camp situated next to a public road? Quick in and out makes arrests difficult. Camp more than 20 km from road = 1, >10km = 2, >5km = 3, less than <5km = 4.	4 (fence off rhino camp from road)
4	2) Is the rhino camp located near a public place or town/city? More than 35 km from town = 1, >25km = 2, >15km = 3 and less than <15km = 4.	3 (do more patrols)
3	3) Are the rhino camps near owner's house, manager or neighbours? Within 500m = 1, 500m-1km = 2, 1km-2km = 3 and more than 3km = 4.	2 (adjust the camp fence)
3	4) Easy points of camp/reserve entrance? Electric fence with alarms = 1, fixed trial cameras on fences/observation posts = 2, electric or 2,4m netted fence = 3, 1,8m steel wire fence with strong corner posts =4.	2 (install cameras at entry points)
4	5) Are there any small camps or only a large rhino camp? Larger isolated camps are more exposed to poaching. Small camps less than <100ha = 1, 100 – 250ha = 2, 250 – 500 ha = 3, more than 500 ha = 4.	3 (divide large camps)
18 x 5 = 90	**Rhino Camp Factor Score**	**14 x 5 = 70**
	P_0 = RHINO POPULATION FACTOR	
Attribute score	**Attribute questions**	**Attribute score**
4	1) How many rhinos on the farm? More rhinos are a higher risk. Less than <10 = 1, 11-25 = 2, 26 - 40 = 3, 40+ = 4.	4 (no options)
4	2) Are rhinos dehorned? Dehorned is a lower risk. More rhinos more difficult to dart regularly: Annual = 1, Bi-Annual = 2, every three years = 3, never = 4.	3 (dehorned every 3rd year)
4	3) Does their home range border a public place or road? >5km = 1, 3-5km = 2, 1-3km = 3 and within 1 km is high risk = 4.	3 (fence off public road)
3	4) What are the age structures of the population? Calves = 2, Sub-adults = 3, Adults and bulls in bull camp = 4	2 (sell extra bulls)
3	5) Are there isolated individuals such as territorial bulls or cow and calf combinations? They tend to stay at specific sites and are a high risk. Sub-adult singles =2, isolated cow-calf = 3, territorial bulls = 4.	2 (trial cam installed at spec. sites)
18 x 5 = 90	**Rhino Population Factor Score**	**14 x 5 = 70**

C_o = CONFIDENTIALITY FACTOR		
Attribute score	**Attribute questions**	**Attribute score**
4	1) How many permanent labourers on the farm? The more workers the higher the risk. Less than <10 =1, more than >10 = 2, >20 = 3, >40 = 4	3 (reduce workforce)
4	2) Any foreign workers in the neighbourhood? Any Mozambican or Zimbabwean workers? Adjacent farms or townships? More than 20km =1, less than 15km =2, less than 10km =3 less than 5 = 4.	4 (no options)
4	3) Do you make use of any casual or seasonal workers from time to time? Less than 10 workers =1, 11-30 =2, 31 - 50 = 3 >50 =4	1 (polygraph tests)
2	4) Any tourist activities on the farm? This is a prevention (such as hunters on farm). None = 1, hunters = 2, tourism = 3, game farm activities = 4.	2 (allow hunters on farm)
2	5) Allowing of any contractors on the farm? Only once =1, annually =2, bi-annually =3 and quarterly =4.	1 (limit contractors)
16 x 5 = 80	**Confidentiality Factor Score**	**11 x 5 = 55**
H_a = **HABITAT FACTOR**		
Attribute score	**Attribute questions**	**Attribute score**
4	1) Are there any rivers/dams that may provide easy entrance to the rhino camp/area? No rivers/dams bordering camp = 1, isolated large dams = 2, part of a river = 3 and dam/river bordering camp = 4.	3 (install cameras near river)
4	2) Is the rhino camp an open grassy plains camp, savannah veld, or thickets such as shrubs and trees? Thickets = 4, trees and shrubs = 3, savannah = 2 and grassy plains = 1.	3 (cameras at sleeping places)
4	3) Are their feeding hot spots fixed or do you rotate these hot spots within the habitat? Natural grazing area = 1, natural feeding hot spots = 2, rotate artificial feeding spots = 3, fixed artificial feeding spots = 4.	3 (rotate feeding buckets)
3	4) Are their drinking troughs near public places, isolated or in the open? Natural drinking place away from roads = 1, camouflaged fixed water troughs = 2, in the open = 3, close to public place (within 1 km = 4).	2 (move water troughs)
2	5) Any high ground; rocky hills, cliffs or dongas where poachers can hide? Hills = 1, dongas = 2, rocky outcrop = 3 and cliffs = 4.	2 (erect viewpoint)
17 x 5 = 85	**Habitat Factor Score**	**13 x 5 = 65**
S_e = **SECURITY MEASURES FACTOR**		
Attribute score	**Attribute questions**	**Attribute score**
3	1) Unconventional measures applied: rhino decoys, mannequins with rifles, etc. = 1, high tech = 2, helicopter = 3, no unconventional strategy = 4.	2 (deploy decoys)
4	2) Conventional measures applied: horse patrols, foot patrols and other stereotypes. Night horse patrols =1, night foot patrols =2, other patrols (vehicles) =3 and stereotypes =4	1 (change stereotypical patterns)
3	3) What kind of equipment applicable? Mainly two-way radios or high tech equipment? Latest tech = 1, drones or equivalent = 2, ordinary equipment = 3, none = 4.	1 (install TrialGuard System)
3	4) Do the guards patrol the perimeter for human tracks or signs? All fences and internal tracks = 1, only fences or only tracks = 2, only monotonous patrols = 3, none = 4.	1 (check all tracks and signs daily)
4	5) Trackers, agents or guards appointed? Personal = 1, own guards = 2, “Bushmen” trackers = 3, contracted guards = 4.	2 (control own guards)
17 x 5 = 85	**Security Measures Factor Score**	**7 x 5 = 35**

A spreadsheet Formula was developed in Excel. The score of each of the five Factors was entered on the spreadsheet Formula next to its Factor allocated weight. The Factor scores are multiplied by the Factor weights. When the scores of all five Factors (point out of 100) were added in the Formula, the Poaching Risk Percentage (PRP) for each rhino site was automatically calculated on the spreadsheet (Table 7.3). After rectifying measures are taken, a rhino site can be re-evaluated to determine the Rectified Poaching Risk Percentage (RPRP).

Table 7.3: A spreadsheet to calculate PRP and RPRP for a rhino site.

Hypothetical Rhino Site	Poaching Risk Percentage (PRP)			Rectified Poaching Risk Percentage (RPRP)		
	Factor weight	Factor score	Poaching risk (%)	Factor weight	Factor score	Rectified risk (%)
Rhino Camp Factor	35%	90	31.5	35%	70	24.5
Rhino Population Factor	20%	90	18	20%	70	14
Confidentiality Factor	30%	80	24	30%	55	16.5
Habitat Factor	5%	85	4.25	5%	65	3.25
Security Measure Factor	10%	85	8.5	10%	35	3.5
	100%		**86.25%**	**100%**		**61.75%**

The 86.25% in the spreadsheet represents the PRP and the 61,75% represents the RPRP after the hypothetical site was re-evaluated.

7.2.2 Evaluate weaknesses identified through the five factors

Alberts and Dorofee (2002) stated that a comprehensive security risk evaluation approach enables decision-makers to develop relative priorities based on what is important to an organization. During the process of the PRP the rhino owner will be confronted with the reality of the poaching risks on his property. Weaknesses can then be identified in his security system and evaluated. One or all of the five factors may show weaknesses. By recognition of specific weaknesses, he can address problem areas.

7.2.3 Address problem areas by implementing precautionary measures

This is the decision-making phase. Definite actions can be taken by implementing drastic precautionary measurements such as the deployment of unconventional methods or installation of trial cameras or doing polygraph tests on the rhino guards. Auster *et al*. (2011) advises that precautionary approaches should be the overarching requirement when facing uncertainties.

7.2.4 Daily monitoring of implemented protocols

After new measurements were introduced the owner enter now the stage of coordination. All protocols must now be continually managed. This phase must be done through Planning, Leading, Organisation and Control. These principles recommended by Tischew *et al*. (2010) must be followed on rhino premises and implemented as a standardized control procedure. By performing these protocols, planning and implementation errors should be avoided and development defects should be detected and corrected in time.

7.2.5 Predict future poaching by gathering continual data from internal and external resources

Data must be collated continually from various natural resources. All collated data must be investigated for patterns, correlations and trends. If certain trends appear the rhino farmer should be alerted of possible risks, i.e. poaching occurrences during the full moon stage. Predict future rhino poaching based on daily gathered data is by now an established method of determining poaching risks. Information gathering can be collated from various reports and use to predict a poaching attack with the use of models such as CAPTURE and PAWS (Nguyen Sinha Gholami Plumptre Joppa Tambe Driciru Wanayama Rwetsiba Critchlow and Beale 2016; Fang Nguye, Pickles Lam Clements An Sing, Schwedock Tambe and Lemieux 2017; Koen 2017).

7.2.6 Statistical data analysis

A statistical analysis was done to determine which one of the five expert-defined factors, used to calculate the PRP, had the strongest influence on poaching at a rhino premises. The data collected for statistical analysis was derived from the 46 rhino questionnaires. No other respondents could be included as these 46 are the only rhino farming sites in the Province.

Rationale for the use of multiple regression:
Stepwise multiple regression was selected for the study as it is particularly suitable to answer the question of what the best combination of independent variables would be in order to predict the dependent variable (Field, 2009). In a stepwise regression, not all independent variables may end up in the equation. Independent variables are entered into the regression equation one at a time. At each step in the analysis, the independent variable that contributes most to the prediction equation in terms of increasing the multiple correlation, R, is entered first. This process is continued only if additional independent variables add statistically to the regression equation. When no additional independent variables add anything statistically meaningful to the regression equation, the analysis stops (Field, 2009).

7.3 RESULTS

Through an objective analysis and evaluation, a pro-active RAPM consisting of five components was constructed. This RAPM enables a rhino farmer to calculate the PRP of the rhino premises, identify and address weaknesses, monitor rhino security as well as predicting a possible rhino poaching onslaught.

A stepwise multiple regression was conducted in SPSS version 19 to evaluate whether all independent variables namely Poaching Risk Percentage (PRP) for Rhino Camp. PRP for Population, PRP for Confidentiality, PRP for Habitat and PRP for Security Measures were necessary to predict the number of rhinos poached. Two constructs namely PRP for Rhino Camp and PRP for Population made a statistical contribution to the model and were entered the regression model. This resulted in a significant model R^2= 0.367, $F(5,40)$ = 5.43, P = 0.001; R^2=0.367. The R^2 value of 0.367 indicates that approximately 37% of the number of rhinos poached could be accounted for by the PRP for Rhino Camp and PRP for Population constructs. The following guidelines, presented by Evans (1996), were used to interpret R^2: very weak (0-4%); moderate (16 – 36%); strong (36-64%) and very strong (64-100%). From these guidelines, the model that was constructed had a strong predictive power towards the number of rhinos poached construct.

The coefficients' table of the regression model is shown in Table 7.4. This Table was used to construct the regression equation for predicting the numbers of rhinos poached construct:

Number of rhinos poached = -5.682 + 0.073 * PRP for Rhino Camp + 0.066 * PRP for Population.

Table 7.4: Model coefficients for regression model of number of rhinos poached.

Constructs	B	SE	β	T	P
PRP for Rhino Camp	0.073	0.026	0.389	2.785	0.008
PRP for Population	0.066	0.030	0.309	2.209	0.033

As can be seen from Table 7.4, PRP for Rhino Camp (β = 0.39, p=0.008) was the most important predictor of the number rhinos poached with PRP for Population the second most important predictor (β = 0.31, p=0.033).

Table 7.5: Regression coefficients for excluded variables.

Constructs	B	SE	β	T	P
PRP for Confidentiality	0.041	0.026	0.229	1.575	0.123
PRP for Security Measures	-0.006	0.040	-0.028	-0.145	0.886
PRP for Habitat	-0.007	0.034	-0.027	-0.189	0.851

Table 7.5 display the regression coefficients for the excluded variables. As can be seen none of these variables were significant predictors of number of rhinos poached and all had p values greater than 0.05.

The mean rhino-poaching risk of the 46 rhino sites in the Province was 64.5%. An alarming eight rhino sites scored a PRP above 75%. Six rhino sites scored a poaching risk below 50%, and up to date no poaching incidents occurred on these sites. The PRP's were grouped (bin) with 10% intervals and zero poaching events were reported in the bins under 50%. The bins with a PRP between 50 - 59% had three poaching incidents from the seven PRP's, seven from 16 PRP's reports poaching in the 60 – 69% bin, 13 of the 14 sites PRP's report poaching in the 70 – 79% bin and all three PRP's in the bin above 80% were poached (Figure 7.2). A RPRP evaluation of each rhino site in the Province were done, and the average poaching risk was reduced to 56% for the Province. It ranged an improvement of between 2% to 17% for all respondents.

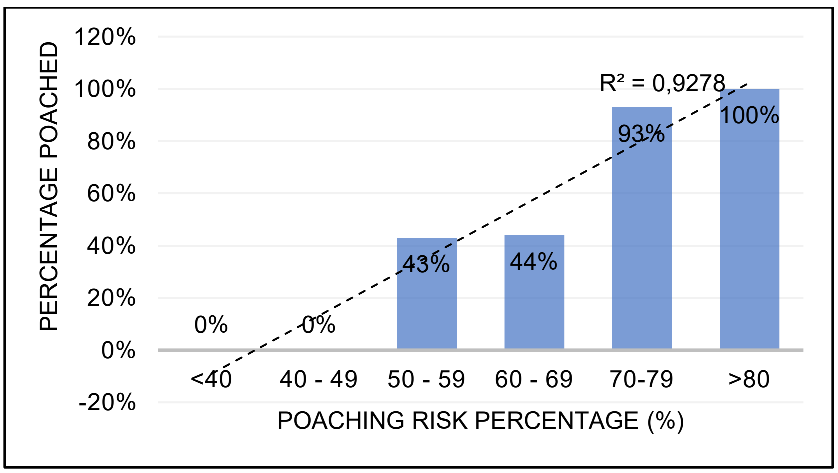

Figure 7.2: Correlation between PRP and actual poaching events.

7.4 DISCUSSION

Various counter poaching models or measures exists, for example:

- An Eight-Step Counter Poaching Model developed by Greeff (2015) based on an evaluation on the proactive and reactive status, with practical guidelines.

- A proactive mathematical model developed by Koen (2017), which mathematically predicts a possible area in which a future poaching attack could take place.
- Cheteni (2014) gives forensic technology trials, radio collars, increased penalties, unmanned aerial vehicles (UAV) and a sustainable approach as measures to stop poaching.
- A paramilitary Eight-Step Counter Poaching Model initially developed by Maggs and Greeff (1994) in the Kruger National Park, based on Information Intelligence, Threat Analysis, Operation Security, Animal Security, Physical Security, Authority, Planning Crisis Management and Reaction, which pivots on pro-active and reactive principles (Maggs and Greeff 1994; Greeff 2015).
- The KwaZulu-Natal Private Rhino Owner Reserves' Standard Operating Procedures (SOPs) describe for their members a more governmental approach with an emphasis on Responsibilities, Intelligence, Investigations, Procedures, Monitoring, Patrolling, Protocols and Systems (Ngubane 2012, Ezemvelo KZN Wildlife 2014).
- A Generalised Linear Model (GLM) created by Lockwood (2010) for KwaZulu-Natal, using a combination of seven variables which include Poaching Status, Population Data, Property Size, Land Management, Infrastructure, Terrain and Housing Density. The GLM identifies the "management of the reserve", "housing density surrounding the property" and the "presence of a main road through or around" as the variables that statistically best explain the rhino-poaching incidents.
- The Endangered Wildlife Trust (2011) provides a booklet with proactive prevention methods and include Property Size, Farms Bordering Roads, Difficult Terrain, Water and Feeding Points, Staff, Location of Property and Lack of Inadequate Systems as the leading role players in strengthening rhino security.
- Lopes and Conrad (2017) provides a model which links the spatial-temporal dynamics of species migration with the economic game of poaching and protection.
- Fang *et al.* (2017) described how PAWS (Protection Assistant for Wildlife Security) could lead to regular deployment to topographic features, species distribution and complex patrolling schedules.

There are parallels between the RAPM and some of the abovementioned models, for example the GLM's "main road through or around" and the RAPM's "rhino camp", which main attribute was also the roads adjacent to rhino sites. Lockwood reports that 80% of poaching occurs when rhino sites in KwaZulu-Natal are situated next to roads. This was also the case in the Free State, where 80% of rhino sites bordering public roads, report poaching.

These models could be of assistance in determining valuable patrols in large scale areas where rhino occur. It might also assist in providing details of areas where rhino guards might patrol in vain, since the areas are not suitable for rhinos, or are areas where they never roam. It will be advisable to patrol the rhino home range instead of the entire rhino site (although patrolling the entire site should not be neglected). The average home range for nine white rhinos were 5.05 km² on the 120 km² Willem Pretorius Game Reserve (Jordaan 2010). It is therefore not necessary to patrol 115 km² in vain, while rhinos only utilise a portion of such a large area.

The RAPM incorporates most of the attributes of the above-mentioned models. It however differs mainly from these models as it is based on an exact measurement. The RAPM is more practical and uses a unique Scoresheet that assists during the evaluation process and the monitoring of its five expert-defined factors. The RAPM also places emphasizes on the usage of the opinions of experts with extensive practical experience rather than theoretical based methods.

Five expert-defined factors were identified as contributors in the development of a RAPM. The statistical analysis showed a strong predictive power of approximately 37% towards the number of rhinos poached and that PRP for Rhino Camp and PRP for Population was significant (Rhino Camp, $P = 0.008$ and Population, $P = 0.033$, significant $P<0.05$) while PRP for Confidentiality, PRP for Habitat and PRP for Security Measures played an insignificant role in poaching. Although only two factors of the model showed significance for the specific study group, the results may change if the study group is enlarged to include rhino sites in other Provinces of South Africa. Further studies that can provide more data through a bigger sample group is needed to justify the removal or replacement of any of the expert-defined contributing factors.

After evaluating all the rhino sites in the Province, an average rhino-poaching risk of almost 65% is of concern. After a rectification evaluation of each rhino site was done, the average poaching risk reduced with nine percent. This indicates that the poaching risk for the Province can be reduced, and certain rhino sites could improve security by 17%. After rectification, 10 sites could score below 50% instead of the current four. Currently 57% of all the rhino sites in the Free State already experienced a poaching incident. A reasonable score would be to have a 50% or less chance to be poached given the current situation. Currently, all rhino sites in the Province that have a PRP of less than 50% did not report any poaching incidents. The PRP for rhino sites in the Free State that scored in a category above 70 % had almost a 100 % poaching occurrence. After rectification, only 10 rhino sites could possibly score below 50%. Based on the PRPs, 40 (87%) of the rhino sites in the Province scored above 50%, and should consider cancelling their rhino projects, or drastically improve their areas of concern, as identified via the RAPM.

7.5 CONCLUSION

For the first time a Rhino Anti-Poaching Model has been developed to measure a poaching risk. This pro-active evaluation model serves threefold: as a measurement; a guide to identify weaknesses, and a practical tool to implement strategies.

The pro-active Rhino Anti-Poaching Model succeeds, through its expert-defined factors, to identify weaknesses on a rhino site, and to predict a poaching risk. It also provides information on rectifying measures that could be used to improve deficiencies on the sites. By rectifying each factor, the rhino owner may now counter an attack ahead of time.

It is believed that the RAPM, as developed through this study, is a significant method to determine poaching risks. Although data collected from rhino premises in the Free State Province only show a strong significance for the two factors, Rhino Population and Rhino Camp, data that may be collected through further studies from additional rhino premises, may indicate that the other three identified factors also show significance. This study lays the foundation for future studies to investigate combinations of variables versus the individual risks of variables. The RAPM can assist in counteracting the escalating onslaught through poaching on a rhino population.

It is recommended that the Department (DESTEA) set a requirement for future rhino farmers to provide a Risk Management Plan before permits are approved for breeding of a TOPS species, such as white rhinos, as required by the TOPS Regulations.

The success of the Rhino Anti-Poaching Model relies on the regular evaluation of the five factors, implementation of corrective measures, and prediction of a possible poaching incident.

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CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 SUMMARY OF MAIN FINDINGS AND HOW IT ADDRESSES THE SET GOALS

Various authors gave evidence of rhino occurrences in the Free State Province of South Africa. The last white rhino was shot in 1836 near Scandinavia Drift in the Vredefort district. Twelve farms in the Free Sate had rhino as a prefix in their names, which indicates that rhinos may have occurred in that specific area. This was investigated for confirmation purposes. Only three farms' localities provide possible evidence of rhinos' occurrence in the Province, namely Rhenosterfontein near Theunissen, Rhenosterkop near Kroonstad, and Scandinavia Drift near Vredefort. Various historical photos and old literature gave a retrospective view into historical times, and indicated that there was insufficient browsing vegetation for black rhinos to survive at mentioned sites. In this thesis, it was emphasised that only white rhino possibly inhabited the Province.

The South African government promulgated numerous environmental legislations to manage the environment with a more holistic approach. To be on par with the international environmental community, the numerous environmental legislative frameworks create more unnecessary enemies to combat, leaving rhino poaching as one of many. Since the promulgation of the environmental legislation, more than 7 245 rhinos were killed, and a limited number of poachers were sentenced. After analysing the various acts and comments of other studies, the conclusion could be drawn that the environmental legislation may be effective, but the over-regulating of minor monitoring issues limits the execution of major transgressions, such as rhino poaching.

This study provides an examination of a range of methods to prevent rhino poaching. The new technological innovations, old conventional methods and new unconventional methods were equated with regards to their reliability and efficiency. A brief discussion on the latest technological innovations gave insight into the individual devices' purpose of development and effectiveness in rhino poaching. A short description of old conventional methods forms the backbone to basic protection, while new innovative unconventional methods provide alternative combat strategies, which might be unknown to poachers. A combination of the latest technological equipment, conventional and unconventional strategies can be implemented together as a strategy to counter rhino poaching.

There is currently a poaching onslaught on the various rhino populations in South Africa. A questionnaire was developed and data were collected, providing statistics on the current stance of security measures on rhino sites in the Province. The results indicate that 80% of the rhino poaching occurs in rhino camps bordering public roads; 69% of the rhino sites located within 20km from the nearest town reported poaching; and 77% of large rhino camps are prone to poaching incidents. A total of 57% of the respondents experienced rhino poaching on their sites.

The Production Loss Formula proved to be valuable in determining production loss due to poaching. The production loss indicates that the Province lost almost R300 million due to the poaching of 60 rhinos. The statistics show that age does not have a significant influence on poaching, but gender does. This confirmed the higher breeding bull value compared to other lower scoring gender groups. The Formula accentuates the value of a breeding bull. The high percentage of adult rhinos poached reflects a poacher's intention to gain the highest possible revenue.

A stepwise multiple regression showed that Rhino Camps and Rhino Population are the two main contributing factors to poaching in the Province. The confidentiality diagram indicates that 74 people are involved in rhino translocations, which limited confidentiality. From the questionnaire, a five-step proactive Rhino Anti-Poaching Model was developed to evaluate the 46 rhino sites in the Province, and to determine the poaching risk of each site. The results from the model indicate that the average poaching risk of the respondents from the Free State is 65%. Only four rhino sites scored a poaching risk below 50%. The Rhino Anti-Poaching Model assists to: a) determine a current poaching risk; b) identify weaknesses on the rhino site; c) rectify problem areas; d) enable continued monitoring; and e) predict possible poaching risk. By rectifying each factor, the rhino owner may now counter an attack ahead of time.

8.2 CONCLUSIONS AND RECOMMENDATIONS TO THE FIELD

The current environmental legislation adequately deals with poachers, but tends to over-regulate rhino breeders. Based on the data provided by the respondents, Free State rhino breeders are not prepared to counter the rhino-poaching onslaught. Due to large rhino camps extending over vast distances along public roads, it is difficult to manage rhino anti-poaching strategies, but not impossible, as new technological equipment exists to counter poachers from the perimeter of the rhino camps.

- DESTEA should use legislation, such as Section 88 of NEMBA, to protect the species by requiring compulsory security plans, compulsory registration of rhino breeding projects at recognised stud breeding institutions, and by providing guidance for the sustainable breeding of rhinos in the Province.
- Specialised law enforcement units such as the National Wildlife Crime Reaction Unit in the Department of Environmental Affairs (NWCRU) should be re-instated, with a subdivision specialising in poaching of endangered species.
- DESTEA may also consider selling or exchange their solitary black rhino bull, as black rhinos probably did not occur historically in the Province.
- The Department needs to re-examine their policy on keeping rhinos in smaller camps, and should introduce innovative solutions to the rhino-farming industry.
- The illegal rhino-horn trade is currently operating in the informal economy. Once the trade in rhino horn is legalised, it can become part of the formal economy, which will enable the State to earn revenue through taxation.
- The Production Loss Formula may assist in court cases as a method to sentence rhino poachers.
- A Rhino Breeding Forum must be introduced to provide rhino breeders with guidelines to protect valuable genetic traits of rhinos through thorough breeding principles.
- The protection of certain individual rhinos, with scarce genetic traits, is a necessity to ensure that adequate genetic traits are not lost through poaching.

- The success of an anti-poaching model relies on new technology, a disciplined conventional 24-hour armed patrol, the implementation of unconventional security measures, and frequent re-evaluation of the five factors in the Rhino Anti-Poaching Model.

8.3 FUTURE RESEARCH

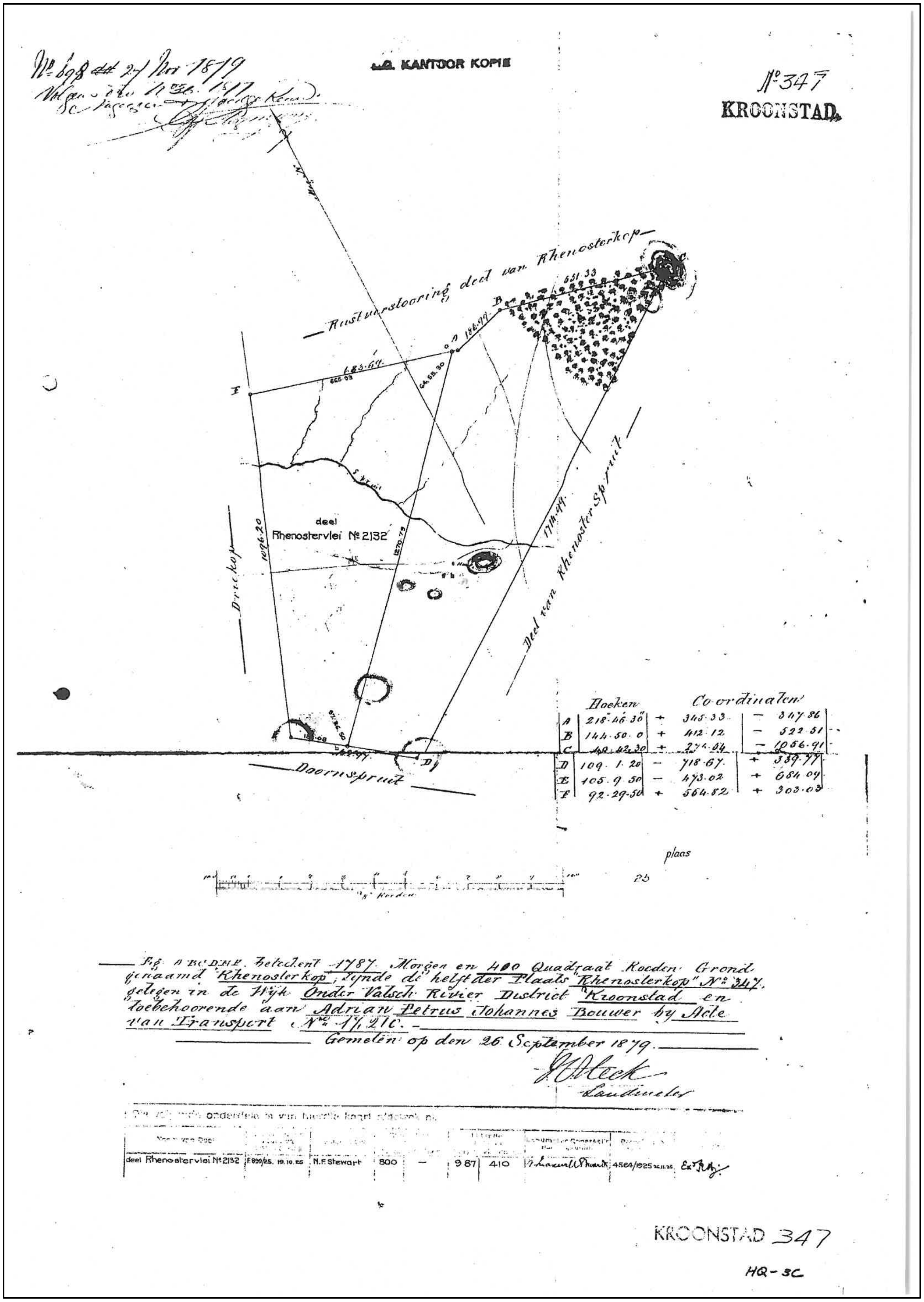
The concept of a custodianship needs attention, and future research is needed before implementation.

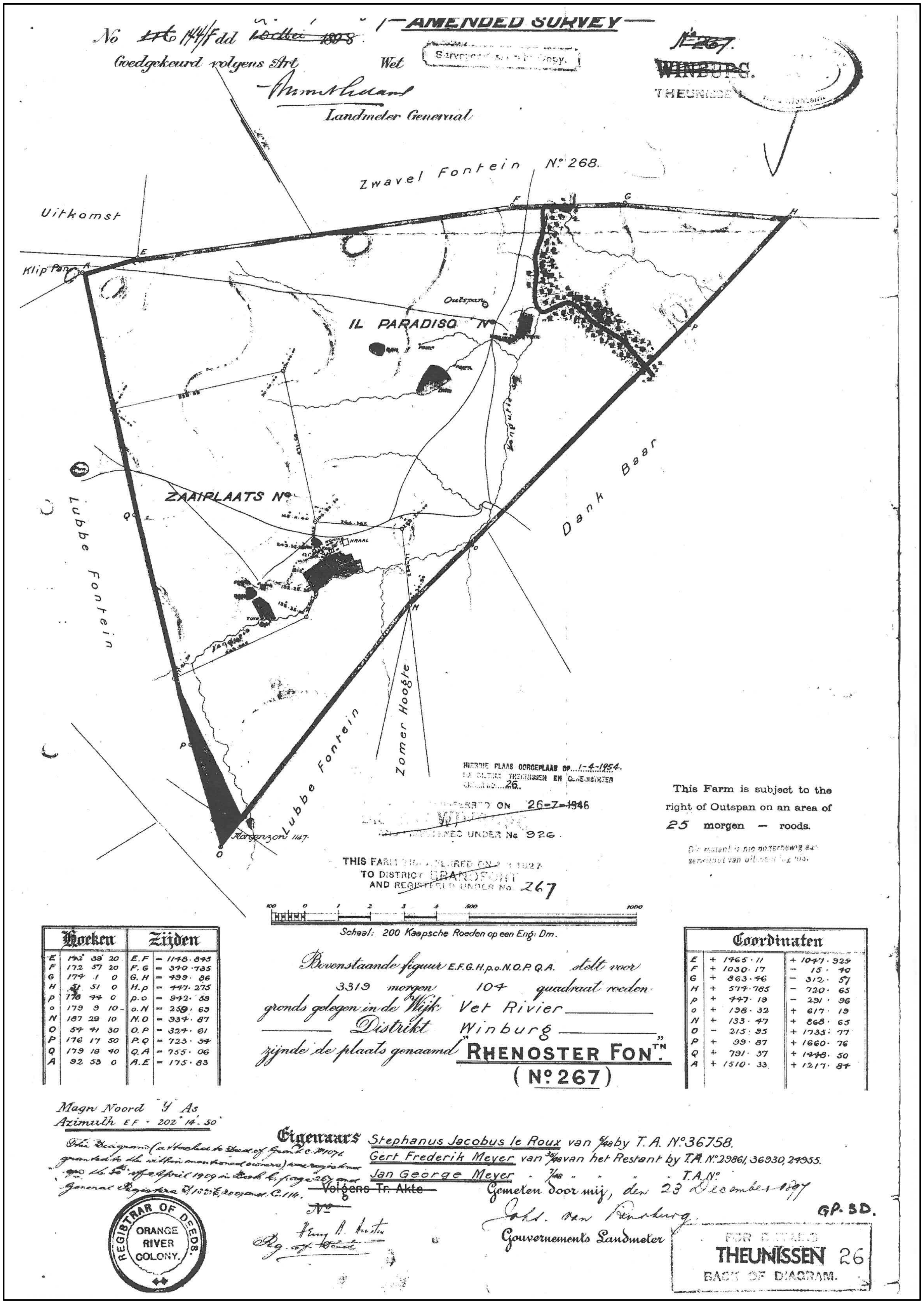
Power-supply problems such as limited satellite battery life of technological devices need investigation and further research, as it would play a vital role in effectively protecting rhinos.

A research project can be registered on convicted rhino poachers to determine their goals, motivation, knowledge and methods used to infiltrate rhino-breeding projects.

Further genetic research will be valuable to determine the influence of poaching on the heterozygosity of rhinos.

ANNEXURE A: Historical maps of "Rhenoster" farms





Hoeken				Zijden	
E	142°	38'	20	E.F	= 1148·845
F	172	57	20	F.G	= 340·735
G	174	1	0	G.H	= 499· 86
H	51	51	0	H.p	= 447·275
p	178	44	0	p.o	= 942· 59
o	179	9	10	o.N	= 259· 63
N	187	29	10	N.O	= 934· 87
O	54	41	30	O.P	= 324· 61
P	176	17	50	P.Q	= 723· 34
Q	179	16	40	Q.A	= 755· 06
A	92	53	0	A.E	= 175· 83

Coordinaten		
E	+ 1465·11	+ 1047·925
F	+ 1030·17	− 15· 40
G	+ 863·46	− 312· 57
H	+ 574·785	− 720· 65
p	+ 447· 19	− 291· 96
o	+ 198· 32	+ 617· 19
N	+ 133· 47	+ 868· 65
O	− 215· 95	+ 1735· 77
P	+ 99· 87	+ 1660· 76
Q	+ 791· 37	+ 1448· 50
A	+ 1510· 33	+ 1217· 84

ANNEXURE B: Questionnaire for rhino breeders

Title of study: Development of a rhino anti-poaching model for game farms and nature reserves in the Free State Province of South Africa

Student: Herman Jordaan

Objectives of this questionnaire:

1) The objective of this questionnaire is to determine the level of security measures amongst rhino' owners in the Free State
2) The questionnaire is a part fulfilment for DTech: Agriculture at the Central University of Technology, Free State

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SECTION A

Rhino Farm Data	Q2 – Q10

SECTION B

Habitat Information	Q11 – Q15

SECTION C

Confidentiality	Q16 – Q20

SECTION D

Rhino Population Management	Q21 - Q25

SECTION E

Security Measures Implemented	Q26 – Q40

SECTION F

Rhino-poaching Incidents	Q41 - Q49

Rhino Farm Data	**For office use only**
1 Questionnaire number ____________________	☐ 1
2 How many years have you been farming with rhinos? ____________________ years	☐ 2
3 How far is your farm from the nearest town or public place? ____________________________________ km	☐ 3
4 Did you erect any small rhino camps? (Small camps <300ha or large camps >300ha) ☐ Yes ☐ No	☐ 4 ☐ 5
5 If Yes, why did you erect small camps? ____ ____	☐ 6
6 How many rhino camps occur on your farm? ____________________________________ ? X ha camps	☐ 7
7 Do any of the rhino camps border a public road (within 1 km)? ☐ Yes ☐ No ☐ Distance	☐ 8 ☐ 9
8 Was the poaching incident on your farm in the small or large camp? ☐ Small camp ☐ Large camp	☐ 10 ☐ 11
9 Where are the rhino camp/s situated on the farm? ☐ Near house ☐ Bordering neighbour ☐ Near town ☐ Near public road ☐ Isolated ☐ Other	☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17
10 My farm is a save place for rhinos	☐ 18

	Strongly agree	19
	Agree	20
	Neutral	21
	Disagree	22
	Strongly disagree	

Habitat Information

For office use only

11 Are there any rivers/dams that may provide entrance to the rhino camp/area? 23

24

	Yes	
	No	

12 Does your farm have any difficult terrain where poachers can hide? 25

	Dense bush	26
	Very large remote camp	27
	Rocky hills with cliffs and caves	28
	Riverine forest	29
	Rocky stones and dongas difficult for vehicle to drive	30
	Other	

13 Are there any high ground (hills, koppies) on your farm? 31

32

	Yes	
	No	

14 Do you move the water and feeding points often on the farm? 33

WATER CRIB		34
	Yes	35
	No	36
FEED POINT		
	Yes	
	No	

15 Are their water and feeding sites close to any roads? 37

WATER CRIB	(drinking area of the rhinos)	38
	Yes	39
	No	40

FEED POINT	(grazing area of the rhinos)
	Yes
	No

Confidentiality

16 Do you make use of external security contractors or own security staff? 41 42 43

	Internal
	External
	None

17 Do you make use of temporary or foreign workers as labours on your farm? 44 45

	Yes	(which country)
	No	
	None	

18 Do your anti-poaching staff reside with your normal work force? 46 47

	Yes
	No

19 Are your security guard/s officially trained in anti-rhino poaching? 48 49

	Yes
	No

20 What are the main work force (staff) problems on your farm? 50 51 52 53 54 55 56 57 58 59

Choose 5 of the 10 possibilities	
Theft	
Stabbings	
Threats with a weapon (knives, etc.)	
Threats without a gun	
Assault	
Alcohol misuse	
Back chatting (Insult)	
Domestic violence	
Political activities	
Labours (include seasonal workers)	

Namely: ______________________

Rhino Population Management

21 How many rhinos do you have? 60
61

Number	
W/Rhino	
B/Rhino	
TOTAL	

22 Do you dehorn as a poaching prevention? 62
63

	Yes
	No

23 Does the rhino's home range border any fences or public places? 64
65
66

	Yes
	No
	Uncertain

24 Are any of your rhinos protected with implanted satellite devices? 67
68

	Yes
	No

25 Should the yearly rhino-poaching incidents drastically increase, what would you do? 69
70

	Increase property security measures	71
	Dehorn rhino	72
	Reduce rhino population through increased hunting quotas	73
	Reduce rhino population by selling more rhino at auctions	74
	Remote tracking transmitters on all rhino	75
	Remove all rhino from property	
	Other	

Security Measures Implemented

26 Are there any security patrols on your farm (e.g. foot patrols, horse patrols)? 76

77

- [ ] Yes
- [ ] No

27 How often do they patrol? 78

79

80

- [ ] Daily
- [ ] Weekly
- [ ] None

28 Any patrols or security procedures on weekends? 81

82

- [ ] Yes
- [ ] No

29 Are weapon searches conducted on your farm? 83

84

- [ ] Yes
- [ ] No

30 If yes, how often are the searches conducted? 85

86

87

88

- [ ] Daily
- [ ] Weekly
- [ ] Monthly
- [ ] Bi-annual

31 Require visitors to sign in at farm (access control) 89

90

- [ ] Yes
- [ ] No

32 Do the guards patrol the perimeter of the premises? 91

92

- [ ] Yes
- [ ] No

33 Manned control room with 24/7 operators? 93

94

	Yes
	No

34 Do you make use of any anti-rhino-poaching experts? 95
96

	Yes
	No

35 What type(s) of security equipment does your farm have in place? 97
98

	Sprinkler systems	99
	Polygraph contracts with all employees	100
	FLIR thermal camera	101
	Night-vision binocular	102
	Electronic tagging (TRACKER device)	103
	Any Pseudo operations to infiltrate poachers (i.e. PIs)	104
	Trackimo	105
	Fuzzy logic intelligence systems	106
	Air supply (chopper, micro light, etc.)	107
	Automatic assault weapons	108
	Two-way radios	109
	Tracker system on rhinos	110
	Mobile radar (270°)	111
	Metal detectors	112
	Alarm system on fences	113
	Sysmopen	114
	CCTV camera	115
	Patrol drone (Phantom 4)	116
	Trial cameras	117

	RFID (High performance microchip - Agrident APR500 Reader)
	Other: Describe (excluding cell phone)

____

36 Does your farm have a written security plan? 118
119

	Yes	120
	No	

37 If yes, are you familiar with the security plan? (Did you read it?) 121
122

	Yes

No

38 Does your security plan include: 123

Operation room 124
Operation map 125
Guard training and patrols 126
Equipment 127
Information and intelligence gathering 128
Communication systems 129
None

39 Do you find the security procedures on your farm to be effective? 130

Very effective 131
Effective 132
Somewhat effective 133
Somewhat ineffective 134
Very ineffective

40 If ineffective, please say why you think they are not effective. 135

____

____

____

Rhino-poaching Incidents

41 Have you ever had any rhino-poaching incidents on your farm? 136

Yes 137
No

42 Details of poached rhino? 138

Age of individual/s 139
Horn length 140
Horn circumference 141
Total productive females in herd 142
Total productive bull/s in herd

43 How many years since introducing of rhinos and first poaching incident? 143

_______________________ years/months/days

44 Have you ever had any <u>attempts</u> of rhino poaching on your farm? 144 145

- [ ] Yes
- [ ] No

45 If Yes, please provide details. 146

____

____

46 When was the poaching incident (date if possible)? 147 148 149

- [ ] During the week (Monday to Thursday)
- [ ] On the weekend (Friday to Sunday)
- [ ] Uncertain

47 Which of the following poacher's strategies are you aware of? 150 151 152 153

- [ ] Pseudo operations
- [ ] Insurgency
- [ ] New technology – radio-wave illuminations
- [ ] Other

48 What was the phase of the moon during the poaching incident? 154 155 156

- [ ] Full moon
- [ ] New Moon
- [ ] 1st quarter
- [ ] 3rd quarter

49 In your opinion, what should be done to prevent rhino poaching in the Free State? 157

____

____

____

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ANNEXURE C: Poachers Sentenced

SENTENCE	CHARGE
S vs. Rogers Ndlovu (Skukuza CAS 153/8/2014)	
Sentenced to 17 years' imprisonment	Trespassing; illegal possession of fire-arm; illegal possession of ammunition; possession of a fire-arm with intent to commit a crime; and illegal hunting in National Park.
S vs. Betuel Rethlangu and others (Naboomspruit CAS 81/4/2013)	
Accused 1 – sentenced to 20 years' direct imprisonment. Accused 3 - sentenced to 12 years' direct imprisonment Accused 4 – sentenced to six years' direct imprisonment Accused 5 – sentenced to 14 years' direct imprisonment	Accused 1 - the illegal hunting of rhino; illegal possession of a prohibited fire-arm and use and possession of the proceeds of crime. Accused 3 - the illegal selling and trading in rhino horns, and use and possession of the proceeds of crime. Accused 4 - the use and possession of the proceeds of crime. Accused 5 - the illegal possession of a prohibited firearm; illegal selling and trading in rhino horns, and the use and possession of the proceeds of crime.
S vs. Job Basi Tlou and 5 Others (Alldays CAS 61/7/2014 and Tweefontein CAS 55/8/2014)	
Accused 1 to 5 – each sentenced to 15 years' direct imprisonment. Accused 6 - sentenced to 10 years' direct imprisonment	Accused 1 to 5 - the illegal hunting of rhino. Accused 6 - the illegal selling and trading in rhino horn.
S vs. Jodie Allen (Milnerton CAS 684/08/2014)	
The accused was sentenced to a fine of R100 000 or 5 years' imprisonment, of which R70 000 or three years was suspended for five years.	Section 47A(1)(b) of the Nature Conservation Ordinance 19 of 1974. The illegal possession of one rhino horn with a mass of 1.251kg.
S vs. Wu Xiaohui (Ravensmead CAS 592/01/2015)	
Rhino horn: The accused was sentenced to 5 years' direct imprisonment, of which three-and-a-half years were suspended for five years; and a further fine of R40 000, or two years' imprisonment. Lion claws and crocodile meat: The accused was sentenced to two years' direct imprisonment, of which one years was suspended for five years. The two sentences will run concurrently.	Sections 47A(1)(b) and 42(1)(b) of the Nature Conservation Ordinance 19 of 1974. The illegal possession of 42 grams of rhino horn without a permit, and three lion claws and 2,852kg of crocodile meat without documentation.

S vs. Xiaowan Liang (OR Tambo CAS 76/11/2015)	
Sentenced to a fine of R20 000 or two years' imprisonment. An additional three years' imprisonment, suspended for five years with certain conditions.	Sections 57(1) of the National Environmental Management: Biodiversity Act, Act 51 of 1977.
S vs. Andilino Muqwebu and Jeremano Tive (Skukuza CAS 34/1/2013)	
Each accused sentenced to 14 years' imprisonment.	Trespassing and illegal hunting.
S vs. Talani Prince Maluleke (Makhado CAS 496/05/2014)	
Sentenced to 11 years' direct imprisonment.	Hunting of rhino on Eckland; trespassing; possession of fire-arm and ammunition.
S vs. Ashraf Gullamhoosen Cassim (Brits CAS 291/3/2009)	
Sentenced to a fine of R1 million, or 6 years' imprisonment.	Illegal dealing in rhino horn.
S vs. Mucindi Abondi, Silver Tibane, Gitto Zith (Skukuza CAS 7/10/2014)	
Accused 1 and 2 sentenced to 30 years' imprisonment.	Trespassing, illegal hunting and possession of fire-arm and ammunition, and possession of dangerous weapon.
S vs. Sibusiso Mthembu and Zakhele Masinga (CAS 78/07/2014)	
Accused 1 and 2 sentenced to 8 years' imprisonment.	Section 57 of NEMBA, conspiracy to hunt rhino, possession of fire-arm and ammunition.

ANNEXURE D: Confidentiality Diagram