FACTORS INFLUENCING THE ESTABLISHMENT OF TRANSLOCATED ELAND (*Taurotragus oryx*) AND SPRINGBOK (*Antidorcas marsupialis*) IN THE NYAE NYAE CONSERVANCY, NAMIBIA

A DISSERTATION SUBMITTED IN FULFILMENT OF THE REQUIREMENTS

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ANOVA	Analysis of Variance
CBC	Community-Based Conservation
CBD	Convention of Biological Diversity
CBNRM	Community-Based Natural Resources Management
CWM	Community-Based Wildlife Management
EFN	Russell E. Train Education for Nature Program
FGD	Focus Group Discussions
GLM	Generalised Linear Model
GRN	Government of the Republic of Namibia
IUCN	International Union for Conservation of Nature
KIIs	Key Informant Interviews
MAWF	Ministry of Agriculture, Water and Forestry
MET	Ministry of Environment and Tourism
MRC	Multidisciplinary Research Centre
NACSO	Namibian Association of CBNRM Support Organisations
NBRI	National Botanical Research Institute
NDVI	Normalised Difference Vegetation Index
NNDF	Nyae Nyae Development Foundation
NSA	Namibia Statistics Agency
NUST	Namibia University of Science and Technology
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptive Land Management

TEK	Traditional Ecological Knowledge
UNAM	University of Namibia
USA	United States of America
SID	Simpson’s Index of Diversity
WTA	Wildlife Translocation Advisor
WWF	World Wild Fund for Nature

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DEDICATION

I would like to dedicate this dissertation to my family who supported me throughout my studies and gave me the opportunity to complete this journey. To my husband, Afonso, and both my biological and spiritual children: thank you for your prayers and encouragement.

DECLARATION

I, **Selma Lendelvo**, declare that this study is a true reflection of my own research and that this work or part thereof has not been submitted for a degree in any other institution of higher education.

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ABSTRACT

The emergence of the Community-Based Natural Resources Management (CBNRM) approach in Namibia contributed to the establishment of communal conservancies that aim to conserve wildlife outside protected areas, as well as benefit local communities. Recent translocations in Namibia involved the movement of wildlife from protected areas to communal conservancies in order to expand the range of wildlife species in the areas they once occupied, as part of effective community-based conservation efforts. Little research has been done to understand the outcome of the translocation of ungulates for the purpose of restocking wildlife populations in communal conservancies, and to determine the factors affecting the establishment of these ungulates, as well as the contribution of translocation to sustainable wildlife management in Namibia. The aim of this study was to establish the factors that contributed to outcomes of translocated eland (*Taurotragus oryx*) and springbok (*Antidorcas marsupialis*) in the Nyae Nyae conservancy. The study utilised a mixed-method design that involved the employment of both qualitative and quantitative data collection methodologies in obtaining primary and secondary data. Field observations were carried out to collect data on the current population structure of the eland and springbok. A total of 56 questionnaires, 19 key-informants and 6 focussed-group discussions (FGDs) with community members and stakeholders, were administered during the period of July 2013 to March 2015. Stakeholders comprised the relevant local, regional and national institutions that worked closely with the Nyae Nyae conservancy in different aspects of wildlife and conservancy management. Secondary data, consisting of long-term wildlife count data, were obtained from the conservancy and the office of the Ministry of Environment and Tourism both in Tsumkwe and Windhoek. Following translocations, a stable trend of the overall wildlife population sizes in the Nyae Nyae conservancy ($r=0.477$; $t_{10}=1.574$; $p=0.145$) was found. The springbok ($r= 0.181$; $t_{10}=0.580$; $p=0.575$) showed a positive population trend while the eland ($r= -0.429$; $t_{10}= -1.502$; $p=0.164$) showed a declining trend, according to the long-term monitoring data collected between 2001 and 2013. The outcome of the field assessments on the habitat utilised by the springbok was consistent with the analysis of the long-term data, indicating that the free-roaming and growing springbok population was found along the Nyae Nyae Pans in the conservancy. However, a free-roaming eland population was not detected but a population confined in the Buffalo Camp was found. The composition of the social groupings of the observed eland and springbok populations comprised solitary, bachelor, mixed, nursery and/or female groups. Perceptions gained from the surveys concluded that the factors such as availability and distribution water resources, range condition, veld fires frequency and level

predation had limited negative influence on the translocated populations of the two species, while human-related activities were attributed to the translocation failure of the eland. There was little evidence of hunting of the eland for both subsistence and trophy purposes, although evidence existed that the eland had been allocated a hunting quota. Although springbok was not commonly utilised for trophy hunting, this species had been hunted sustainably for subsistence and the purposes of meat distribution since 2004. The selection of a suitable, natural habitat, coupled with limited human disturbance, contributed to the establishment of the translocated springbok population. However, the eland population not increasing after translocation in 2001 remains complex because the confined eland population that was moved into the Buffalo Camp of the conservancy since 1994 was able to survive in a similar habitat for over two decades. Suitability to natural habitat factors alone is not sufficient to contribute to the establishment of translocated wildlife species. Therefore, the anthropogenic elements of a habitat should form part of the suitability assessments during the translocation process of wildlife into conservancies because of the nature of community-based conservation areas.

CHAPTER 1: INTRODUCTION

1.1 Background

For many years, the conservation approaches in Africa and elsewhere in the world were based on protected-area management (Brook, Sodhi & Bradshaw 2008; Pimbert & Pretty 1997). Over 100,000 protected areas worldwide have been established in the form of national parks, sanctuaries, as well as reserves, and these have contributed to the conservation of many species and habitats (Chape, Harrison, Spalding & Lysenko 2005; Jenkins & Joppa 2008). Protected areas have rescued several wildlife species from extinction worldwide, especially with the expansion and changes of human settlements and economic activities (Chape et al. 2005). However, many protected areas over the years have become too small and isolated to conserve biodiversity and habitats effectively (Hayes & Hayes 2013). Although protected areas were successful in conserving wildlife, they largely ignored the wildlife populations that were outside protected areas and these species were subjected to over-exploitation due to the absence of protection frameworks (Pimbert & Pretty 1997; Songorwa, Buhrs & Hughey 2000). Many communities, particularly in Africa, have a long history of living with wildlife and depended on various species for their livelihood for millennia (Pimbert & Pretty 1997). A change of direction in the conservation approaches calling for involvement of local communities in conservation was experienced world-wide, including Namibia (Kiss 1990; Songorwa et al. 2000).

The Community-Based Natural Resources Management (CBNRM) approach was introduced in different Southern African countries as a rural development strategy that enables rural communities, occupying communal land, to participate directly in conservation while benefiting from the conservation efforts (Child & Barnes 2010; Jones, Hulme & Murphree 2001; Taylor 2009). The implementation of the CBNRM in Namibia was partly necessitated by the indiscriminate killing of wildlife outside protected areas, mainly due to a lack of legal frameworks to involve people in the protection of wildlife found within communities (Jacobsohn & Owen-Smith 2003). Furthermore, the CBNRM enabled the devolution of rights to rural communities, allowing them to manage, utilise and benefit from the wildlife resources, thereby contributing to the livelihood of people as well as the national economy at large

(Jacobsohn & Owen-Smith 2003; Silva & Mosimane 2014; Van Schalkwyk, Mcmillin, Witthuhn & Hoffman 2010).

In Namibia, the large number of wildlife losses outside protected areas, including farmlands, were noted before the implementation of the CBNRM programme (Jones 2007; Richardson 1998). During the 1980s, some large mammals in Namibia became extinct while others were close to extinction in communal lands (Jacobsohn & Owen-Smith 2003; Richardson 1998). For example, there were sharp declines in black rhinoceros (*Diceros bicornis*) and elephant (*Loxodonta africana*) populations in Namibia during this period due to poaching (Richardson, 1998). Most large mammal species disappeared from the communal areas of Namibia in the northern regions because of a combination of different factors, which include clearing land for agriculture, changes in settlement patterns and increasing human populations (Jones 2007). For decades, species such as kudu, oryx and eland, were locally extinct from the Namibian north-central regions until the implementation of the communal conservancy programme in the 1990s (Richardson 1998). The lack of a sense of ownership regarding wildlife and the legally denied access to resources in communal lands had a much more detrimental effect on wildlife populations (Jones 2007).

The indiscriminate and substantial killing of wildlife by locals in Namibia has been extensive since the colonial era during the German rule (1880s) up to the 1960s when the Odendaal Commission implemented new reforms for land demarcations (Botha 2005). Although this led to clearly defined boundaries for protected areas and alienating wildlife from farming communities, the wildlife population continued to be affected as different species were still found outside the fences and continued to be an important resource for the livelihood of the local people (Berry 1997; Botha 2005; Lendelvo, Angula & Mfune 2015). Wildlife management reform was necessary to introduce alternatives in order to prevent further losses of wildlife species, and, if possible, to reverse the situation. Wildlife legislation in Namibia, which allowed for the involvement of local communities in conservation, started with the enactment of the Nature Conservation Ordinance 31 of 1967. This law allowed commercial farmers to benefit from the wildlife species on their farms and to prevent the loss of wildlife (Barnes, MacGregor & Weaver 2002; Jacobsohn & Owen-Smith 2003; Jones 2007).

However, this piece of legislation was not inclusive as it excluded communal farmers, probably due to the fact that it was enacted during the apartheid era. Heavy losses of wildlife due to illegal hunting in the communal areas during the 1980s continued to occur, partly because these areas were excluded from the legislation (Jacobsohn & Owen-Smith 2003). The introduction of the CBNRM in Namibia was an acknowledgement that the local communities, whether on communal or commercial farms, were important partners in conservation as long as they were granted rights within which they could operate when utilising and managing wildlife resources (Jacobsohn & Owen-Smith 2003). After its independence, Namibia also identified conservation as a national responsibility, as this has since been highlighted in the Namibian National Constitution. Article 95 of the Namibian constitution emphasises the need for maintaining healthy ecosystems through the biodiversity conservation of natural resources which should also be utilised on a sustainable basis (Government of Republic of Namibia 1998). The enactment of the Nature Conservation Amendment Act of 1996 ensured the inclusion of communal land in the management of wildlife and other resources, and this has led to the establishment of communal conservancies (NACSO 2004; Weaver & Petersen 2008).

Communal conservancies are defined as "legally-recognised, geographically-defined institutions, formed by communities and designed to achieve environmental conservation objectives (e.g. increasing wildlife numbers and preserving habitats) by allowing local residents to manage and benefit from wildlife and other natural resources" (Silva & Mosimane 2014, p. 184). At national level, these institutions are important partners in the biodiversity initiative to protect landscapes, ecosystems, species and genes, as well as to improve the rural economy (NACSO 2014). The conservancy programmes in Namibia have grown dramatically over the years (see Fig. 1). The first four conservancies (covering about 16,821 km^2) were gazetted by the Ministry of Environment and Tourism (MET) in 1998, namely, the Nyae Nyae Conservancy (Otjozondjupa region), Salambala Conservancy (Zambezi region), Torra and #Khoadi //Hôas Conservancies (Kunene region). Five years later, the number of conservancies in Namibia had expanded to 70, 995 km^2 after a further 29 conservancies were gazetted by the MET by the end of 2003 (NACSO 2004). The number of conservancies continued to increase in the country and by the end of 2013, a total of 79 registered conservancies had been established in different regions on communal land (NACSO, 2014). In total, 43.5% of the country's surface area was under wildlife conservation by 2013, consisting of 16.8% state-protected areas, 6.1% freehold conservancies, 0.8% tourism concession areas, 19.4% communal conservancies and 0.4% of community forests outside conservancy areas (NACSO 2014). By the end of 2016, there were 82 communal conservancies covering 161, 900 km^2, registered in Namibia (www.nacso.org.na).

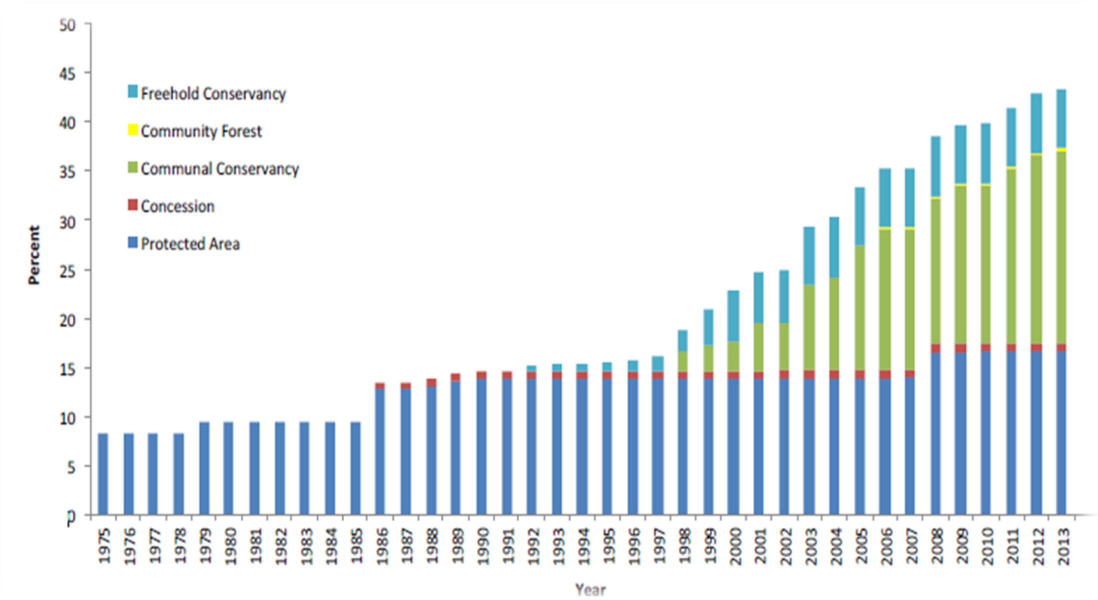


Figure 1: The development of conservation approaches in Namibia, including the communal conservancy areas between 1975 and 2013

(Source: Government of the Republic of Namibia 2014)

Although the establishment of the conservancies secured an effective conservation practice, stabilising a wildlife population and restocking wildlife in communal areas were necessary to strengthen further conservation efforts (NACSO 2014). An increase of the wildlife population in the conservancies was achieved by the process of translocation, which involved the movement of wildlife species from protected areas or commercial land into these community-managed, communal areas (NACSO 2013; Paterson et al. 2008b). Wildlife translocation is not a new phenomenon in Namibia it has been practised for decades, particularly to rescue threatened wildlife species and to relocate them to protected areas (Beytell 2010; Hofmeyr & Lenssen 1975) or to private commercial farms (Green & Rothstein 1998; Matson 2004).

This recent situation in Namibia of wildlife from protected areas being moved to communal areas presents a unique opportunity for conserving biodiversity as it allows for re-introductions of wildlife in the different habitats of the country (NACSO 2010; Paterson et al. 2008b). By 2013, more than 8,000 animals from approximately 15 mammal species had been translocated from commercial farms and protected areas in Namibia to communal conservancies throughout the country (NACSO 2013). Most of the species, such as the black rhinoceros, black-faced impala, giraffe, zebra, eland, blue wildebeest and sable, that disappeared in various communal areas, were restored through translocation (NACSO 2013). The success of this translocation programme depended on the ability of the conservation practices in the communal areas to support the translocated animals in order to establish viable populations.

The assessment of the outcomes of any translocation process is crucial for sustainable conservation and the well-being of the different species. Different species worldwide have been translocated. These include, but are not limited to, amphibians, reptiles, avian and mammals (Fischer & Lindenmayer 2000; Seigel & Dodd 2002; Wolf, Garland & Griffith 1998; Wolf, Griffith, Reed & Temple 1996; Wolf & Mangel 2008). The outcomes of these different translocation programmes depended on the prevailing conditions of the habitats or the surrounding environment; some programmes succeeded while others failed (Armstrong & Seddon 2007; Seddon, Armstrong & Maloney 2007). Habitat conditions include any feature of the environment relevant to a species, such as vegetation type and quality, interactions with humans, fires, predators, competitors or pathogens (Armstrong 2005). Such factors are crucial for the translocation outcomes and, when well-studied, failing outcomes of translocation can be avoided or those hindrances to the persistence of translocated animals in the new habitat can be addressed.

Therefore, this study aimed to examine the outcomes of two ungulate species, namely, the springbok (*A. marsupialis*) and eland (*T. oryx*), translocated from the National parks and commercial farms to the communal Nyae Nyae conservancy, as well as to determine the factors that contributed to the outcomes of these translocated species. The Nyae Nyae conservancy was one of the beneficiaries of wildlife populations through translocation, after its gazetting in 1998.

1.2 Linking translocation to wildlife management in Namibia

In Namibia, the translocation of wildlife has been practised for a variety of reasons, including and not limited to, recovering species or increasing species ranges for the survival of some species (Hofmeyr & Lenssen 1975), improving biodiversity in the country by restoring wildlife species that were drastically decreasing or had become locally extinct in the farmlands (Green & Rothstein 1998; Matson 2004), contributing to saving different species from extinction in certain localities and also improving the distribution of wildlife species across the country, as well as allowing wildlife to contribute effectively to the economy of the country (Brodie et al. 2011; Linklater et al. 2012).

The translocation of black rhino has been one of the most documented among the ungulates species in Namibia (Beytell 2010; Brodie et al. 2011; Linklater et al. 2012). The black rhino is listed by the International Union for Conservation of Nature (IUCN) as a critically endangered species, and it is estimated that the world-wide population of black rhino has dropped from 65,000 in 1970 to less than 2,500 in 1992 (Beytell 2010; Brodie et al. 2011). This decline has mainly been caused by poaching rhino for their horns, particularly in habitats with limited protection. The translocation of black rhino in Namibia was mainly undertaken to restore, rescue and recover the species, and also to establish new, viable populations in suitable habitats (Linklater et al. 2012). All black rhino had been removed from farmlands (especially communal areas) to protected areas through translocation until 1998 when community-based conservation was first introduced in Namibia. A large population of black rhino had been translocated back into areas outside the protected areas so that, to date, this species is found in different conservancies with the largest population in the north-western belt of Namibia (Brodie, et al. 2011).

Another example of the translocation of ungulates in Namibian involved the endangered black-faced impala (*Aepyceros melampus petersi*) which was endemic to the Kaokoveld in the north-western part of Namibia and in the south-western part of Angola (Matson 2004; Green & Rothstein 1998). The decline in the black-faced impala population was mainly due to hunting by local communities, as well as devastating droughts that occurred in these regions (Green & Rothstein 1998). In the absence of legislation to protect wildlife during the 1970s in these communal areas, the numbers of black-faced impalas were drastically reduced from their endemic habitat. Successful translocations of black-faced impala were made between 1970 and 2001 from the Kaokoveld communal areas to about 20 Namibian commercial game farms (Matson 2004). After the successful establishment of this species in protected areas and commercial farms, the black-faced impala had once more been translocated back to their native habitats in communal conservancies during the 2000s (NACSO 2013).

Predators in Namibia are perceived to be problem animals both in communal and commercial areas due to livestock and human conflict; this result in the decline of carnivore populations. Namibian conservationists opted to translocate predators from areas where they were threatening livelihoods or human lives to protected areas (Linnell, Annes, Swenson, Odden, & Smith 1997; Marker & Dickman 2003). Carnivores have also recently been moved from one area to another for tourism purposes (Stander, 2003). This translocation exercise involved three lions (a male and 2 females) and two cheetahs were translocated to the Kalahari Game Lodge from the Kgalagadi Transfrontier Park in Botswana and the farmlands of the Hochveld area in Namibia, respectively, to the Kalahari Game Lodge along the Namibia and Botswana border (Stander 2003). Between 1996 and 2006, Namibia witnessed the largest translocation of cheetah from both communal and commercial farmlands. More than 2,550 cheetahs were translocated to game farms with strict protection mechanisms in place to reduce conflict with farmers (Marker & Dickman 2003).

The establishment of commercial and communal area conservancies contributes to wildlife protection network, thus allowing species connectivity across habitats (Griffin 1998). Over the years, protected areas became isolated from habitats outside their boundaries, making them more ineffective for wildlife conservation as this isolation may affect the long-term viability and movements of many wildlife populations (Bolger, Newmark, Morrison, & Doak 2008; DeFries, Hansen, Newton, & Hansen 2005). In Namibia, the translocation of wildlife into farmlands has improved the connection between habitats for wildlife populations by returning species to historical ranges and allowing ease of movement between different conservation areas (Weaver & Skyer 2003). Such a scenario has a great potential to improve the survival and management of wildlife in the country. The establishment and movement of species, particularly ungulates, have contributed to a widespread distribution of these across different landscapes and land tenure (see Fig. 2).

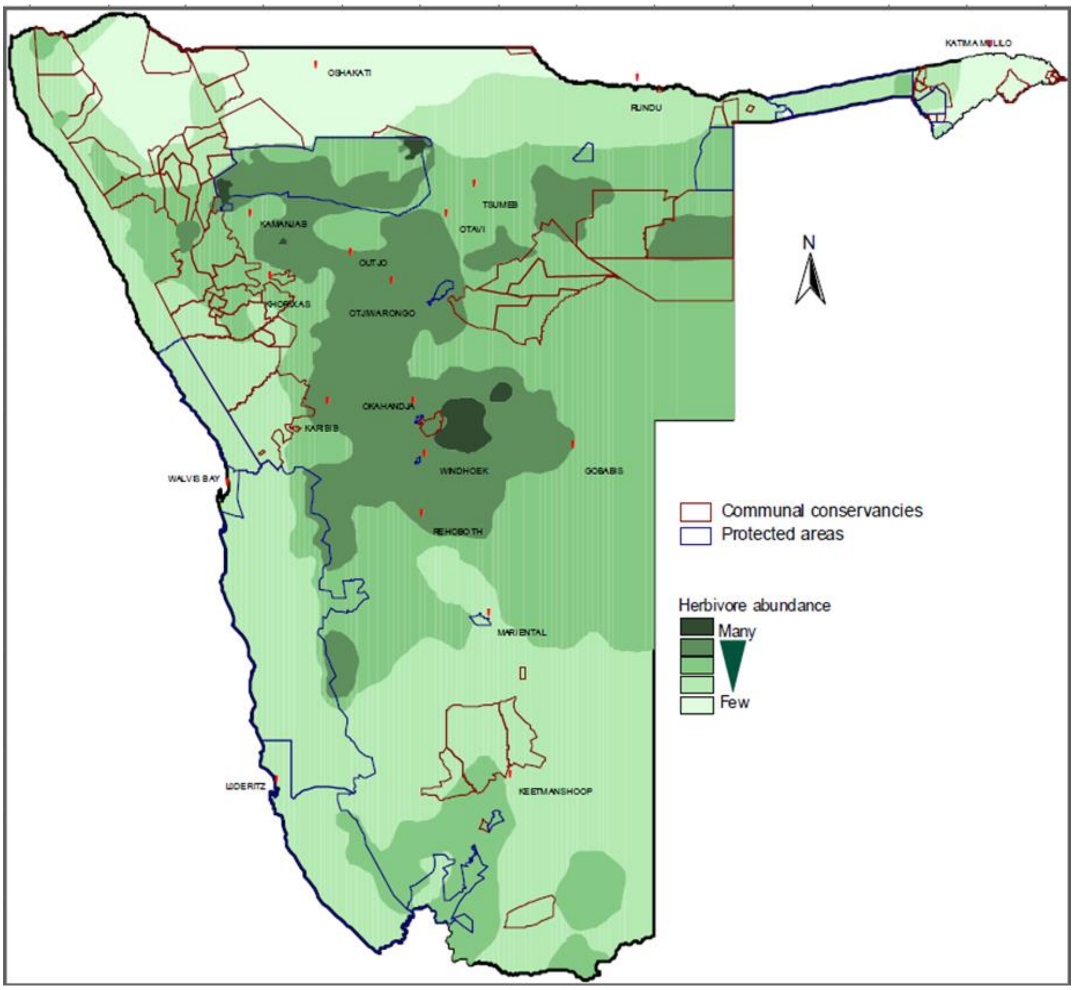


Figure 2: The distribution of ungulates across Namibia, 2008

Source: (www.nacso.org.na)

1.3 The importance of CBNRM to local communities in Namibia

CBNRM is a concept contributes to the debate of decentralising biodiversity conservation and the integration with local communities (Child 2009). CBNRM recognises the value that local people can add to conservation and the benefits they can derive from these conservation and management practices. CBNRM not only focuses on conservation, but it is a multi-faceted concept which combines economic, political and institutional goals for the empowerment of rural communities (Child

2009). CBNRM is said to have gained its momentum and spread rapidly in the 1980s in sub-Saharan Africa, especially in southern Africa (Hutton, Adams, & Murombedzi 2005). The CBNRM approach also gives communities rights to the management of resources in order to generate benefits to improve their livelihoods and to ensure the continued survival of these resources (Suich 2013a).

The Namibian CBNRM programme has been classified as a success story by some scholars because, since its inception, it has generated positive, conservation outcomes and economic benefits for communities in most instances (Bandyopadhyay, Shyamsundar, Wang & Humavindu 2004; Jacobsohn & Owen-Smith 2003; Lendelvo, Munyebvu & Suich 2012; Silva & Mosimane 2014). The CBNRM provides the possibility to generate both monetary and non-monetary benefits from consumptive and non-consumptive wildlife activities (Child & Barnes 2010; Naidoo et al. 2011).

There are different types of benefits derived from conservancies or CBNRM initiatives (Murphree 2009; Child & Barnes 2010; Suich 2013b; Silva & Mosimane 2014). A variety of benefits can be derived from joint-venture tourism, trophy hunting, indigenous plant products, own-use game harvesting, community-based tourism, shoot-and-sell game harvesting, craft production and live game sales. In addition, further benefits, such as social benefits (funeral support, educational support, food for the elderly and sick people), cash benefits, conservancy jobs and access to game products like meat and hides, have also been classified as being important (NACSO 2014).

Strengthening local institutions to manage their resources and utilising resources sustainably are the core pillars of CBNRM (Turner 2004; Murphree 2009). The devolution of power through CBNRM should be implemented in such a way that it will strengthen local capacity that contribute to sustainable conservation practices (Child & Barnes 2010). The Namibian CBNRM case has been applauded for providing strong, initial support from MET, NGOs and international agencies, particularly to build the capacity of local people to manage their conservancies (Child & Barnes 2010; Jones et al. 2001). When local communities are empowered and working closely with government and expert agencies, conservation in these community-led programmes is more likely to succeed and contribute significantly to the welfare of the community (Child & Barnes 2010; Jones et al. 2001). In addition, other conservation approaches, such as translocation being introduced in conservancies with empowered leaders, could also yield positive results to sustain conservation practices in the area (NACSO 2013).

1.4 Statement of the problem

Ungulates are amongst the largest group of large mammals worldwide (Leuthold 2012) and dominate most of the conservation areas in sub-Saharan Africa (Sinclair & Arcese 1995). These species have proved over the years to be important not only for the environment in terms of contributing to the biological diversity but also crucial for economic enhancement as they play a vital role in tourism, the meat industry, as well as maintaining the trophy-hunting industry in southern Africa (Van Schalkwyk et al. 2010). Wildlife translocation has been applied as a useful management strategy in different parts of the world, including Namibia, for different purposes, such as increasing the range of species in areas where they are threatened or have been severely reduced (Seddon et al. 2013). The focus on factors affecting the outcomes of translocation programmes has generated a considerable volume of research (Fischer & Lindenmayer, 2000; Rout, Hauser & Possingham, 2007; Seddon et al. 2013; Wolf & Mangel 2008). However, these studies have generally been on translocation programmes in protected areas and on endangered or threatened species.

With the emergence of the community-based conservation approaches in Namibia, ungulate species were translocated to conservancies to build species populations, and allow communities to derive benefits from the conservation effort. There is generally limited knowledge in the country on the impact of translocation on wildlife populations in conservancies, although general projections through reports by the government, NGOs, donors and other publications have reported positive contributions to conservation in the country. Scientifically, there is a great need for in-depth investigations on the translocation outcomes at both species and conservancy levels. The translocation of wildlife species to the Namibian communal conservancies is a new phenomenon that could provide lessons for other parts of the world and strengthen future translocations of that nature. Limited understanding of translocation outcomes and factors affecting the establishment of translocated species in conservancies will impede informed decision-making on future translocation and biodiversity in general.

1.5 Study objectives

The overall objective of this study was to investigate factors that contributed to the translocation outcomes of the springbok (*Antidorcas marsupialis*) and eland (*Taurotragus oryx*) populations in the Nyae Nyae conservancy. Apart from the springbok and eland translocations, the conservancy also received translocations of other six species, totalling to over 2,000 animals from eight species moved into the conservancy between 1999 and 2008. Therefore, this study will also assess the influence of translocation on the overall wildlife species composition, diversity and distribution in the conservancy to establish the contribution of translocation to conservation in the area.

The specific objectives of the study were to:

1) Determine the effects of translocation on the trends in composition, diversity and abundance of all the wildlife species found in the Nyae Nyae conservancy during the period of 2001 – 2013;
2) Assess the influence of translocation on the sizes and distribution of the springbok and eland populations between 2001 and 2013;
3) Determine the age and sex structures including social grouping and activities of the existing springbok and eland populations in the Nyae Nyae conservancy;
4) Evaluate the influence of identified habitat and anthropogenic factors on the translocation outcomes of the springbok and eland populations in the Nyae Nyae conservancy;
5) Assess the effects of the practice of hunting in the Nyae Nyae conservancy on the translocated springbok and the eland populations as well as other translocated species.

1.6 Research hypotheses

1) Translocation has a positive influence on the trends in composition, diversity and abundance of the overall wildlife species found in the Nyae Nyae conservancy because of the habitat suitability assessments carried out for all translocated species prior translocation.
2) The translocated numbers of the eland and springbok will enable the two species to establish into viable populations with stable growth over time, and well-distributed within the conservancy;
3) Hypotheses associated with Objective 3:
   - There will be no sex dominance among translocated individuals of the two species;
   - Adult individuals will significantly dominate in the different groups;
   - The number of individuals in different groups of the two species will be significantly different;
   - The current springbok and eland will engage in different social activities that will be significantly different between the different groups of the two species;
   - The current springbok and eland individuals will be feeding on several vegetation species found in the habitats they occur.
4) Different identified habitat and anthropogenic factors will have minimal effects on the translocation success of the two species because of comparable satisfactory rating by Wildlife Translocation Advisor (WTA);
5) Hunting practice in the conservancy will not have a negative effect on the translocation success of the two species because of the hunting monitoring system jointly implemented by MET and conservancies.

1.7 Layout of chapters

Chapter 1 serves as an introduction to the study, whereas Chapter 2 presents a review of relevant academic literature, as well as the theoretical framework that underpins this study. In Chapter 3 the materials and methods employed when conducting the research are explained. Chapter 4 presents the findings from the data collected and in Chapter 5 these findings are discussed. In Chapter 6 conclusions are drawn from the findings and recommendations are made.

CHAPTER 2: LITERATURE REVIEW

2.1 Conservation and management of ungulate species

2.1.1 The perspectives of wildlife management in Africa

'Wildlife' is defined as a natural resource which includes wild animals and their supporting habitats, thus giving the term 'wildlife' a different connotation from terms, such as 'fauna', 'game' and 'wild animals' (Roth & Merz 1997). In addition, the term 'wildlife' is also regarded complex as it looks at species from an ecological perspective, considering various aspects of the environment on which species depend. Wildlife management, in the context of this study, was considered to refer to any type of organised, purposeful, human engagement with wildlife resources which includes dimensions, such as conservation (protection, maintenance and promotion), control (reduction/increase in certain species) and utilisation (offtake and the use of some species by humans) (Roth & Merz 1997). For many decades, conserving wildlife through protected areas has been considered as being amongst the most effective approaches for wildlife management (Algotsson 2006; Child & Barnes 2010; Salafsky & Wollenberg 2000; Songorwa et al. 2000).

Wildlife management dates back to the colonial settlers who applied the protected area wildlife management approach or what is also known as 'fines-and-fences' approach in Africa (Mariki 2013; Songorwa et al. 2000). The fence-and-fine approach was also known as the preservation model or fortress conservation; it was characterised by enforcing restrictive regulations and viewing the presence of humans as incompatible with the conservation of biodiversity (Kubo & Supriyanto 2010; Newmark & Hough 2000). The perception of this approach was that the use of wildlife by communities was brutal and wasteful, and this seemed to justify the prohibition of access to wildlife species by parks officials or early conservationists (Songorwa et al. 2000; Kiss 1990). The approach was embraced by different sub-Saharan African countries for decades through the expansion and development of parks and protected areas, with the aim of achieving the goal of the preservation of biological diversity (Mariki 2013). It is also argued that these centralised, protectionist laws caused communities to be alienated from wildlife which, in the long run, had an adverse effect on the wildlife population, especially those outside protected areas (Child 2009; Nelson & Agrawal 2008).

On the other hand, the decline in the wildlife population has continued unabated, despite the enactment and enforcement of protectionist laws. This might be partly due to the isolation of protected areas so that local communities did not regard wildlife as their resource to conserve (Newmark & Hough 2000). Another critical aspect brought about by the protectionist approach was the over-exploitation of biodiversity which led to the loss of wildlife habitat outside the protected areas and the increasing trend in the poaching of animals since the utilisation of wildlife was restricted (Newmark & Hough 2000).

The negative manifestations resulting from the exclusion of communities from conservation initiatives brought about criticism from some conservationists during the 1970s and 1980s (Songorwa et al. 2000). New conservation debates led to the proposition of an 'alternative paradigm' which argued that, as the availability of natural resources became more limited, ecological policies needed to take account of the most successful drivers of conservation (Songorwa et al. 2000; Mariki 2013). This alternative approach also advocated that communities had to be included in the wildlife conservation approaches through the process of devolution and the decentralisation of conservation strategies (Newmark & Hough 2000; Mariki 2013). A more people-centred conservation approach emerged in most parts of Africa from a conservation history deeply entwined in injustice, exclusion and dislocation (Kiss 1990). These new approaches were referred to as 'Participatory Conservation' because they brought communities into the application of the laws of nature, which incorporated the dual objectives of community welfare and natural resources conservation (Kubo & Supriyanto 2010). Community involvement in conservation programmes gained further momentum during the late 1980s and early 1990s when a number of programmes were established in different parts of Africa, in countries such as Madagascar, Namibia, South Africa, Uganda, Kenya, the Central African Republic, Rwanda, Ghana, Zambia, Tanzania, Zimbabwe, Burkina Faso and Botswana (Kiss 1990; Child 2009; Jones et al. 2001; Jones & Weaver 2009; Newmark & Hough 2000; Virtanen 2003; Algotsson 2006)

The Community-Based Conservation (CBC) restored community participation in the access to wildlife resources by allocating the right to utilise and control wildlife, bringing in justice and addressing the equality of access to common resources. These approaches led to an improvement in the welfare of communities, as well as the creation of enhanced wildlife habitats and the better connection of conservation areas (Songorwa 1999; Songorwa et al. 2000).

2.1.2 Characteristics and conservation practices regarding ungulate species

This study focused on ungulate species because they were the species translocated to the conservancies in Namibia (NACSO 2013), and also because these species have dominated conservation programmes throughout Africa (Sinclair & Arcese 1995). Early translocations in Namibia involved endangered ungulates, which included the black rhinoceros (Linklater et al. 2012; Brodie et al. 2011) and black-faced impala (Green & Rothstein 1998; Matson 2004), as well as several carnivores, such as the cheetah, lion and leopard (Linnell et al. 1997; Marker & Dickman 2003). In this section, the general description and nature of ungulate species will be presented.

Feeding habits, habitat preferences, water dependency and other key behavioural characteristics have been identified by different scholars as important factors affecting the interaction of ungulate species with their habitats (Verlinden 1998; Stapelberg, van Rooyen, Bothma, Van der Linde & Groeneveld 2008; Rudee 2010; Owen-Smith & Goodall 2014; Tennant & Macleod 2014;).

Ungulates are conventionally categorised into ‘browsers’, ‘grazers’ and ‘intermediate (mixed) feeders’ (Estes 2012). The cranio-dental and gastro-intestinal, morpho-physiological diversity reflects the feeding habits of members of the ungulates (Tennant & Macleod 2014). Ungulates that are grazers consume a greater quantity of monocot materials (>80%), and also feed on grass which is high in fibre and low in protein (Estes 2012; Tennant & Macleod 2014). The grazers include, but are not limited to, the oryx, hartebeest, wildebeest, waterbuck and buffalo. Browsers are characterised by a much lower level of monocot-material intake, and are mainly feeding on fruit, as well as shrub and tree foliage (Tennant & Macleod 2014). Examples of browsers include giraffe, kudu and some small ruminants, like the duiker and dik-dik (Estes 2012; Roodt 2011).

Intermediate feeders are both browsers and grazers as they feed on foliage from forbs, shrub, trees, as well as on different grasses. The springbok and eland are examples of intermediate or mixed feeders where the eland predominantly browse on forbs, shrub and trees, with a tendency to feed on green grass during the rainy season. The springbok predominantly graze but also have the tendency to shift to fruit, shrub and tree foliage when grass is limited (Estes 2012; Skinner & Chimimba, 2005). The food preferences and feeding types of ungulates also dictate their interaction with the habitat (Vavra & Ganskopp 1998).

Ungulates have different water requirements. While some species depend heavily on water, others are able to survive without water for long periods of time. The maintenance of body temperature and water balances determines the differences in water dependency among ungulates (Cain III et al. 2012). Water-dependent species are those species that require a daily water intake primarily driven by low-water content food. For example, most grazers are likely to be water-dependent (Leuthold 2012). This is particularly true in the case of elephant, buffalo, blue wildebeest, black rhino, kudu and the sable antelope, to mention but a few (Cain III et al. 2005; Cain III et al. 2012; De Boer et al. 2010). Species, such as the eland, springbok and red hartebeest, are less dependent on water, and are not restricted to habitats with permanent surface-water sources (Cain III et al. 2012). They also feed on succulent food sources, such as melons, bulbs and tubers, that are likely to supplement the water requirements in their bodies (Leuthold 2012; Roodt 2011; Stuart & Stuart 2014). Species that are less dependent on water have the ability to reduce water losses based on physiological mechanisms and such species also have a tendency to be dependent on high water-content forage (Cain III et al. 2005). For example, the springbok and eland will drink regularly if water is readily available but can also supplement their water requirements with water from succulent vegetation (Skinner & Chimimba 2005).

The social structures and behaviour of most ungulates are also different. A few ungulate species are exclusively solitary while most ungulate species form large social groupings (Leuthold 2012; Roodt 2011). Territorial behaviour within species will lead to a group of members of a species defending and protecting their territory from incursions by other members, particularly during mating seasons. Most males of the ungulate species tend to be territorial, but this is less so among kudu and roan antelope (Leuthold 2012). Both eland and springbok are gregarious species, assembling in groups of different sizes; however, they are different because springbok males display territorial behaviour while eland bulls do not (Skinner & Chimimba 2005).

The distribution of food resources has a direct link to the dispersal and movement of ungulate species in a particular habitat (Leuthold 2012). The differences in food resources and habitat structures also cause co-existence among ungulate species (Cain III et al. 2012). Some species lead nomadic lifestyles and move long distances in search of ephemeral food sources, like the eland migrate that can cover long distances either due to disturbances or in search of preferred habitats (Harris et al. 2009). Migrant species, such as the blue wildebeest, are well-known for their "great migration" in the Serengeti-Mara regions of east Africa (IUCN 2016; Leuthold 2012). In southern Africa, migration of ungulates is driven by various factors, such as searching for water, food availability and also environmentally triggered situations like drought and flooding (Harris et al. 2009). Other species, such as the oryx, kudu and the red hartebeest, are more sedentary species and their movements are mainly triggered by harsh climatic conditions, such as drought (IUCN 2016).

2.2 Wildlife translocation

2.2.1 The definition of translocation

This study employs the term 'translocation' as in the IUCN definition because it has commonly been used as the standard by several translocation scientists (Armstrong & Seddon 2007; Rout et al. 2007). The IUCN defines translocation as the human-mediated movement of living organisms from one area, with release in another (IUCN/SSC 2013). Translocation for conservation is mainly intentional, as included in the definition, rather than accidental. Intentional translocation is carried out with the main purpose of improving the status of species or to restore the natural ecosystem processes of a habitat in order to fulfil conservation objectives, while accidental translocation occurs when organisms are moved unintentionally (IUCN/SSC 2013; Seddon et al. 2013). No unintentional movement of wildlife species has been recorded in Namibia.

Conservation translocation consists of the dichotomy that involves, on one hand, the movement of species to known, indigenous habitats (population restoration) and, on the other hand, the movement of species to a totally new environment (conservation introductions) (IUCN/SSC 2013; Seddon et al. 2007, 2013) (see Fig. 3).

For the introduction of conservation, assisted colonisation is when species are moved beyond their known range in order to protect them. In such instances, the protection against current or likely future threats in the receiving habitat becomes less than in the area of origin. This introduction is also known as “assisted migration” or “managed relocation” (Dodd & Seigel 1991; Novellie & Knight 1994; Seddon 2010; Seigel & Dodd 2002; Wolf et al. 1998). Ecological replacement or substitution, on the other hand, is practised in the event of species loss or extinction, and involves the introduction of another related or sub-species that could perform a similar ecological function as the extinct species (IUCN/SSC 2013). The primary focus for the introduction of conservation is to strengthen the functions of the ecosystem rather than that of a single species. For example, an exotic Aldabra giant tortoise (*Aldabrachelys gigantea*) was translocated to the offshore islands of Mauritius as a replacement for the extinct *Cylidraspis* species in order to restore grazing and seed dispersal in those islands (Seddon et al. 2014).

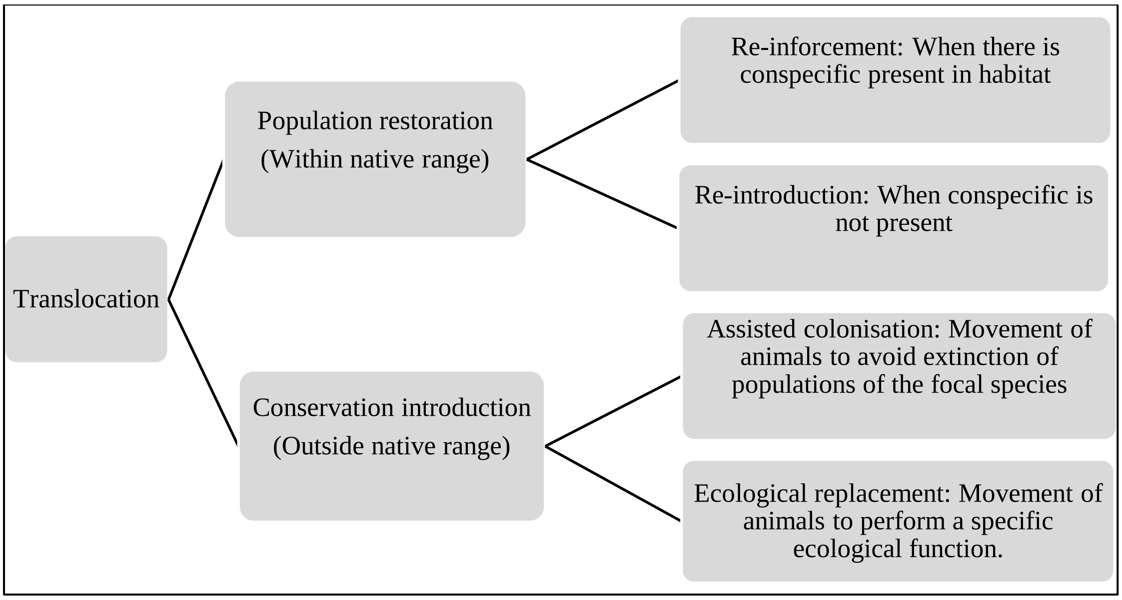


Figure 3: The components of the definition of conservation translocation

(Source: Adapted from IUCN/SSC, 2013)

Conservation restoration is a common form of translocation that involves translocating species to a known historical range of species, and its primary focus is to build up a certain species in their native habitat (Seddon et al. 2013). Reintroduction involves re-establishing a viable population that was previously found in the area. These are the core components of population restoration that primarily aim to translocate species to their indigenous range (IUCN/SSC 2013;

Seddon et al. 2014). During 1995 – 1996, wolves were reintroduced into the Yellowstone National Park in the United States of America (USA) from other areas in the country (Seddon et al. 2014). The viability of existing populations in an area is enhanced through reinforcement when numbers are increased or specific demographic stages are improved. Other terms, such as supplementation, augmentation, restocking and enhancements, are used with similar connotations to re-establishment (Fischer & Lindenmayer 2000; Seddon 2010). Most of the translocation programmes involving mammals and birds were conducted mainly for reintroducing species into their historical range or restocking the existing populations of certain species (Seddon et al. 2014). In the present study, the definition and components of conservation restoration was mainly used.

2.2.2 Purpose and extent of wildlife translocation

Translocation has been a crucial conservational tool for decades in contributing to the fulfilment of biological preservation, biodiversity conservation and restoration objectives (Seddon et al. 2007). This important conservation tool has also been employed throughout the world to overcome barriers of dispersal among wildlife species and habitats (Seddon 2010). Translocations are done either for conservation or non-conservation purposes (Seddon et al. 2013). The components embedded in the definition of translocation in the previous section also reflect the conservation purposes of translocation, such as rescuing the endangered or threatened species, species augmentation, re-introduction and also species substitution. Translocation for non-conservation purposes include non-lethal control and management of problem animals, commercial and recreational, biological control, aesthetic, religious, wildlife rehabilitations, as well as animal rights activists and liberations (Seddon et al. 2013). In terms of the scale of occurrence, translocation has been practised in different parts of the world, such as North and South America, New Zealand and Australia, Asia, Europe, as well as Africa, involving species from different genera (Fischer & Lindenmayer 2000; Fontúrbel & Simonetti 2011). The first translocation cases were recorded in North America where about 15 American bison (*Bison bison*) were moved to new reserves in Oklahoma in 1907 (Caughley 1994). A large number of translocation programmes have been recorded, mostly during the 1970s and 1980s, and they are now on the increase in different parts of the world (Seddon et al. 2013; Wolf et al. 1996). It is estimated that about 700 translocation programmes were conducted annually in the USA during the 1990s (Wolf et al. 1996). By 2005, a total of 424 species were involved in translocation worldwide (Seddon et al. 2014).

Reviews of past translocation cases show that translocation involved a diversity of species and that most translocations involved mammals and birds (Fischer & Lindenmayer 2000; Griffin et al. 2000), and this trend continues (Seddon et al. 2014). Mammals account for more than 41% of world-wide translocations studied in 181 cases between 1980 and 2000 (Fischer & Lindenmayer 2000; Seddon et al. 2014). Among the mammals, ungulates and carnivores dominate translocation programmes (Jule et al. 2008; Wolf et al. 1996). No single, distinct reason exists to explain this taxonomic bias in translocation programmes but one could conclude that larger animals are more adaptable to diverse habitats and conditions (Rout et al. 2007; Oro et al. 2011; Wolf et al. 1996). On the contrary, translocation of invertebrates, reptiles, amphibians and fish was limited; perhaps this is relatively related to their prevalence in nature (Seddon et al. 2014; Seigel & Dodd 2002).

One of the common, non-conservation translocations is the non-lethal approach to solving human-wildlife conflict (Fontúrbel & Simonetti 2011; Linnell et al. 1997). Academic literature also shows that translocation was applied to remedy wildlife-wildlife and human-wildlife conflicts (Linnell et al. 1997; Pinter-Wollman et al. 2009). In a review, it was established that about 50 scientific publications on the translocation of carnivores to resolve human-wildlife conflicts existed worldwide (Fontúrbel & Simonetti 2011). In 2013, 10 wild dogs were released at the Tsvavo west/Mvomazi border area of Tanzania and Kenya to restore the wild dog populations to their former ranges (Githiru et al. 2014). In Namibia, a total of 23 adults and 10 juveniles were recently translocated from a captive area to the wild to build up free-roaming cheetah populations in the country (Weise et al. 2015). In the 1990s, eight lions were translocated from an area close to villages in Zimbabwe after they had caused damage to livestock, while in Namibia 10 lions were moved to the Etosha National Park after they had killed several livestock in the neighbouring, community area (Linnell et al. 1997).

Another, non-lethal control of animal populations involves the African elephant that had recently been translocated due to the increasing human-elephant conflict in countries like South Africa and Kenya in an attempt to reduce the conflicts (Pinter-Wollman et al. 2009; Viljoen, Ganswindt, Du Toit & Langbauer Jr 2008). For example, due to the escalating human-elephant conflict incidents along the Shimba Hills on the coastal region in Kenya, a total 150 elephant were moved from the Shimba Hills National Reserve and Mwaluganje Elephant Sanctuary to Tsava East National Park which was about 160km away from these protected areas. In another example, 12 elephant were translocated 16 times in Sri Lanka to solve human-elephant conflicts (Fernando et al. 2012).

The black rhino are ungulates that face the threat of extinction, and have been translocated for conservation purposes to reduce the risk of extinction and to build new populations in different parts of southern Africa (Linklater et al. 2012). The translocation of black rhino started as early as 1826, following the outbreak of poaching incidents on the species that caused heavy declines in populations across southern Africa (Göttert et al. 2010). The extensive translocation history of the black rhino has been documented. For example, close to a 100 black rhino were translocated from the Etosha National Park, which had more than 95% of the Namibia black rhino population in the 1970s (Göttert et al. 2010), to establish new populations in other Namibian and South African protected areas since 1973 (Erb 2000). Over a period of 25 years (1981 – 2005), a total of 682 black rhino were translocated to 81 reserves of Namibia and South Africa (Linklater et al. 2012). However, recently, the translocation of black rhino was carried out to reintroduce the species to its historical range for conservation and tourism purposes. For instance, Namibia translocated black rhino from protected areas to private land (Göttert et al. 2010). Black rhino are being moved from protected areas to communal farmlands for the purpose of strengthening different conservation programmes in the country and as tourism initiatives (NACSO 2013). These translocations were also conducted to reduce the overpopulation of certain species at the source (Paterson et al. 2008b).

In addition, other translocations were practised to satisfy recreational or amenity values (Seddon et al. 2013). Besides augmenting species in general, translocation has been used to restock hunted species or for the supply of species for non-consumptive and/or tourism purposes (Spear & Chown 2008). About 500, non-indigenous, individual ungulates from 19 species were moved from captive landscapes to open conservation areas between 1987 and 2006 in South Africa to improve tourism and the hunting potential in these areas (Spear & Chown 2008). Elephant translocations in South Africa have been carried out to improve the tourism prospects of many privately-owned lands, and by 1994 over 1300 young elephant were translocated from the Kruger National Park to private land (IUCN/SSC 2003).

2.2.3 Factors influencing translocation outcomes

The ultimate goal of any translocation programme is to achieve greater survival rates among translocated individuals, leading to the establishment of a population or the augmenting of existing populations in new habitats. Investigating those factors that affect the translocation outcomes is not only important for translocated species but also crucial for building the resilience of ecosystems for the conservation of biodiversity. Successful translocations are important for biodiversity, and these translocations are considered to be successful when a viable and self-sustaining species population is established due to the presence of enabling factors that provide a conducive environment for the species (Pinter-Wollman et al. 2009). Translocation is typically considered to have failed when the species die out or severely decline, either naturally or due to habitat and anthropogenic influences (Novellie & Knight 1994).

Translocation is said to be influenced by several factors that could be methodological; these include the release procedures, the composition and choice of source stock or environmental factors which include general habitat and climatic conditions (Wolf et al. 1998). In addition, the anthropogenic factors of habitats can have direct effects on the species in a habitat or can produce ecological effects that can affect wildlife negatively (Lande 1998). These factors may include, among others, land clearing, the over-exploitation of resources, pollution, settlements and the use of wildlife habitats for cultural and agricultural purposes. However, the methodological factors were outside the scope of this study.

Success rates for earlier translocations were as low as 23% (Seddon et al. 2014), and this may have resulted in either fewer publications reporting failed translocation cases (Rout et al. 2007) or low success rates achieved because scientists and practitioners were not fully aware of the different aspects that could affect the translocation of wildlife species (Fischer & Lindenmayer 2000; Sarrazin & Barbault 1996). However, Armstrong and Seddon (2007) indicate that failing translocations during these periods prompted the need for greater interest in the study of translocation outcomes and the factors associated with the outcomes (Fischer &

Lindenmayer 2000; Griffin et al. 2000; Seddon et al. 2007). Broad reviews of bird and mammal translocation programmes were conducted for about 93 species in 1989 (Fischer & Lindenmayer 2000; Griffin et al. 2000); furthermore, an updated list of 181 species in 1998 for earlier translocations was reviewed to assess factors affecting translocation outcomes (Seddon et al. 2014). Generally, success among these translocations was attributed to good habitat conditions in the receiving habitats, the species being released into historical ranges and also the release of large group-sizes of a species (Seddon et al. 2014). For reinforcement programmes, larger founder populations were also identified as important determinants of success in the establishment of species.

Among the few species that were successfully translocated during the 1970s and 1980s were the golden lion tamarin in Brazil, the red wolf in the USA, the California condor in USA, the black-footed ferret in the USA and the Arabian oryx in Jordan which were moved from areas in which they were threatened to protected areas, with close post-release monitoring programmes (Jule et al. 2008; Sarrazin & Barbault 1996). The successful translocation of the golden lion tamarin was mainly attributed to suitable habitat conditions that were combined with rigorous and continuous monitoring of the area and species (Kierulff et al. 2012).

The translocation programmes involving mammals and birds had better success rates when compared to those involving invertebrates, tortoises, fish, amphibians and reptile species, probably because these are more sensitive and require greater care (Seddon et al. 2014). The translocation of individual invertebrates also needs to be done under critical and well-studied conditions to attain higher survival rates (Seigel & Dodd 2002; Tuberville et al. 2005). In addition, habitat suitability models were necessary before translocation under these taxonomies. For example, habitat suitability models were developed before the translocation of the Western tortoise (*Psuedemychuru umbrina*) to increase its survival after the release of species individuals into the new habitats (Seddon et al. 2014).

Specifically, higher success rates were experienced for the translocation of ungulates (Novellie & Knight 1994; Seddon et al. 2014). After translocation, ungulates tend to establish into viable populations either within or outside historical ranges as they have the ability to adapt easily to different habitats, particularly when negative human activities are absent or limited (Spear & Chown 2008). An 85% success rate was experienced among 18 ungulate species translocated to four national parks in South Africa, and the habitat quality mainly attributed to most successes (Novellie & Knight 1994). Black rhino translocations also yield high success rates when translocated to suitable habitats; the major threat to the successful establishment of black rhino translocated to an area is largely attributed to anthropogenic activities (Linklater et al. 2012). Therefore, the likelihood of the successful translocation of ungulates to protected areas was mostly increased by the absence or little anthropogenic activities; however, habitats exposed to hunting and other human-related interactions could lead to the failure of ungulates to settle or be established in viable populations after translocation (García-Marmolejo et al. 2015).

The pre- and post-release monitoring of both species and habitat conditions has been identified as a critical practice at different stages of translocation to increase the chances of establishing populations (Armstrong & Seddon 2007; Weeks et al. 2011). The poor success rates of many earlier translocation programmes was pointed out as being due to the poor planning or lack of pre-release monitoring such as undertaking habitat suitability investigations or identification of supportive measures for species to be released (Fischer & Lindenmayer 2000; Sarrazin & Barbault 1996; Seddon et al. 2013). Furthermore, earlier translocations lack detailed understanding of the genetic and behavioural knowledge of both the animals to be released and those of the founding populations and this was particularly due to the limited involvement of different expertise at the early stage of translocation implementation (Sarrazin & Barbault, 1996). The pre-release monitoring which involve the planning component of translocation is also an important stage because it provides prior information regarding the potential opportunities and threats that could influence the ability of translocated species to succeed in the area (IUCN/SSC 2013). Pre-release monitoring also increases the chances of the successful establishment of the translocated species in their new habitat (Novellie & Knight 1994). During this phase, the preparation of translocation programmes should focus on the prior knowledge of the species and the habitat in order to increase the chances of success (IUCN/SSC 2013).

The type of information required at the planning phase for translocations of ungulates include forage identification and appropriate shelter (vegetation types, condition and distribution), predator density and behaviour and natural competitors, as well as other human disturbances, including hunting. These aspects will all be critical in promoting the success of translocation programmes to allow released individuals to cope in a new environment (Griffin et al. 2000; Rout et al. 2007). The founder population dynamics and history are important determinants of the translocation outcome, and the historical background will assist in planning future translocations (Armstrong & Seddon 2007). Continuous monitoring after the translocation of the identified aspects during the planning stage is essential for the persistence of the established population which eventually becomes an integral component of the conservation plans of the species and the area at both population and meta-population levels (Armstrong & Seddon 2007; IUCN/SSC 2013).

Unfavourable habitat conditions contributed to most failures among mammal species, particularly when habitats are characterised by degradation and fragmentation, high predator density or human disturbances (Fischer & Lindenmayer 2000; Wolf et al. 1998). Habitat conditions have been considered crucial to the success of translocation programmes. They include, but are not limited to, habitat quality, food availability, natural competitors and predators (Seddon et al. 2013; Wolf et al. 1998). Habitat quality refers to "the ability of the environment to provide conditions appropriate for individual and population persistence" (Armstrong & Seddon 2007, p. 22). This comprises factors such as, but not limited to, environmental characteristics (altitude, rainfall and temperature), vegetation characteristics, predation, disease, fire and also natural competitors (Armstrong & Seddon 2007; Norris 2004).

The habitat at the release site should be able to support the translocated species through maintaining the quality of habitats and continuous monitoring. Although most ungulates feed on vegetation, different species specific habitat remains crucial for translocation success. For example, the eland is a mixed feeder and depends on both grazing and browsing (Watson & Owen-Smith 2000). The researchers also indicate that the grazing proportion is higher (up to 60%) during the wet season when the grass is green than the dry season while they depend more on browsing mainly selecting leaves with low fibre content (D'Ammando et al. 2015; Watson & Owen-Smith 2000). The eland is not restricted to habitats with permanent water sources because it is not a water-dependent species. They have developed strategies to conserve their body water content such as feeding on moisture-rich and succulent vegetation, feeding and being active at night and in the early hours and also reducing sweating during the day in order to conserve water in their bodies (Roodt 2011).

The main threat associated with the eland population was identified to be hunting rather than natural enemies (predation) or disruption to reproduction. Earlier translocations of eland during the 1970s aimed at removing the remaining population located in unprotected areas to save the populations from overexploitation (Hofmeyr & Lenssen 1975; Underwood 1981). Where protection is absent, the species suffer great stress due to human hunting both by subsistence and commercial farmers (IUCN 2016). Historically in Namibia, free-roaming eland could be found across the woodlands and savannah areas of the country (Figure 42 in the Appendix section), however, the population saw a decline and eland were moved to protected areas (Brown 2006; Hofmeyr & Lenssen 1975). In terms of predation, eland is mainly threatened by the African lion (*Panthera leo*), spotted hyena (*Crocuta crocuta*) and/or African wild dogs (*Lycaon pictus*) (Hillman 1987).

In addition, the springbok is placed in the category of "least concern" by IUCN because it is amongst the most abundant and wide-spread antelope in its range. In addition, there are no major threats that could affect the long-term survival of the springbok as the current conservation status continues to contribute to a healthy growth trend for the species (IUCN 2016). The species is estimated to have a high annual population growth of as much as 35% to 45% (Stapelberg et al. 2008). Most of the springbok population in Southern Africa is found on private land (60%) with only 12% found in protected areas and the rest (28%) elsewhere (IUCN 2016). Namibia contains the largest springbok population in Southern Africa with an estimated population of 730,000 individuals (IUCN 2016).

Historically, the springbok was mainly dominant in open habitats of Namibia except the North-Eastern wetter part of the country (Brown 2006; Shortridge 1934).The present distribution is now concentrated in the central, southern and western parts of the country, where the species has been totally removed from areas with high human population densities (Brown 2006; Mendelsohn et al. 2002). In Namibia, the species has adapted to arid habitats with variable food resources ranging from grasslands, bushland or shrub land and at times migrating sporadically in vast herds between these ecosystems (Shortridge 1934).

The migration of the springbok is not characterised by seasonal movement but rather mainly triggered by the search for food or water, responding to rainfall variability. Generally, springbok are considered as mixed feeders but forage selectively. The common diet of springbok includes young and tender grass, grass roots, forbs, succulent vegetation and leaves of several shrub or tree species. Springbok is a water-independent species, and although it does not need to drink often, when water is available it will drink on a daily basis (Skinner & Chimimba 2005). The water requirement of springbok is determined by diet, as the species has the ability to obtain moisture from foraging succulent shrub leaves, flowers, roots and seeds (Roodt 2011; Stapelberg 2007; Stapelberg et al. 2008).

Not much literature exists about the translocation of springbok in Namibia and Southern Africa. This could be due to the fact that the species is still abundant across its range. However, a translocation case of springbok documented in South Africa together with other species indicated showed successful outcomes. Out of the four National Parks in South Africa the springbok was translocated into, three of the parks were part of the areas the springbok previously occurred. The springbok managed to establish into viable populations in all these Parks including the Park the springbok did not occur before (Novellie & Knight 1994).

In addition to natural habitat factors, anthropogenic factors in conservation areas tend to cause physical alterations to the habitat, changes the behaviour and interactions of the species, and lead to mortalities or local extinctions in species (Teixeira et al. 2007; Steidl & Powell 2006). The survival and success rates among wildlife species can be affected negatively by human-related or anthropogenic activities, such as habitat destruction, degradation, fragmentation and over-exploitation or over-hunting, as well as the spreading of diseases (Hayes & Hayes 2013). Noise pollution and disturbances in wildlife habitats through interactions with humans have also been identified as affecting wildlife populations negatively (Steidl & Powell 2006). Within a habitat, increased protection and reduced human impact (hunting, trapping or poaching) made translocation programmes more successful (Moritz 1999). It has been regarded that most species adapt better and survive much longer after translocation when the habitat allowed for the use of a wider landscape, but when translocated to isolated patches failure was increased (Moritz 1999). This is particularly true for degraded and fragmented habitats where the quality of the habitat is reduced (Lande 1998).

Since most translocations have been focusing on protected areas, very little literature reports the influences of anthropogenic factors on translocation. However, there exists rich literature on the influence of anthropogenic factors on wildlife populations, particularly those found outside protected areas (García-Marmolejo et al. 2015; Waltert et al. 2009). Humans have a long history regarding the exploitation of wildlife as a source of food, revenue or for recreational purposes. Hunting is undoubtedly the most substantial, direct impact of human predation on wildlife where different species have been hunted for various reasons (Theuerkauf & Rouys 2008). The exploitation or quota system is one of the ways that can be employed to determine sustainable levels of wildlife exploitation, and this method has been applied to different species (Du Toit 2002; Fa & Brown 2009). It involves the estimation of extraction levels based on population growth rates which are determined from monitoring information. Sometimes, however, it is difficult to estimate sustainable levels accurately (Du Toit 2002). Deriving quotas from wildlife monitoring data is one strategy used to determine the extraction levels for the hunting of each species in a particular area (Du Toit 2002). Quota levels should be set dynamically to match population fluctuations since the wildlife population does vary over time, due to various factors. These include climatic conditions, human influences and other natural factors. Therefore, over a long period of time, it is better to focus on and put more effort into data collection and monitoring rather than simply harvest for sustainable exploitation (Du Toit 2002).

Translocation failures result in population declines or local extinction, ending up either in high post-release dispersal or mortality (Armstrong & Seddon 2007; Le Gouar et al. 2013). High, post-release dispersal and mortality in most cases could result from other habitat and/or anthropogenic factors, and could have adverse effects on the translocated populations. The diagnostic approach proposed under the pre-release monitoring assists in identifying factors that could influence the translocated population at the release area negatively (IUCN/SSC 2013). Some translocation programmes also seem to have failed because individuals returned to their home ranges (Pinter-Wollman et al. 2009). Other habitat factors contributing to the failure of translocated programmes are physiological or stress pressure, predation, fires and diseases (Tarszisz et al. 2014; Teixeira et al. 2007).

2.3. Theoretical framework: The declining-population paradigm

The theoretical foundation of this study is to relate translocation to conservation biology as translocation has been recognised as an important tool for contributing to the conservation of biodiversity (Hodder & Bullock 1997; Weeks et al. 2011). Two paradigms, considered to be crucial for conservation biology, the declining-population and small-population paradigm, were introduced by Caughley (1994) as a dichotomy. The small-population paradigm focuses on understanding the population fluctuations through the modelling of small populations to predict the extinction of species (Boyce 2002; Caughley 1994; Norris 2004). The other paradigm is the declining-population theory that deliberates on the identification of causes of population decline and threats of extinction through field-based investigations (Boyce 2002). The declining-population paradigm was applied to the objectives of this study in the identification of factors with the potential to affect the establishment of translocated, ungulate species.

The declining-population paradigm was found more appropriate for this study as it focuses on detecting causes of population decline (Caughley 1994). This theory is also applicable to this study because it evaluates the need to understand the reasons for previous declines, ensuring that those conditions that caused the previous decline are investigated and mechanisms to increase the survival of species are identified. There are internal and external contributing factors to the population decline. Strategies to address these factors that contribute to the persistence of translocated species can be identified through the application of this paradigm (Armstrong & Seddon 2007). In order to establish the causes of decline, aspects of habitat use, demography and the behaviour of species need to be understood to inform management of decisions about species or habitats under threat (Caughley 1994; Norris 2004). Increasing abundance, and thereby increasing the persistence of the species in a habitat, will make exploitation of that species possible. In this theory, this is an expected process to develop effective management strategies (Norris 2004). This paradigm identifies the “evil quartet” which may contribute to species extinction, namely, (i) over-harvesting; (ii) habitat destruction and fragmentation; (iii) competition from introduced species and (iv) chains of extinction (Caughley

1994). The “evil quartet” are the primary contributors to human-induced extinction among wildlife species (Caughley 1994). Wildlife populations can be affected heavily when human disturbances to the environment pose a threat to the fitness of adaptable strategies that animal species use. This “evil quartet” should be built into conservation management to avoid a loss of biodiversity and ecosystem functions (Brook et al. 2008). Approximately 49% of some major biomes, such as tropical and temperate forests, temperate grasslands and tropical savannah, have experienced habitat loss due to human activities (Hayes & Hayes 2013). For example, the introduction of the Nile perch (*Lates nilotica*) to Lake Victoria (East Africa) contributed to the loss of about 200 – 400 endemic fish species (Hayes & Hayes 2013). The over-exploitation of wildlife species is one main reason for the decline in numbers of populations (Waltert et al. 2009).

Chains of extinction are of the evils or threats identified in the declining population paradigm that could lead to species extinctions. An extinction vortex (see Fig. 4) has been used by extinction experts to describe a process that declining species will go through during the mutual reinforcement of biotic and abiotic factors that pull the population downwards to extinction (Brook et al. 2008). In this vortex, the evil quartet, together with other combining factors, will be the cause of the population declining. Signs of this include demographic fluctuations, fragmentation in populations, in-breeding depression and also genetic drift, which can result in a smaller ability to adapt (Brook et al. 2008). If these signs remain undetected and unaddressed, the population will continue to decline and eventually end up becoming extinct. In addition, the chances of success in the translocation of a species, where the contributors to decline are not identified, are also reduced.

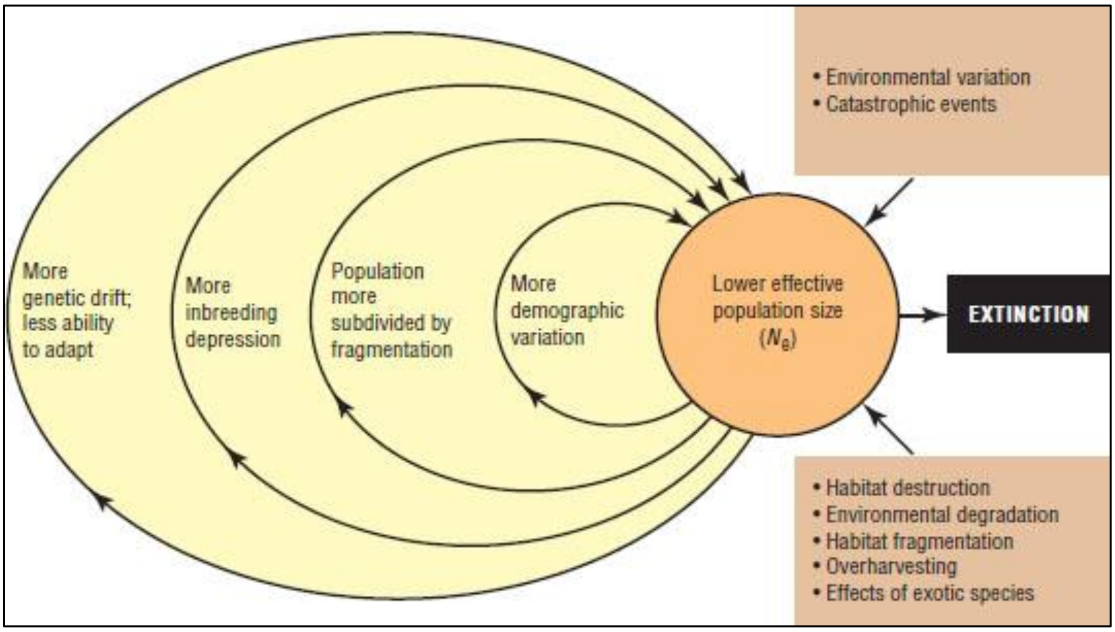


Figure 4: The extinction vortex

(Source: Adaptable from (Brook et al. 2008))

Despite its application in the field of conservation and restoration biology, the declining-population theory has weaknesses and shortfalls (Boyce 2002; Norris 2004). The major criticism is the fact that the declining-population paradigm cannot be treated in isolation from the theory of small-populations as introduced by Caughley (1994) and seen as two distinctive theories. They should rather be applied together in order to be effective when saving threatened species (Asquith 2001; Hedrick et al. 1996). Applying the two paradigms collectively would allow the use of different methods, such as field-based data together with modelling, to generate a greater impact on conservation biology (Boyce 2002). In an article entitled “Misdirections in conservation biology” it was strongly pointed out that there is a need for synergies to analyse and address conservation issues holistically (Asquith 2001). However, translocation cases have been studied successfully by employing the declining-population paradigm, especially in the identification of factors affecting the success of translocations and ensuring that previous conditions that had caused the decline were addressed (Armstrong & Seddon 2007).

In most cases, translocation is pragmatic for the purpose to build up populations into viable populations in areas where such populations have declined. Although the translocation process may reverse the decline by augmenting the numbers, the declining-population paradigm should be utilised to ensure that future declines are prevented through the continuous assessment and monitoring of the habitats. Armstrong and Seddon (2007) relate translocation to the declining-population paradigm by generating key questions at population, ecosystem or mega-population levels that could be used to assess the effects of several factors on the establishment and persistence of the translocated populations (see Fig. 5). The declining-population theory can be adapted to the analysis of the management of translocated species by identifying key questions that can assist scientists and practitioners to improve the establishment and persistence of translocated species in the new habitat (Armstrong & Seddon 2007). Furthermore, the declining-population theory was applied to the management of threatened species, especially bird populations (Norris 2004), and it was concluded that effective conservation after translocation required the implementation of management strategies that could address identified causes of decline.

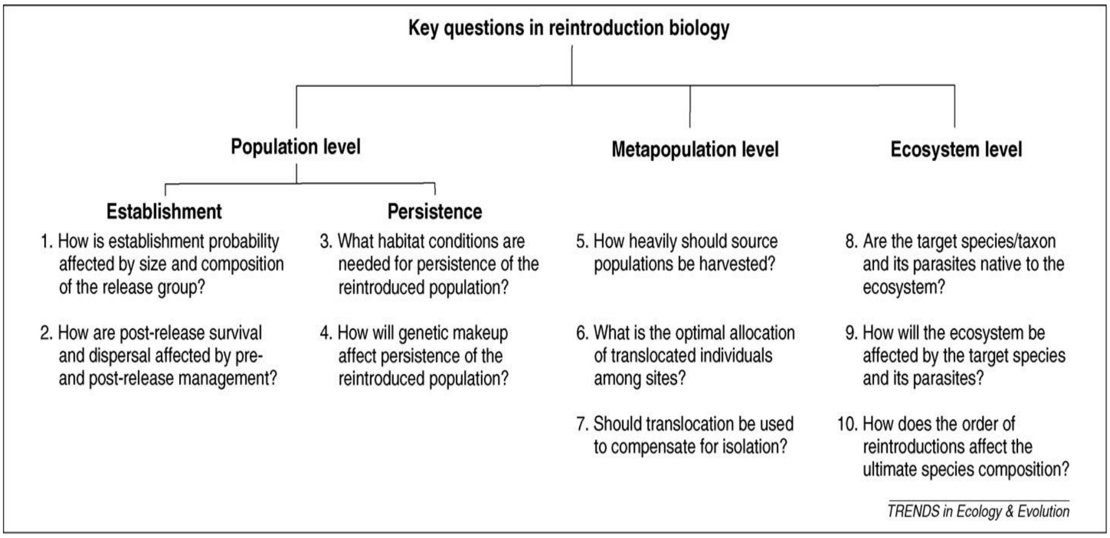


Figure 5: The key questions in translocation

Source: (Armstrong & Seddon 2007)

Therefore, since the current study focused on species that had declined (such as the eland) or became locally extinct (such as the springbok), the declining-population theory was fundamental in guiding the present research during the assessment of the habitat conditions needed for the persistence of these populations in the area, as well as identifying the agents of decline. The study site, the Nyae Nyae conservancy, is located within suitable landscapes for the eland (Van der Walt 1989); however, the species has declined tremendously in the area before the translocation was done (Weaver & Skyer 2003). Also, even though there is historical evidence from literature that springbok used to roam in the region of the Nyae Nyae conservancy (Brown 2006; Shortridge 1934), this species is extinct in that area.

In summary, this chapter reviewed existing literature regarding the translocation of species, both locally as well as internationally. It also discussed the theoretical framework which underlies this study. The next chapter will discuss the methodology applied when collecting data for this study.

CHAPTER 3: MATERIALS AND METHODS

3.1 Study area and species of focus

3.1.1 Location of the Nyae Nyae Conservancy

The study was conducted in the Nyae Nyae Conservancy (located at 20^{o}S, 20^{o}E) which is in the Tsumkwe Constituency of the Otjozondjupa region (see Fig. 6). The Tsumkwe constituency covers an area of 26,010 km^2 and constitutes communal land and the Khaudum Game Reserve (Mendelsohn et al. 2002). This constituency is the least populated in the Otjozondjupa region with under 10 000 inhabitants, according to the 2011 National Census (Namibia Statistics Agency (NSA 2014). The Tsumkwe settlement (which shares the same name as the constituency) is the main urban town in the constituency, and is the centre for both the constituency and the conservancy. This settlement houses government offices, the conservancy office, primary and secondary level schools, a clinic, the main hotel, the main shopping centre and other service providers. This settlement has a population of 2,000 – 3,000 people (Hays et al. 2014).

The Nyae Nyae Conservancy was registered in 1998 with MET, making it one of the oldest communal conservancies in Namibia. This conservancy has borders with other conservancies where the Ondjou conservancy borders with the Nyae Nyae conservancy in the southern part, while on the western part lies the N≠aJaqna conservancy. In the northern direction, the Nyae Nyae conservancy borders with the Khaudum Game Reserve while in the eastern direction the conservancy borders with the Namibia-Botswana borders. The conservancy has an area of 8 992 km^2 and makes up 35% of the area of the Tsumkwe Constituency (NACSO 2004).

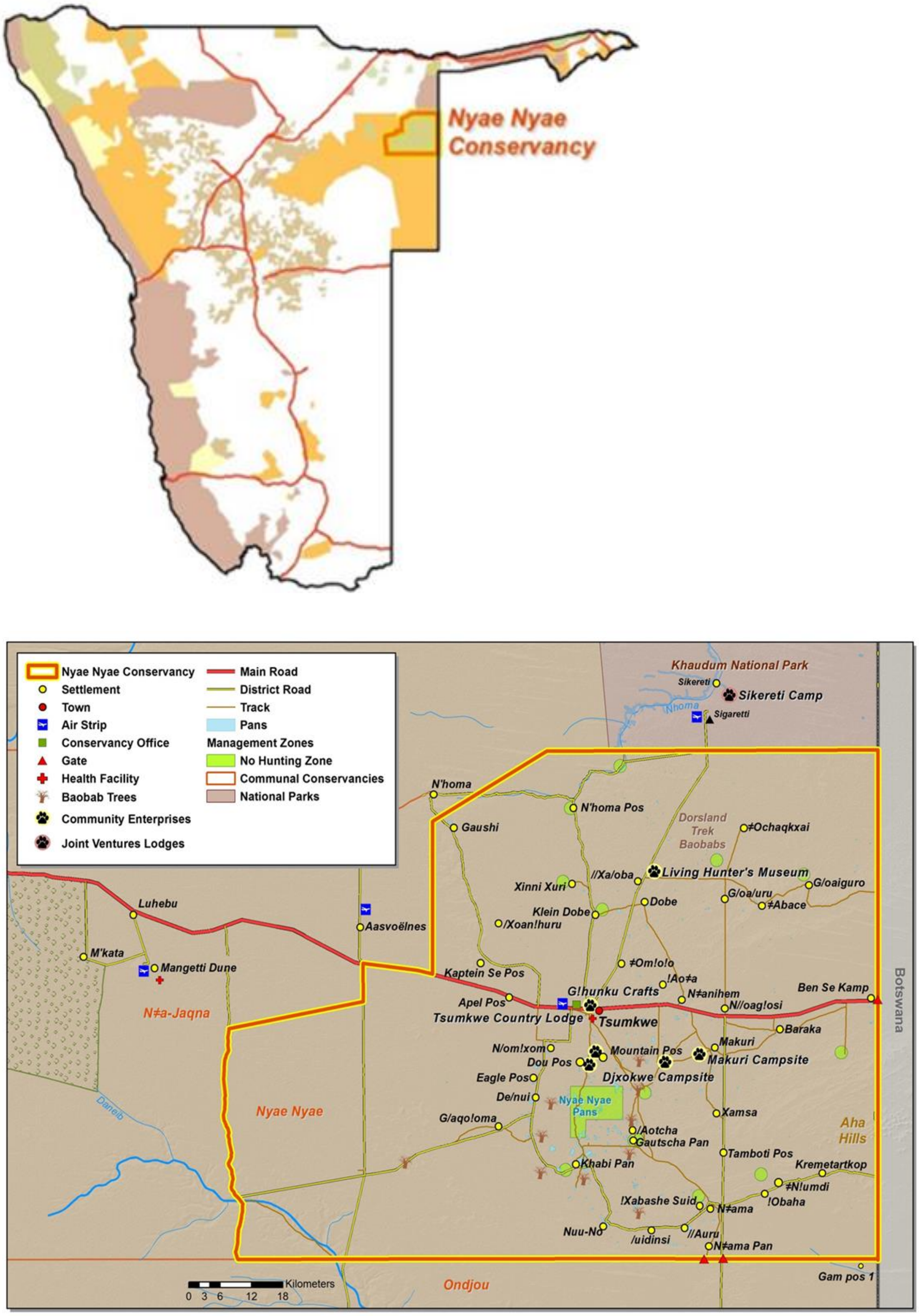


Figure 6: Location of the Nyae Nyae Conservancy in Namibia and Africa

(Source: WWF in Namibia/NACSO (2016)

The Nyae Nyae conservancy is also characterised by a very low population density as villages outside the main Tsumkwe settlement have a human population density of less than 1 person/km^2 (Biesele & Hitchcock 2013; Weissner, 2004). During the 1950s, it was estimated that about 1 000 individuals lived in Nyae Nyae areas, scattered through some 38 different villages, each of which was organised around kinship ties and territorial rights. The number of these villages remain the same to date, and there are now approximately 3 000 people living in these 38 villages in the Nyae Nyae conservancy, with a range of 15 – 20 households per village (Hays et al. 2014). This conservancy is located in the north-eastern part of the Tsumkwe Constituency, and covers land under the jurisdiction of the Ju/'hoansi (San) community.

3.1.2 Sources of livelihood of the Nyae Nyae Conservancy

The majority of the people in this conservancy are historically hunter-gatherers, although recently some diversification of livelihood is evident (Biesele & Hitchcock 2013; Suzman 2001). For example, village-level gardens mainly growing vegetables, such as sweet potatoes and melons, are being run to supplement the diets of the community members (Hays et al. 2014). The changes in the livelihood systems are attributed to the declining natural resources, emerging legislation regulating access and protection of natural resources, but also as a result of diminishing hunter-gathering interest, knowledge and skills. For instance, interest in hunting activities or other San traditional activities among the young San members waned as more have gained interest in modern, educational programmes introduced to them (Suzman, 2001). The livelihood activities and support systems on which community members currently depend include pensions and social welfare grants, food aid, permanent and casual employment, subsistence crop production, livestock, small businesses, sale of natural products or informal and tourism-related activities (Biesele & Hitchcock 2013; Dieckmann et al. 2014; Suzman 2001).

Hunting-gathering was more visible as a dominant livelihood activity among the San community during the 1950s while, by the 1970s, fewer households (only about 5%) depended on hunting and gathering as primary livelihood (Suzman 2001). After Namibia’s independence in 1990, almost all households among the San community in the Nyae Nyae area were not solely depending on hunting and gathering for their livelihood; this has led to several, alternative livelihood options to be introduced in the area (Biesele & Hitchcock 2013). There is a long history of community development efforts in the Nyae Nyae area, one being the Ju/wa Farmers' Union established in 1989. The Union was later transformed into the Nyae Nyae Farmers' Co-operative in 1990 in order to allow for the expansion of initiatives that were core to enhancing livelihood activities in the area (Suzman 2001).

The South African regime in Namibia officially permitted the San population in the Nyae Nyae area to hunt by using traditional means (bow and arrow), and this practice has remained in place after Independence in 1990 (Suzman 2001). The conservancy concept was then introduced to community members when the Nature Conservation Act of 1967 was amended in 1996 to include communal land dwellers in the management of wildlife (Suzman 2001). The amendment provided community members with the opportunity to continue hunting, generate income from trophy hunting, harvest natural products, promote both consumptive and cultural tourism, obtain direct employment and strengthen other livelihood opportunities (Biesele & Hitchcock 2013; Suzman 2001).

3.1.3 Natural resources of the Nyae Nyae conservancy

The Nyae Nyae Conservancy is located in a dry area where most water sources are boreholes and some dry drainage routes where surface water flows for very short periods of time after rainfall. The Nyae Nyae conservancy mainly receives summer rainfall (January – February) which ranges between 400 – 500mm (Mendelsohn et al. 2002). The study area is situated within the Kalahari woodlands which consist primarily of mixed, broad-leaved and acacia woodlands (Mendelsohn & El Obeid 2005). The conservancy comprises of thick Kalahari sands which support tall and broad-leafed trees such as Kalahari Apple leaf , Sand camwood and some scattered Makalani palms and Baobabs, as well as several shrubs the Terminalia spp, *Combretum* spp, *Senegalia* spp. and *Vachellia* spp (Curtis & Mannheimer 2005; Mendelsohn & El Obeid 2002; Wanke & Wanke 2006). The *Senegalia* spp and *Vachellia* spp common in the Nyae Nyae conservancy include but are not limited to *S. caffra, V. erioloba, V. mellifera, V. sieberiana and V. tortilis* (Strobach & Kutuahuripa 2014; Wanke & Wanke 2006). The trees and shrubs of Africa that belonged to the genus Acacia were assigned to either *Vachellia* or *Senegalia* genera (Kyalangalilwa et al. 2013).

Numerous grass and other herbaceous species are also found in the Nyae Nyae conservancy (Wanke & Wanke 2006).The underlying geology is Kalahari sand which is poorly suited for crop production (Mendelsohn & El Obeid 2002). Frequent fires are also common in the Kalahari woodlands, of which most are man-made and these fires occur mainly during June – October (Mendelsohn & El Obeid 2002).

The Nyae Nyae conservancy is home to diverse wildlife species which include, but are not limited to, blue wildebeest, roan antelope, oryx, kudu, red hartebeest, eland, buffalo, tsessebe, springbok, giraffe, duiker, steenbok, lion, cheetah, leopard, spotted hyena, wild dogs and many other small mammals. In addition, the conservancy houses a large population of approximately 2 000 elephants moving between the Nyae Nyae conservancy, the Khaudum Game Reserve and neighbouring communal areas (NACSO 2013; Weaver & Skyer 2003). During the 1980s, the establishment of permanent water points in the Nyae Nyae area drew large herds of elephant to the area (Wiessner 2004).

3.1.4 Selection the Nyae Nyae conservancy

The reason for selecting the Nyae Nyae conservancy was primarily due to its wildlife translocation record and consistency in wildlife counts undertaken by the conservancy in collaboration with the MET and NACSO since 2001. The Nyae Nyae conservancy being one of the oldest conservancies in Namibia, has been carrying out both local monitoring (the event-book) through local Rangers (Stuart-Hill et al. 2005) and the annual water-point game counts since 2001, except for 2006 when the area was inaccessible due to flooding (Pers. comm. Raymond Peters, WWF in Namibia, May 2015). In addition, although different conservancies have been boosted with wildlife through translocation (NACSO 2013), the Nyae Nyae conservancy was among the first to benefit from the government translocation programme, and has received the highest number of both wildlife species and individuals (Weaver & Skyers 2003). A total of 8 388 animals representing 15 different wildlife species were translocated to different communal conservancies between 1999 and 2011 (NACSO 2013). Over the same period, a total of 2 200 individual animals from 9 wildlife species were translocated to the Nyae Nyae conservancy (MET database, unpublished). The species translocated to the conservancy included springbok (*Antidorcas marsupialis*), eland (*Taurotragus oryx*), oryx (*Oryx gazelle*), giraffe (*Giraffa camelopardalis*), red hartebeest (*Alcelaphus buselaphus*), kudu (*Tagelaphus strepsiceros*), black rhino (*Diceros bicornis*), blue wildebeest (*Connochaetes taurinus*) and Burchell's zebra (*Equus burchelli*). The Nyae Nyae conservancy is among the areas classified as having significant numbers of large, herbivorous mammals in Namibia, alongside the Etosha National Park, Khomas Hochland region and Naukluft mountains and therefore creates an opportunity for wildlife related assessments like the present study (Mendelsohn & El Obeid 2002).

3.1.5 Selection of study species

Criteria for translocating wildlife to conservancies

Wildlife translocation in Namibia is evaluated thoroughly by the MET, experts from NGOs and donors, like NACSO and WWF in Namibia, to ensure that wildlife is translocated to suitable habitats. These evaluations are done to increase the success rates of the translocations, especially in the conservancies that have not been supporting some species over a long period. Two sets of criteria were developed by the MET, together with local stakeholders, to evaluate the suitability of a conservancy for wildlife species, namely, (i) the general translocation criteria and (ii) species-specific translocation criteria.

The general translocation set of criteria aim to assess the preparedness of a conservancy or habitat to receive translocated animals. The general criteria include aspects, such as the management capacity of the conservancy, tourism and the trophy-hunting potential of the area, wildlife breeding and productivity potential, the ability for the ecosystem to support the wildlife, the importance of wildlife to the livelihoods of the conservancy communities, as well as the type and level of threats to the wildlife populations within and around the surrounding areas (Paterson et al. 2008b). The criteria also assesses whether wildlife management in the conservancy is of a compatible, land-use type where it will not negatively affect traditional, land-use types, such as livestock and crop farming. The criteria are also used to establish the acceptance of the species by the inhabitants, as well as the cultural significance. Such kind of evaluation also intends to determine the extent to which the conservancy (after the proposed translocation) will be able to contribute to the national conservation objectives in terms of managing key habitats, wildlife corridors, conservation buffer zones and also specialised initiatives, such as trans-frontier conservation areas (Paterson et al. 2008a).

The second set of criteria evaluates the suitability of the conservancy for a specific species. For these criteria, the ecological suitability (historical range, rainfall and habitat), and the levels of the existing population of the specific species as well as the water resources in terms of availability and accessibility are determined. The ability by the conservancy to support the national plan for the particular species is also assessed under the second set of criteria (Paterson et al. 2008a).

The data related to the criteria described above were entered into a Wildlife Translocation Advisor (WTA) which is a computerised tool developed by the MET and assessed by wildlife experts to address the complex decision-making process of determining the appropriateness of the conservancy and species for translocation. Figure 7 below shows the results from the WTA for the Nyae Nyae Conservancy (Paterson et al. 2008b). According to the results from the WTA, the two species selected for this study, the eland and springbok, showed comparable suitability. The eland and the springbok displayed moderate suitability based on the WTA when compared to species, such as oryx, giraffe, kudu, blue wildebeest and red hartebeest. The eland and springbok were mainly selected based on the similar WTA outcomes, coupled with their different historical backgrounds to the study areas.

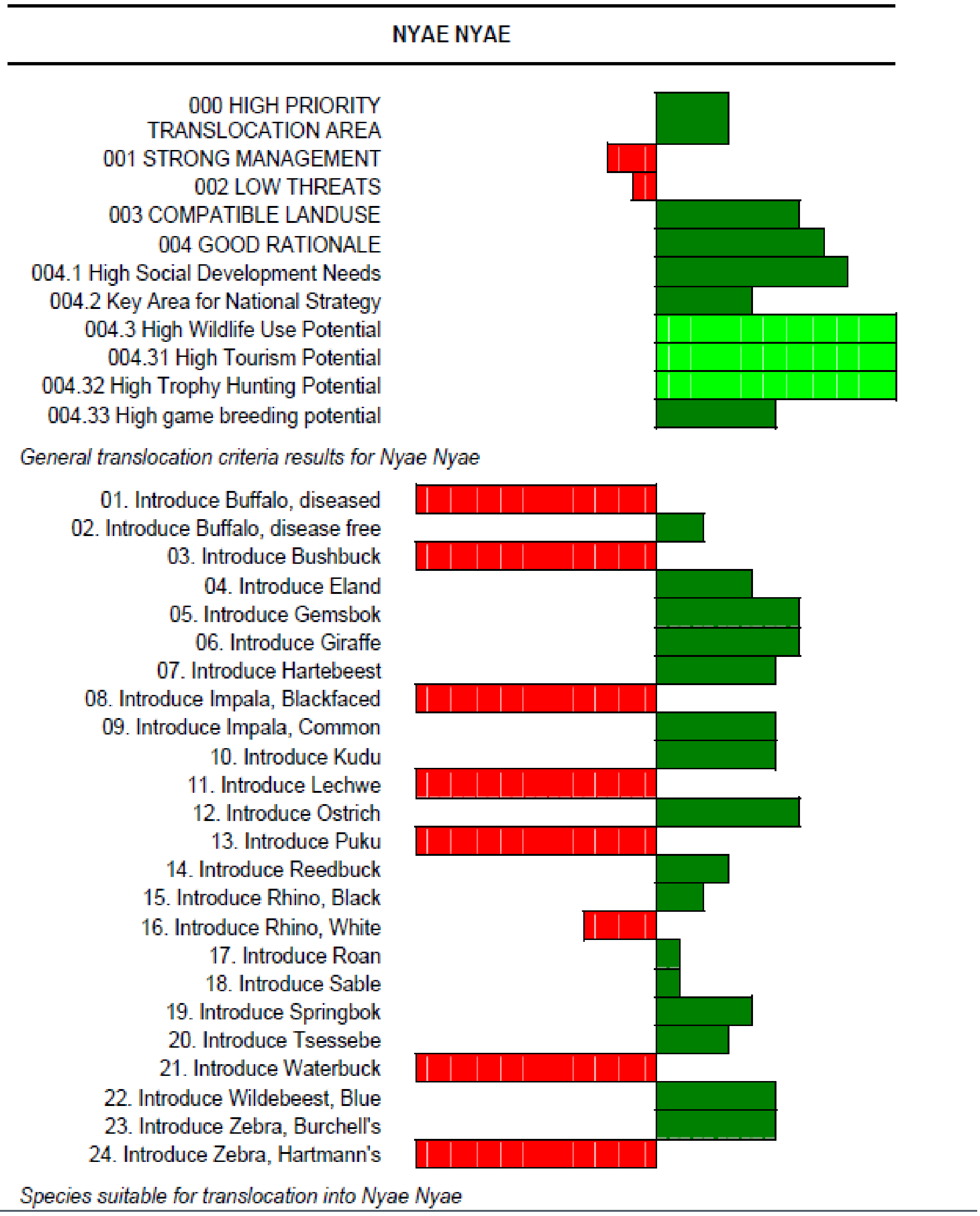


Figure 7: The output of the Wildlife Translocation Advisor (WTA): Translocation suitability for the Nyae Nyae Conservancy

***(red/dark grey with stripes = unsuitable, green/dark grey = suitable; light green/light grey = top priority). Source:* (Paterson et al. 2008b)

Description of the species of focus

Out of a total of nine species supplemented by translocation into the Nyae Nyae conservancy, this study focused on two species, namely the springbok (*A. marsupialis*) and eland (*T. oryx*). The detailed description of the two species is found in Appendix 1. The reasons for selecting these species were based on the fact that they had similar WTA outcomes in terms of their suitability for translocation to the Nyae Nyae conservancy. In addition to the rating, these two species experienced declines in population sizes within the habitat (Table 1) where the eland were still found in the conservancy but in very low numbers at the time of translocation (Weaver & Skyer 2003), while the springbok did not occur in the conservancy at the time of translocation but was said to have existed in the conservancy in the past (Brown 2006). These historical declining scenarios for the two species enables the application of the declining populations theory for diagnosing factors affecting the populations of these species in order to assist in designing future management programmes to prevent future declines. In addition, there is also historical evidence that springbok lived in the Nyae Nyae conservancy (Shortridge 1934). However, it is not known when the springbok ceased to exist in the Nyae Nyae area and what could have contributed to their disappearance from the area. The absence or low numbers of founder populations of these two species, being another reason for the selection of these species (Table 1), was identified to allow the study to gain a better understanding of the contribution of translocation to population growth. In addition, this will also facilitate a better understanding of the success of the translocation, as majority of individuals, if not all, that were assessed came from the translocated individuals

These species are comparable because they both have the ability to adapt to a wide-range of habitats, are migratory in nature and have related feeding and water requirements (Roodt 2011). However, their historic trends and distribution in southern Africa, including Namibia, depict dissimilarities where the springbok is still widely distributed, while the eland has become more confined to certain parts only (IUCN 2016). As a result, the similarities and differences were important to determine which factors might have an effect on the success of the translocation of these species in the Nyae Nyae conservancy.

The 1998 aerial survey information was used for the founder numbers because this survey was conducted at the inception phase of the Nyae Nyae conservancy and a year before the translocation programme commenced in 1999. The 1998 survey count for each species, translocated numbers and sources of translocated individuals of the two species are summarised in Table 1. Translocations of eland and springbok after 2005 did not form part of the study because the data-base of MET was not updated at the time when the study commenced.

Table 1: Founder and released numbers of translocated springbok (*Antidorcas marsupialis*) and the eland (*Taurotragus oryx*) into the Nyae Nyae conservancy during 1999 – 2005

Species	Eland (*T. oryx*) (% of total released)	Springbok (*A. marsupialis*) (% of total released)
Founder size (1998 aerial survey)	12	0
Released numbers 1999	0	89 (14%),
Released numbers 2000	83 (31%),	92 (15%),
Released numbers 2002	0	209 (33%),
Released numbers 2003	150 (56%),	243 (38%)
Released numbers 2005	35 (13%)	0
Total released numbers	268	633
Source populations	Waterberg and Farm Eden	Etosha National Park

Source: Own compilation from (Weaver and Skyer 2003 & MET translocation database)

3.2. Research Methodology: Mixed-method design

This study employed a mixed-method design which involved employing parallel data collection using both quantitative and qualitative methods and integrating the two forms of data in the analysis (Creswell & Clark 2011). This design provides a more comprehensive understanding of the issues by bringing together numeric trends and proportions from the quantitative procedures and the narrative details from the qualitative methods (Creswell 2014). The mixed-method design also provides a platform for the in-depth analysis of different types of data to answer a set of identified, research questions. The approach has also been referred to as an integrated, synthesis methodology or simply a multi-method approach (Bryman 2006; Tashakkori & Teddlie 2010). The mixed-method design is relatively new, originating from a methodology developed in the 1980s, based on different types of research and expertise from various fields, mainly in the area of social sciences. It recently spread to other sciences, including the biological sciences, particularly for studies of multidisciplinary nature (Creswell, 2013). In addition to the primary qualitative and quantitative data collection methods, secondary, quantitative data gathering was also incorporated into the design. Applying the mixed-method design was appropriate for this study to address both ecological and social data and also for the purpose of triangulation and in-depth examination of the factors.

Detailed description of the different mixed data collection techniques that were applied in the study to gather both the primary and secondary data will be presented in this section and the methods that will be discussed comprised of:

- Secondary long-term data on water-point counts, event-book and aerial surveys;
- Road transect and backtracking methods for springbok;
- Camera trapping and the use of traditional ecological knowledge (TEK) for the eland;
- Remote sensing method for vegetation cover and classes;
- Secondary data for map development of fire and water points;
- Social surveys: Questionnaire, Key-informant and Focussed Group Discussions (FGDs)

The data collection sites of the primary data assessments are indicated below in Figure 8.

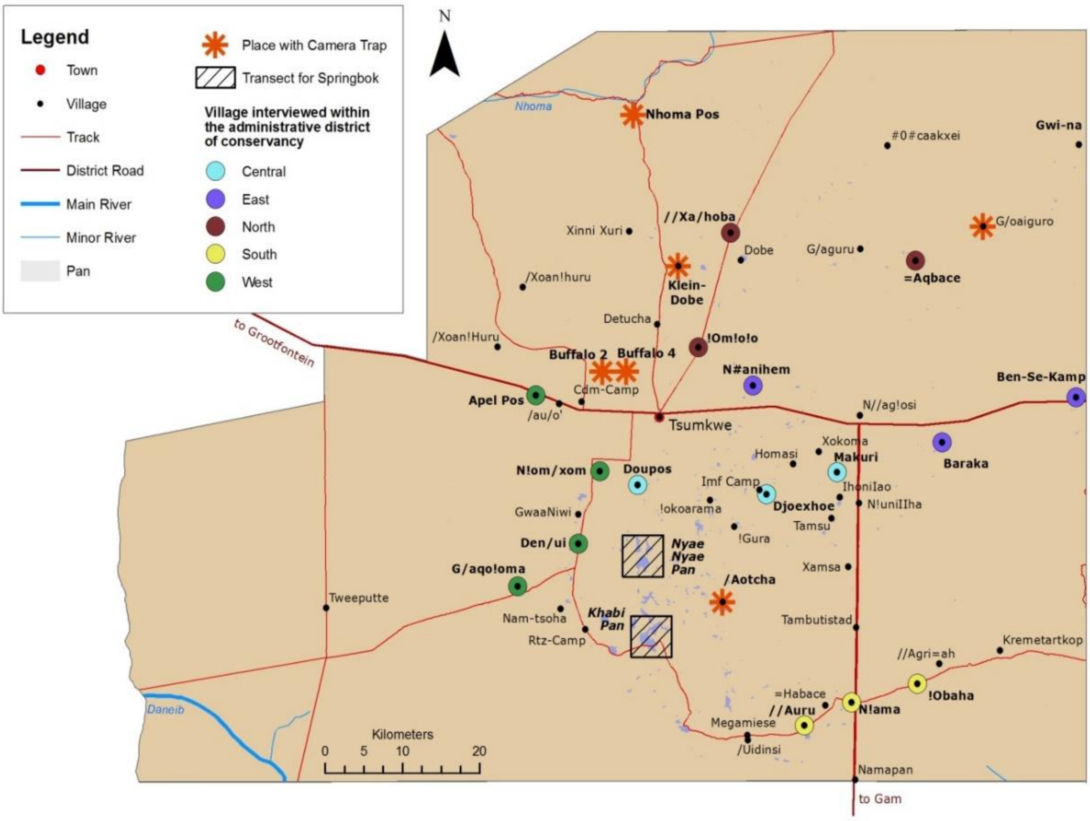


Figure 8: Location sites for household questionnaire interviews, camera trapping for eland and transects for springbok assessments

Source: Own compilation with the assistance of WWF in Namibia/NACSO

3.2.1 Trends in species composition, diversity and population sizes using long-term data

In general, long-term, secondary data from the monitoring counts are important for analysing the composition, trends, distribution and diversity of wildlife species over time. These parameters are necessary to conservation because they provide comprehensive analysis of ecological matters (Magurran et al. 2010). The CBNRM programme through the MET and the NACSO network has been supporting the conservancies in carrying out annual game counts either as individual conservancies or as groups of neighbouring conservancies to assess wildlife growth and trends in these locally-managed areas over the years (NACSO 2013). The Nyae Nyae conservancy has consistently implemented the event-book system and annual water-point counts since 2001.

The use of long-term, secondary data in this study was to assist in addressing three of the study objectives, namely, to (i) determine the trends in species composition, diversity and abundance of wildlife species in the Nyae Nyae conservancy, including those species that were supplemented through translocation, (ii) assessment of impact of the released numbers of the two translocated on their abundance and distribution in the Nyae Nyae conservancy and (ii) assessment of the effects of the practice of hunting in the Nyae Nyae conservancy on the success of the translocation of the springbok and the eland populations and other translocated species.

The raw, secondary data from the event-book system were collected directly from the Nyae Nyae conservancy office in Tsumkwe. The event-book system is a local-level monitoring system carried out through regular patrols by local rangers (several patrols weekly in 4 – 5 days) to generate weekly reports that are eventually compiled into monthly reports (Stuart-Hill et al. 2005). Data for the event-book are collected by the rangers, who are employees of the conservancy. They capture all wildlife events, such as wildlife spotted visually and noted tracks, mortality and breeding cases, poaching incidences that they observe during their patrols. The incidents are recorded on paper forms that are carried in the ranger's pouch during field patrols (Stuart-Hill et al. 2005). Monthly and annual reports are prepared from the daily reports of the rangers by the senior ranger and the conservancy management team.

The event-book contains crucial wildlife and habitat information and is used together with other monitoring data from the aerial surveys and water point counts, to inform the MET on the performance of different wildlife species in the conservancies (Stuart-Hill et al. 2005). Despite being an important source of data, the event-book did not contain records of faraway remote areas because they were not reachable to the rangers. The Nyae Nyae conservancy is a large conservancy with deep, remote forests that rngers are not able to reach, not only because of distances but also because of their safety as they patrol individually and on foot. Therefore, species that prefer to roam deep in the woods are not sufficiently captured in the event-book database. The inaccessible woodlands in the conservancy make a small proportion of approximately 10% of the conservancy and these are mainly found in the western and northern part of the conservancy (Pers. Comm., Gabriel Hipandulwa, Community Development officer, NNDF, 2017). Data for the areas that were not collected by the Rangers were acquired through aerial survey reports conducted over the area.

Secondly, the database of the 48-hour, annual water-point count (2001 – 2013) for the Nyae Nyae conservancy was also used. This database was obtained from the NACSO office with the permission of the Nyae Nyae conservancy and the MET under the terms of the research permit. These annual water-point counts of wildlife species in the Nyae Nyae Conservancy was implemented in 2001 and are carried out during the full-moon period in September annually. The process of collecting these data involved 2-person teams at each water point over a 48 hour period. At each water point, the species, number of individuals and groups sizes that visited the water point were recorded over 48 hours. Although this dataset contained consistent data of wildlife species in the conservancy, it did not record a variety of details, such as the age and sex variables of the species, and was also limited to one specific season as the data were only collected in the month of September every year. Since data from this method only consisted of species information that visited water points over 2 days in the year, it was important to use it together with other methods such as the event-book data.

Beside the water-point counts and the event-book system, reports of the aerial surveys conducted in the area were also obtained from the MET offices. The 2004 and 2013 aerial surveys were the only surveys carried out in the area after the translocation of the species to the conservancy since 1999. Different intensities were used, as the survey of 2004 covered only the Nyae Nyae conservancy and sampled at an average intensity of 33 % while the survey of 2013 covered both Nyae Nyae and Khaudum Game reserve at an average intensity of 7 %.

The use of three different secondary long-term data was to particularly respond to and address objectives 1 and 2 because they were the major data sources that provided long-term wildlife data for the Nyae Nyae conservancy for determining trends. These methods complemented each other in terms of their strengths and limitations. While the water point counts on focused on the numbers of species and individuals captured at water points, the event book systems were also able to provide stochastic events such as mortalities, breeding, predation, illegal hunting and levels of formal hunting. Although the limitations of the aerial surveys were that they only covered two years between the study period of 2001 to 2013, they nevertheless provided a better understanding of wildlife movement and density patterns in the areas that could not be physically reached for counts.

3.2.2 Population structure and diet composition of springbok

3.2.2.1 Age, sex and social structure of springbok

In order to determine the social structure (including age, sex and social groupings) of the present springbok, a road transect method was used. The 'present' represent the actual presence of the species during the period when this study was undertaken. The social structure of the several ungulate species have been studied using direct observation methods (Havarua et al. 2014; Reid 2005; Shrestha & Wegge 2006). In addition, the transect methods for wildlife counts are commonly used to study the different ecological and conservation parameters of different species (Silveira et al. 2003). The method of counting number of individuals of a particular species along transects have been considered useful to understand the population and make population estimates where not all the animals can be seen (Witmer, 2005).

The springbok were assessed along the plains of the Nyae Nyae and Nyae Khabi pans in the conservancy using the road transect method. Although other studies used the capture and re-capture methods mainly to study the ungulate populations (Cizauskas et al. 2015), the road transect method has been commonly used to understand the ecology of springbok (David 1978; Reid 2005; Stapelberg et al. 2008). This road transect method was also found to be ideal for the assessment of the population of the springbok in the Nyae Nyae conservancy. The transect method allowed for the detection of springbok individuals across different landscapes and for recording the wide variety of social activities in which they were engaged. There were, however, also limitations associated with the road transect method during this study, such as the fact that the vehicle caused disturbances among some of the detected groups and the gravel road network was not covering some of the areas. The use of binoculars assisted in detecting some springbok individuals or groups that were farther away.

During 2013-2014, the areas along these pans were affected by different climatic conditions. The area suffered a severe drought in 2013, and the springbok migrated and were seldom detected along the sampled area as they could have moved to other areas where water was available. In 2014, heavy rains were experienced in the Nyae Nyae conservancy and the sampled area along the pans was totally inaccessible for almost 6 months and assessments could therefore not be conducted. Hence, springbok assessment was only done during 2015 along the sampled road transects around the Nyae Nyae and Nyae Khabi pans where springbok were most frequently detected during the analysis of the annual water-point counts. The area does not have many roads; there was only one road connecting the pans and about four other minor routes going to the surrounding water points. A daily trip from 07h00 to 17h00 was undertaken for two consecutive weeks to collect data along the selected routes around the Nyae Nyae and Nyae Khabi pans where the springbok population was predominantly roaming.

A 4x4 vehicle was driven along these routes between 20 and 40 km/hr, with two persons seated in the back to observe the area, using binoculars. At every point where springbok individuals were spotted, the vehicle halted and recordings were taken. The following information was recorded on the data recording sheet for each sighting of springbok:

(i) General information about the commonly detected vegetation species;

(ii) Date and time when the data were recorded;

(iii) The size of the group and the group type (including sex and age classes), according to the following classification (Reid 2005, pg. 40):-

  a. Alone – any individual (sub-adult and adult females or sub-adult males);
  b. Territorial males – lone adult males;
  c. Bachelor herds – adult and sub-adult males;
  d. Mixed herds – females, sub-adults, juveniles and one or more males;
  e. Nursery herds – females, sub-adults and juveniles with no adult males present.

(iv) The activities in which individuals were engaged: (a) feeding - browsing, grazing, feeding on other materials, (b) drinking water, (c) licking salt, (d) walking, (e) running away, (f) looking around or (g) other (to be specified). These set of activities are important to understanding the social structure of a species population and its established ecological relationship with the natural habitat (Reid 2005).

The animal age classes used included: adult (>2 years), sub-adult (1 – 2 years) and juvenile (<1 year) (Owen-Smith & Mason 2005). The local rangers at the Nyae Nyae conservancy also used the same age classes and, as a result, two local rangers who were field guides during the data collection period assisted in determining the sex and ages of the spotted individuals, based on the size of the animal, length and formation of the horns and the degree of tan of the skin colour. The sex and age class of species in groups larger than 20 individuals were not determined, because it was difficult to accurately detect all animals in these large groups.

3.2.2.2 Diet composition of springbok

In order to determine the diet composition and plant species preferences, the feeding site examination or backtracking methods were used. These methods have been used by researchers under various conditions for different ungulates, including springbok (Havarua et al. 2014; Shrestha & Wegge 2006; Van Lieverloo et al. 2009). Backtracking (Van Lieverloo et al. 2009) or feeding site examination (Shrestha & Wegge 2006) are direct observation methods used to determine the diet of a species by the researcher tracking backwards to the location where the animals were observed to feed. For the purpose of this study, identification of the plant species on which the animal was feeding and distinctive bite marks left by the animal were observed and recorded for groups of one to 10 individuals. Smaller groups are easier to examine when engaged in feeding and other activities (Reid 2005).

The selection of a focal animal(s) was used as a sampling tool for individual animals or groups, and the backtracking method was used to observe their feeding closely (Havarua et al. 2014; Reid 2005). Since it was not easy to focus on an individual within a larger group of more than 10 individuals, such groups were excluded from further data collection using this method (Reid 2005). The selected individuals were observed up to a distance of 100m by using binoculars in approximately five minutes of observation. At each feeding site, plant species on which the springbok were feeding was recorded, including the part of the plant that the animals were feeding on. A total of 20 feeding, focal groups were studied and vegetation specimen identified. In cases where the vegetation species could not be identified immediately, a specimen was collected and pressed to be identified later with the assistance of the herbarium at National Botanical Research Institute (NBRI) in Windhoek.

3.2.3 Population structure and diet composition of eland

3.2.3.1 Age, Sex and social structure of eland

In this study, camera trapping was used to study the presence of eland, their age, sex and social groupings. Remote photography through camera traps has been used in ecological studies as far back as 1877 (Cutler & Swann 1973). Camera trapping has been used to study diverse areas of ecology, including but not limited to, species abundance and behaviours, different population parameters and also to assess the presence of a specific species (Meek et al. 2014; Sunarto et al. 2013; Swann et al. 2011). This method has also been referred to as a non-invasive method and is best used to study animals that are difficult to observe in habitats that are characterised by dense vegetation and collecting data without requiring the presence of the researcher (Silveira et al. 2003).

The eland being a timid species, keen-sighted and at times very cautious as well as being inactive during the day but more active in the evening and early hours of the day, make sighting them difficult (Shortridge 1934; Skinner & Chimimba 2005; Underwood 1981). This behaviour was confirmed by the local rangers who patrolled the Buffalo Camp stating that eland were difficult to see, especially due to the thickness of the forest in the camp. Other methods for direct observation were not going to yield great results in detecting species individuals because of the nature of the eland, particularly in thick woodlands. Camera trapping is ideal for spotting timid species like eland. However, this only enables the study of species only at the camera point and not in the wider landscape habitat.

The selection of the camera locations was guided by the distribution levels of the eland in the conservancy, according to the analysis of the annual Nyae Nyae conservancy water-point count data. A total of six water points with records of visits by the eland were sampled by means of camera trapping (see Figure 8). At each site, two remote cameras (Bushnell Trophy Cam HD) were mounted on fixed structures, either trees or poles, and located in viewing directions that complemented each other, with the exception of the two water points in the far northern part of the conservancy where only one camera was set up. The cameras were placed approximately 100m from the water point, and mounted at the average shoulder height of an eland, which is about 120 cm. Cameras were placed at a slight sideways angle to minimise any random exposures, due to flash activation (Marker, Fabiano, & Nghikembua 2008; Meek et al. 2014). The Bushnell camera model used eight, long-life batteries using four at a time and switched to the other four when the battery life ran low. This allowed the batteries to last for up to two months.

The data from the 32-G memory cards that were placed in the cameras were copied to a laptop and deleted from the memory card for more observations. The memory card was reloaded to the camera every second week. Two community members were assigned to assist with checking the cameras during this period, mainly copying the data, replacing the batteries and ensuring that the cameras were in working order or had not been knocked over by any animal. The operations team had all the necessary accessories and equipment to maintain the cameras. The cameras were set up in mid-August 2014 and were operational until mid-March 2015. In total, the cameras were active for about five months (see Figure 8). In the months of December and January, the cameras were switched off because of the rains and also due to the fact that some areas were inaccessible, especially the Buffalo Camp, because staff members were on holiday.

3.2.3.2 Diet composition of the eland

In this study, traditional, ecological knowledge (TEK) was utilised to determine the diet composition of the eland in the area where they were detected during camera trapping. This method was primarily used following non-detection of any eland directly feeding through other attempts. The evidence of the presence of the eland in the Buffalo Camp was noted through the annual water point counts data and from the experiences of the local rangers, as well as during camera trapping. The researcher, together with rangers responsible for guarding the Buffalo Camp, drove for 5 days along the existing road tracts while three local rangers identified plant specimen that they observed the eland consuming in the camp. These plant specimens were pressed and taken to the NBRI for identification.

3.2.4 Assessment of habitat factors affecting translocated springbok and eland species

In order to assess influence of different habitat factors on the outcomes of the two translocated species, several methods were used. Water resources, range condition, veld fires, predation as well as human settlement and farming were among the habitat factors that were evaluated to understand their effect on the translocation outcomes of the two species. The use of the combination of data from the event-book system and interviews provides a broader understanding of the influences of these factors on wildlife species. Mapping exercises were also undertaken to better understand the distribution of water, vegetation and fire occurrences.

3.2.4.1 Mapping of vegetation cover, veld fires and water points

Mapping the vegetation types and cover was done to evaluate the influence of habitat conditions on the establishment of springbok and eland in the Nyae Nyae conservancy and other translocated species. Vegetation cover is one of the indicators of habitat quality because it provides the different vegetation classes found in a specific habitat. Habitat quality refers to the ability "of the environment to provide conditions appropriate for the persistence of translocated individuals and populations" (Armstrong & Seddon 2007, p. 22).

Vegetation maps were produced from satellite images, with the assistance of the remote sensing experts from NUST and MAWF. The satellite images were downloaded from Landsat, a joint initiative of the United States Geological Survey and the US National Aeronautics and Space Administration or NASA (www.landsat.usgs.gov). For this study, the images (for April only) of each year over a period of 10 years (2004 – 2014) for the conservancy were downloaded. Most images, particularly of dry places like Namibia, are captured during April towards the end of the rainy season, and during this period herbaceous vegetation has not yet dried up and is visible together with woody vegetation structures (Pers. Comm., Mr. BK Nathanael, Forester, National Remote Sensing Centre, 28 January 2014).

The processing of downloaded satellite images was conducted starting with the pre-process of the images to prepare for identification of vegetation types. The vegetation classification was undertaken by using ENVI, a remote-sensing, software programme employed to reduce or eliminate any errors on the satellite images (Rozenstein &

Karnieli 2011), particularly those that occurred when the two plates or images for the study area were mosaicked to produce a single image. Unsupervised classification is a form of imagery analysis that allows for organising the images without the user providing sample types, but rather the software identifies related pixels and groups them together into types (Rozenstein & Karnieli 2011). The vegetation classes produced during the unsupervised classification of the images were the ones used during the ground truthing field visit conducted in March 2014 (see Fig. 9).

After the analysis of the images, points for ground truthing were identified for the different types of vegetation of the produced map and were randomly sampled. Ground truthing is an important component for remote sensing as it is primarily undertaken to verify information on the map with the situation on the ground as well as to assist in better explaining certain parameters on the maps that prove difficult to understand (McCoy 2011). A total of 8 sites were randomly selected from the classified images by using a stratified method to ensure that at least two sites from each class were sampled.

A map indicating the location of the sampled points and their GPS coordinates was used by the research team to locate the points in the field. During the fieldwork, a line intercept method was used for vegetation measurements by recording the vegetation type, cover and the height of vegetation at the observation points (McCoy 2011). This ground validation method to assess the vegetation types in the Nyae Nyae conservancy by using the line intercept method (McCoy et al. 2008) was selected because it was suitable for the Nyae Nyae topology and terrain, as it allowed the inclusion of all vegetation types and other biophysical features. The choice of the methods was done in consultation with and on the advice of the officials of the Directorate of Forestry in the Ministry of Agriculture, Water and Forestry and the recommended ground truthing methods for Savanna ecosystems in McCoy (2011).

Once the sampled point was located, the direction was selected randomly by picking papers marked with the following 8 directions (N, NW, NE, S, SW, SE, W, E) from a bag. A 100m measurement tape was stretched out in a straight line along the selected direction from the GPS point of each site (Fig. 9). Two field personnel made sure that the tape was well stretched out over the 100m distance and in the right direction. Observations were taken every 1m over the 100m transect and, at every observation point, the vegetation species at every observation point were recorded. If the canopy of a shrub or tree species fell on the observation point, then that tree or shrub species was recorded and the height was estimated. The bare soil and water were also recorded if they fell on the observation point. The observed types included bare soil (BS), grass (G), shrubs (S), trees (T) and water (W). Therefore, a total of 100 observations were collected at each transect. This exercise was not linked to the occurrence of wildlife species, but was conducted to identify the vegetation types (grassland, shrub land, moderate or dense forests) and cover (whether most areas were covered by vegetation or bare ground) to determine the quality of the habitat upon which the wildlife species was dependent (McCoy 2011). Vegetation cover was measured by estimating whether most of the observation points were under vegetation or bare soil.

Figure 9: Conducting ground truthing for vegetation mapping in the Nyae Nyae Conservancy during April 2015

Source: (Selma Lendelvo, 2015)

After the fieldwork for ground truthing, further classifications are done to produce the final maps (Rozenstein & Karnieli 2011). The data recorded during the field visits were used to select the training sites for the supervised classification, because vegetation types were already identified and determined during the first classification of the Landsat images. The final, classified images with vegetation types were further processed and vectorised to produce the final land cover map, including both vegetation and other parameters such as water and bare soil. The land cover maps were produced for both 2009 and 2014, and these years were selected to detect if there were any noticeable changes over the 5-year period. The 5-year period was selected after detecting few signs of land degradation during the ground truthing fieldwork and the last 5 years were used to assist in detecting the kind of recent changes found in vegetation cover in the area.

The fire maps for the Nyae Nyae conservancy utilised in this study were collected from the Directorate of Forestry, Ministry of Agriculture, Water and Forestry (MAWF), in Windhoek. The Directorate of Forestry annually monitor fire in different communities of the country as a strategy to manage the forestry resources. The fire maps for the Nyae Nyae conservancy are generated annually by the Ministry and shared with conservancies. For the purpose of this study, two fire maps were developed with the assistance of DOF staff and they include, (i) a map indicating the areas burned in 2013 and (ii) another map with combined fire data of the area over 10 years (2003 – 2013). These maps were employed to assess the extent of veld fires in the Nyae Nyae conservancy and the fact that fire is an important ecological factor that can influence the establishment of species translocated into the area. The water points map indicating distribution of water points in the conservancy was derived from water points count database of the conservancy that had water point names and GPS coordinates. This map was developed with the assistance of the NACSO Natural Resources Working.

3.2.4.2 Social Surveys for Community and stakeholder perceptions

The perceptions of the members of the Nyae Nyae conservancy and stakeholders were gathered using the household survey, the key-informant interviews and focussed-group discussions (FGDs). The community, in the context of this study, refers to the residents who are members of the conservancy, either ordinary members, traditional or conservancy leaders. The stakeholders refer to people representing other institutions with a stake in conservation or community development and are working with the conservancy; they are either located within the conservancy, or at regional or national level. The questionnaire mainly collected data from the residents on their views of the factors affecting the translocated species, while a part of the questionnaire also collected the residents' perceptions on the distribution and status of the translocated species, which is part of objective 2. The focus group discussions were carried out with local households, while in-depth key-informant interviews were conducted with community members, local stakeholders and also national stakeholder representatives.

Understanding community members' perceptions is important for conservation because it provides feedback on the kind of interactions and attitudes that exists, thus contribute to ensuring the effectiveness of the conservancy operations which include translocation. The perceptions obtained from the community and stakeholders were gathered to link the views of the respondents with data generated through other methods.

(a) The household survey

A household questionnaire survey was administered to the residents of the Nyae Nyae conservancy during June and July of 2013. A closed-ended questionnaire was designed to collect data from households and it was close-ended because most of the elaborative or open-ended questions were generated from the in-depth key-informant interviews. All respondents were asked the same questions about their socio-economic details, awareness of translocation, views on the changes in population sizes and interaction with different species and hunting aspects. Trained field assistants assisted the principal researcher to administer the survey to selected households and to collect the completed questionnaires.

The population of interest in this study were households in the Nyae Nyae conservancy. According to the records of the conservancy, there were approximately 500 households in the 38 villages and about 300 households in the Tsumkwe settlement. The Nyae Nyae conservancy is divided into four districts, including the Tsumkwe settlement. With the exception of Tsumkwe, the villages are very small, with 10 – 15 households per village (Hays et al. 2014). There was a great deal of movement among household members, where some homesteads could be empty for up to a month as the residents moved to other areas for various reasons. Villagers would move when food was not sufficient, lives were threatened by wild animals or when they had to collect natural products, such as devils claw; this has been identified as a livelihood strategy among the residents of this conservancy (Suzman 2001).

A sample size of 60 households, representing about 20% of the total Nyae Nyae conservancy household population was considered for data collection. The sampling size of 10 households per district and 20 households in Tsumkwe were set. A stratified, random method was employed to sample three to four villages per district in the conservancy using a list of computer-generated, random numbers for each village with a random output of numbers that represented the selected villages.

A total of 56 households from 13 villages from the four districts and the Tsumkwe settlement were actually interviewed. The actual sample size of 60 households could not be achieved as many households were found to be unoccupied during the survey. Furthermore, two of the selected villages were totally empty during the survey, and were therefore replaced with neighbouring ones.

(b) Key informant interviews (KIIs)

KIIs were conducted with selected residents of the Nyae Nyae conservancy, as well as stakeholder representatives from local, regional and national institutions working closely with the implementation of the conservancy and/or translocation programme. At local level, a mapping exercise of potential respondents was carried out, mainly aiming to identify different categories of informants.

The mapping exercise was carried out with local leaders to identify different groups in the conservancy in order to ensure the inclusiveness of the sampling. The selected informants were from the following groups: local traditional leaders, conservancy leaders (board and management committee members), conservancy staff, professional hunters, MET (local and national staff), NGOs and the World Wild Fund for Nature (WWF) that is involved in capacity building in conservancies in Namibia. These categories of institutions and suggested positions or categories of informants were determined during a preliminary visit to the conservancy before the interviews were conducted.

The selected key informants were asked about the process of wildlife translocation, its purpose, challenges and successes experienced, factors affecting the translocated wildlife, their perceptions about management and monitoring strategies, the future of wildlife translocation and the benefit of translocated wildlife to community members. Guiding questions were used to collect information from the respondents and tape recorders were used to capture interviews, which were later transcribed.

A total of 22 key-informant interviews were conducted with four traditional leaders (the Chief and three village heads), four conservancy leaders, three conservancy staff, five MET officials (one local and four at national level in Windhoek), two officers from the Nyae Nyae Development Foundation (NNDF), three respondents from WWF and one professional hunter operating in the Nyae Nyae conservancy. The interviews with the stakeholders were conducted in English, except with conservancy leaders and staff who were interviewed in Afrikaans, while interviews with Traditional Authority members were done in the local Ju/'hoansi language through a translator.

(c) Focus group discussions (FGDs)

The Focus group discussions (FGDs) were facilitated in Afrikaans through a translator in the Ju/'hoansi language which is the local Nyae Nyae language. A total of six FGDs were conducted with the residents at different villages in the Nyae Nyae conservancy. Three of these groups were mixed, consisting of both males and females, two were women-only groups and one men-only group of different age classes. One of the limitations of using this method was how to ensure participation in these group discussions as many people who were invited to these meetings refused to participate. This was probably due to the high illiteracy levels among the residents. This constraint was overcome by going house-to-house to request if they could delegate a member to attend and to assure them that the discussions were going to be very general about the conservancy, wildlife and natural resources.

The successful groups were from the central (Tsumkwe), east (Baraka) and far south (Na#ma) Nyae Nyae districts where invited community members were present and able to participate in the groups. One of the group discussions from the far south was conducted away from the villages in the forest where household members were camping and collecting devil's claw. The FGDs that were intended for the north and western villages were unsuccessful because several attempts to recruit groups failed as most community members were out in the fields harvesting devil's claw in areas that could not be accessed.

All the FGDs were conducted during June 2014, using a question guide that mainly focused on the importance of wildlife, knowledge about translocation and factors affecting the translocated species in conservancies. During these meetings, questions about hunting and its effects on the translocated species were also discussed.

3.2.5 The effects of the practice of hunting on translocated species in the conservancy

Data were collected to assist in understanding the effects of hunting in the conservancy on the translocated species, particularly with reference to the two target species, the eland and springbok. Data on hunting were derived from the long-term data from the event-book system (described in section 3.2.1) and also from social surveys with community members and stakeholders that are described above in section 3.2.4).

3.3 Data analysis

Primary data (i.e. interviews, assessments of the present springbok and eland populations) and secondary data which included water-point and event-book information were analysed, initially to generate descriptive summaries in SPSS. The mean sightings and standard error for each species, groups of species and all species together in the conservancy were calculated. In addition, frequencies and cross-tabulations were also generated to establish the proportions between different variables in SPSS. Frequencies were also run to establish the percentage of the springbok groups that foraged on different vegetation species. Most of the quantitative data analysis was done by using SPSS version 24 while some data were analysed by using R.

The chi-square test was run for association between two categorical variables and was employed for variables from both the primary and secondary study data. This test was particularly useful because it provided detailed information with limited restrictions where parametric assumptions could not be determined (McHugh 2013). Furthermore, the ANOVA (Analysis of Variance) was performed by using SPSS version 24. The One-Way ANOVA was employed to test the differences in the mean sightings of the different wildlife species groups from the secondary and primary data and to establish whether changes in the diversity of wildlife species in the Nyae Nyae conservancy over the 12 years were statistically significant. The One-Way ANOVA was also used to analyse the primary data from the springbok and eland assessments where group sizes were dependent variables and group types, sex of individuals and age classes of the two species were the independent variables. These analyses also included primary data collected to determine the structure and activities of the present eland and springbok populations.

Before the analysis of the photos, the information regarding the eland gathered from the camera traps was sorted manually by the researcher and local game rangers. Firstly, the sorting was by detecting the presence or absence of eland individuals in the photos, counting them in each photo and placing them in a separate folder in Microsoft Excel. The information recorded from each photo included: (i) number of individuals in the picture (if an animal was cut by the camera, it was only considered if it could be identified), (ii) date and time that the picture was taken, (iii) activity in which the individual animal was engaged, (iv) age class (adult, sub-adult and juvenile) and (v) sex (male or female). These data were then analysed by using a one-way ANOVA test in the SPSS where the group sizes were the dependent variables while the age classes, activities individuals were engaged in, sex of the animals were the independent variables.

The changes in abundance of the eland and springbok between 2001 and 2013 were also tested by running a correlation test in R for each of these species from the secondary, long-term, water point count data. From the same dataset, lattice graphs were plotted in R to indicate the distribution of the two species at different water points in the conservancy over the years (2001 – 2013). Trends of all the wildlife species recorded in the conservancy from the water point count database were tested in R by using a Spearman correlation test to assess if the changes in population sizes over the years were statistically significant.

A General Linear Model (GLM) was run for the association of different factors influencing the species' trends in the conservancy. GLM is particularly important in analysing both large and small datasets with multiple response parameters, and is also ideal for count data (Warton, Lyons, Stoklosa, Ives & Schielzeth 2016). For this study, the response variable was the number of species translocated between 2001 and 2013, while the explanatory variables included the initial count of 2001, the last count of 2013, the translocation status of the species (whether supplemented with translocation or not), the feeding behaviour of the species, classification (large ungulates, small ungulates or predators), the water dependency of the species and the founder and released sizes for the species whose numbers were supplemented by translocations. In addition, a GLM was also run for the association between the changes in population sizes of eland and springbok from the water-point count data and those from the event-book system. The GLM was also fitted with some attribute data from the event-books against the trends from the water-point counts. These attributes comprised the age classes (adults, sub-adults and juveniles), mortality, as well as released and founder numbers. A Hierarchical Cluster Analysis (HCA) was run with R to establish groups among wildlife over the years, particularly using the presence/absence of species over the 12 years assessed from the water point count data of 2001 – 2013.

The Simpson's Index of Diversity (SID) also indicated as (1-D) was determined for the diversity of wildlife species in the conservancy, using the long-term water-point count data.

Simpson's Index of Diversity (SID)=1-D:

Where:

$$D = \frac{\Sigma n(n-1)}{N(N-1)}$$

D= Simpson's Index.

n= A total number of organisms of a particular species

N = total number of organisms of all species

SID is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species (Keylock 2005). SID is an important measure to understand the conservation value of a habitat in terms of the species it comprises. As the richness and evenness of the species increase, so diversity increases (Keylock 2005). SID was used in this study specifically to determine the diversity of wildlife species between 2001 and 2013 across different landscapes or habitats in the Nyae Nyae conservancy. A Turkey's pairwise comparison was performed to find the cause of the significant results by comparing the species diversity over the years.

The Normalized Difference Vegetation Index (NDVI) is a "satellite-based vegetation index that correlates strongly with aboveground net primary productivity" (Pettorelli et al. 2005, p. 504). The strong link between NDVI and vegetation productivity can assist in linking this index to the changes in population sizes of ungulate species because these species depend on the vegetation, and the level of productivity can play a role in assessing trend dynamics. Also, the NDVI has been used to provide a better indication of environmental events in the savannah ecosystems, such as flooding, drought or fire (Pettorelli et al. 2005). In this study, the NDVI for the Nyae Nyae conservancy covering the period of 1999 to 2014 were downloaded from the website (https://modis.gsfc.nasa.gov/data/mod13) and interpreted, together with the overall changes in wildlife population in the conservancy.

KIIs and FGDs data were used to identify the perceptions of the local communities and stakeholders of the factors affecting the establishment of the translocated species, particularly springbok and eland. This qualitative data were transcribed and analysed using the ATLAS.ti version 7.1.4.

3.4 Limitations of the study

Limitations of the study included the following: The water-point counts data used for the study were collected between 2001 and 2013 but did not contain the data for 2006 because the conservancy did not carry out the count that year due to heavy rains that flooded most parts of the conservancy. Likewise, the plan to carry out the assessment for springbok along the Nyae Nyae and Nyae Khabi pans failed during 2014, because the sites were completely flooded for almost 6 months, making them inaccessible. Furthermore, camera trapping was not very successful in areas that were not fenced as some equipment was destroyed by the animals, especially elephants, while others were either moved into opposite positions or totally removed. Three cameras were destroyed while the other three were removed from the poles and could not be traced. Also, gaps occurred in the data as sites were only visited every second week due to long distances between water points and locations. Most of the photos were not clear that were captured during heavy rains, especially in the months of November and February, despite efforts to develop larger protected covers for the cameras. As a result, most of these pictures could not be included in the analysis. The database of translocated animals did not contain details on the sex and age groups of the translocated individuals of different species. In addition, a follow-up to the MET offices to provide these details did not succeed, because no records could be traced. In 2016, twenty-nine springbok individuals plus a total of 73 eland were moved into the Nyae Nyae conservancy. However, these figures did not form part of the analysis of this study because they were not available for use in the database.

The non-detection of feeding eland individuals was also another limitation in ascertaining the species that eland was mostly foraging on. Nonetheless, this limitation was addressed by using the local, ecological knowledge of the rangers and verified it with some neighbouring commercial farmers. This study could not look at seasonal variations, because of the nature of the study that focused on identifying various factors rather than focusing on specific ones. Besides, conducting these experiments seasonally was beyond the budget of the researcher.

In summary, this chapter discussed the methodology as well as the materials employed when conducting the study. The next chapter will present the results of the data collected.

CHAPTER 4: RESULTS

This chapter presents the results from the different data sources, including both primary (wildlife assessments, and social surveys) and secondary long-term data that comprises water-point counts, event-book system and aerial surveys. The analysis considers the overall wildlife species found in the conservancy and the two target species of the study, namely, the springbok and the eland. The first section (4.1) presents results on the composition, diversity (SID) and trends in abundance of all the wildlife species found in the conservancy as derived from the secondary data sources. This section also presents the outputs from GLM to show relationships between the two secondary datasets (the annual, water-point counts and the event-book data), and also the effect of translocation on the wildlife species trends. Other parameters fitted into the GLM include the feeding guilds, water dependency and classes (large ungulates, small ungulates and predators) of the species.

Section 4.2 focuses only on the two target species (springbok and eland) and mainly looks at the results regarding the changes in abundance and distribution over the years The analysis covers water-point count data, supplemented with data from aerial and questionnaire surveys, especially those related to the distribution of the species after translocation.

The primary data collected on the sex and age structure, assemblages and diet composition of the present eland and springbok population in the Nyae Nyae conservancy are presented in Section 4.3. In terms of the social structure of the springbok and eland populations, this section will also elaborate on the different social activities in which species individuals were engaged during the field assessments, as well as the vegetation on which the springbok and eland fed in their current habitats.

The analysis of the habitat factors affecting the establishment of the translocated species was based on the combination of methods to provide a broader understanding of the influences of these factors on species and draw on the long-term data from the event-book system. The perceptions of the residents and stakeholders and also mapping of water, vegetation cover and fire occurrences. These are presented in Section 4.4. In Section 4.5 the results regarding the hunting levels and types, as well as their effect on the translocated species are presented. These results were mainly drawn from the hunting monitoring database of the conservancy which form part of the event-book data and the perceptions of community members and stakeholders.

4.1. Trends in the composition, diversity and abundance of wildlife species

This part of the results provides an overall picture of the wildlife population in the conservancy in terms of trends in the composition, diversity and abundance between 2001 and 2013. The analysis gives a useful context for discussions regarding the contribution of translocation and the factors associated with trends and species diversity of wildlife in the conservancy. Under this section, the hypothesis that translocation has a positive influence on the trends in composition, diversity and abundance of the overall wildlife species found in the Nyae Nyae conservancy was tested.

4.1.1 Species composition

The information pertaining to the composition of wildlife species were derived from long-term data of water-point counts conducted in the conservancy. These data were collected over 12 years from 2001 to 2013, excluding 2006 due to flooding, at a total of 29 water points that comprised both natural and artificial water points.

Table 2: The common and scientific names, classification and the mean (±SE) number of animals sightings at water point during the counts of 2001 to 2013

Common Name	Scientific Name	Class *	Means (±SE)	No. of sightings of species individuals (N)**	Frequency of sightings
Buffalo	*Syncerus caffer*	LU	92 ±19.6	2931	32
Elephant	*Loxodonta africana*	LU	64±10.7	9554	148
Springbok	*Antidorcas marsupialis*	SU	*58±11.8*	*1691*	*29*
Blue Wildebeest	*Connochaetes taurinus*	LU	*45±6.9*	*3605*	*80*
Kudu	*Tragelaphus strepsiceros*	*LU*	*19±1.9*	*2589*	*140*
Eland	*Taurotragus oryx*	*LU*	*14±2.8*	*341*	*25*
Giraffe	*Giraffa Camelopardalis*	*LU*	*3±1.6*	*14*	*5*
Red hartebeest	*Alcelaphus buselaphus*	*LU*	*9±1.3*	*324*	*35*
Roan	*Hippotragus equinus*	*LU*	*9±1.4*	*547*	*60*
Oryx	*Oryx gazella*	*LU*	*7±1.5*	*310*	*43*
Warthog	*Phacochoerus africanus*	*SU*	*6±0.6*	*551*	*89*
Black Rhino	*Diceros bicornis*	*LU*	*4±1.0*	*71*	*16*
Steenbok	*Raphicerus campestris*	*SU*	*3±0.4*	*249*	*88*
Duiker	*Sylvicapra grimmia*	*SU*	*2±0.4*	*68*	*32*
Burchell's Zebra	*Equus burchelli*	*LU*	*2±0.0*	*2*	*1*
Wild Dog	*Lycaon pictus*	*P*	*9±2.5*	*327*	*35*
Jackal	*Canis mesomelas*	*P*	*5±0.5*	*496*	*102*
Spotted Hyena	*Crocuta crocuta*	*P*	*4±0.6*	*570*	*130*
Leopard	*Panthera pardus*	*P*	*2±0.1*	*92*	*59*
Lion	*Panthera leo*	*P*	*2±0.5*	*9*	*5*

*LU – Large ungulates; SU – Small ungulates; P=Predator; **These totals were used as the (N) for the correlation analysis for each species. **Source of data: Water point count data from the Nyae Nyae Conservancy (2001-2013)**

The total number of sightings of species individuals and the frequency of sightings serve as important source of information for understanding abundance of difference species in the area (Table 2). For the purpose of the analysis, the wildlife species detected during the water-point counts during the period 2001 to 2013 were categorised as large mammals, small mammals and predators. These classifications were done not necessarily to contribute to a specific objective, but rather to group species for an understanding of the kind of wildlife species found in the conservancy. The large and small ungulates were distinguished, based on the species' average body mass. Stuart and Stuart (2014) indicate that large ungulates weigh between 100 kg to more than 5,000 kg, while small ungulates weigh between less than 5 and 100 kg. This categorisation was necessary to allow for the grouping of species with similar characteristics for a better comparison among and within groups, where most ungulates are categorised based on body size (Stuart & Stuart 2014).

A total of 20 species, comprising of ungulates and predators, were recorded over the 12 year period from the annual, water-point count data (see Table 2). The total number of species observed over the years at the water points were primarily ungulates (N=15; 75%) which consisted of small ungulates (N=4; 20%) and larger ungulates (N=11; 55%). The rest of the species were predators (N=5, 25%). The results from the One-way ANOVA revealed that the mean frequency of sightings for the different species for the combined 12 years under the three classification groups were not statistically different ($F_{2,\ 17}$ = 1.06, P = 0.368). In addition, the dendrogram (Fig. 10) showed two groups consisting of the year 2013 and the other group consisting the rest of the 11 years. The year 2013 exhibited the highest number of individuals sighted during the counts of a few species such as the elephant, buffalo and blue wildebeest which are also classified as water-depended large mammals (Table 1). However, the degree of dissimilarity at 0.14 is also very low suggesting little variations in wildlife species sighted between the two groups.

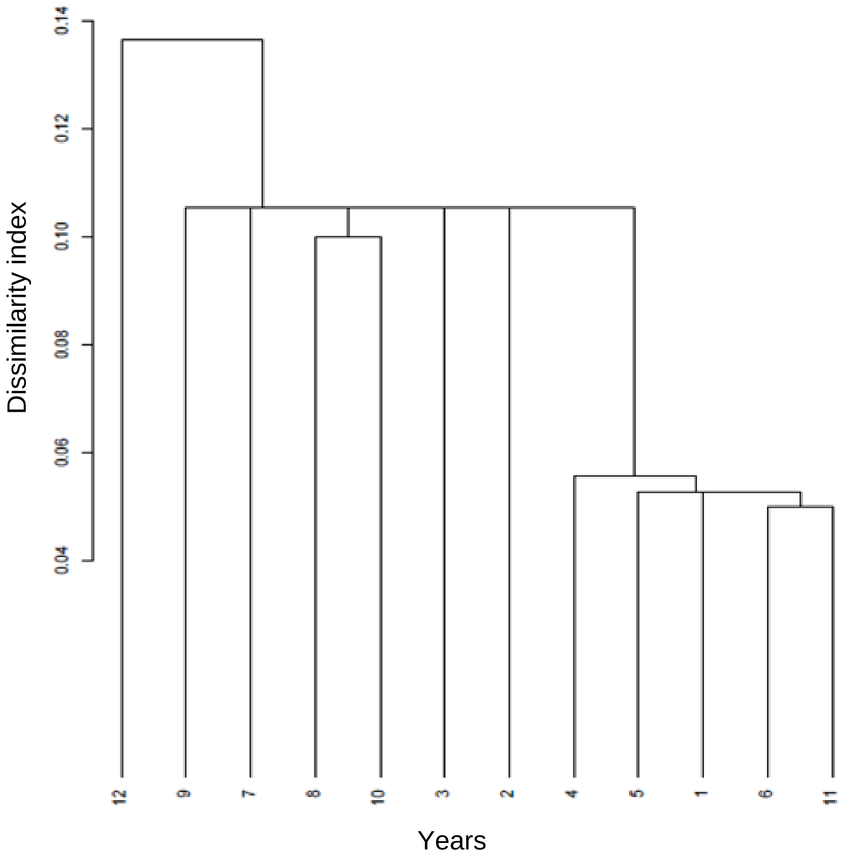


Figure 10: Dendrogram resulting from cluster analysis of visits of different wildlife species between the years of 2001 to 2013 excluding 2006 (1 represents 2001 – 12 representing 2013)

Source of data: Water point count data

4.1.2 Diversity of wildlife species

The trends Simpson Index of Diversity (SID) for wildlife mammal species in the Nyae Nyae conservancy from 2001 to 2013 is presented in Figure 11. The Kruskal Wallis test (X^2_{11}=19.06; P=0.001) revealed a significant decline in the SID, being highest in 2001 (SID=0.851) to lowest in 2013 (SID=0.720). This significant decline over the years was largely affected by the dominance of a few wildlife species with high recorded numbers, which include the buffaloes, elephants and kudus during 2013. The Turkey's pairwise comparison confirms the significant differences of wildlife diversity for 2013 with most of the others years (Table 3). Despite this decline, the Nyae Nyae conservancy displayed an average of SID of 0.811 for the wildlife species was found in the conservancy from 2001 to 2013.

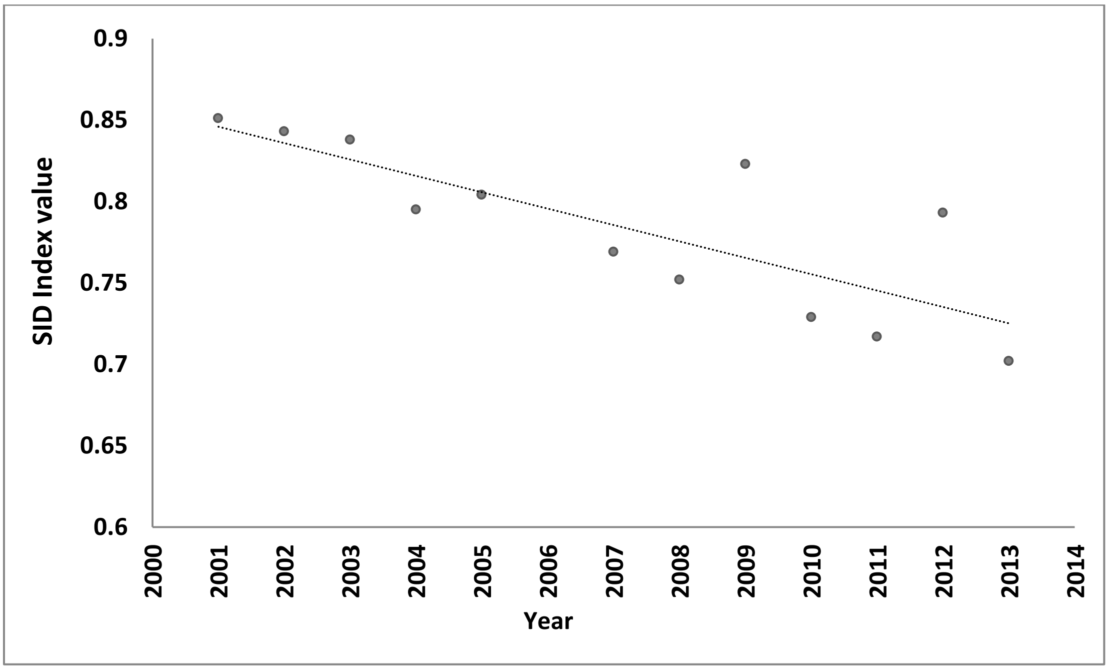


Figure 11: Simpson's Index of Diversity (SID) for all the sighted wildlife species in the conservancy over the period of 2001 – 2013

Table 3: Turkey's pairwise comparison output for wildlife species diversity between the years

	2001	2002	2003	2004	2005	2007	2008	2009	2010	2011	2012	2013
2001		1	1	1	0.9988	0.5802	1	0.9997	1	1	1	0.0019
2002	0.4639		1	1	1	0.8015	1	1	1	1	1	0.0072
2003	0.7677	0.3037		1	1	0.9039	1	1	1	1	1	0.0159
2004	0.9195	0.4556	0.1519		1	0.9388	1	1	1	1	1	0.0231
2005	1.322	0.8578	0.5541	0.4022		0.9872	1	1	1	1	0.9992	0.0578
2007	3.052	2.588	2.285	2.133	1.731		0.8728	0.9713	0.9439	0.7981	0.6148	0.696
2008	0.6609	0.1969	0.1068	0.2587	0.6609	2.391		1	1	1	1	0.0121
2009	1.133	0.6692	0.3655	0.2136	0.1886	1.919	0.4723		1	1	0.9998	0.0382
2010	0.9462	0.4823	0.1786	0.0267	0.3755	2.106	0.2854	0.1869		1	1	0.0247
2011	0.4556	0.008344	0.3121	0.4639	0.8661	2.597	0.2053	0.6776	0.4906		1	0.0070
2012	0.06675	0.3972	0.7009	0.8528	1.255	2.986	0.5941	1.066	0.8795	0.3888		0.0023
2013	5.876	5.412	5.108	4.956	4.554	2.824	5.215	4.743	4.93	5.42	5.809	

In addition, the diversity of wildlife species in different parts of the conservancy was compared to one another by using the SIDs for each landscape (see Fig. 12). The open landscapes[1] of the conservancy, particularly the central and southern parts, had higher SIDs while the Buffalo Camp (closed landscape) displayed the lowest diversity of wildlife species. Although located in the central part of the conservancy, determining the diversity of wildlife species at the Buffalo Camp[2] was done separately because the Camp contained wildlife species not found elsewhere in the conservancy. Furthermore, the wildlife numbers were regularly adjusted to the carrying capacity of the area. The comparison was made in order to determine differences in the level of diversity of wildlife species in different parts of the conservancy. The Buffalo Camp is a very important wildlife enclosure in the conservancy where buffalo and other sensitive species are protected. It was expected that the diversity of the species in the camp would be lower when compared to other areas, as this camp only had a few selected species, such as buffalo, black rhino, eland, kudu and oryx.

[1] The open landscapes in the context of these analyses denote habitats not camped off and which contain free-roaming species. They were classified based on the operations of the rangers, where some rangers were responsible either for the south, the north and the central parts of the conservancy. This was useful because the raw data in the conservancy event-book were recorded based on operational areas.

[2] The Buffalo Camp was established in 1996 to accommodate the sensitive buffalo that were found in the area. This was done to avoid close contact with other species in the conservancy as buffalo are susceptible to foot-and-mouth disease. The camp was expanded from its initial size of 2400ha to 9600ha during 2006/7 to make it a viable habitat for the species found inside it. This camp contains mainly ungulate species, such as buffalo, black rhinoceroses, kudu and eland. The predators found in the camp were only those that were able to slip into the area through the fences (Pers. comm. Mr Raymond Peters, WWF in Namibia, May 2015).

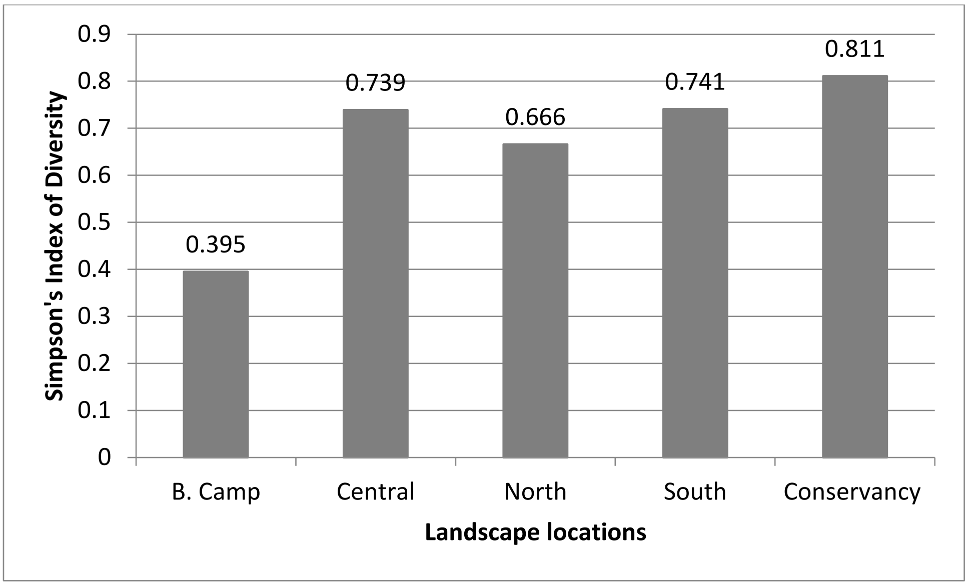


Figure 12: Simpson's Index of Diversity (SID) for the sighted wildlife species within different landscapes across the conservancy observed between 2001 and 2013

4.1.3 Trends in abundance of wildlife species

Trends in the abundance of the different wildlife species derived from the numbers of species individuals sighted at different water points covering the period of 2001 to 2013. Trend analyses were performed in R using the Spearman correlation test based on number of individual sighted for each species between 2001 and 2013, including species groups (large ungulates, small ungulates and predators) and also for all the species combined. A positive trend in abundance was observed for all the species combined sighted over the period in the conservancy, although it was not statistically significant ($r=0.477$; $t_{10}=1.574$; $P=0.145$). The overall trends for all large ungulates ($r=0.266$; $t_{10}=0.872$; $P=0.404$) and the small ungulates ($r=0.334$; $t_{10}=1.122$; $P=0.288$) were also positive over the period but also not statistically significant. The predators sighted over the years showed a negative trend which was also not statistically significant ($r=-0.199$; $t_{10}= -0.642$; $P=0.535$).

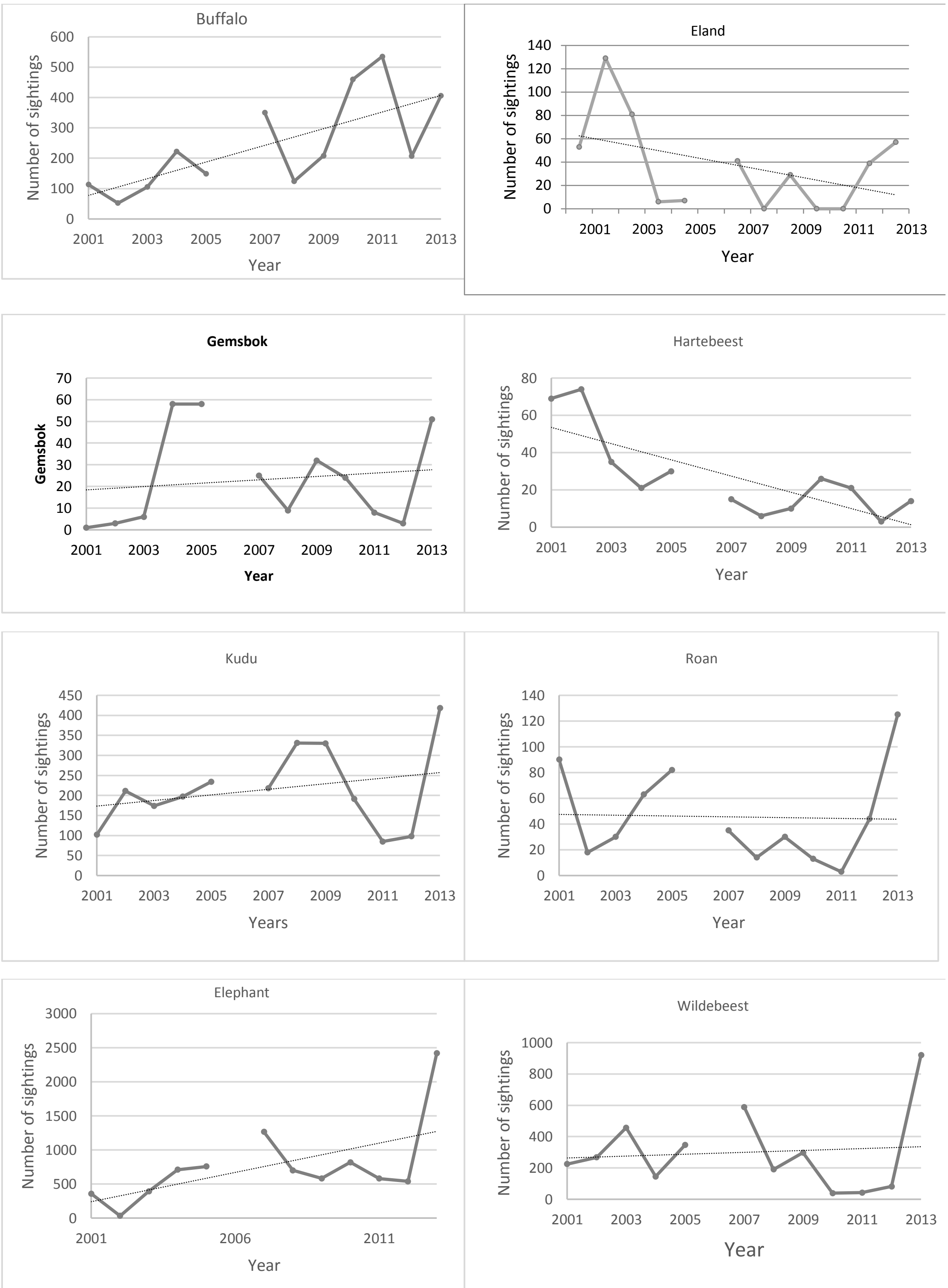


Figure 13: Trends in the numbers of different large ungulate species sighted at the water points in the Nyae Nyae Conservancy during the period of 2001 - 2013

Source of data: (Water point counts data, Nyae Nyae conservancy)

Different trends were shown by large ungulates (Fig. 13). Out of the ten large ungulates spotted during the water-point count at the conservancy, seven species were either re-introduced or restocked through translocation. Among those species not involved in the translocation programme were the elephant and the buffalo which appeared to be the most abundant species, and these showed statistically significant, positive trends in the numbers sighted over the years (r=0.588; t_{10}=2.300; *P*=0.044) and (r=0.707; t_{10}=3.164; *P*=0.010), respectively. The roan antelope also did not form part of the species boosted with translocation and showed positive trends but not statistically significant (r=0.001; t_{10}=0.0032; p=0.998).

The analysis of the trends in numbers sighted over the years for those large ungulates that were enhanced with translocation also showed differing results. These species included the eland, red hartebeest, giraffe, oryx, kudu and blue wildebeest. Despite restocking with additional individuals, the eland showed a negative, but not statistically significant, trend (r= -0.429; t_{10}= -1.502; *P*=0.164), while the red hartebeest showed a statistically significant, negative trend over the years (r= -0.765; t_{10}=-3.757; *P*=0.003). For the rest of the species, such as the giraffe (r= 0.534; t_{10}=1.996; *P*=0.740), oryx (r= 0.172; t_{10}=0.552; *P*=0.593), kudu (r=0.273; t_{10}=0.877; *P*=0.391), and blue wildebeest (r=0.099; t_{10}=0.3145; *P*=0.760) not significant positive trends were observed. The GLM results showed that released numbers of eland (z=0.040; p=0.969) and hartebeest (z=0.012; p>0.001) showed a positive association with the positive overall species in the conservancy. This suggests that the released numbers were adequate to contribute to positive abundance of the two species; however, due to factors to be discussed later, it was not the case.

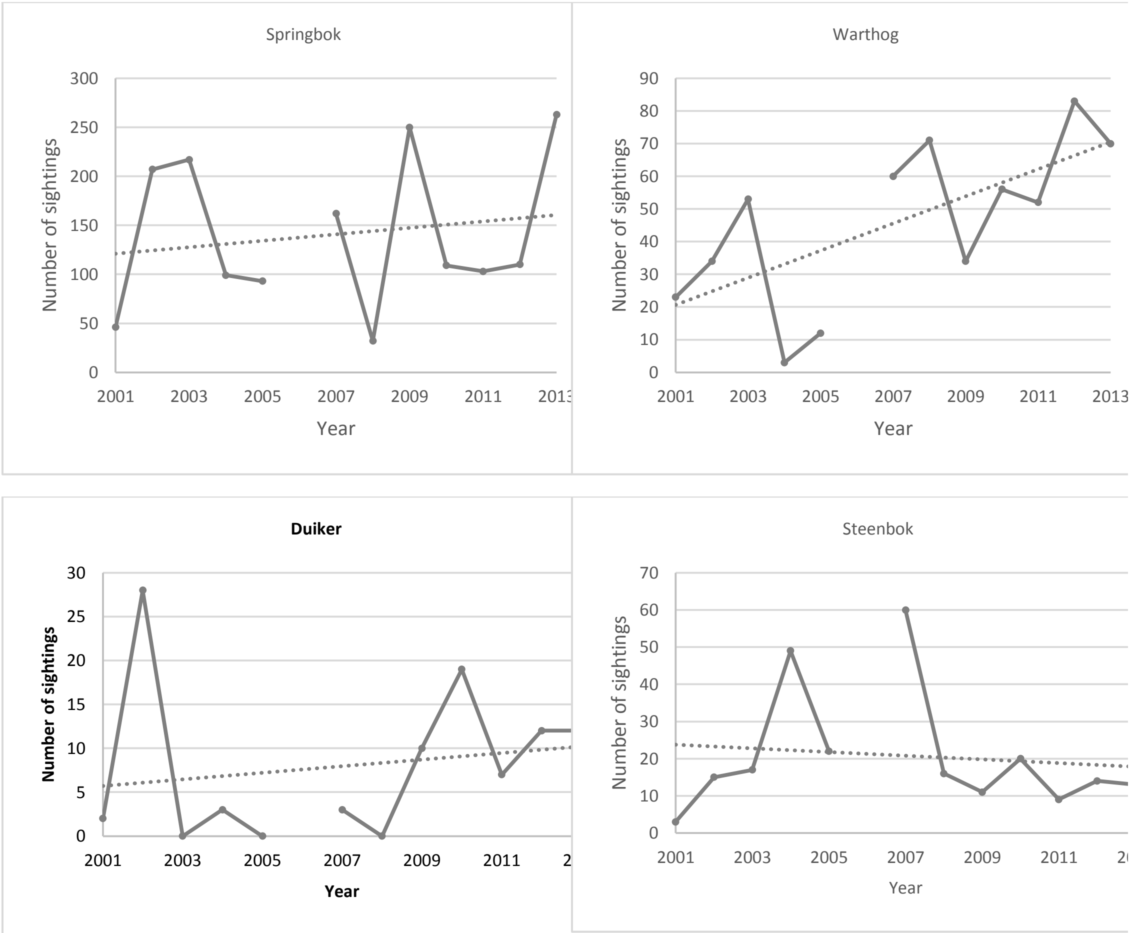


Figure 14: Trends in the numbers of the small ungulate species sighted at the water points in the Nyae Nyae Conservancy during the period of 2001 - 2013

Source of data: (Water point counts data, Nyae Nyae conservancy)

The small ungulates consisted of four species that were detected during the water-point counts of 2001 to 2013 (see Fig. 14), with three showing positive trends, namely, the springbok (r= 0.181; t_{10}=0.580; P=0.575), warthog (r=0.657; t_{10}=2.755; p=0.020) and duiker (r=0.176; t_{10}=0.567; p=0.583). The numbers of warthog sighted over the years was significantly increasing. The steenbok showed a negative trend over the years, although not statistically significant (r=-0.134; t_{10}=-0.427; p=0.678). The high number of sightings and the positive trend displayed by the springbok between 2001 and 2013 reflected the contribution of translocation to wildlife populations in the Nyae Nyae conservancy as the springbok was reintroduced into the conservancy after having disappeared from the area some decades ago.

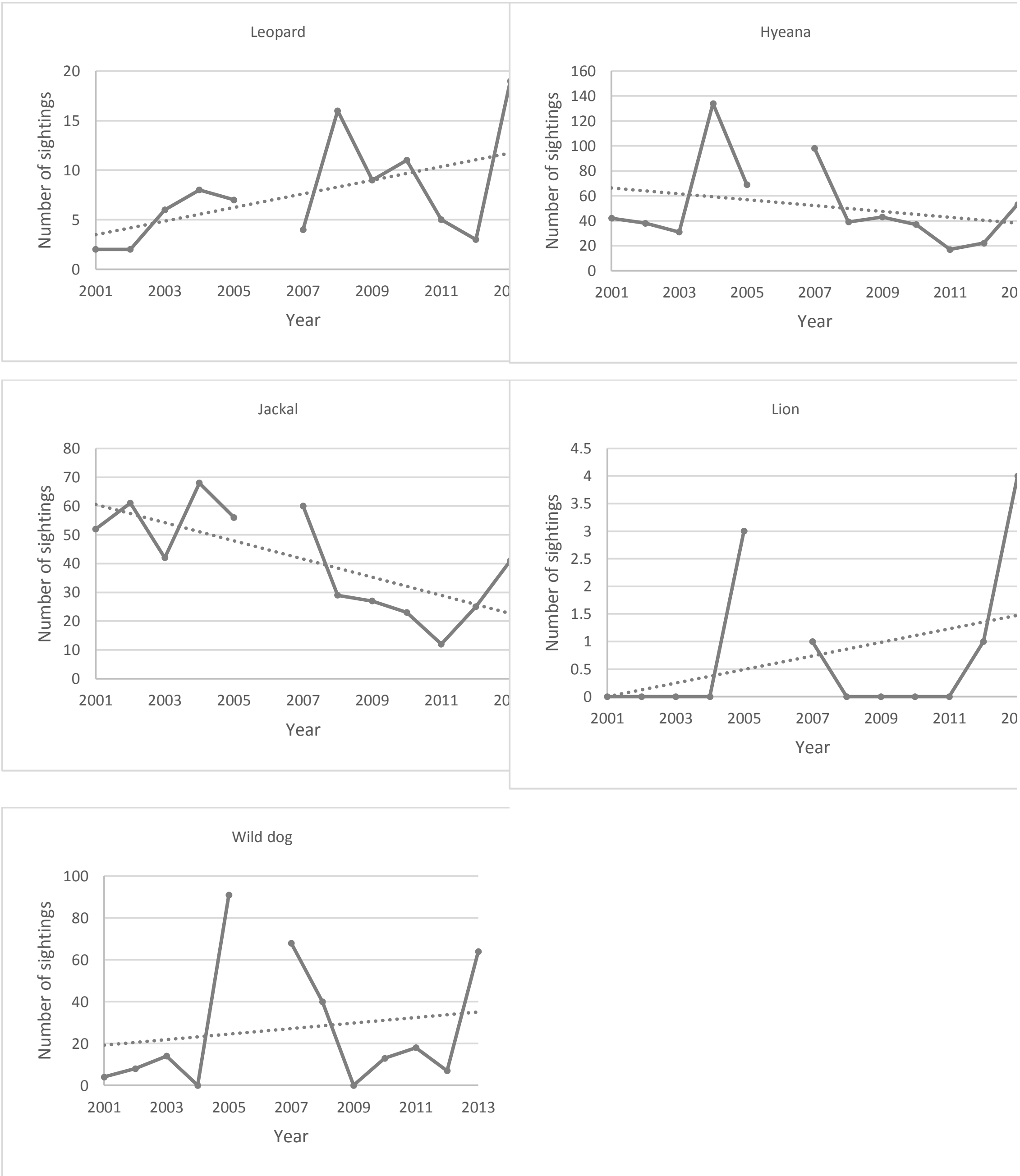


Figure 15: Trends in the numbers of predator species sighted at the water points in the Nyae Nyae conservancy during the period of 2001 - 2013

Source of data: (Water point counts data, Nyae Nyae conservancy)

The overall group of predators sighted in the conservancy at the water points between 2001 and 2013 showed a negative trend (r= -0.199; t_{10}=-0.642; *P*=0.535), but this was not statistically significant (see Fig. 15). However, major individual predator species, such as leopard (r= 0.518; t_{10}=1.917; *P*=0.084) and lion (r= 0.399; t_{10}=1.378; *P*=0.198), had positive trends over the years but not significant. This implies that sightings of these large predators at the water points in the conservancy over the years are growing. The jackal showed a statistically significant, negative trend over the period (r= -0.696; t_{10}= -3.064; *P*=0.012), while the hyena also showed a negative, but not statistically significant, trend (r=-0.278; t_{10}=-0.916; p=381). However, the jackal and hyena, together with wild dogs, were among the predators with the highest sightings. In addition, the hyena and the leopard had been deliberately reduced in the conservancy by translocating some individuals to protected areas. A total of eighteen leopard and eight hyena individuals were removed from the Nyae Nyae conservancy during 2004 – 2013 to reduce predation incidences in the conservancy.

4.1.4 Factors influencing trends in wildlife composition, diversity and abundance

The overall trend in the number of wildlife species sighted was compared to the NDVIs, which are a proxy for rainfall that indicate changes in the live, green vegetation through satellite processes (Chammaille-Jammes, Valeix & Fritz 2007; Pettorelli et al. 2005). In this study, the NDVI values were used because consistent rainfall figures dating back to the year that wildlife counts had started were unavailable. This index assumed that the greener the area, the higher the NDVI and also the higher the amount of rainfall that was received during that year (Pettorelli et al. 2005). Figure 16 illustrates that there were fluctuations experienced in the NDVIs over the years but with a trend line showing a slightly positive trend. This could imply that recent rains had led to a high, net, primary productivity when compared to the previous years. The highest species sightings of 4,758 animals were experienced during 2013, which was also the year that had the lowest NDVI since 2003. Species, such as the elephants, buffalo, blue wildebeest, kudu, roan and springbok, had the highest counts during 2013, clearly depicting high concentration of some wildlife numbers at water points.

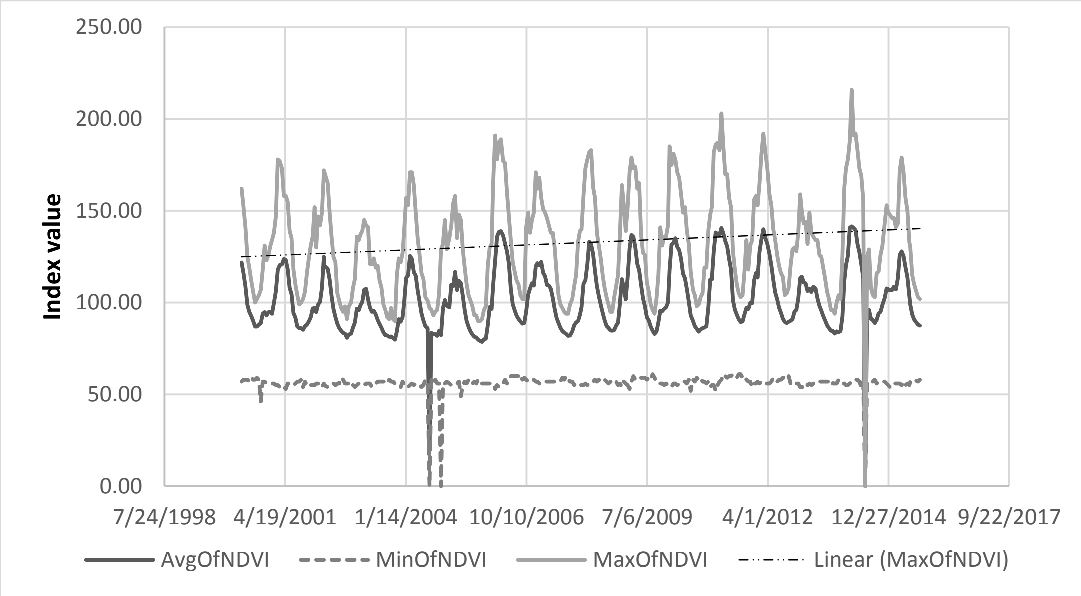


Figure 16: NDVI values for the Nyae Nyae conservancy during the period of 2001 - 2014 indicating the averages, minimum and maximum values

(Source: https://modis.gsfc.nasa.gov/data/mod13)

In addition, a GLM was used to test whether translocation and other species parameters had had any influence on the changes in the numbers of animals of each species sighted over the years (2001 – 2013). Firstly, the GLM was fitted with translocation figures to understand if translocated numbers had had any influence on the total number of individuals of all species over the years; these included the population size before translocation (founder population) and the total number translocated (released population) (see Appendix 1). Other parameters that were also fitted into the GLM were the last water point count of 2013, the translocation status of the species (whether supplemented by translocation or not), the feeding guilds of a species (whether a browser, grazer or carnivore), classification (large ungulates, small ungulates or predators) and the water dependency of a species (water-dependent or not water-dependent).

There was a positive association between the end counts of 2013 and the overall species trend in the conservancy, although not statistically significant ($z=0.712$; $p=0.476$), which means that most species that showed high numbers in the 2013 count were also those that showed positive trends during the period of 2001 to 2013. Since the large ungulates species dominated the species observed in the area, their numbers were also likely to influence the overall trend of the species in the conservancy (z=0.005; *P*=0.996). The trend of the small ungulates (z=-0.295; *P*=0.768) and predators (z=-0.005; *P*=0.996) showed an inverse relationship, but not statistically significant, to the overall species trend. The GLM also showed that water-dependent species were likely to influence the overall trends of the species, as these were positively associated with the overall trend though not statistically significant (z=0.752; p=0.452). The water-dependent species included the Buffalo, Blue wildebeest and elephants, while the rest were considered not water-dependent. However, feeding guilds (browser, grazer and carnivore) did not show any association with the overall trend of the species between 2001 and 2013.

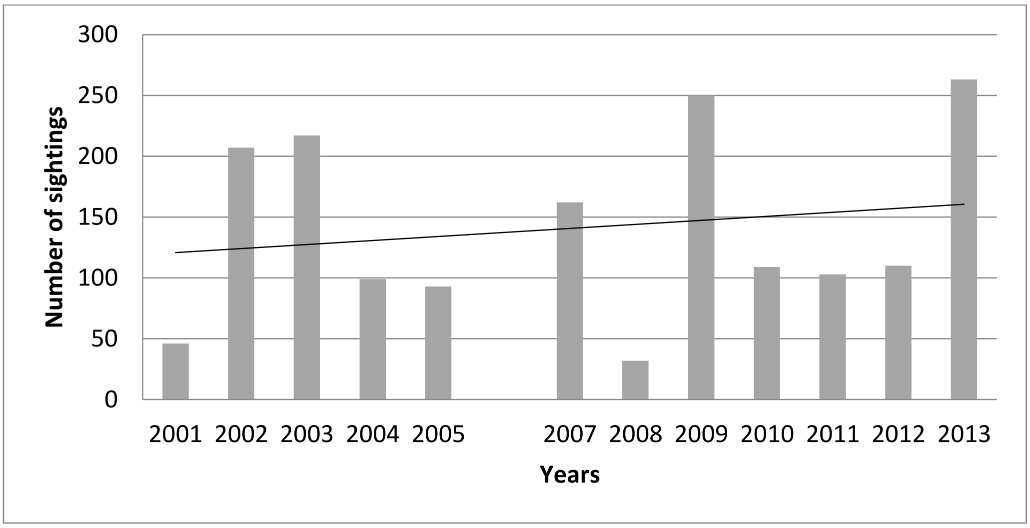
The translocated numbers did not show any relationship to the overall trend, hence, they did not have any significant influence on the overall trend of the species (Z=-0.875; P=0.382). The GLM results indicated that the species that had had higher founder populations continued to show positive trends, and the released numbers did not necessarily influence these trends; these species included the oryx (z=-3.218; p=0.001), kudu (z=-1.372; p=0.015) and blue wildebeest (z=-18.328; p>0.001). However, for the reintroduced springbok, there was a positive association between the species trend and the translocated (released) numbers (Z=20.147; p>0.001).

4.2 Changes in population sizes and distribution of springbok and eland

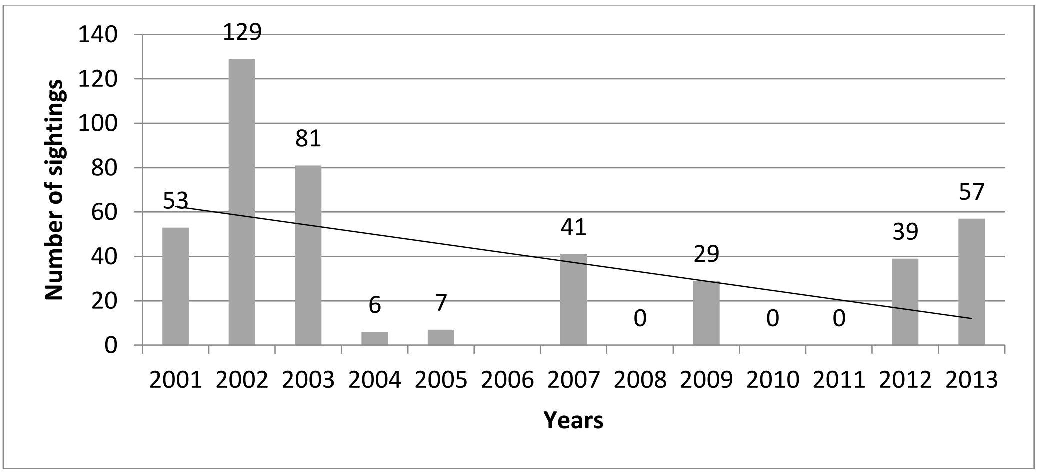
This section presents results regarding the changes in numbers sighted and distribution of the two target species (the eland and the springbok) from the water-point counts and event-book data. Analysis from the questionnaire survey with community members, together with information from two aerial surveys carried out in the area during 2004 and 2013, were used to present the recent and historical distribution of the two species. The hypothesis that states ‘translocated numbers of the eland and springbok will enable the two species to establish into viable populations with stable growth over time and well-distributed within the conservancy’ was tested with the analysis under this section.

4.2.1 Trends in population sizes of the springbok and eland

The trends regarding the numbers of individual springbok and eland over the years were derived from the annual water-point count database of the Nyae Nyae conservancy over the period 2001 to 2013. Figure 17 (a & b) shows the number of eland and springbok sighted between 2001 and 2013 and fitted with a trend line. The eland showed a negative trend (r= -0.429; t_{10}=-1.502; p=0.164) while the springbok showed a positive trend (r= 0.181; t_{10}=0.580; p=0.575) in abundance over the years; however, it was not statistically significant for either species.



(a)



(b)

Figure 17: Annual sightings and trends (trend line) for (a) springbok and (b) eland from the water-point count during 2001 - 2013 period

Source of data: (Water point counts data, Nyae Nyae conservancy)

When the trends of the water-point count data and those of the event-book (game rangers patrols) were fitted into the GLM, there was a very significant positive association between the two data sources for both springbok ($z=19.013$; $P<0.001$) and eland ($z=7.010$; $P<0.001$) during the same period (2001 – 2013) (see Tables 4 and 5). The springbok adults sighted during the ranger patrols as entered in the event-book showed significantly the opposite trend to the species trend from water-point counts ($z= -10.846$; $P<0.001$), meaning that the numbers of springbok adults recorded during the daily patrols were decreasing over the years. Furthermore, this could be influenced by the fact that in the earlier years, after translocation, springbok adults could be detected easily because they were translocated to the central parts of the conservancy, which was an area easily accessible by rangers; later-on, however, it became difficult to detect them as they moved deeper to the pans.

Even though not statistically significant, the eland adults sighted, according to the event-book, also showed an opposite trend to the water-point data ($z= -2.561$; $p=0.010$). For the eland, this suggested that more adult eland were observed, through the event-book, over the years, despite the fact that there were still low numbers of adults. However, the event-book data for sub-adult ($z=11.994$; $P<0.001$) and juvenile ($z=12.146$; $P<0.001$) springbok, were significantly related to the water-point count trends. The GLM could not establish the relationship between the eland sub-adults and juveniles from the event-book data compared to the overall water-point count trend, as the numbers recorded in the event-book were very low. Overall, very little mortality among both species occurred as the carcasses of only three eland and one springbok were found in the 2001 – 2013 period as recorded in the event book.

Table 4: The GLM output on the effects of event-book data, adult, sub-adult, juvenile, hunting, translocated numbers and mortality levels on the overall trend of the springbok *(A. marsupialis)*

Factor	Estimate	SE	Z value	P value
Intercept	-0.0313	0.213	-14.668	<0.001
Overall Event-book	2.759	0.1451	19.013	<0.001
Adult	-0.397	0.0366	-10.846	<0.001
Sub-adult	1.704	0.1571	10.847	<0.001
Juvenile	1.925	0.1753	10.979	<0.001
Hunting	1.508e-01	0.00878	17.168	<0.001
Translocated numbers	0.0107	0.00053	20.147	<0.001
Mortality	-0.6778	0.0686	-9.871	<0.001

Table 5: The GLM output on the effects of event-book data, adult, sub-adult, juvenile, hunting, translocated numbers and mortality levels on the overall trend of the eland *(T. oryx)*

Factor	Estimate	SE	Z value	P value
(Intercept)	0.03003	0.2004	14.985	<0.001
Overall Event-book	7.937	1.132	7.010	<0.001
Adult	-0.4224	0.1650	-2.561	0.0104
Sub-adult	-	-	-	-
Juvenile	-	-	-	-
Hunting	-2.164	0.2806	-7.713	<0.001
Translocated numbers	-0.00475	0.0009	-5.025	<0.001
Mortality	-0.1516	0.0469	-0.032	0.9742

4.2.2 Distribution patterns for the eland and springbok in the conservancy

The distribution patterns of springbok and eland were analysed from three perspectives: (i) using data from water-point counts; (ii) using data from aerial surveys and (iii) feedback from community members and stakeholders.

a) Distribution according to water-point counts

The eland and the springbok were only sighted at 12 and 7 water points, respectively, out of the 29 water points where the counts were conducted during the period of 2001 – 2013. Based on this, it can be deduced that the eland and springbok were mainly concentrated along the water points in the central and southern parts of the conservancy (see Table 6). The Boma water point recorded the highest number of free-roaming eland in the conservancy and this water point was located at the site where translocated species were released between 1999 and 2005. Furthermore, water-point counts within the camp (Buffalo 1 to 5) also showed high sightings for eland individuals.

Table 6 also shows that the highest numbers of springbok were recorded at the Nyae Khabi and Nyae Nyae pans, although some springbok were also sighted at the release site (Boma water point). Statistically, the mean numbers of eland at those water points where they were sighted in the conservancy did not vary significantly between 2001 and 2013 ($F_{8,16}$=0,596, P=0.768), and the same applied to springbok ($F_{11,17}$ =0.554, P=0.839).

Table 6: Mean (±SE) numbers of eland and springbok observed during the water-point count (2001 - 2013)

Water point	District	Eland	Springbok
//Xaece	Central	12.75±8.79	13.00±6.36
Boma	Central	40.00±0.00	43.67±21.70
Buffalo 1	Central (Camp)	18.67±12.67	0.00±0.00
Buffalo 2	Central (Camp)	16.50±5.11	0.00±0.00
Buffalo 3	Central (Camp)	5.00±0.00	0.00±0.00
Buffalo 4	Central (Camp)	25.50±0.50	0.00±0.00
Buffalo 5	Central (Camp)	9.50±5.50	0.00±0.00
Djxokhoe	Central	1.00±0.00	32.00±0.00
G/a!oan	North	0.00±0.00	1.00±0.00
Grenspos	Central	6.00±0.00	0.00±0.00
Gura	Central	0.00±0.00	1.50±0.50
Klein Dobe	North	5.00±0.00	0.00±0.00
Nyae Khabi	South	0.00±0.00	102.78±24.43
Nyae Nyae	South	6.00±0.00	67.38±21.44
Xamsa	South	1.00±0.00	0.00±0.00

Figures 18 to 21 present the sightings of individuals of the two species at the water points in different parts of the conservancy between 2001 and 2013. For the central part of the conservancy, sightings of the springbok were done at a few water points during the translocation period (2001 – 2003) and in recent years (2011 – 2013) (see Fig. 18). The highest number of springbok sightings during these periods was recorded in the southern part of the conservancy, particularly at the two pans of Nyae Khabi and Nyae Nyae (see Fig. 19). No sightings of springbok were recorded at the water points in the northern parts and at the Buffalo Camp (see Fig. 20 and 21).

Very low numbers of sightings of eland individuals were recorded at the central, southern and northern water points during the indicated period. Although the translocation of eland into the conservancy (1999 – 2005) was done in open landscapes in the central part of the conservancy, only a few individuals were found to be free-roaming over the years. The highest number of free-roaming eland was last sighted at water points, such as Boma, Xaece and Grenspos (see Fig. 18). The Xaece water point in the central part of the conservancy showed close to 40 sightings of eland individuals in 2012, while consistent sightings of eland individuals at the water points at the Buffalo Camp were recorded. At the time of the research, most of the eland were sighted at the water points in the Buffalo Camp. An interview with a stakeholder revealed that these eland, released into the Buffalo Camp in 1994, were moved to the area for the purpose of domestication, namely, to provide milk to supplement the diet of the local people.

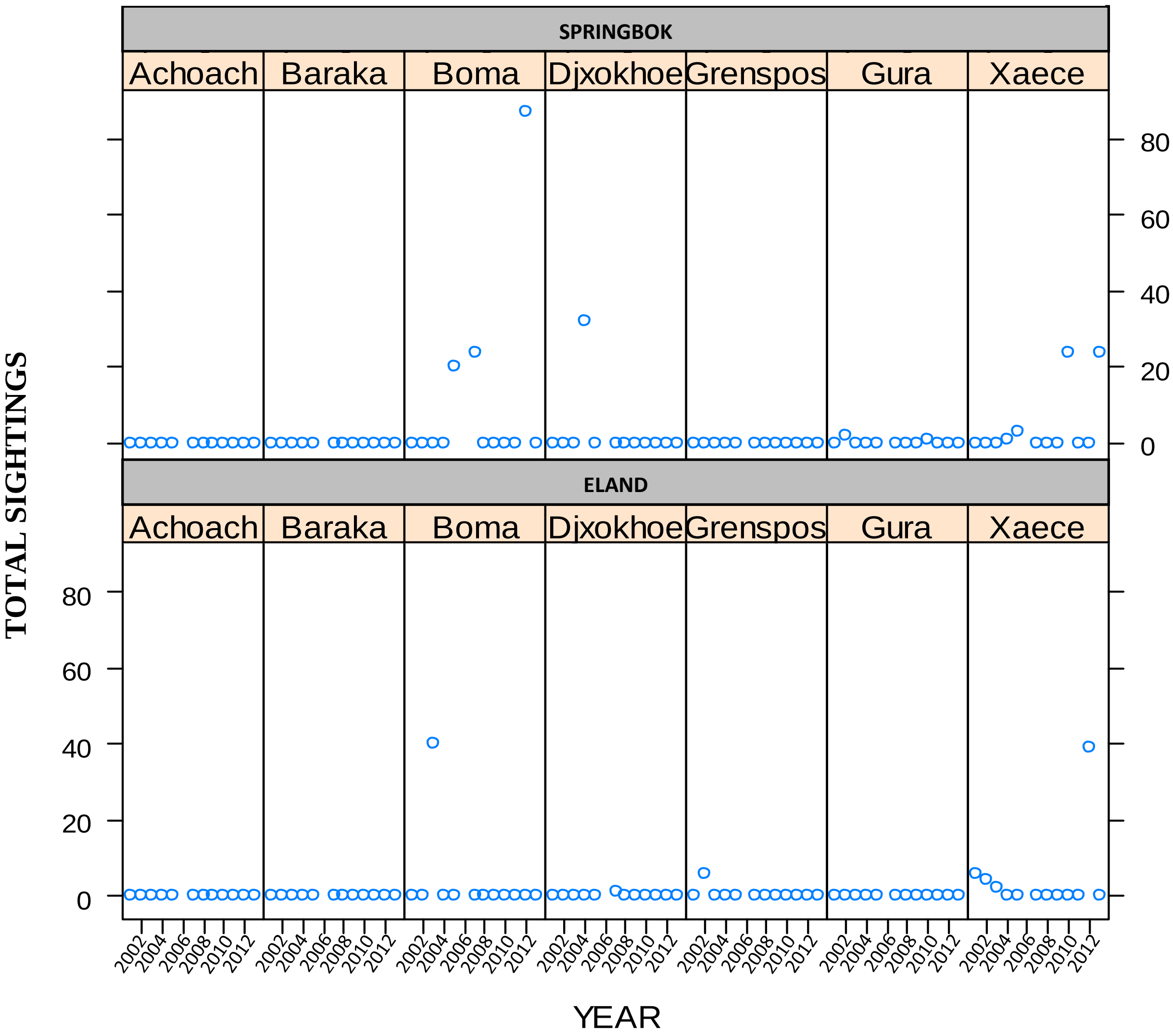


Figure 18: The total sightings of eland and springbok individuals at the water points located in the central part of the Nyae Nyae conservancy during the period of 2001 - 2013

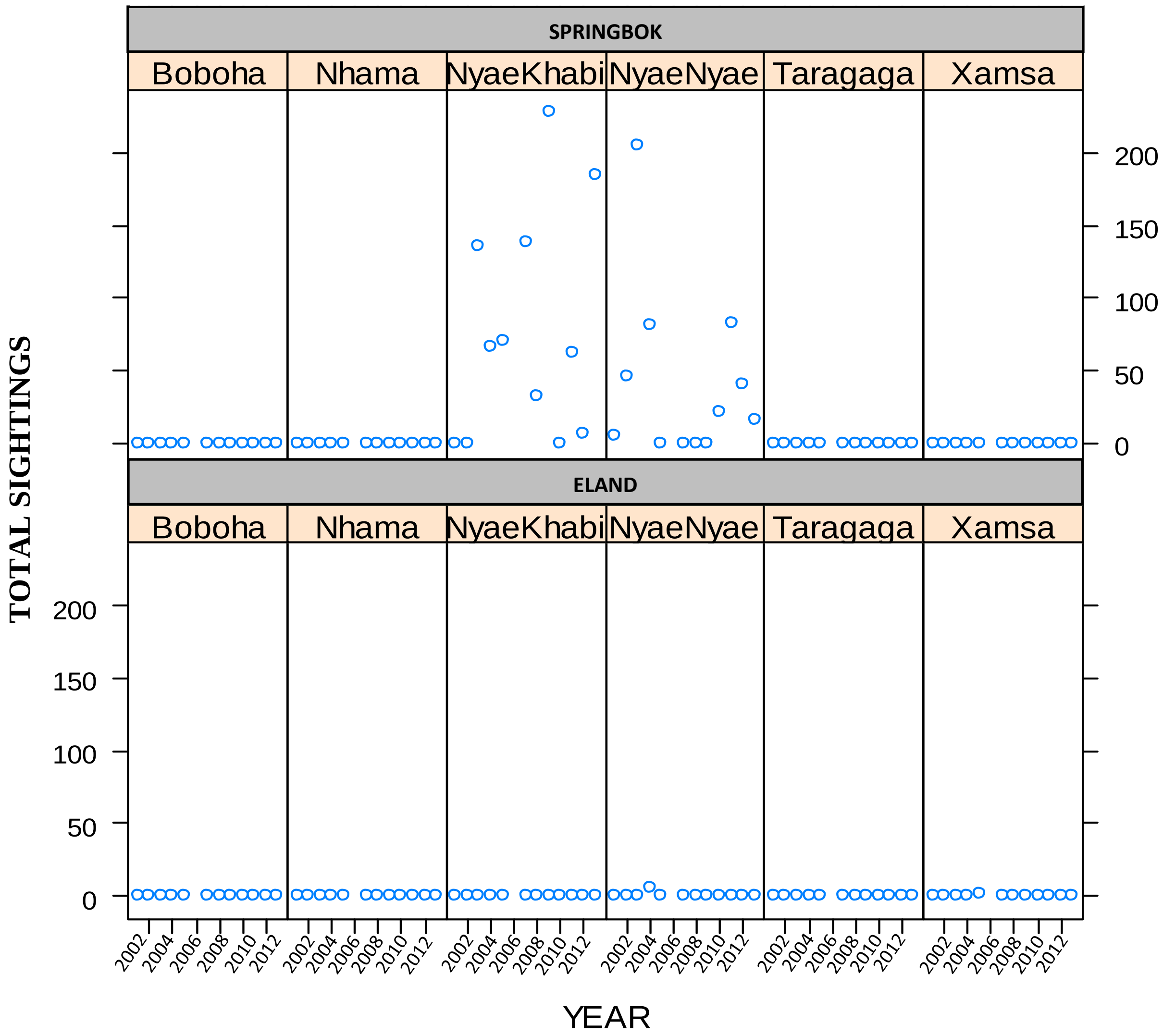


Figure 19: The total sightings of eland and springbok individuals at the water points located in the southern part of the Nyae Nyae conservancy during the period of 2001 - 2013

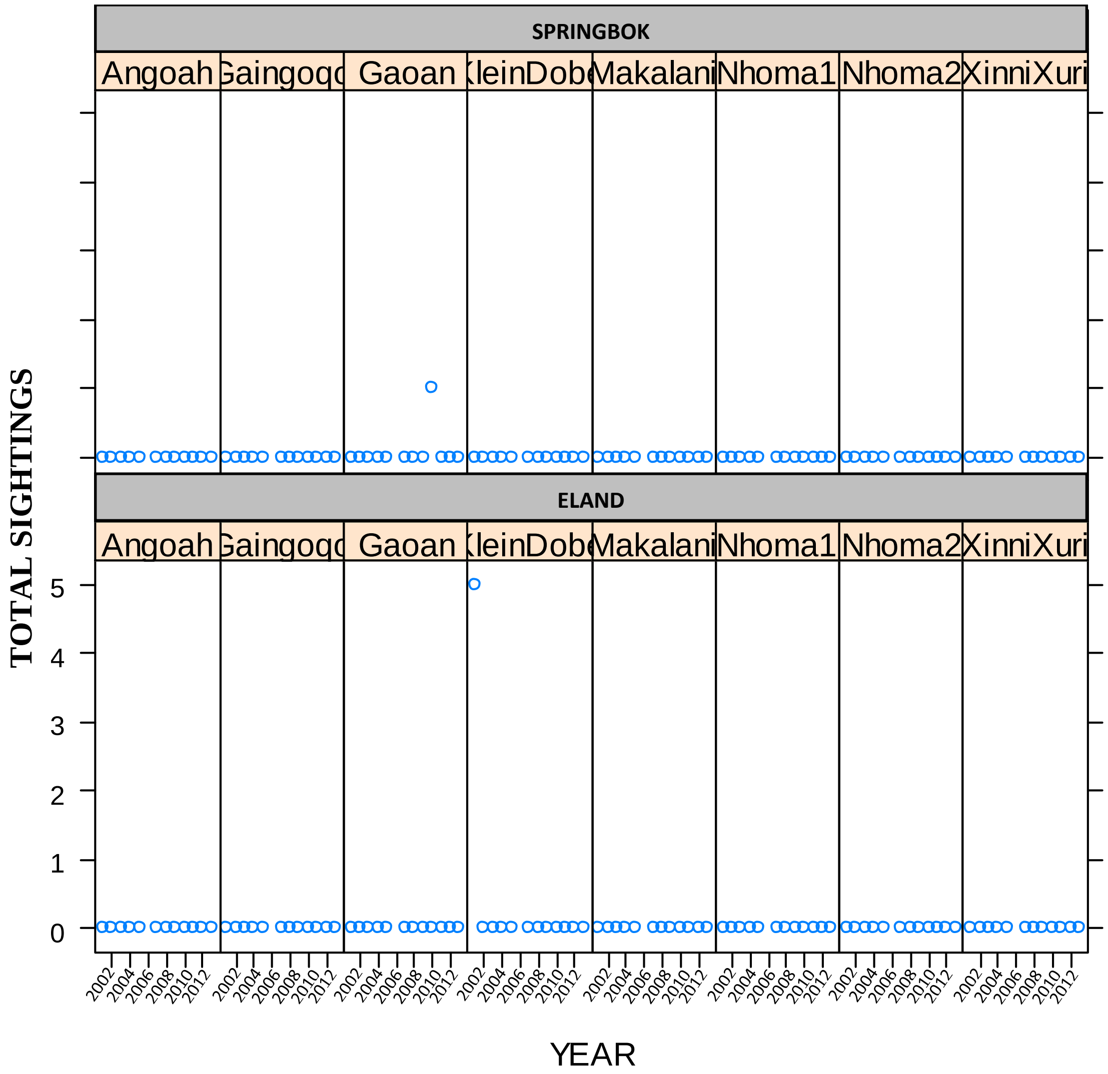


Figure 20: The total sightings of eland and springbok individuals sighted at the water points located in the northern part of the Nyae Nyae conservancy during the period of 2001 - 2013

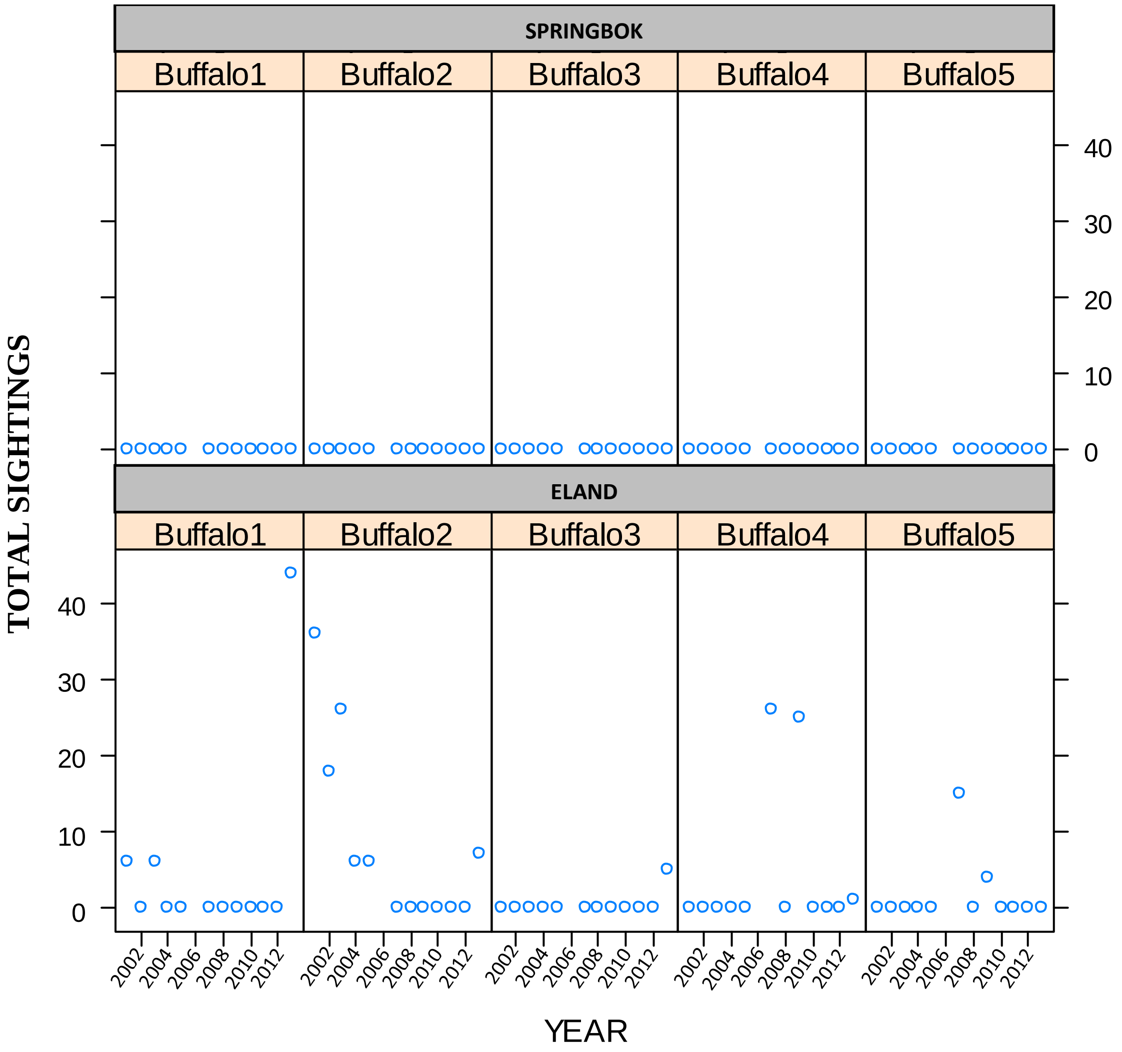


Figure 21: The total sightings of eland and springbok individuals at the water points located in the Buffalo Camp during the period of 2001 – 2013

b) Distribution according to data from aerial surveys conducted in 2004 and 2013

A further way to understand the distribution of these two species (eland and springbok) was to use the data from the aerial surveys conducted in 2004 and 2013. According to these surveys, both the eland and springbok were sighted in the conservancy during the aerial survey of 2004, but only springbok was seen during the 2013 survey. During the 2013 survey, the eland were seen only at the Khaudum Game reserve which borders the Nyae Nyae conservancy in the north. According to the aerial survey of 2004, there was a wider dispersal of springbok in the southern part of the conservancy, with 65% of the population concentrated at the Nyae Nyae and Khabi Nyae pans (see Table 7).

Furthermore, during the 2004 aerial survey, eland were mainly found along the western and northern borders further away from the water points where the counts took place, while a few were also seen at the Nyae Nyae and Nyae Khabi pans. The 2013 survey did not detect any free-roaming eland but showed that eland were widely distributed across all landscapes of the Khaudum Game reserve. Again, according to the aerial survey of 2013, the springbok mainly concentrated along the pans in the southern part of the conservancy.

Table 7: Number of springbok and eland individuals recorded by the aerial survey counts in 2004 and 2013 at the Nyae Nyae conservancy and Khaudum Game reserve

Species	Aerial survey 2004		Aerial survey 2013	
	Nyae Nyae	Khaudum	Nyae Nyae	Khaudum
Eland	35	Not sampled	0	88
Springbok	144	Not sampled	12	0

Source: Aerial survey reports of 2004 and 2013, Ministry of Environment and Tourism

c) Community perceptions on the trends and distribution of springbok and eland

In the questionnaire survey, perceptions of conservancy members on the levels of occurrence of the springbok and eland species were provided. The majority (81%) of the respondents believed that springbok had increased over the years; however, regarding the eland, there were mixed views (Fig. 22). Some respondents indicated that eland had increased (46%) in numbers while another group was of the opinion that eland numbers had decreased (48%) in the conservancy (Fig. 22).

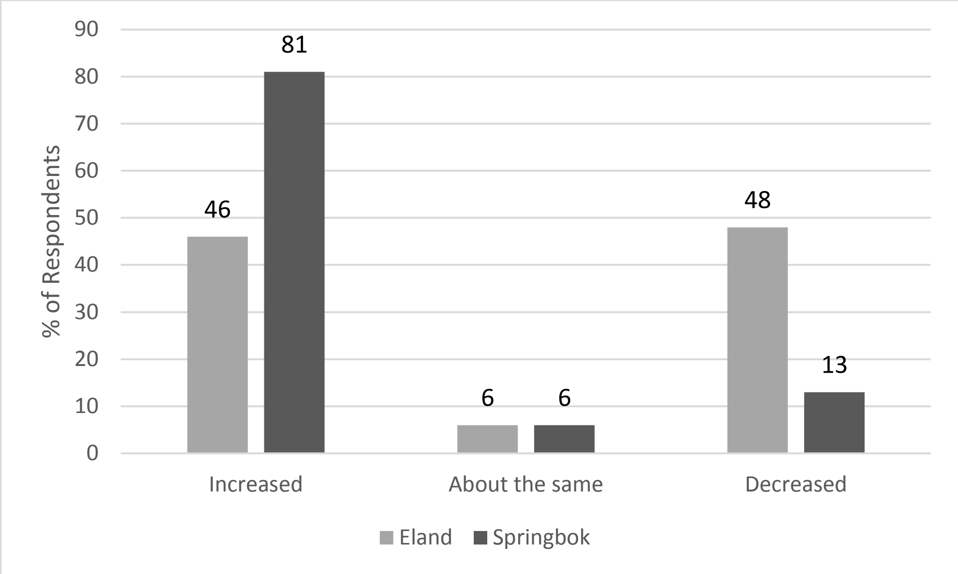


Figure 22: Perceptions of the residents on whether the eland *(T. oryx)* and springbok *(A.marsupialis)* populations increased, decreased or remained the same after translocation in the Nyae Nyae conservancy (N=56)

The perceptions of the community members regarding the trends of the two species were linked to whether they had seen the animals or their tracks, as well as the location and time period the animals were last seen (see Table 8). A greater proportion of the respondents had seen springbok (62%) while others indicated that they had only spotted their tracks (38%). The animals or their tracks were seen mainly along water points that were either far from most villages (48%) or those considered closer to the villages (28%). Only respondents from villages in the southern part of the conservancy had indicated to have spotted springbok at water points close to their households. This data support the secondary data that springbok were mainly found in the southern part of the conservancy. In terms of when individuals or the tracts of springbok had been seen (using the day of the interviews as the reference point), there was no dominant time-frame within which community members had seen the individuals or their tracks. Some community members had seen springbok a year ago (32%), within the last 6 months (28%), recently (a month ago) (20%) and more than a year ago (20%).

For the eland, 52% of respondents indicated that they had seen the eland while others (39%) had only seen their tracks. Contrary to the springbok, eland or their tracks were seen at diverse locations, as shown in Table 8. The eland had not been seen recently, as most respondents said that they last saw them more than a year ago, with only a few who indicated to have seen the animals or tracks recently.

Table 8: Proportion (%) of respondents who indicated that they had seen or not seen eland and springbok at different locations over different periods in the conservancy

Presence/Absence	**Eland** % of Respondents (N=52)	**Springbok** % of Respondents (N=52)
Animal seen	52	60
Track seen	39	38
Not seen	9	2
Total	*100*	*100*
Location	Eland % (N=29)	Springbok % (N=35)
Nearby their villages	14	9
Other villages	24	9
Water points nearby	10	28
Water point far from village	21	48
Remote areas far from villages	21	3
Camps (Buffalo or offload camp)	10	3
Total	*100*	*100*
Period	Eland % (N=33)	Springbok % (N=32)
Recently*	21	19
1- 6 months ago	12	28
7 – 12 month ago	12	34
More than a year ago	52	19
Could not remember	3	0
Total	*100*	*100*

*Recently referred to 1 – 30 days before data collection date.

4.3 Population structure and social activities of the present springbok and eland

This section presents the analysis of primary data from the assessments carried out to study the present eland and springbok populations in the conservancy. The third objective is to determine the social structure (age, sex and social grouping) and diet composition of the present springbok and eland populations in the Nyae Nyae conservancy and this will be analysed in this section. The data of the eland were mainly derived from the photos gathered by camera trapping at the water points while the data of the springbok were gathered through direct observation by using road transects. Backtrapping and traditional ecological knowledge were methods used to determine the diet composition of the springbok and eland, respectively. The following hypotheses were tested under this section: (i) there will be no sex dominance among translocated individuals of the two species; (ii) adult individuals will significantly dominate in the different groups; (iii) the number of individuals in different groups of the two species will be significantly different; (iv) the exiting springbok and eland will engage in different social activities that will be significantly between the different groups of the two species; (v) the existing springbok and eland individuals will be feeding on several species found in the habitats the area they occurring;

4.3.1 The age, sex and social structure of the present springbok population

In this section, results for the areas where the springbok individuals were physically observed along the Nyae Nyae and Nyae Khabi Pans and the surrounding artificial water points located in nearby shrub land are presented. The road transects were along Nyae Nyae Pan (Site 1), along Nyae Khabi Pan (Site 2) and along the surrounding shrub land (Site 3). The results show that the springbok individuals observed at these three sites were congregating in social groupings. A total of 49 groups of springbok were observed along these sites which ranged from 1 individual to more than 20 individuals per group. There was no statistically significant difference between the means of the group sizes observed at the different sites ($F_{2,49}$=0.611, P=0.547). Furthermore, the group types found along these sites were not statistically different ($X^2_{8,\ 49}$=8.192, P>0.001). The mean sizes and standard errors of springbok individuals observed at three sites are shown in Fig. 23.

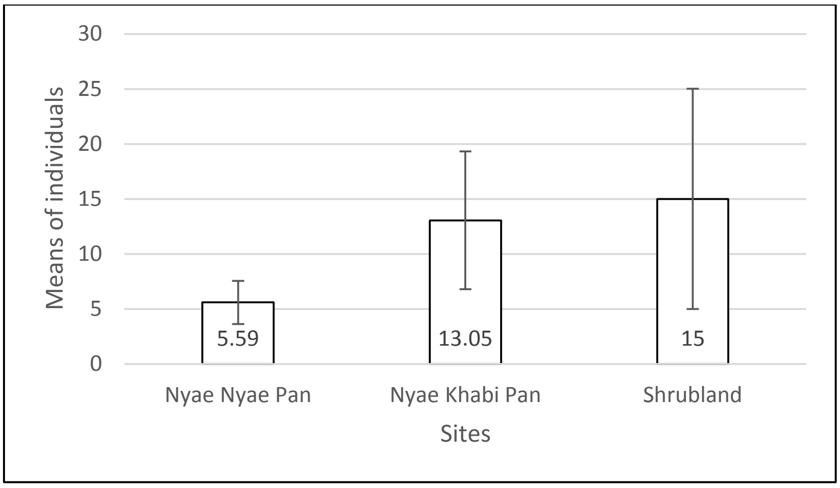


Figure 23: Mean ±SE number of individuals found in the different groups of the springbok at the three study sites, at the Nyae Nyae Pan, Nyae Khabi and Shrubland.

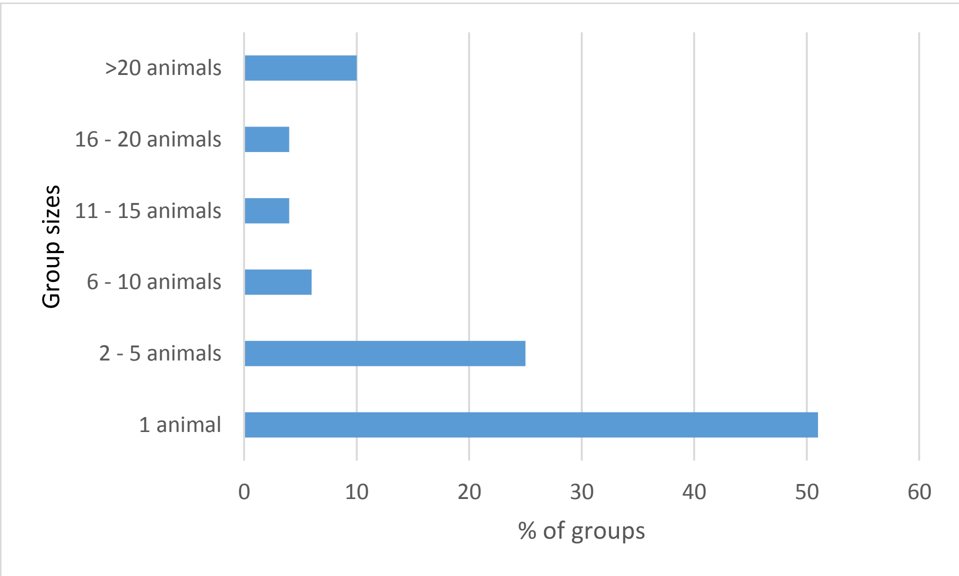


Figure 24: Proportion of group sizes of the observed springbok groups along the three sites

Different springbok groups were observed during the fieldwork (see Fig. 24 & 25). The observations of springbok group sizes indicated that groups mainly consisted of one individual (51%) followed by 2 – 5 individuals (25%), with fewer bigger groups (Fig. 24). These springbok groups were classified into solitary, bachelor, nursery and mixed groups (Stapelberg, et al., 2008). Both the solitary and bachelor groups were made up of one individual, with the bachelor groups only containing male adults. Mixed groups consisted of a combination of adults, sub-adults and even juvenile individuals of different sexes. The nursery groups were different from the mixed groups as they only comprised female adults with juveniles and sometimes sub-adults also. The mean group sizes of springbok ($F_{5,527}$=13,851, P<0.001) differed significantly between group types as mixed groups consisted of many individuals (over 20) in a group, despite the fact that only a few mixed groups were observed during the study. Mixed groups contained the largest number of springbok individuals observed (61%), followed by the solitary groups (23%) which were the most frequently observed (Table 9).


Figure 25: Groups of springbok individuals in and along the dry Nyae Nyae and Nyae Khabi pans in the conservancy

Source: (Selma Lendelvo, 2015)

The sex and age structure were only analysed for those groups that contained up to 20 individuals, because bigger groups with more individuals affected the accurate recording of sex; these groups comprised many animals that were constantly on the move. Therefore, they were excluded from the analysis. The male and female proportions in groups of up to 20 individuals were 45% and 55%, respectively. The bachelor group comprised male-only individuals while the nursery groups were female-dominated groups. The male individuals observed in the nursery groups were those that were still sub-adults or juveniles.

Table 9: The sex composition and proportions of the different springbok groups at the three sites

	Solitary (%)	Bachelor (%)	Mixed (%)	Nursery (%)	Total (%)
Male	32	10	56	2	100 (N=49)
Female	14	0	67	19	100 (N=60)
Total	23	5	61	11	100 (N=109)

*N is derived from groups with less than 20 individuals

Groups of springbok comprised age classes of adults, sub-adults and juveniles (Fig. 26). In terms of age structure, 88% of the 49 of springbok groups observed had adult springboks and about 44% groups of the 49 groups had sub-adults. Only 8% of the 49 springbok groups had juveniles (see Fig. 26). The juveniles were mainly found in nursery groups and a few mixed groups. The group sizes, based on the age structure of the springbok, were not significantly different ($F_{2,109}$=0.923, P=0.400), with means of adults (6.96±0.795), sub-adults (8.53±1.132) and juveniles (4±0). Again, the calculation of the means of age excluded larger groups, those above 20 individuals, as it was difficult to establish the precise number of individuals belonging to the different age classes in large groups, and the individuals were moving around a lot to derive accurate calculations.

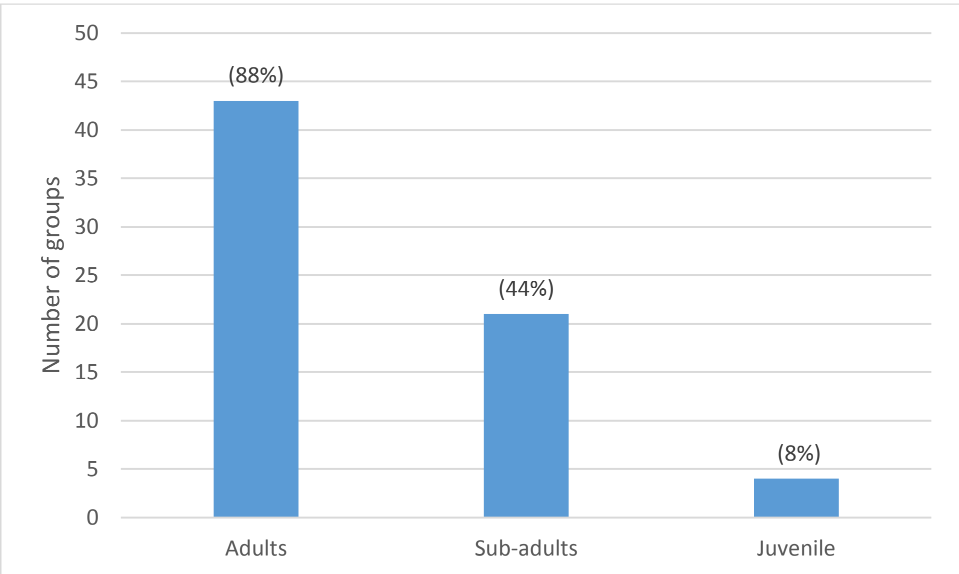


Figure 26: The level of presence of adults, sub-adults and juveniles in the different springbok groups

4.3.2 Social activities and diet composition of the springbok

There was a range of activities in which the observed springbok individuals engaged during the field assessment. The springbok were found grazing, licking salt in the dried parts of the pans, browsing, drinking water in the pans and other artificial water points, walking, lying down, standing, playing or fighting, and running. Grazing, licking salt and browsing were the dominant activities in which the observed springbok were engaged as compared to the other activities (Table 10). The One-way ANOVA results confirmed that the different social activities in which springbok groups engaged were statistically different ($F_{7,101} = 4.021$; $p=0.001$). While the social activities of springbok individuals found in solitary groups were extensive (Fig. 27), those of the individuals from the other groups were limited. For instance, bachelor groups were mainly found standing and starring around (67%) with a few feeding (33%). The individuals of the mixed groups were predominantly found feeding (66%) with a few licking salt (23%) and starring around (11%). The individuals of the nursery groups were also mainly found feeding (62%) and some running around (38%).

Table 10: The mean (±SE) of social activities the observed springbok individuals were engaged in for all the groups

Social activity	Mean(±SE)
Grazing	10.04±1.03
Licking salt	7.28±0.86
Browsing	9.00±4.49
Drinking water	1.00±0.00
Lying down	5.29±1.30
Standing and starring	2.80±0.42
Running	2.20±0.49
Walking	1.00±0.00
Playing or fighting	2.00±0.30

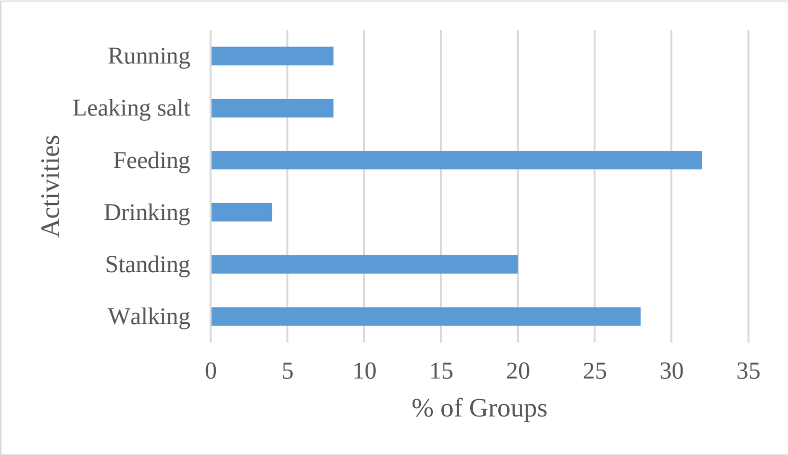


Figure 27: Social activities for the solitary groups

Diet composition of observed springbok

A total of 20 groups of springbok or individuals found feeding (grazing or browsing), were identified as focal groups and their feeding was observed directly. Plant species on which the focal groups were feeding were closely examined to identify the species and how these plants were consumed by the springbok individuals. Of the 20 focal groups of springbok that are selected for close feeding examination, 40% were solitary, 45% mixed and 15% nursery groups. A total of six plant species on which springbok individuals fed were recorded (see Fig. 28). The plant species consisted of three grass species (*Leptochloa fusca*, *Odyssea paucinervis* and *Eragrostis spp*), two perennial herbs (*Cyperus laevigatus* and *Suaeda salina*) and one shrub (*Catophractes alexandri*).

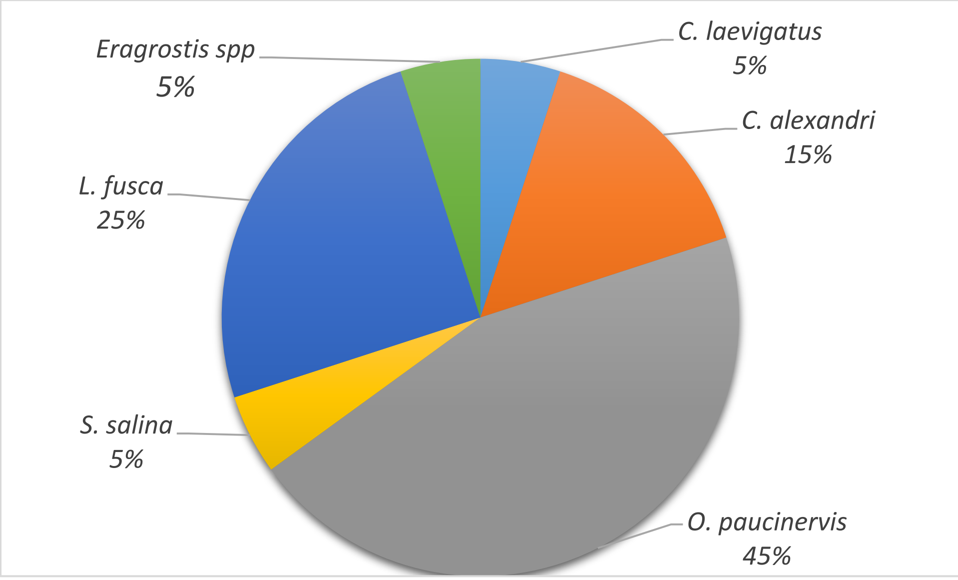


Figure 28: The proportion (%) of springbok groups that fed on different plant species

The *O. paucinervis* was not only the most consumed plant species (45% of the groups) but it also covered the largest part of the dry parts of the two pans. This grass species consisted of spiky unpalatable leaves; however, the springbok were observed to be feeding on the roots by digging underground. In contrast, only the foliage of other grasses seemed to be consumed directly such as the *L. fusca* and *Eragrostis spp*. Together with another two perennial herbs, the *O. paucinervis* was spread across the saline pans, but during the years of good rains they become submerged by water (interview with a ranger). The *L. fusca* was found mainly growing on the periphery of the pans where, most of the time, water did not reach during normal rains.

4.3.3 The age, sex and social structure of the present eland population

The age, sex and social structure of the eland in the Nyae Nyae conservancy were studied by utilising camera traps that were placed at five water-point sites (2 sites inside the Buffalo Camp and 3 at other water points in open landscapes). Based on the results, individual eland were observed by the cameras that were placed at the two water points in the Buffalo Camp with cameras marked W06 and W10. Approximately 4,800 photos were downloaded from the cameras located at these two water points. Of more than 4,000 photos, a total of 357 photos had eland present in them, such as the one in Fig. 29. According to the photos, the eland did not visit the two water points in the Buffalo Camp consistently as there were times when they had not been detected for a whole week; they either used other water points or, since being a water-independent species (Skinner & Chimimba 2005), they did not visit any water points regularly. Over a three-month observational period, eland only visited the two water points at the Buffalo Camp for five weeks. The other photos were affected by poor visibility due to heavy rains.

Figure 29: An example of the eland group as captured by the camera traps at different times of the day in the Buffalo Camp

The results of inspection of photographs from camera traps revealed that eland were in mixed groups (59.6%), female only groups (more than 1 female adults) (24.2%) and solitary groups (either male or female) (16.3%). Female groups were expected to be accompanied by juveniles, however, only sub-adults were identified in these groups. It is not clear whether the absence of juveniles was affected by the season when data were collected or simply because it had to do with the behaviour of the species. The mean group sizes of eland that visited the water points in any of these weeks (see Fig. 30) differed significantly from one another ($F_{4,352}$=12.152, P<0.001).

The group sizes of eland recorded ranged from a minimum of one to a maximum of eight individuals.

The group sizes might have been influenced by the location of the cameras at the water points. The cameras were placed close to the water points to make it easier to identify the sex and age class of individuals. In addition, the groups that visited the water points during these five weeks showed similar patterns in terms of group types ($X^2_{12,357}$=104.045, P<0.001), sex proportions ($X^2_{4,1015}$=85.255, P<0.001) and age groups ($X^2_{4,1015}$=57.857, P<0.001).

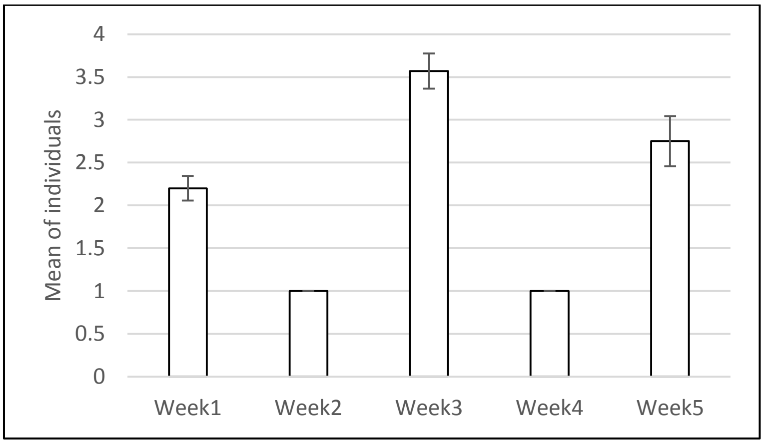


Figure 30: Mean (SE) number of eland individuals that visited water points over five weeks at the Buffalo Camp water point

Most visits of the eland to the water points in the Buffalo Camp were in the evening and early hours of the day (see Fig. 31). Most eland were detected at the water points between 20h00 to midnight (49%), followed by those that visited the water points from midnight to the early hours of the day (before 09h00) (26%).

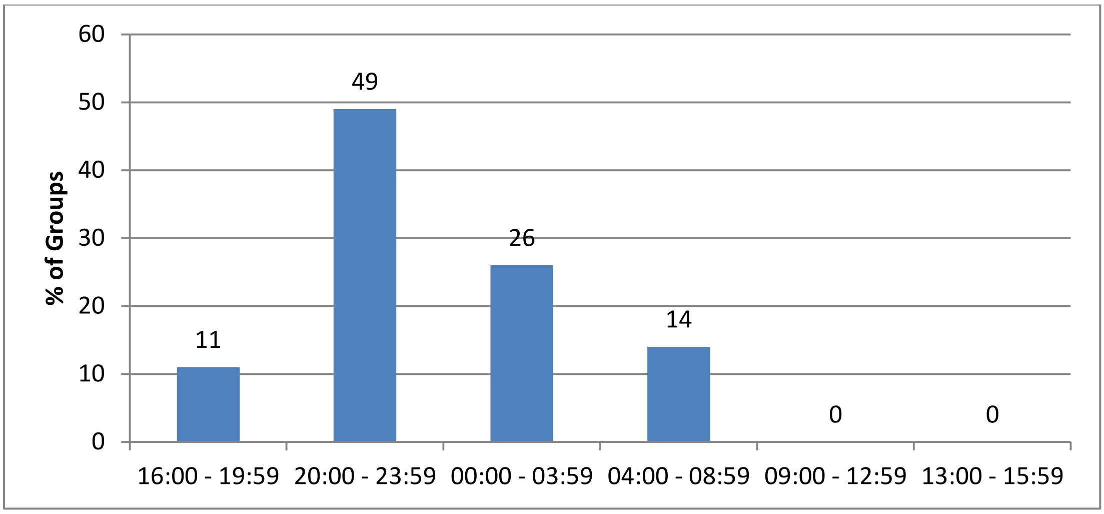


Figure 31: Times (hours) eland visited water points as captured on cameras in Buffalo Camp water point

More females (69%) than males (31%) were observed during the camera trapping at the water points. There was a significant difference in the sex of individuals found in the different groups of eland ($X^2_{23,1011}$=167.225, p<0.001). The breakdown of the sex data showed that over half of the males and females were found in mixed groups, this was particularly the case because mixed groups were larger than the other groups (Table 11).

Table 11: Proportion of eland by sex in the different groups observed by camera trapping at Buffalo Camp water points

		Solitary (%)	Bachelor (%)	Mixed (%)	Nursery (%)	Females only (%)	Total (%)
Eland	Male	25	6	69	0	0	100 (N=308)
	Female	11	0	55	0	34	100 (N=686)
Total		18	3	62	0	17	100 (N=994)

The percentage of eland in different age classes was significantly different among the group types ($X^2_{3,\ 1011}$=87,141, P<0.001). The majority of the eland groups were dominated by adults. The eland groups comprised different ages, and most of groups (85%) consisted of an adult and only 21% of the groups contained sub-adults (see Fig. 30). None of the groups captured during camera trapping comprised any juveniles. The group sizes for different age structures were significantly different ($F_{1,1016}$=94.756; P<0.001), with high mean values of adults (5.10±0.094) in comparison to sub-adults (2.22±0.145).

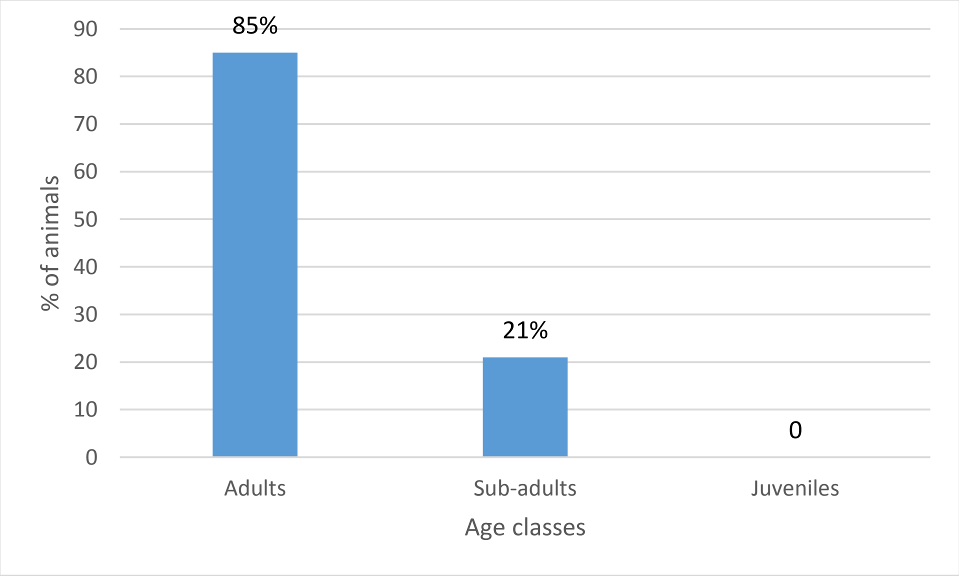


Figure 32: Proportion (%) of adults, sub-adults and juveniles in the different eland groups captured at the Buffalo water point

4.3.4 Social activities and diet composition of the observed eland

Eland were only observed in photographs captured by camera traps at the water points in the Buffalo Camp and that dictated the activities recorded. Their activities were limited, as indicated by the means (±SE) of the number of individuals in the groups. These activities included drinking water (5.20±2.94), standing/looking around (4.82±0.11), walking (1.00±0.00) and resting (1.00±0.00). The activities which the eland individuals were found doing during the camera trapping at the water points were significantly different for the different group types ($X^2_{12,994}$ =213.303; P<0.001). For eland individuals, drinking water and standing around were dominant activities and were mostly found among mixed and female only groups.

During the camera trapping, no eland was observed feeding; even while driving along the existing tracks a number of times, no eland was observed. Therefore, no eland focal groups could be studied as no individual was physically observed feeding. The plant species making up the diet of the eland were identified with the assistance of local rangers, and collected by the researcher in Buffalo Camp where the eland had been surviving since 1994. The plant species collected were only those that had been observed to be grazed or browsed by the eland during the patrols of the rangers in the camp. Six plant species formed part of the eland's diet at Buffalo Camp, where most of the eland in the conservancy were found. These species were identified by community game rangers who patrolled the camp, and later identified at the NBRI. These plant species comprised mainly shrubs, such as *Marsdenia sylvestris* (climbing shrub), *Sansevieria aethiopica* (only the tubers were eaten), *Clerodendrum ursinatum* (since it was a spiky shrub, the eland fed on the flowers only), *Dichapetalum rhodesicum* (only fed on the leaves), *Salacia leubberti* (only fed on the leaves) and the Apocynaceae family (also a succulent climbing shrub and the eland fed on both the stem and leaves).

4.4 Factors perceived to influence the translocation outcomes of the species

This section presents the results of the primary data from a combination of methods which included a questionnaire survey, KIIs, FGDs and remote sensing images. In addition to the primary data, secondary, long-term data were also analyzed to provide a further understanding of the factors that affected the translocation outcomes. The hypothesis tested under this section is: 'Different identified habitat and anthropogenic factors will have minimal effects on the translocation success of the two species'.

Resident respondents to the questionnaire survey had different views about the effect of different factors on the establishment of the translocation of the species (see Fig. 33). These possible factors were pre-determined in consultations with local community members in the Nyae Nyae conservancy. Factors, such as water availability (63%), vegetation/range condition (68%) and predation (64%), were not considered by most respondents to have a serious effect on the translocation outcomes of the species. However, on average, about a third of the respondents (32%) thought that the above-mentioned factors affected the translocated species seriously. Furthermore, slightly more respondents felt that poaching (40%), human settlements (49%) and migrations within species (50%) had a serious effect on the translocated species.

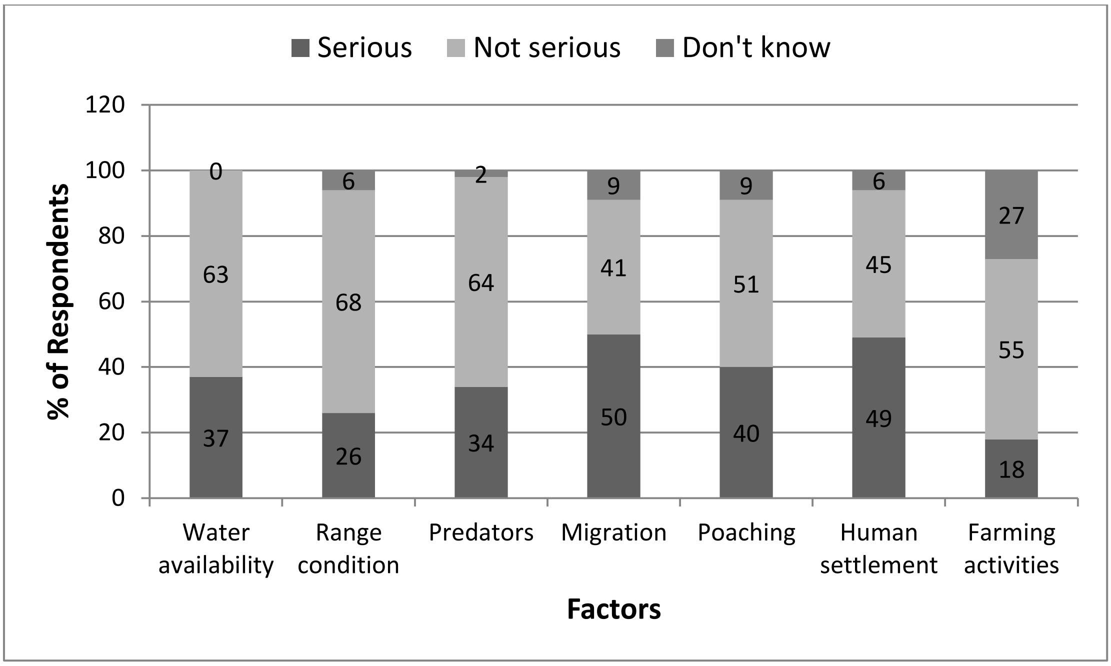


Figure 33: Views of residents on the level of effects of factors affecting the translocated species in the Nyae Nyae conservancy

4.4.1 Water sources

Water points were distributed across the Nyae Nyae conservancy, with fewer water points in the far western and northern parts, due to their inaccessibility by humans (see Fig. 34). There was a total of 40 water points across the conservancy, of which 87% were artificial and drawn from boreholes. The natural water points were pans, with only one of them (/Aotcha pan in the central part of the conservancy) being a permanent source of water, even during drought years. Most of the water points were found in community villages (75%), and a few more were provided solely for use by wildlife (25%). All the water points were visited by wildlife, as the water-point counts were carried out at all sources of water, including those at the villages. Out of these water points, 30 were common where the annual water points are being conducted.

°The Circles represent the water-points in the conservancy. **Compiled by WWF in Namibia/NACSO, 2016**

Figure 34: Map of the distribution of water points in the Nyae Nyae conservancy.

The dominant view gained from the key-informant interviews with both community members and stakeholders was that there were sufficient water points for wildlife in the Nyae Nyae conservancy. This is in line with the questionnaire survey results where 63% of the respondents (Fig. 33) indicated that water availability in the conservancy did not have a serious effect on the translocated species. However, there were some areas that still required water sources, especially in the far western and far northern parts of the conservancy. Unfortunately, it would be a challenge to supply water to every part of the conservancy. Conservancy leaders and staff indicated during the interviews that the maintenance of the water sources that provided water to the wildlife was a major challenge, and this was again linked to the size of the conservancy. Furthermore, some views from conservancy respondents reflected the effect of water availability on wildlife species, and when maintenance of water points was not done timely, the animals had to compete for a limited supply. This could affect some species negatively. A stakeholder respondent indicated that *"in any natural environment, competition for key resources will always affect some negatively"*.

The maintenance of the water-supply infrastructure was mainly required for artificial water points which were the most common type in the conservancy. The artificial water points received water from boreholes by the utilisation of solar or diesel pumps. The responses from community respondents revealed that there were many water points on which wildlife relied, but they were not functional for long periods of time. Some views were on water points functionality where respondents felt that many non-functional water points were in such condition for periods that ranged from one month to several months, with a few not repaired for a year or longer. Others indicated that the wildlife was sometimes forced to visit water points around villages. Although, insights of elderly respondents specified that villagers had co-habited with wildlife for a long time and knew how to co-exist, they also felt that the contacts between wildlife and people should be minimised. There were some feelings of unhappiness among village leaders, who indicated to have been in conservancy meetings where the water maintenance budget was discussed, but on the ground things were implemented very slowly. In another case, a local resident said: *"We have so many water points in the conservancy, but not all of them are in a working condition"*.

The maintenance of artificial water points in a large conservancy like Nyae Nyae was a task that not only required funds but also skills and commitment to sustain. A local stakeholder said that water points required regular monitoring to ensure that they were working and that there was water available for wildlife. He indicated that there were various ways to implement effective monitoring, such as establishing a water coordination unit in the conservancy that should involve all patrols (game and village patrols) to monitor the water and involve different stakeholders (MET, NGOs, village leaders and residents), as well as the recruitment of a water coordinator with the responsibility to monitor and maintain water points in the conservancy so that there would be consistent water supplies throughout the year. This would be a new initiative and the effect on water maintenance and wildlife management could still be recorded.

Both eland and springbok were classified during the interviews and in the literature (Skinner & Chimimba, 2005) as species that were not water dependent, i.e. that they did not drink water regularly, but could be affected differently by water shortages. Respondents agreed that eland were more affected by water shortages when compared to springbok. The rangers and local MET staff indicated that some translocated eland did not move immediately away from the drop-off area located in the central parts of the conservancy. They stayed for up to six months around the area. The rangers, furthermore, emphasised that some eland were observed sharing water points with villages and some were found at water points frequented by elephants. Furthermore, some views referred to the sensitivity of eland to different kinds of disturbances involving coming in close contact with people either at water points or in the forests as well as shooting occurrences, and that translocated eland would be even more sensitive.

Some perceptions also highlighted that most eland individuals visited water points at night, but those that visited in the early hours or in the mornings interacted with some species or even humans. The interactions resulting from the sharing of water points with humans and large groups of animals, such as elephant, caused the animals to move far away to avoid those kind of disturbances. In support of the above view, one respondent said, *"This conservancy supports a large number of elephants that can overcrowd a water point and prevent other species from drinking, and this is currently happening because of some water points not being operational"* (Local Stakeholder). This was perceived by respondents as contributing to the disturbance and stress of the eland, especially the fact that they were new to the environment.

Respondents were all in agreement that springbok were concentrated along the Nyae Nyae and Nyae Khabi Pans which were located a long distance from the settlements and were large enough to allow the sharing of water by different species. These pans contained abundant water for the different species without them having to compete for it. However, rangers and MET respondents also indicated that springbok and those other species depending on the pans were affected during severe drought years as these pans could dry out completely, as has happened in 2013. These species, in most cases, utilised artificial water points situated close to the pans, as they depended on the mineral licks in the pans.

Demographically, springbok around the pans were viewed to have been performing well since their translocation to the area. This was a clear indication that the water, coupled with suitable food sources, was sufficient for them because these animals would migrate away from areas if they were facing serious water shortages.

Water-point distribution was identified as one of the effective ways to avail wildlife across a conservancy. Although respondents have acknowledged the wide-distribution of water points in the conservancy currently, some also indicated that water points should be erected in areas that have none (Fig. 34). Water points were regarded as playing an important role in facilitating the retention of wildlife species within the conservancy.

There was also a strong conviction among the local respondents that eland species moved to the far, remote areas but were still within the conservancy. As a result, some of them suggested that water points should be established in those remote areas to prevent eland from crossing the conservancy boundaries, in cases where there were insufficient water available.

4.4.2 Vegetation/Range condition

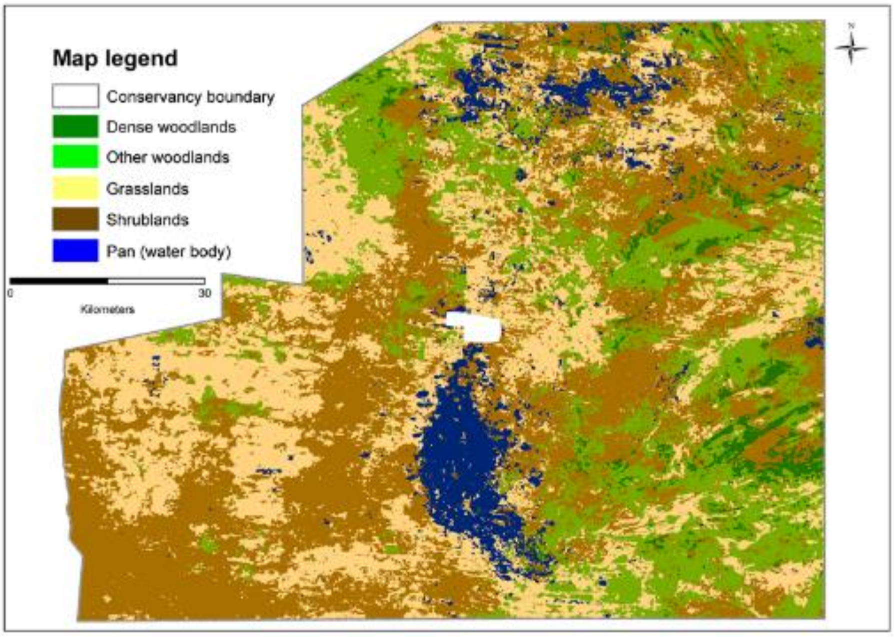
Most respondents (68%) in the questionnaire survey did not perceive the rangeland condition of the conservancy to have any influence on the wildlife species, including the translocated species. During the key-informant interviews, both community members and stakeholders agreed that vegetation and habitat in the conservancy were in good condition and able to support a variety of wildlife species. Overall, local and stakeholder respondents reflected the historical references related to the importance of the area to wildlife, saying that the conservancy had been supporting different wildlife species for years, because wildlife was a primary source of livelihood for the local people. The interviews also cited the culture of the San people of not being destructive to nature and thus encouraged wildlife to stay in the area.

Vegetation in the conservancy was perceived by both locals and stakeholders to be suitable for both eland and springbok. Two elderly residents interviewed explained that they always found the vegetation on which these species fed when they moved around in the forest. In addition, respondents also made reference to the good quality foliage and diversity of tree, bush (shrub) and grass species that are found in the conservancy, creating a choice for different species. One of the traditional authority respondents said that *"our animal species have a lot of plant species to select from"*.

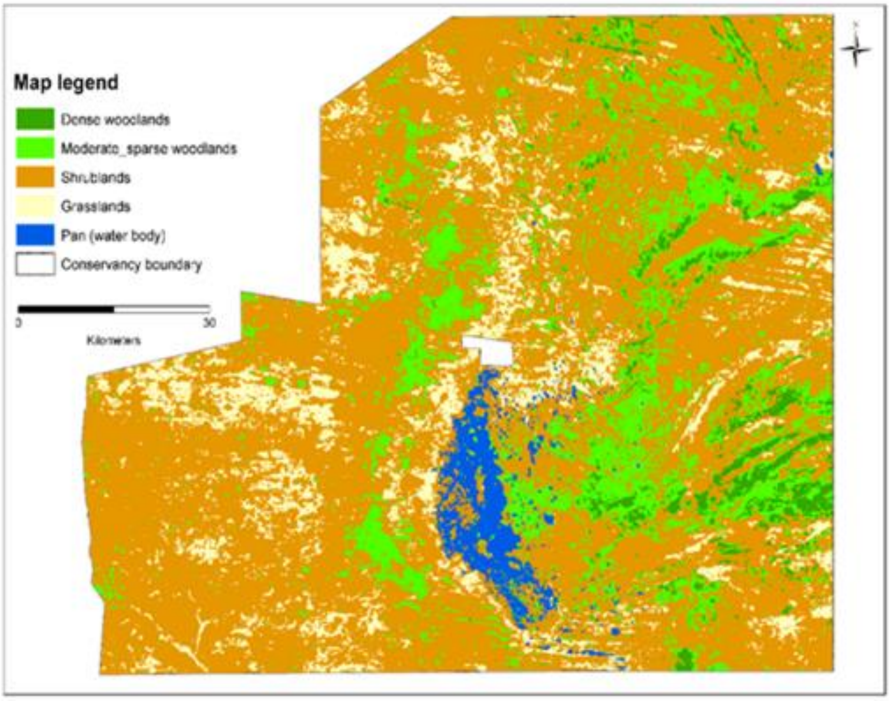
The advantage of large size of the Nyae Nyae conservancy was perceived to assist in maintaining the integrity of the vegetation. This was mainly linked to the fact that people were concentrated in some areas, leaving a larger part virtually unoccupied and only utilised by wildlife. Another advantage concerning the size of the conservancy was the diversity of different landscapes, hence, the ability of the conservancy to allow wildlife species to locate in suitable habitats, and thereby reducing competition amongst them. Almost all respondents who commented on the condition of vegetation indicated that there were few signs of land degradation in the area such as loss of vegetation species.

Vegetation changes in the Nyae Nyae conservancy using Remote Sensing

Figures 35(a) and 35 (b) clearly show that the Nyae Nyae conservancy comprised different vegetation types and/or landscapes. The vegetation consisted of dense and moderate-sparse woodlands, shrub lands and grasslands, as well some parts covered by surface water at the pans. The vegetation maps of 2009 and 2014 clearly show that no large patches of degraded areas, such as bare ground, were detected or visible in the Nyae Nyae conservancy. As a result, the changes in vegetation cover between 2009 and 2014 had more to do with changes in vegetation cover (i.e. in vegetation type) rather than with any loss of vegetation. In addition, Figures 35(a) and 35(b) also indicate that both 2009 and 2014 were comparable and were years of good rainfall. In 2009, the Nyae Nyae conservancy was mainly covered with shrubland (41%), grassland (30%) and moderate to scattered woodland (20%). Very little area was covered under dense woodland to water body (Fig. 35a & Table 12). In 2014, the shrub lands appeared to be the most dominant vegetation type (69%), followed by moderate to sparse woodlands (14%) and good grassland coverage (11%) (Fig 35b &Table 12). The water body, mainly covering the Nyae Nyae and Nyae Khabi pans, reduced slightly in 2014 (3%) from 6% in 2006. While the dense woodland remained constant between the five year period.



(a) 2009 (Own compilation from Satellite images and ground truthing)



(b) 2014 (Own compilation from Satellite images and ground truthing)

Figure 35: Maps of the different vegetation types and water bodies for (a) 2009 and (b) 2014 in the Nyae Nyae conservancy

Table 12: Proportion of vegetation and water cover (%) in the Nyae Nyae conservancy in 2009 and 2014

Land cover	Percentage of cover (%)	
	2009	2014
Shrub land	41	69
Moderate to sparse woodland	20	14
Dense woodland	3	3
Grassland	30	11
Water body	6	3

Own compilation from Maps in Fig. 35a and Fig 35b.

4.4.3 Human settlements and farming activities

Human settlements were considered by many community members (49%) in the conservancy to have a serious effect on the establishment of translocated species (Fig. 33). However, another group of community members (51%) felt that this factor did not have a serious negative impact on the translocated species in the conservancy. In the case of farming activities in the conservancy, most respondents (55%) indicated that this factor did not have a serious impact on the translocated species, but there was a proportion of respondents (27%) who did not know what the impact of this activity could be on wildlife species.

Different views about the impact of these activities emerged during the key-informant interviews where human settlements and farming activities in the conservancy were not found to have any negative influence on the translocated species because it was not a common practice in the area. This was mainly indicated in line with low human population density in the area and the traditional lifestyle of the majority of the local inhabitants, the San, who historically did not practise farming (either cropping or livestock). A member of the traditional authority stated: *"our villages are very small (in terms of household numbers) and spread across the conservancy and this helps us to have sufficient areas for hunting and also not to* *destroy the environment".* This quotation does not only show the impact of villages on the natural environment around them but also the connection of the people to the wildlife resources.

Livestock farming was not a common activity in the area and very few livestock were kept. However, a concern was raised that people from the surrounding conservancies were moving into the Nyae Nyae conservancy with large herds of livestock in search of grazing. Among those who raised this concern were both the residents and stakeholders referring to this issue as one of the contributing factors to increasing livestock numbers in the conservancy, which might lead to competition over resources between the livestock and wildlife. However, respondents also indicated that the conservancy leadership, together with the traditional authority, enforced a rule that no village should have livestock numbers exceeding 50 heads of large livestock. The strict enforcement of this conservancy regulation was regarded to have been successful in regulating livestock numbers in the conservancy. It was also perceived among the residents that the presence of livestock in the conservancy could attract more predators to their conservancy because livestock was a somewhat more easy prey when compared to the wildlife.

One respondent said: *"most of our translocated species were most affected during the years of translocation because while some of these individuals were still locating to suitable habitats, some people started to hunt them when spotted*". Most of those respondents who pointed out this issue indicated that this practice appeared to affect eland more than springbok as the eland moved to remote areas while the springbok settled along the pans, within the reach of people. The stakeholders indicated that the eland was by nature a sensitive species, and once they felt threatened they would move in search of safer places. The elderly and one of the MET officials pointed out that eland had the ability to travel long distances.

4.4.4 Veld fires

Veld fires were not considered to have a serious effect on the translocated species. All local people interviewed agreed that burning some parts of the forest was a cultural practice among the local inhabitants that was carried out for various reasons. Fires were set to increase visibility when people were in the wild areas of the conservancy, either for hunting, for collection of food products or when moving from one area to another. The local respondents stated how important it was for them to burn around areas they would use for collecting veld products (usually plants) or for hunting. To community members, this practice was not attached to any particular season of the year and they did not burn large areas, except when the fire spread so fast and they were unable to control it.

Local respondents said that they also practised burning as an approach to attract wildlife species into the area. Areas that were burned were believed to stimulate a healthy growth of grass and would produce the new grass preferred by most grazers and mixed-feeders. They also pointed out that the reproduction of different wildlife species was enhanced by feeding on the grass sprouting from burnt areas. An elderly, local respondent reflected: *"one of the best ways to attract wild animals is the fresh sprouting of new grass that comes from burnt areas and this can draw different species from far distances"*.

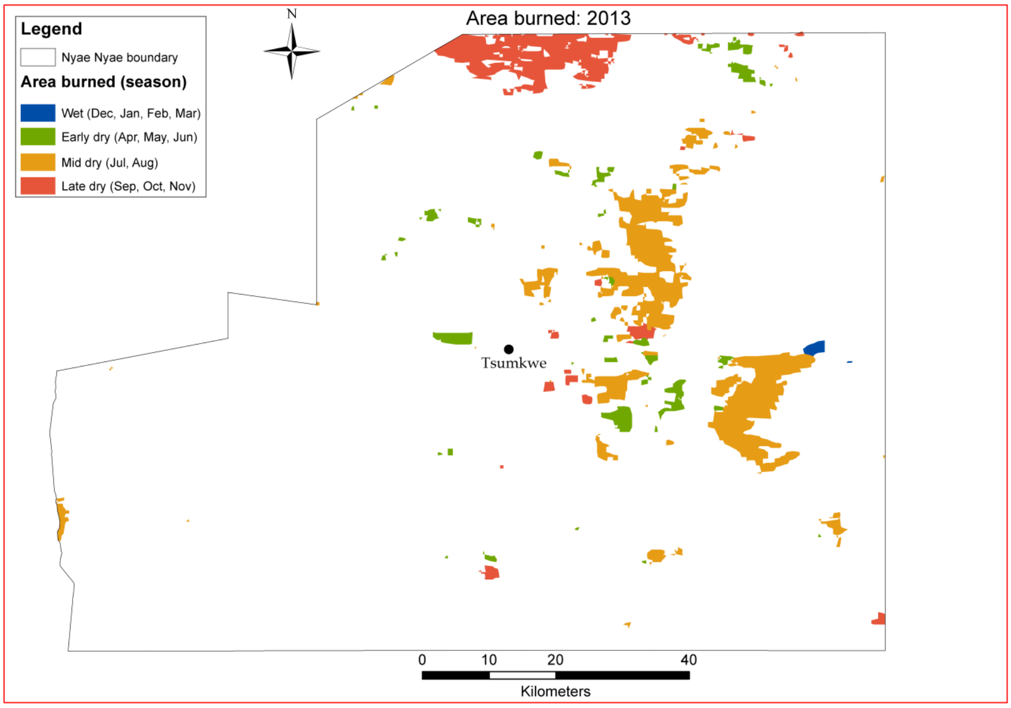
On the other hand, the local MET and NGO respondents expressed their concern about the manner in which burning was carried out by local people:

> *When every farmer goes out any time of the day, any time of year to either hunt or collect wild fruits, it becomes a problem because they end up burning everywhere. The burning practice does not need to be stopped but requires control"* (local NGO respondent).

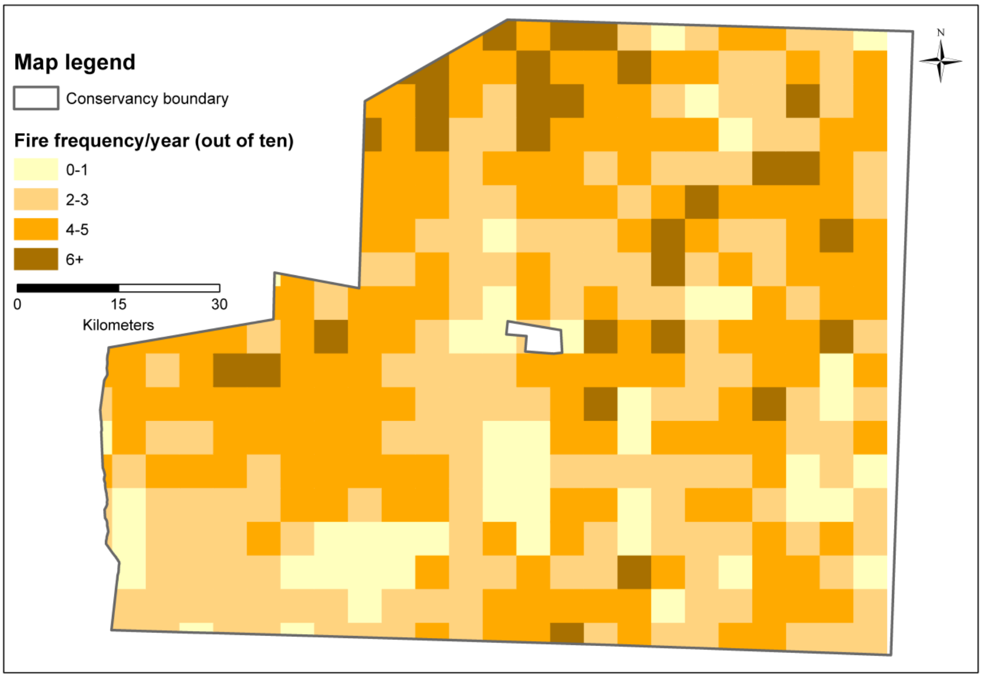
Burning during the dry season (July-October) was found dangerous as the grass was then at its driest and fires spread further. It also emerged from the interviews with the residents that the dry season was a good time to hunt because wildlife depended on a smaller number of water points, thus increasing the possibility of locating them in nearby forests. Stakeholders condemned burning during the dry season because fires could become uncontrollable and affect large areas, harming different landscapes and species. The MET officials and experts from the NGOs pointed out that veld fires could separate groups of wildlife or cause calf mortalities. Another respondent pointed out that frequent fire could be devastating to the wildlife because, although some species attempted to return to a burnt-down area, some species would not return if the burning continued.

Although respondents could not link the effect of veld fires to any particular species, they suggested that eland were more disturbed than springbok, because they were found roaming in some areas of increased human contact, where fires were more likely to happen.

Figure 36(a) shows that in 2013, veld fires occurred mostly in the northern, central and towards the eastern parts of the conservancy. The total area burnt in 2013 was 56 572 ha (covering about 7% of the conservancy). Based on the frequency of fires over a 10-year period (2002 to 2013), fire was a common occurrence but not very extensive because only a few parts of the conservancy had experienced veld fires consecutively for 6 years or more (Fig. 36b). However, it is a matter of concern that some areas had been affected by fire for 4 to 5 consecutive years in the past 10 years. The springbok population was not likely to be affected seriously by fires, because the area in which the springbok were found around the Nyae Nyae pans had experienced a low occurrence of fires in the past 10 years. In the case of the eland, it was difficult to establish directly the effects of fire on the free-roaming population.



(a) Own compilation from MAWF veld fires database, 2002 - 2013



(b) Own compilation from MAWF veld fires database, 2002 - 2013

Figure 36: Fire maps indicating (a) the occurrence of fires in 2013 (b) fire frequency over the period of 2002 to 2013 in the Nyae Nyae conservancy

4.4.5 Predation

This section presents feedback from community members and stakeholders regarding the effect of predation on springbok and eland in the conservancy. Predation was not perceived as the cause of many threats to translocated or other species by most respondents. Most respondents (64%) did not see the presence of predators in the area as having any negative effects on the establishment of translocated species. On the contrary, about a third of the respondents (34%) felt that predation had a serious impact, specifically on the translocated species.

During the survey, community members did not think that predation had a serious impact on the establishment of the translocated species. During the key-informant interviews, however, they pointed out that translocated individuals were more likely to be negatively affected by predation as they were new to the habitat.

Local rangers and some stakeholders indicated that predation was not always negative but was necessary in any conservation area to regulate the population numbers of ungulates. Some arguments were around the point that the healthy ungulate population attracted predators to the area..

Other differing views regarding predators were also expressed. A ranger indicated that the presence of lions, especially when they were in a group in a specific location, could cause the ungulates in that vicinity to move from that area. A female respondent from the //Aotcha village said, *"two lions were found roaming around our village during 2012"*. Another elderly man indicated that the number of leopards had increased because most of the kills of wildlife and some livestock pointed to them (leopards). Some women stated that they were currently very fearful of predators when they go out to collect veld products, because these animals were easily spotted, especially the leopard. Despite the different predators mentioned, local communities could not relate how predation was directly linked to the translocation of wildlife, specifically to the eland and springbok.

According to event-book data, a total of seven predator species were spotted or their tracts seen during the patrols undertaken by rangers (see Fig. 37). The number of jackals (45 ± 14.7, $p=0.022$) and cheetah (59.50 ± 11, $p=0.053$) observed in the period 2004 to 2014 were statistically significant between 2003 and 2014. The numbers of caracal (4.3 ± 2, $p=0.261$), wild dog (226.5 ± 20.2, $p=0.524$), lion (33.8 ± 6.3, $p=0.056$), spotted hyena (308.8 ± 38.4, $p=0.991$) and leopard (152 ± 20.7, $p=0.448$) did not appear to change significantly between 2003 and 2014. With the numbers of cheetah decreasing over the past 10 years, the numbers of jackal appeared to be increasing. However, these data from the event-book were contrary to that from the water-point counts presented earlier which indicated that the jackal had a declining trend. In addition, cheetahs were not spotted during the water-point counts but were observed during the patrols and recorded in the event-book.

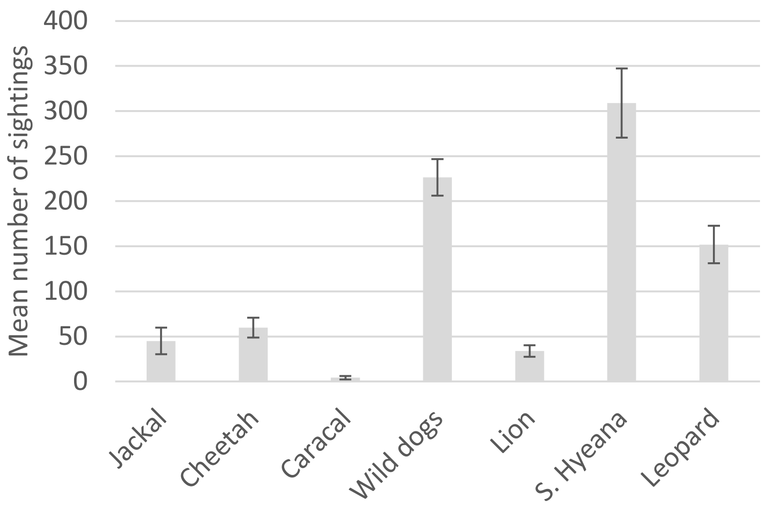


Figure 37: The mean number of different predators sighted during the period of 1999 - 2014 in the Nyae Nyae conservancy

Source of data: Event-book, Nyae Nyae conservancy

The number of incidents between the different predators and ungulates are shown in Fig. 38. Spotted hyena and leopard caused the most predation incidents during the period 2003 to 2014 when compared to cheetah, wild dog and jackal. None of the incidents caused by these species significantly increased during the same period.

In order to address a presumed excessive predation problem by the residents, a total of eight spotted hyenas and eighteen leopards were to be translocated out of the conservancy between 2003 and 2014.

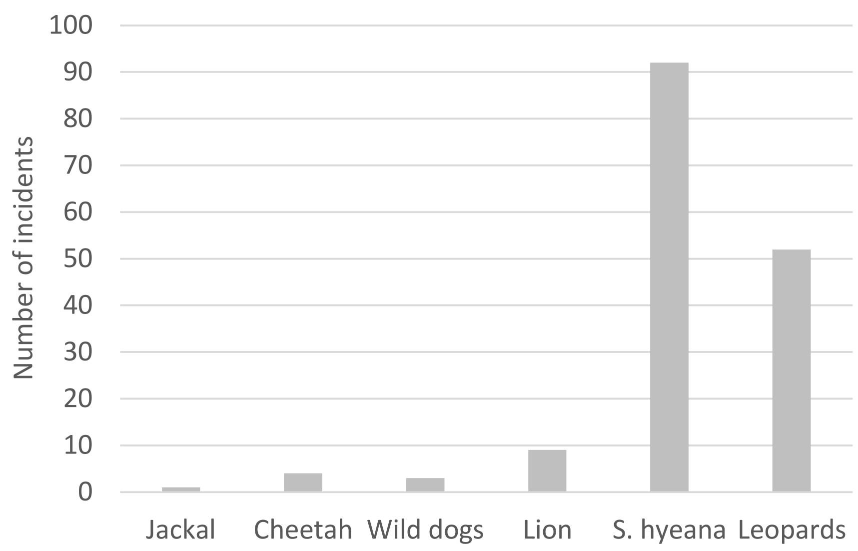


Figure 38: The mean number of different incidents caused by predators during the period of 1999-2014 in the Nyae Nyae conservancy

Source of data: Event-book, Nyae Nyae conservancy

Very few mortality incidents for springbok and eland were recorded, as only three springbok and one eland carcasses were found between 1999 and 2014. These mortality cases were considered to be caused by predation. Deaths caused by disease were not recorded for any species. The hyena and leopard were captured during camera trapping in the Buffalo Camp (Fig. 39).

Figure 39: The hyena and leopard captured during camera trapping in the Buffalo Camp

4.5 The impact of hunting on translocated species

This section provides an analysis of the views of conservancy members and stakeholders regarding the importance of hunting to the conservancy, as well as the effect of hunting on the establishment of translocated species. The respondents were allowed to give their opinion in general about translocated species where it was difficult to refer specifically to springbok and eland. The hypothesis tested under this section indicates that the hunting practice in the conservancy will not have negative effects on the translocation success of the two species because of the hunting monitoring system implemented by MET together with conservancies.

4.5.1 The influence of the practice of hunting on translocated species in the Nyae Nyae conservancy

Hunting in the Nyae Nyae conservancy was classified into subsistence and commercial hunting. Subsistence hunting, also referred to by some respondents as hunting for own use, involved hunting carried out by the conservancy management for meat distribution to households and the provision of game meat to social events, such as conservancy meetings, local festivals, support at funerals and other needs of the conservancy. Another type of subsistence hunting involved the hunting by conservancy members using bow and arrow. Commercial hunting primarily involved trophy hunting although conservancy leaders and some stakeholders indicated that this category also included live game sales or the shoot-and-sell of game. Trophy hunting is carried out by contracted professional hunters while people from other areas are not allowed to hunt in the conservancy.

Furthermore, the interviews also revealed different benefits of hunting for the community. Hunting was regarded as an important activity by respondents because it contributed to the sustainability of the conservation efforts of the community by controlling the numbers of animals. Some stakeholder respondents indicated that different species in the conservancy performed differently; therefore, species numbers had to be regulated to assist the different species to perform better. There were those wildlife species that increased quickly, while others remained as stable populations over a long period of time and others declined in number for various reasons. Both community and stakeholder respondents indicated that hunting could assist in regulating wildlife numbers which would help to achieve a sustainable management of the habitat.

Hunting was found to be important by respondents for its economic significance as it was a major income-generating activity for the conservancy. The views from both community members and stakeholders agreed that most of the conservancy income was generated from trophy hunting. Trophy hunting in the conservancy was carried out by external, professional hunters who had an agreement with the conservancy. Currently, the Nyae Nyae conservancy had signed contracts with two professional hunters. It was indicated by the conservancy leaders and some stakeholder respondents that in recent years, the MET played a major role in monitoring the contracts between conservancies and professional hunters to ensure that conservancies entered into agreements with reliable hunters and hunting was implemented according to the stipulations of the contract. These agreements, in most cases, were signed for a period of three years, with the possibility of renewal.

It also emerged from the interviews that regular reporting by hunters to the conservancy and MET was important for the maintenance of sustainable hunting in the conservancy. Hunters were expected to submit bi-annual reports to the MET, and the conservancy had to ensure that a community ranger accompanied professional hunters. This kind of monitoring system is suggested not to police hunters but rather to facilitate better working relations between hunters and the conservancy, as well as to identify mutually the threats to, and opportunities for, hunting in the conservancy. An example was cited by an MET official that when rangers accompanied hunters, it could improve their monitoring of wildlife because they would understand the habitats better, especially those that were out of reach when they patrolled on foot. The two professional hunters contracted by the conservancy had areas designated to them where they could hunt, and records were regularly submitted to the conservancy and MET. Subsistence hunting by the conservancy management was subjected to the same monitoring conditions as that of the professional hunters, and was mainly carried out by the MET-trained hunters.

Beside its economic importance to the community, hunting also had a cultural importance. Although translocation had improved the numbers of wildlife in the conservancy and thus enabled conservancy members to hunt and feed their families, more wildlife in the conservancy would also allow the local people to continue, and preserve, their culture of hunting. Every conservancy member was authorised to hunt for household consumption based on the quota available for a particular species, and could only use a bow and arrow to hunt. Unlike the trophy hunting and subsistence hunting by conservancy management, a number of uncertainties were raised with regards to hunting by community hunters or traditional hunting.

Most external stakeholders (GRN and NGOs) feared that traditional hunting was likely to exceed the quotas, leading to overhunting. Despite the presence of quota figures, local people normally hunted to satisfy the needs of their households and this was not necessarily done based on quotas. One of them asked the question: *"Can one stop the locals from hunting even when quota levels are reached, how?"* The MET stakeholders were of the opinion that if hunting by locals was not well controlled, it could easily disrupt the wildlife population in the conservancy. The eland was mentioned as one of the species that were very sensitive to human disturbances, as well as the preferred species for hunting by the local San people. Conservancy leaders also could not confirm certainty the reliability of the hunting records regarding hunting by the locals, although they indicated recent improvements in the recordings at village level.

The conservancy leaders discussed the monitoring process of local hunters. According to them, the current practice was for local hunters to report their activities, including the species and numbers of animals they had shot, to the village heads. On a monthly basis, rangers collected the forms from the village heads and submitted these to the conservancy office. The conservancy office compiled a report for the entire conservancy and submitted it to MET. However, conservancy and traditional leaders, as well as the stakeholders, were of the opinion that the current monitoring of hunting activities by local hunters was unreliable. Although some indicated that the hunting monitoring procedures of completing the forms was an easy task, some felt that not all people were honest enough to report all the species and numbers they had hunted.

Some challenges were identified for subsistence hunting involving community members. There were views about animals being wounded and allowed to flee without being pursued. In many cases, local hunters would not record those that were wounded because these animals would eventually die and affect the population; therefore these went unreported. It was established during the interviews with both local and stakeholder respondents that the poison used did not kill instantly. As a result, hunters had to go after that specific animal until they found it. In some cases, especially the large bodied or fast species might die after having run a long distance; hunters often gave up pursuing such an animal. When animals were shot but not recorded, it posed a threat to wildlife populations. Another challenge that emerged from the interviews was that local hunters went into the forest to hunt individually and might also be in the same areas as the professional hunters. This could pose some disturbances among wildlife species, causing a situation of unrest among the species.

However, views from the local members during group discussions indicated that different hunting restrictions should be adhered to. These restrictions included that only adult males should be hunted and that older males in any group should be targeted. Shooting some species, such as eland, red hartebeest and giraffe, was also not allowed in subsistence hunting; furthermore, no weapons other than the bow and arrow should be used by community members, and hunting around water points should not be allowed. They further indicated that hunting became illegal when it was not authorised by the conservancy, when a species was not included in the quota, when quotas were exceeded, as well as at certain places that are non-hunting zones such as the area around the pans, and when using prohibited weapons like guns and spear. This level of knowledge by local members was also confirmed by the local stakeholders and the conservancy leaders and staff who stated that there was a growing understanding among the residents of the Nyae Nyae conservancy of the negative effects of hunting and other practices regarding wildlife species and the sustainability of the conservancy.

To improve the control of hunting by locals, suggestions regarding the control or monitoring of mechanisms were drawn from the interviews. Some suggested the elimination of the regulation that provided for San people to hunt, which appeared to be a national pronouncement. Others called for effective control mechanisms to be put in place to ensure that traditional hunting did not pose a threat to wildlife in the area, as well as considering the importance of wildlife to the livelihoods of the community members in the conservancy. Others advocated that more support, such as allowing rangers to accompany hunters or registering local hunters and granting those permits, should be given to monitor hunting. Perhaps a hunting season for local hunters needed to be introduced for certain seasons when members of the community could hunt.

4.5.2 Hunting levels among the translocated species in the Nyae Nyae conservancy

Hunting in the conservancy had been boosted through the translocation of wildlife to the conservancy since 1999. Six out of eight translocated species, including springbok, eland, oryx, red hartebeest, kudu and blue wildebeest, were hunted from 2004. The black rhino and zebra were not hunted because the black rhino was an endangered, protected species, while the translocated zebra in the conservancy had died out as only two individuals had been moved to the conservancy.

In general, more animals were hunted for subsistence rather than for trophy purposes (see Fig. 40). The numbers of animals hunted for trophy purposes were significantly different over the period 2004 to 2014 (χ^2 =97.48; df=75; p=0.042) when more species were hunted. The numbers for the six translocation species hunted for subsistence did not change significantly between 2004 and 2014 (χ^2=28.70; df=24; p=0.232). However, species, such as kudu, springbok, blue wildebeest and oryx, that displayed stable trends in population sizes between 2001 and 2013 showed higher levels of hunting. The same was also true for species with declining trends in populations where the eland and the red hartebeest showed the lowest numbers of being hunted.

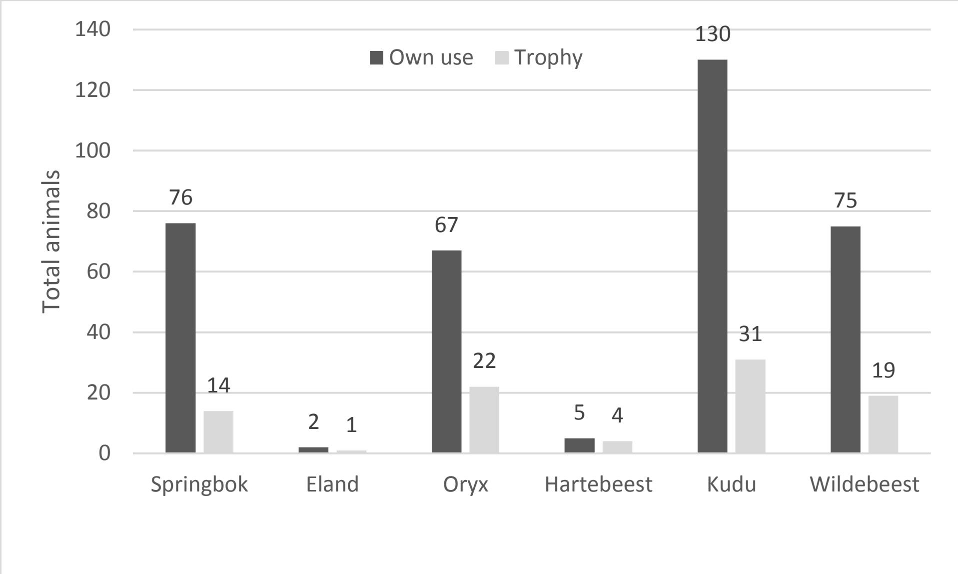


Figure 40: The total number of animals legally hunted for subsistence and trophy hunting in the Nyae Nyae conservancy during the period of 2001-2014

Source of data: Event-book, Nyae Nyae conservancy

The records showed that less eland were hunted than springbok. Springbok were first translocated into the conservancy in 1999, and the hunting of this species both for trophy and subsistence started in 2004 (see Fig. 41). Springbok were hunted more for subsistence, particularly for meat distribution to households and meetings, than trophy hunting. Only three eland were hunted; one was for trophy purposes in 2004 and the other two were for subsistence during 2004 and 2005.

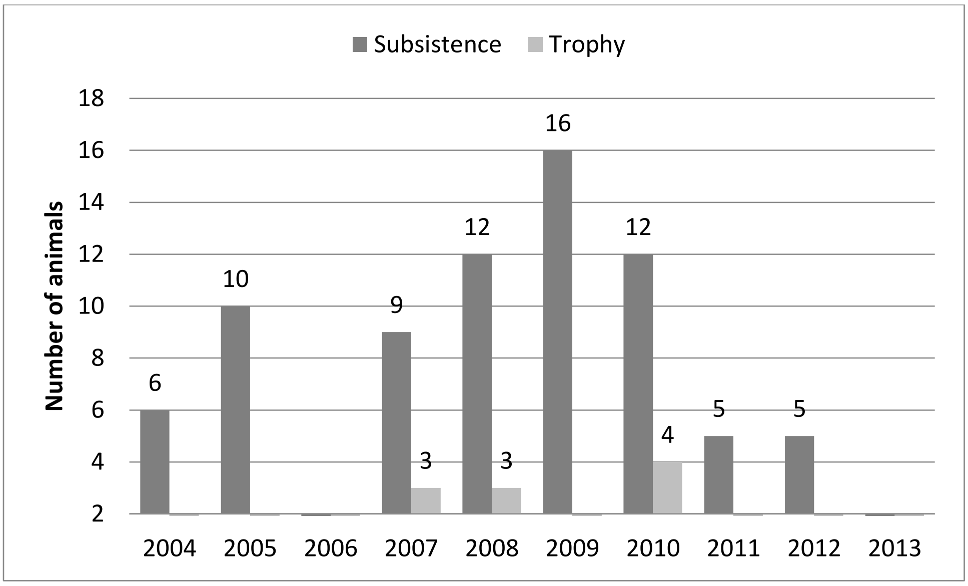


Figure 41: Number of springbok hunted for trophy and subsistence purposes during the period of 2004 - 2013 in the Nyae Nyae conservancy

Source of data: Event-book, Nyae Nyae conservancy

The Nyae Nyae conservancy, together with the MET, set quota levels for each huntable species in the conservancy. This process had been in place since the inception of the conservancy but it was not well documented. From 2009, the quota-setting process was revisited and well documented. As a result, it was concluded by MET that the annual quotas should be determined for three years, unless any species was found to be endangered. The annual quota allocated for trophy and subsistence hunting for springbok for the past three years (2010 to 2013) was set at eight (8) and 42 individuals, respectively. The quota allocated for the eland varied between two individuals for trophy and five individuals for subsistence hunting over the period 2010 to 2013, and low quota levels can be related to the declining trend and low numbers recorded during annual counts. When the records of the number of animals hunted were compared to the quota levels, it was clear that in none of the years overhunting (hunting that exceeded the allocated quota) of springbok or eland was experienced.

In the survey conducted with the residents, more than half of the surveyed households (59%) stated that they did hunt or benefited from a co-villager who had hunted; however, they rather depended on the distribution of conservancy game meat. When the survey results were related to the hunting by the conservancy members, it appeared that most hunted species that also showed the highest hunting records in the conservancy, like the kudu. Kudu (50%) was the species most hunted by local hunters for the purpose of consumption at household level. It was followed by the oryx (14%) and blue wildebeest (10%). Only a few households (5%) indicated to have hunted springbok, while none indicated hunting an eland (see Table 13).

Table 13: Number of households that hunted different wildlife species during 2012 – 2013

Species	No. of households	(%)
Kudu	21	50
Oryx	6	14
Blue Wildebeest	4	10
Springbok	2	5
Warthog	3	7
Birds	4	10
Steenbok	1	2
Duiker	1	2
Total	42	100

The low interest and participation by the youth of the community was a great concern to the elderly and traditional leaders. One elderly man said: *"our young people are becoming less interested in our culture, they are lazy and cowards. They are just following alcohol"*. He also indicated that the skill of hunting remained currently mostly with the elderly and only some young people. Furthermore, villages had only between two and three hunters instead of each household hunting on their own. Another elderly man referred to the decline in access to the poison that they put on arrows because the knowledge and skill were dying out. It also emerged from the interviews that not only were hunting skills in decline, but nowadays not all households possessed the hunting tools.

4.5.3 Perceptions of the effects of hunting on translocated species

Some stakeholders, particularly those from local institutions, indicated that wildlife had been translocated to a functioning conservancy that already had wildlife populations. Translocation aimed to boost the populations of existing species, with the exception of springbok, black rhino, giraffe and zebra. These respondents indicated that hunting had already taken place before the translocations. As a result, some translocated animals might have been affected by hunting immediately after translocation, an event which was likely to disturb these populations who were still in the process of settling themselves into the new habitat. The conservancy found it hard to control the effects of hunting on the existing population, and the newly translocated individuals, as translocated animals were released into the central part of the conservancy. Another stakeholder felt that some animals were not given a chance to settle before being disturbed by hunting; even if they were not the target of hunting, the spaces they occupied could have been disturbed. This is especially true because the translocation site at Boma was located in the central part of the conservancy in the close proximity of some villages.

The eland was well-known to the local hunters; however, the fact that it had been spotted by hunters after translocation could have caused a temptation for them. From the legal hunting and poaching lists, as well as the survey results and group discussions with residents, there was little evidence of the hunting of eland, but the stakeholders and other community respondents continued to ask: *"Where did the eland go?"*

The hunting case of springbok by locals was said to be low in the conservancy, because the area around the pans was protected by the conservancy, and hunting by local people was prohibited in that area. Furthermore, there were only a few trophy hunters interested in springbok; this lowered the burden that hunting or disturbances put on the species. Eland emerged as the preferred wildlife species by the residents due to historical connections, its good meat and multi-purpose uses of its body parts. Some residents admitted that the eland used to be targeted exceedingly for hunting by the local hunters, especially before the conservancy was established, but now education about why not to hunt eland was given to communities. However, the NGO and MET respondents emphasised the importance that local communities should have a good understanding of wildlife management and hunting to avoid negative effects for the species in the area in future.

In summary, this chapter presented the results obtained from the data collected. The major outcome is that translocation played an important role in contributing to the presence of springbok, while translocation could not assist in building up the eland population in the Nyae Nyae conservancy. The next chapter comprises a discussion of these results.

CHAPTER 5: DISCUSSION

5.1 Factors influencing the composition, diversity and population sizes of wildlife species

The consistent composition of wildlife species in any protected area is mainly attributed to the capacity of the habitat to maintain the needs of different groups of species (Leuthold 2012). The composition of the wildlife species in the Nyae Nyae conservancy was mostly dominated by ungulates (75%) with the rest made up of predators (see Table 2). This finding is not unusual as it has been well-documented that ungulate species or herbivores make up the largest proportion of animals in most protected areas in Africa (Griffin 1998; Ottichilo et al. 2000; Owen-Smith 2008; Sinclair & Arcese 1995; Western et al. 2009). The fact that the composition of the species in the Nyae Nyae conservancy is comparable to other conservation areas, based on the literature, reflects the ecological importance of this conservancy for Namibia. The Nyae Nyae conservancy is also characterised by the co-existence of ungulates and predator species with nearly a constant wildlife species composition over the years. This reflects the importance of co-existence among ungulates and predators species in the area. Such co-existence is important to ensure the ecological functions necessary to maintain the integrity of the habitat. A low fluctuation in species composition over the years was one key finding that reflected the high retention level of wildlife species in an open system, such as a community-based conservation area.

Healthy and heterogeneous habitats are essential to maintain a high diversity of animal species and safeguard species richness (Kiffner, Wenner, La Violet, Yeh & Kioko 2014; Tews et al. 2004; Waltert et al. 2009). The Nyae Nyae conservancy presented a Simpson Index of Diversity (SID) of 0.81, which is a relatively high species diversity, because the closer the SID of an area is to 1, the higher the species diversity of that area (Keylock 2005). High species diversity provides protection to habitats, and increases the tenacity of the ecological community against environmental and anthropogenic stresses (Luck et al. 2003). Despite the high overall species diversity displayed by the results of the present study, a decline was detected in the species diversity between 2001 and 2013 (X^2_{11}=19.06; P=0.001). The results show that the diversity of animal species declined from the highest SID level of 0.85

in 2001 to the lowest SID level of 0.71 and 0.72, during 2011 and 2013, respectively. This decreasing species diversity is unexpected, given the translocation efforts and low changes in species composition over the years in the conservancy.

Generally, SID is an index that takes into consideration the species richness and relative abundance of individuals of the species found in an area. Since there were limited changes in species richness in the wildlife over 12 years in the Nyae Nyae conservancy, these results imply that the decline in species diversity is affected mostly by the changes experienced in the abundance of wildlife species of the conservancy. When one refers to the NDVIs of the Nyae Nyae conservancy, it indicates that the lowest SIDs recorded were from the years with the lowest NDVIs, suggesting that the abundance of some species might have been influenced by low precipitation. A study, using NDVIs, found a similar tendency where rainfall variability influenced wildlife abundance and diversity, reflecting the effect of this variability on the dynamics of the wildlife population of the savannah herbivore (Georgiadis et al. 2003).

One of the most important findings of this study is that ungulate species influenced the trends regarding the abundance of the species found in the conservancy. In order to strengthen this argument, two classes of ungulate species were identified to influence the positive trends in the abundance of wildlife species in the conservancy. Water-dependent species, such as the elephant, buffalo, blue wildebeest and black rhino (Hayward & Hayward 2011; Roodt 2011), are more likely to show positive trends in population sizes, as was found in the present study. Similarly, the abundance of species, for example kudu, springbok and oryx that are not water-dependent, although they would drink regularly when water was available, showed positive trends over the years, and this was not linked to their water dependency (Hayward & Hayward, 2011). Historically, these species are also amongst the most abundant species in Namibia, as they are well-adapted to the conditions of the country (Griffin 1998; Shortridge 1934; van der Walt 1989).

While two thirds of the species detected during the water-point counts depicted stable trends over the years, the other third showed declining trends. The positive trend among most species, coupled with a constant composition of wildlife species over the years, clearly reflects the conservation potential of the Nyae Nyae conservancy and the contribution of communal conservancies to conservation efforts in the country. The species that showed negative trends in population sizes (30%) included large ungulates, such as the eland and red hartebeest, or smaller ungulates, such as the steenbok and duiker or predators that did not require drinking water regularly. It could be argued that the abundance of these species could have been affected by the method used to estimate the abundance of wildlife species, namely, the water-point count. However, the present study also found that there was a positive relationship between the trends from the water-point counts and those of the event-book system, which consisted of records collected at and away from water points. Therefore, the declining in the abundance of this species could be an indication that there might be other environmental or anthropogenic factors which affected these species negatively in the conservancy.

The translocation of wildlife species in the Namibian conservancies has been identified as an important conservation tool (NACSO 2013; Paterson et al. 2008b) that is practised mainly to augment, or reintroduce, species to their native ranges (IUCN/SSC 2013; Seddon et al. 2013). In general, the present study found that the translocation did not influence the overall trend in abundance of all sighted species over the years. However, the most striking result from the analysis was that translocation outcomes in the Nyae Nyae conservancy could be presented in three distinct categories. Firstly, species with relatively good levels of founding populations, such as kudu, blue wildebeest and oryx that were augmented with individuals through translocation, continued to show positive growth over the years. The size of a founder population was found to have had an influence on the outcome of the translocation of species populations (Armstrong & Seddon 2007). Species that already have higher founder population sizes are likely to continue showing positive trends after translocation, and this enables the translocated individuals to contribute to population stability (Seddon et al. 2014). In many cases, species re-enforcement assisted in the strengthening of an existing population for the purpose of increasing benefits from hunting and tourism opportunities (Weaver & Skyer 2003).

The second category comprised species that had lower founding populations at translocation. Species, like the eland and the red hartebeest, showed positive abundance only during the years after translocation but afterwards continued to show declining trends. This suggests that translocation failed to build up eland and red hartebeest populations, thus defeating the purpose of translocation. Populations that experience chains of decline even after efforts of restoration are under threat, and agents of decline alike, should be identified to prevent further declines (Caughley 1994). The species that were re-introduced into the conservancy after disappearing from this habitat due to unknown reasons, represents the third category. In the Nyae Nyae conservancy, the springbok, giraffe and also other endangered species had been re-introduced between 1999 and 2005 and have since been showing an increasing trend in population sizes. For such species, released numbers become important for the success factor of translocation (Armstrong & Seddon 2007). This is a reflection of the contribution of translocation to the biodiversity and species diversity (Parker et al. 2013; Seddon et al. 2014). Conducive environmental factors and limited anthropogenic pressure have been identified in assisting re-introduced species to survive and persist within a habitat after translocation (Armstrong & Seddon 2007).

Despite the positive translocation outcomes stressed, study results could not totally support the first hypothesis that translocation has a positive influence on the overall trends in the population sizes of the species in the conservancy, as some re-enforced species failed to build-up even after translocation. However, the effects of translocation on the species richness were positive as all re-introduced species managed to be re-established in the Nyae Nyae conservancy.

5.2 The trends in abundance and distribution of eland and springbok

The re-introduced springbok into the Nyae Nyae conservancy have shown positive outcomes because they displayed an increasing trend in abundance over the years since their re-introduction. This increase is reflected in the total of 633 springbok individuals that were translocated in the conservancy between 1999 and 2003 from the Etosha National Park. Large released groups have the advantage to be successful in establishing viable populations due to habitat characteristics to support the species in that particular area (Wolf et al. 1998). There is also evidence from historic translocations in southern Africa that the re-introduction of most ungulate species has a greater chance to succeed, because the natural habitat conditions prevail (Novellie & Knight 1994). The results show that the numbers of springbok translocated (released) were primarily important for the establishment of this re-introduced species that had become locally extinct from the area years ago. In addition, a positive sign in the growth of this re-introduced species was the increasing trends among juvenile abundance and decreasing mortality levels in the conservancy. The viability of any population is shown through the ability of the species to reproduce in the habitat in which they are translocated (Jarvie, Recio, Adolph, Seddon & Cree 2016; Seddon et al. 2014).

The springbok established a niche along the open plains of the Nyae Nyae and Nyae Khabi pans in the southern part of the conservancy where they continued to show a steady growth. Both aerial surveys of 2004 and 2013 indicated the presence of springbok in the conservancy at the habitats along the pans in the southern part of the conservancy. The springbok showed a normal, post-release dispersal (Le Gouar et al. 2013) as they selected a natural habitat after moving from the released site that they located in the central part of the conservancy to areas around the pans a few years after re-introduction. Pans have been identified as suitable habitats for the springbok in many parts of Africa (Milton et al. 1992). The vegetation along the pans is dominated by grassland plains and scattered shrub land, with salt supplements from the pans. Springbok were able to choose habitats along the pans because of the openness of the landscape; they did this to avoid predators; this is an important behaviour contributing to the success of translocation (Armstrong & Seddon 2007).

From data gathered from the total of 268 individuals translocated to the Nyae Nyae conservancy during 2000 to 2005, it was established that a negative trend in abundance during the period of 2001 to 2013 was experienced. The study also showed a very low and declining recruitment of sub-adults and juvenile segments into the eland population in the conservancy. The sign of breeding in a population is mainly the presence of sub-adults and juveniles, which reflects the positive growth of a population, while the absence of these younger age groups could mean that the population is not performing (Owen-Smith & Mason 2005). Although the aim of translocation of eland was to increase the free-roaming eland population in the Nyae Nyae conservancy, the translocation efforts did not succeed because no viable free-roaming eland population could be established. Very low mortality levels through the detection records of carcases of eland could also not explain the decreasing population trend; this means that the disappearance of the translocated eland individuals could be explained by factors other than mortality.

Due to a high post-release dispersal among translocated species, many populations may also fail to establish or select a suitable habitat (Le Gouar et al. 2013). Spontaneous dispersal of eland species individuals from the release site after translocation was revealed by the negative trend in abundance. Also the results from the aerial survey of 2004 that showed congregations of eland along the borders of the conservancy long distance from the release site coupled with non-detection of free-roaming eland individuals in the conservancy from the aerial survey of 2013. In the absence of movement data to understand the movement of translocated species beyond the conservancy, it could be speculated that eland that were translocated to the Nyae Nyae conservancy must have moved to the neighbouring Khaudum Game Reserve, as there was no fence between the conservancy and the game reserve. Interactions with humans and other anthropogenic activities have the potential to cause disturbances to species that, in turn, cause the species to move away from such disturbances (Waltert et al. 2009). Wildlife in community-based conservation areas located close to national parks tend to move to these protected areas in the buffer area or they enter the park in the absence of fences, especially when they are threatened by human activities (Kiffner et al. 2014). Eland have been documented as moving from areas of potential threat or disturbance, and are also known to travel long distances (Harris et al. 2009), also known as the 'trek' (Shortridge 1934). For example, extensive movements of eland individuals across landscapes were documented in the Kalahari savannah of Botswana and South Africa during 1985 – 1988 (Skinner & Chimimba 2005).

The main and novel conclusion from this section is that the released numbers only contributed to translocation success of the springbok and not the eland. The increasing trends in abundance and breeding, as well as normal dispersal from the release site to occupy a naturally selected habitat in the conservancy, were indicators of translocation success. In the case of the eland, a spontaneous dispersal pattern among eland individuals after translocation, coupled with low breeding and mortality levels, is linked to the disappearance of eland from the conservation, which contributed to the unsuccessful translocation outcome of the species.

5.3 Population structure and diet composition of the springbok and eland population

5.3.1 Age, sex and social structures of the eland and springbok

Part of this section provides an analysis of springbok individuals that were directly observed in the Nyae Nyae conservancy as part of the successful re-introduction story. Springbok individuals were assessed along the pans, and were found assembled in different social groupings. The different social groups in which the springbok individuals occurred comprised the solitary (23%), bachelor (5%), mixed (61%) and nursery (11%) groups; the dominance of mixed groups has been found to be a common characteristic of springbok populations elsewhere (Bigalke 1972; Cain III et al. 2008). Social grouping is an important characteristic for the springbok when fulfilling the ecological roles of the species in terms of breeding, foraging, predator avoidance, as well as defending territory and contributing to the integrity of the habitat (Reid 2005; Stapelberg et al. 2008). Congregating in larger mixed groups has been found to be important for the springbok species, particularly when they have been newly translocated to an area, for the reason that it provides protection against predators and also identification of suitable forage (Reid 2005). Juveniles and sub-adults are important for the viability of any population and their survival is very important; this may be why they are mainly found in larger groups since they are found to be less vigilant than the adults (Skinner & Chimimba, 2005). Nursery groups also congregate in larger groups to be able to move more frequently in order to identify nutritional food resources for the juveniles (Reid, 2005).

The results of this study also revealed that the age and sex structure of the springbok were comparable to springbok populations in other habitats of Namibia and South Africa (Stapelberg et al. 2008), despite being newly re-introduced to this area. Although the composition of age classes in the different sizes of groups did not differ significantly, the presence of the adult segment of the population was more prominent, as almost every group consisted of at least one adult individual. There was no particular evidence of any specific sex dominance in the springbok population studied in Nyae Nyae conservancy; however, nursery groups were dominated by females while bachelor groups were predominantly male. Similarly, previous studies found no specific sex dominance with the springbok population they studied (Kruger et al. 2005; Bigalke 1972). The presence of groups consisting of sub-adults (21%) and juveniles (4%) in nursery and mixed groups is evidence of reproduction among the springbok and this concurs with the long-term data recorded in the conservancy. The ability of any re-introduced species to reproduce in a specific habitat through the indication of juveniles and sub-adults in springbok herds implies that the species is persisting in the new habitat (Weeks et al. 2011). It has also been found in other studies that springbok prefer to move in larger, mixed groups to provide opportunities for courtship and mate selection (Reid 2005).

The eland formed part of a different translocation programme but were currently found in the confinement of the Buffalo Camp in the Nyae Nyae conservancy as no eland were detected free-roaming in the conservancy. The eland, being a gregarious species, were also expected to be found in different social groups (Hillman 1987; Skinner & Chimimba 2005). The eland that were detected in the camp in this study were observed in smaller groups ranging between one to eight individuals. In general, the social grouping of eland species varies, although this depends mainly on the habitat and size of the populations (Skinner & Chimimba 2005). In other studies, eland were found in larger groups of more than ten individuals on freehold, commercial, farm ranches in Namibia (Mattiello et al. 2004), and even up to 700 per group in larger national parks like the Hwange National Park in Zimbabwe (Skinner & Chimimba 2005). These smaller groups among the eland in the Buffalo Camp of the Nyae Nyae conservancy could be due to the small size of the eland population in the camp, or it could be a strategy to avoid predators because, in general, smaller groups are said to have a better chance to hide in thick woodlands (Mattiello et al. 2004; Underwood 1981). The eland also tend to break up into smaller groups to form manageable nursery groups during and after the calving season (Skinner & Chimimba 2005) which was when this study was carried out.

Furthermore, this study found that eland individuals mostly congregated in mixed and female-only groups comprising only adults and sub-adults with no juveniles detected. Some of the sub-adults in the female-only groups had just graduated from the juvenile stage. It was revealed in the literature that eland had a tendency to hide their calves when visiting water points to avoid attacks on their young (Underwood 1981). However, this behaviour could put eland calves in vulnerable situations as predators may still find them in the hiding places (Peters, 2014, per comm. WWF Namibia). The calving period of eland is normally from August to October and females start forming nursery groups (Skinner & Chimimba, 2005) which, in this study, was referred to as female-only groups because only sub-adults were accompanying the females. A social grouping is also an important activity for the survival of the species in terms of forage seeking and predator avoidance. It has also been indicated in the literature that eland characteristically form a great array of social groupings, depending on the prevailing habitat conditions (Skinner & Chimimba 2005).

5.3.2 Activities and diet composition of springbok and eland

The use of habitat by any species can be assessed through those activities in which the species engage. These are, but not limited to, playing, fighting, feeding, resting, drinking water and also licking minerals (Reid 2005), and that could be determining the interaction of a particular species with the habitat to which they have been translocated. In this study, the dominant activity in which the springbok engaged was mainly grazing, followed by licking salts from the dried-up pans and being vigilant. These activities were also observed among springbok populations in other studies in South Africa and Botswana (Reid 2005; Milton et al. 1992; Stapelberg 2007). Activity patterns not only display the use of the habitat by the species (Reid 2005), but also provide an in-depth understanding of the integration of the species individuals into a species habitat to allow the long-term persistence and viability of the species in the said habitat (Armstrong & Seddon 2007; Seddon et al. 2013). The springbok mainly preferred the habitats along the pans for succulent feed, mineralised water and licks, which were vital for their diets (Milton et al. 1992).

Eland were mainly photographed drinking water or standing around water points. Although this method did not give a broad spectrum of the use of the habitat by eland, it provided important data on the presence and drinking pattern of the specie,s as drinking behaviour among eland is of ecological importance for the survival of the species. The results showed that the present eland individuals in the Buffalo Camp mainly visited water points in the evenings, at night and in the early morning hours. This could be explained by the fact that eland generally are diurnal as they spend their day resting, and become active for feeding and drinking water during the early morning hours and late afternoon (Hillman 1988; Skinner & Chimimba 2005; Watson & Owen-Smith 2000). The visiting patterns of the eland to water points in the Buffalo Camp confirmed the usual drinking behaviour of the eland, as was found in earlier studies in Zimbabwe (Weir & Davison 1965) and Namibia (du Preez & Grobler 1977) who classified eland as night and morning drinkers. Eland do not drink regularly and in most cases visit water points in groups, being cautious to avoid predators (Furstenburg 2016).

Both springbok and eland are regarded as highly adaptable species in a wide range of habitats. They are classified as selective, intermediate, mixed feeders (Cain III et al. 2004; Roodt 2011; Skinner & Chimimba 2005; Stapelberg 2007). This study found similar trends, with springbok individuals feeding on herbs, grass, forbs, succulent vegetation and the leaves of shrubs. Springbok foraged mainly on perennial grass species (*O. paucinervis*) as it was the dominant species along the Nyae Nyae Pans; they particularly, utilised the succulent roots of these plant species. Utilising different parts of different plant species has been identified as an important strategy among the springbok to obtain their nutritional requirements from the available food resources in the habitat (Skinner & Chimimba 2005; Stapelberg et al. 2008). As springbok are less water-dependent, they obtain extra moisture from the roots to supplement their body water content (Stapelberg et al. 2008). Feeding behaviours and patterns are dictated by the local environment of the habitat due to the ability of the species to adapt to a wide range of habitats in the savannah and grasslands of southern Africa. In Namibia, springbok in the dry Kunene region have been found to browse mainly on the leaves of shrubs and on sprouts, since the choice of feed by the species is dependent on the habitat they occupy (Lehmann et al. 2013). This adaptable nature of springbok could explain the translocation success after re-introduction to the Nyae Nyae conservancy.

Vegetation consumed by eland in the Buffalo Camp as identified by rangers consisted mainly of grass, forbs, shrub and tree foliage. These classes of food resources are similar to those indicated in studies on South African wildlife habitats (D'Ammando et al. 2015; Underwood 1981; Watson & Owen-Smith 2000). Eland are classified as mainly browsers, although grazing has also been classified as part of their diets where they were found grazing on sprouting grass species during the wet seasons (Watson & Owen-Smith 2000). An element of selective feeding among the eland has been attributed to the intake of high nutritious, value food, mainly to allow for the maintenance of their large bodies (D'Ammando et al. 2015; Jessen et al. 2004). Not observing eland feeding directly has limited this study, as it is difficult to point out the most preferred vegetation species for the eland found in the Buffalo Camp.

Although the eland population studied was not part of a free-roaming population, this study showed that the eland in the Buffalo Camp had developed survival strategies, such as usual social structures, drinking and feeding patterns, which are crucial for any viable population. Although the non-detection of juveniles in the observed groups is of great concern, it does not necessarily mean that there was a failure in reproduction, as sub-adults also represented a younger segment of the population. Similarly, the current springbok population in the conservancy proved to be viable, as most of the observed social structures, social activity and feeding patterns were comparable to springbok in other habitats.

5.4 Factors influencing the translocation outcomes of the springbok and eland

The effect of a range of habitat factors on wildlife populations have been at the centre of the declining population paradigm, mainly looking at the drivers of extinction of the species (Boyce 2002; Brook et al. 2008; Caughley 1994). In applying this theory, the analysis of the results focused on investigating the ability of the identified factors to cause decline or any negative effects on the translocated species. The results show that while the natural habitat for wildlife in the conservancy was in a fair condition, the effects of anthropogenic activities in the conservancy habitat were rather problematic. Activities, such as poaching, human settlements and associated activities were perceived by residents to have potential repercussions on the establishment of translocated species in the Nyae Nyae conservancy. The interviews revealed that conservancy members used the forest area in the conservancy to harvest natural products and also for hunting. Such interactions may result in different impacts on translocated and other resident species. Both habitat (including both biotic and abiotic factors), as well as those anthropogenic factors, can alter the integrity of the ecological communities of habitats that can potentially affect species and, subsequently, lead to declines in wildlife populations (Brook et al. 2008). Most human interaction with the environment involves activities that aim at contributing to human livelihood, and sometimes this can have a negative effect on the state of habitats on which wildlife populations depend, or affect the wildlife populations directly (Hayes & Hayes 2013). However, human interaction with habitats and wildlife populations in community-based conservation initiatives are inevitable (Berkes 2004; Hoole & Berkes 2010).

There is historical and current evidence to suggest that where there are free-roaming eland populations in Namibia, South Africa and Tanzania, the population experiences decline due to human activities (Jessen et al. 2004; Harris et al. 2009; Waltert et al. 2009; Watson & Owen-Smith 2000; Underwood 1981). Human activities, such as hunting, various forms of interaction and also cultural belief systems, have the ability to affect wildlife populations despite the suitability to the habitat (Harris et al. 2009; Owen-Smith & Mason 2005). Cultural practices in most San inhabited communities of Southern Africa have been connected to the hunting and use of some antelope species, including the eland, and have the potential to disrupt the species population, particularly in recent habitats that are highly fragmented (Lewis-Williams & Biesele 1978).

Human disturbances can contribute to the substantial decline of some species, mainly through disruption of their natural activities, such as breeding, foraging and the like (Bolger et al. 2008). Respondents also pointed out the importance of the eland species to their culture and that they preferred eland meat as part of their diet. Although the inhabitants of the conservancy did not see the preference of eland over other species to be negative, stakeholders tagged this line of belief to have affected the eland negatively. There is a historical connection between eland and the San communities in Namibia, Botswana and South Africa (Lewis-Williams & Biesele 1978); however, there is no evidence in the literature to show the effect of this cultural connection to the performance of the species. However, while noting the importance of eland meat to local diets, it is also important to emphasise the sensitivity of eland to human activities (Bolger et al. 2008). The density of eland has decreased in different parts of southern and eastern Africa due to overexploitation, poaching and other human activities (Bolger et al. 2008; Jessen et al. 2004; Waltert et al. 2009).

The outcomes of the interviews with different respondents revealed that eland were mainly affected by settlements and human activity because of their historic connection to the residents of the Nyae Nyae conservancy. The culture of the San people of southern Africa, including residents of the Nyae Nyae conservancy, has been linked to the species (Biesele 1978; Lewis-Williams & Biesele 1978; Lewis-Williams 1997; Wiessner 1983). The eland has also been referred to as the unifying symbol of the San culture (Lewis-Williams 1997; Wiessner 1983). The relationship between the eland and San culture was mainly illustrated through the importance of the eland for hunting, central to most ceremonies, use of different animal parts and also its importance in medicinal uses (Lewis-Williams & Biesele 1978). In addition to cultural connections, the Nyae Nyae conservancy was also identified as the home range area for eland as indicated in the earlier work of Van Der Walt (1989) but the eland were found to have declined from the area at the establishment of the conservancy (Weaver & Skyer 2003). The evidence of decline of a species after the efforts of translocation suggests that free-roaming animals are susceptible to some form of disturbance, such as human activities.

Conversely, the interaction of springbok with settlements and community members seemed to have less of an impact on this species for two reasons. The springbok was re-introduced to the area, after having disappeared for a long time from these areas, and most responses could relate to any previous interaction before re-introduction and, hence, fewer cultural connections to community members. Another reason is that the species moved away from settlements towards the pan areas, resulting in less frequent interactions with the residents, displaying a normal dispersal level which led to establishment. However, respondents did not see farming activities as having any influence on this translocated species because they were not common activities in the conservancy. Therefore, the results in the present study on the effect of human interaction, in terms of settlements and farming, on the springbok appear to have minimal potential to threaten the springbok population.

Other habitat factors, such as range condition, water resources and predators, were also said to have little or no effect on the two translocated species. Residents of the Nyae Nyae conservancy have a long history of dependence on forest products through gathering of veld products, and these practices did not necessarily lead to any habitat loss (Biesele & Hitchcock 2013; Weissner 2004). Respondents indicated that the translocated species were not affected by the condition of the vegetation in the conservancy, indicating that the vegetation was still in good condition to support the present wildlife. In support of this view, the results of the mapping of land-cover changes showed a nominal change in vegetation cover over the past 5 years (between

2009 and 2014), with little sign of land degradation in terms of bare ground. One distinct change noticed between 2009 and 2014 was the reduction in woodland and grassland, resulting in an increase in shrub land. On the other hand, the presence of different vegetation classes and species diversity provided diverse habitats and foraging opportunities to support translocated species, although regular monitoring of habitat-use patterns is important to sustain such forage (Owen-Smith 2003). Availability of food for wildlife through suitable vegetation is an important factor that can contribute to the persistence of translocated species in a new area (Armstrong & Seddon 2007).

The changes in vegetation structures could be related to the connectivity between the use of habitat and climatic conditions. For example, this study clearly showed that during years of poor rainfall, large herds of animals congregated at the few artificial water points as other water sources had dried-up since drought had been frequent in this area. This was particularly true for the water-point count results of 2013 that showed the highest sightings of species at some water points. Wildlife and livestock congregating around artificial water points is a common phenomenon in arid habitats, mainly during droughts, and this is particularly true for water-dependent species (De Leeuw et al. 2001). This can lead to reduced vegetation cover and loss of the productivity of the habitat (De Leeuw et al. 2001). This study found occurrences of bush encroachment, and this is mainly caused by a combination of anthropogenic and natural factors, such as overgrazing and browsing, frequent fires, human settlements and variable rainfall (Roques et al. 2001). This is an important diagnosis through the results of this present study that, although vegetation loss occurred over the years through the increase of bare soils, it was not a threat in the Nyae Nyae conservancy; loss in vegetation productivity through bush encroachment is of great concern as it has the potential of reducing the carrying capacity of the area which causes the negatively affected persistence of translocated species. Bush encroachment in savannah landscapes has been widely studied, and has the ability to reduce the productivity and carrying capacity of the landscape (De Leeuw et al. 2001; Kraaij & Milton 2006; Roques, et al. 2001).

An ungulate population would usually develop strategies to protect itself against predators by avoiding areas of high-risk (Crosmary et al. 2012; Thaker et al. 2011). In this study, the results showed low levels of predation, despite the presence of several predator species, including spotted and brown hyena, wild dogs, leopard, lion, cheetah, caracal and jackal, found in the conservancy. Although during the survey the residents indicated that predation had little or no effect on the translocated species, during interviews respondents linked predation to the establishment of the translocated species, fearing that predators might interrupt their process of establishing themselves into the new area. One of the common characteristics of an ungulate population is to develop natural predator avoidance behaviours (Griffin, Blumstein & Evans 2000; Skinner & Chimimba 2005); however, this requires knowledge of the habitat through long-term interaction with a particular area, which is not the case with newly translocated individuals (Griffin et al. 2000). The absence of such anti-predator behaviour leads to sporadic fright responses that may affect the population structures negatively or cause severe injuries or fatalities among the translocated individuals (Engeman, Constantin, Gruver & Rossi 2009). In addition, the conservancy data also revealed that the conservancy implemented a predator control programme that removed some predators from the conservancy to reduce the impact of predation on the ungulate species. The results of this study also show that the majority of mortalities recorded for the eland and springbok were caused by predation and only a few mortality cases were recorded, denoting the low impact of predation on the two translocated species.

The distribution and availability of water resources were viewed by respondents as having little or no effect on the translocated species, as water points were well distributed across the conservancy. The conservancy is mainly dominated by artificial water points drawn from underground water sources through boreholes and is indicated as an efficient water supply in dry environments, such as Namibia (Epaphras et al. 2008). Although the long-term data from the water-point and event-book counts reflected the distribution of the wildlife species in the conservancy, the aerial surveys revealed the presence of species that were not reflected in these counts because they were at the periphery of the conservancies, beyond the reach of rangers. Adequate water resources in any conservation area are important habitat factors as they have the ability to retain wildlife species within the habitat. During droughts, most ungulates migrate to other habitats in search of water and forage (Verlinden 1998). Consequently, the results showed that well-distributed water sources in the conservancy have contributed to the retention of many wildlife species; however, the effect of water distribution on the eland could be argued to be that some water points utilised by wildlife were based at villages.

Southern African savannahs are prone to veld fires because of the dry climate which causes damage to wildlife habitats and other resources (Dube 2015). Fire has direct effects on vegetation in terms of forage quantity, quality and species composition (Roques et al. 2001). This, in a way, affects ungulate species due to their high dependency on the habitat resources for food, reproduction and general survival (Mattiello et al. 2004). Although the Nyae Nyae conservancy is prone to veld fires where fires occur almost every year, only a small proportion of the area is frequently affected by fires, like burning consecutively for six years (see Fig. 36). Frequent fires have been reported to have the ability to reduce the heterogeneity of the vegetation which, in turn, lowers the productivity, resulting in wildlife struggling to find quality forage in several national parks in southern Africa (Carruthers 2007). Under normal circumstances, residents in this conservancy light fires during hunting or for other forest uses carried out by residents and should only cover small patches. However, the views of the key-informants during the interviews were that the use of fire had increased because the residents were using the forest throughout the year, and when burning occurred during the dry season, fires could become uncontrollable and difficult to contain. Similar to the outcomes of this study, many African societies use veld fires as a traditional, African, habitat management tool to manage the vegetation structure and also as part of hunting activities, with limited destruction to the environment (Nyamadzawo et al. 2013). Generally, there was narrow association between the occurrence of fires and the establishment of translocated animals due to the patchy occurrence of fires in the conservancy.

Although the most habitat factors emerged to have limited effect on the translocated species, human activities stood out as a contributing factor to the failure of the translocation of the eland. Both the habitat and anthropogenic factors did not appear to have any negative influence on the translocation success of the springbok in the conservancy. The discussions under this section provide a diagnostic scrutiny of the different factors to assist in providing management direction in order to avoid future failure, and to promote continuance for established translocated species.

5.5 The effects of the levels and hunting types on translocated species

The primary purpose of the development of CBNRM approaches was to allow wildlife management not only to focus on biodiversity conservation, but also contribute to the socio-economic needs of those involved in conservation management (Bandyopadhyay et al. 2010; Lendelvo et al. 2012; Suich 2013b). Hunting is a form of extraction of wildlife resources with both ecological and economic benefits, and sustainable hunting can contribute to the welfare of local communities in community-based conservation (Barnes et al. 2002; Lindsey et al. 2013). Hunting can also be regarded as an important conservation approach in regulating ungulate populations and maintaining biodiversity (García-Marmolejo et al. 2015). As a result, ungulates are regulated through the determination of sustainable yields by quota setting to ensure that the extraction of wildlife does not reduce the wildlife base of an area (Du Toit 2002). Predators, in most cases, are regulated in community-based conservation areas because they may not only hunt wildlife, but also cause damage to the residents, a practice that may cause ungulates to increase in the area. The views of the respondents and long-term monitoring data were in agreement that different species were hunted in the conservancy either for subsistence or commercial purposes (see Fig. 40).

Most of the species, including those supplemented by translocation, have been hunted for both subsistence and commercial purposes. One of the reasons for boosting species numbers through translocation in the conservancy was to increase the hunting potential as the species build up over time (Cabezas & Moreno 2007; Weaver & Skyer 2003); however, the present study revealed an overall, significant decline in numbers hunted for trophies (χ^2 =97.48; df=75; p=0.042), and no change for species hunted for subsistence (χ^2=28.70; df=24; p=0.232). Furthermore, more species supplemented by translocation in the Nyae Nyae conservancy were hunted for subsistence than for trophies, while those with stable trends in population sizes were likely to be targeted more for hunting. Generally in Namibia, fewer wildlife are hunted for their trophies than for the provision of meat (Van Schalkwyk et al. 2010). Species, such as kudu, oryx, blue wildebeest and springbok, are among the most abundant species in Namibia, and play an important role in the provision of game meat in the country (Van Schalkwyk et al. 2010).

In terms of the two species of focus in this study, there was a positive relationship between translocation outcomes and levels of hunting. While the eland, showing a declining trend, was hardly ever hunted legally, the springbok was targeted for hunting for both trophy and subsistence purposes. The springbok has demonstrated to be an example of successful translocation for this conservancy, as the species was able to re-establish itself and produce a stable population ready for hunting within five years after translocation.

Although eland had been allocated a hunting quota, community members indicated that they were not allowed to hunt eland, and none of the households claimed to have hunted eland during 2013 and 2014. This study, however, could not conclusively confirm the numbers of legally and illegally hunted eland individuals by residents, but one could not separate the effect of hunting on the declining numbers in the conservancy, based on the preference for this species by the locals. The density of species, such as eland, was reported to have been severely affected by overhunting and poaching in Tanzania (Waltert et al. 2009). In addition, it was also found that some ungulate species were more disturbance-intolerant than others, especially human disturbances (García-Marmolejo et al. 2015). The eland, being a sensitive species to human activity, are likely to travel long distances away from disturbances, reducing the opportunity for community members to benefit from them (Verlinden 1998; Harris et al. 2009). The fright response causes species to disperse further away from the disturbance, and is one of the major causes of high dispersal rates among species (Crosmary et al. 2012). In the context of this study, attempts to hunt the eland could have resulted in the species fleeing from such interactions to habitats farther away.

Monitoring of hunted animals, particularly to ensure that the hunting does not exceed quota levels, is crucial in maintaining sustainable hunting in conservation areas (Du Toit 2002). Although monitoring mechanisms for all hunting methods existed in the conservancy, monitoring of hunting by local hunters emerged to be complex and difficult. This complexity in monitoring local hunters was mainly contributed to the historical and livelihood realities of the residents of the Nyae Nyae conservancy, as hunting formed part of the cultural and livelihood activities practised by most household (Biesele & Hitchcock 2013; Suzman 2001). When hunting is not properly monitored, it is likely to affect all wildlife species, particularly the translocated species, in terms of a reduction in population size or causing disruption to their dispersal patterns (Bolger et al. 2008; Newmark & Hough 2000).

According to the declining population paradigm, one of the contributing factors regarding the declining numbers is the over-exploitation of resources (Caughley 1994; Skinner & Chimimba 2005). Illegal hunting is a major threat to conservation efforts in many parts of Africa (Theuerkauf & Rouys 2008). The residents in the Nyae Nyae conservancy argued that poaching could potentially affect the translocated species negatively since it is an untargeted disruptive exercise. Poaching in the Nyae Nyae conservancy was a serious problem as a total of 82 cases were recorded over the period of 1999 – 2014; however, it did decline over these years as far as species, such as guinea fowl, warthog, dik-dik, steenbok and several birds, were concerned. Very few instances of poaching involved translocated species, such as the giraffe and eland, and these led to two arrests in 2010 and 2014. Nevertheless, there was a reluctance by community members to share their views about poaching and illegal hunting willingly, and perhaps this was due to fear of prosecution if found guilty. The conservancy residents were allowed to hunt, but hunting by using traditional hunting weapons (the bow and arrow) and targeting non-huntable species or animals of prohibited sizes or sexes, that contravened the guidelines of the conservancy, were considered poaching. Beside reducing population numbers, inappropriate or illegal hunting was also documented as a form of disturbance to the wildlife population, as it could disrupt normal activities or cause adjustments to the behaviour of species, such as shifting habitats or a decrease in mating opportunities (Crosmary et al. 2012; Waltert et al. 2009;). In many cases, this happened due to the non-adherence to, or absence of, control measures that stipulated restrictions, such as sex, age or pregnant animals, in the permitted hunting periods. It also included hunting zones, requirements, methods, as well as individual species that were allowed to be hunted (Lindsey et al. 2006, 2013).

The evidence of hunting of wildlife species, particularly the translocated species, is an important result, reflecting the important contribution of translocation to sustainable conservation efforts by locally-based institutions. However, the results of this study continue to highlight the complexity in monitoring subsistence hunting carried out by the residents, especially due to the fact that hunting is an integral part of local livelihoods.

This chapter discussed the results of the data collected for this study. The final chapter of this dissertation will present conclusions and recommendations drawn from the collected data.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusions derived from the results that were discussed in Chapter 5. It will elaborate the major outcomes and inadequacies under the different objectives of the study.

The study has shown that the Nyae Nyae conservancy is home to a diversity of wildlife species, with an overall increasing trend in abundance over the years. In addition, there appeared to be a relatively high diversity of wildlife species in the conservancy; however, a decline over the years was detected, mainly due to changes in the relative abundance of individuals of certain species and not necessarily in species richness, as the composition of the wildlife species in the Nyae Nyae conservancy remained more or less constant over the years.

Although translocation has proven to be contributing positively to the trends in abundance at species level, the overall translocated numbers of wildlife species in the conservancy did not influence the overall trends statistically. Released numbers of re-introduced species influenced the translocation outcomes of these species positively, as all re-introduced species managed to be established after translocation and they continued to show increasing trends in abundance over the years. Furthermore, the size of the founder population also played an important role in the translocation outcomes of the augmented species. Species with larger founding populations at translocation continued to displayed positive trends in abundance over the years, while species that had a low founding population continued to show declining trends over the years.

The water-point count data were the major source of information for the analysis of trends and, although the outcomes were found to be strongly related to the event-book data, the GLM revealed a positive association between trends of water-dependent species and the overall trend for all the wildlife species in the conservancy. However, one of the major outcomes of this study was the use of an interdisciplinary, mixed-methods approach which allowed a better understanding regarding the broader picture of wildlife trends and performance in the conservancy.

The translocation outcomes of the two focus species, the springbok and eland, were different. While the released numbers of springbok contributed to a positive trend of the species over the years, thereby leading to translocation success, the released and founding numbers of the eland failed to contribute to the establishment of an eland population in the conservancy. In addition, the positive growth of sub-adult and juveniles of the springbok over the years was also a sign of the growth and good performance of this species. The continued detection of springbok after translocation in the southern part of the conservancy along the pans is a reflection of the species having identified a suitable habitat; this confirms literature reviewed in this study that claims that habitats along pans are preferred habitats for springbok in southern Africa. In the case of the eland, there was little evidence of mortality and breeding cases recorded, which could mean that the translocated individuals did not settle in the area, which would have enabled reproduction. Although the free-roaming eland individuals were last detected in 2005, there were continued sightings of eland, consisting of a group that was translocated under a different programme in 1994 in the Buffalo Camp.

The analysis of the data regarding the present springbok population in the conservancy indicates that it comprised individuals belonging to the translocation programme, because there were no springbok at the time of translocation. The outcomes of the camera trapping at water points outside the Buffalo Camp were in line with annual water-point counts, showing limited detection of eland outside the camp. The study concluded that the current populations of both species comprised normal age, sex and social structures that were comparable with similar species found in other habitats.

The normal structures associated with social activities and diets aligned to the current habitats are clear indicators of the adaptation of the species to their current habitat. Both species were mixed feeders, based on the identified diet, but springbok were found to be mostly grazing while more shrub and tree foliage were identified for the eland. Therefore, the presence of springbok in a naturally selected habitat after re-introduction and the engagement of the species individuals in different activities also reflected the translocation success of the species. On the other hand, the persistence of the eland in the Buffalo Camp over the years reflects the species' ability to adapt to the Nyae Nyae habitat but under strict protection. Although this is not enough to generate the conclusion that the entire conservancy habitat was suitable for eland, ample literature and the WTA results show that the Nyae Nyae conservancy was a suitable habitat for eland.

The Nyae Nyae landscape was described by various scholars in the reviewed literature, as well as the residents and stakeholders in this study, as being ideally a suitable habitat for eland. The literature and interviews also described the residents in this conservancy as having strong connections with the eland species, as well as a high preference for the meat and other products of the eland. From the study it is clear that human activities, such as settlement, hunting and the use of forest areas, were identified as being strongly linked to the disappearance of free-roaming eland from the conservancy. However, the causes of the failure to establish the eland were complex and hard to define because, while counts indicated that the eland were not spotted, there was no particular evidence of mortality or hunting of the species by the local people. As a result, they could have dispersed to the outskirts of the conservancy, as reflected by the aerial survey, or to neighbouring areas. Furthermore, the present eland could have just been hard to find during the counts, as was experienced in the Buffalo Camp where the presence of the species was only monitored by means of camera trapping rather than physical observations. The eland could also have been over-harvested and people might have been careful to hide any evidence of hunting from game rangers and village heads, fearing prosecution, as residents confirmed during interviews that they preferred eland meat to that of all other wildlife species and that they were not allowed to hunt eland.

The different translocation outcomes of the two species display different forms of the contribution of translocation to wildlife conservation in the country. There was limited proof of eland mortality in the Nyae Nyae conservancy and the visible evidence of migration from the aerial surveys could mean that the translocated eland moved to other conservation areas. As a result, although the translocation of eland had not directly benefited the Nyae Nyae conservancy, it would seem to have benefited the surrounding areas, thereby continuing to maintain the Namibian eland population.

Conversely, the translocation of springbok benefited the Nyae Nyae conservancy by contributing direct benefits to the community, which will contribute to the national objective of community-based, conservation programmes. The limited interaction between springbok and human activities, such as hunting and settlements, could not be attributed to distance alone, but also to the absence of a historical connection between this species and the residents.

Species supplemented by translocation and showing increasing trends in abundance over the years are also likely to show high hunted levels. The stable utilisation of springbok through hunting in the conservancy reflects the contribution of translocation to hunting in the conservancy. However, the eland did not show any positive prospects for hunting after translocation, because the species continued to show a negative trend in its population size over the years. The Nyae Nyae conservancy has proven to have measures in place that monitored hunting for both commercial and subsistence purposes. Although, it clearly emerged from the analysis that commercial hunting was monitored smoothly, there appeared to be uncertainties and unreliability in the monitoring of hunting for own use by local hunters. Although this study could not establish the exact influence of the weaknesses in the monitoring of local hunters on the species, such as the declining numbers of eland, there was a strong belief that a lack of appropriate monitoring mechanisms for local hunters could lead to unsustainable hunting. If not properly dealt with in the conservancy, the lack of proper monitoring measures could also continue to exacerbate the current, high levels of poaching in the conservancy which could pose a threat to wildlife conservation, as well as to the success of translocation in future.

Therefore, this study generated fundamental evidence of translocation outcomes of wildlife species in communal conservancies that will assist future translocation programmes in Namibia. The key message from this study is that the success of translocation in communal areas is possible but requires species specific monitoring and management approaches.

Recommendations:

- The Nyae Nyae conservancy has proven to be among the Namibian, communal conservancies that consistently implemented a combination of wildlife monitoring systems; however, there is a need to develop monitoring systems that are specific for translocated species, such as collaring and other non-invasive methods to understand the species performance while they are in the process of stabilising to the conditions of the new habitat. Early detection of threats could assist in developing measures to minimise translocation failure.

- Future eland translocated to the area should be investigated thoroughly to reduce human impacts to enable communities to derive benefits from the species or more specifically placed under confinement.
- There is a need to enforce a hunting season or designated hunting periods and zones, as well as permit systems for local hunters in the conservancy, to control hunting for own-use more effectively to ensure the sustainable utilisation of wildlife resources.
- Vigorous education programmes for communities should be instituted to create awareness of ways to improve the success of translocation, thereby limiting negative interaction between humans and wildlife.
- Despite showing a positive trend, continued monitoring of the performance of the springbok is necessary to ensure the long-term persistence of the species in the conservancy.
- There is a need to conduct in-depth species-specific biological assessments, understand population viability, habitat size and use, as well as direct threats on the translocated species in the conservancies.

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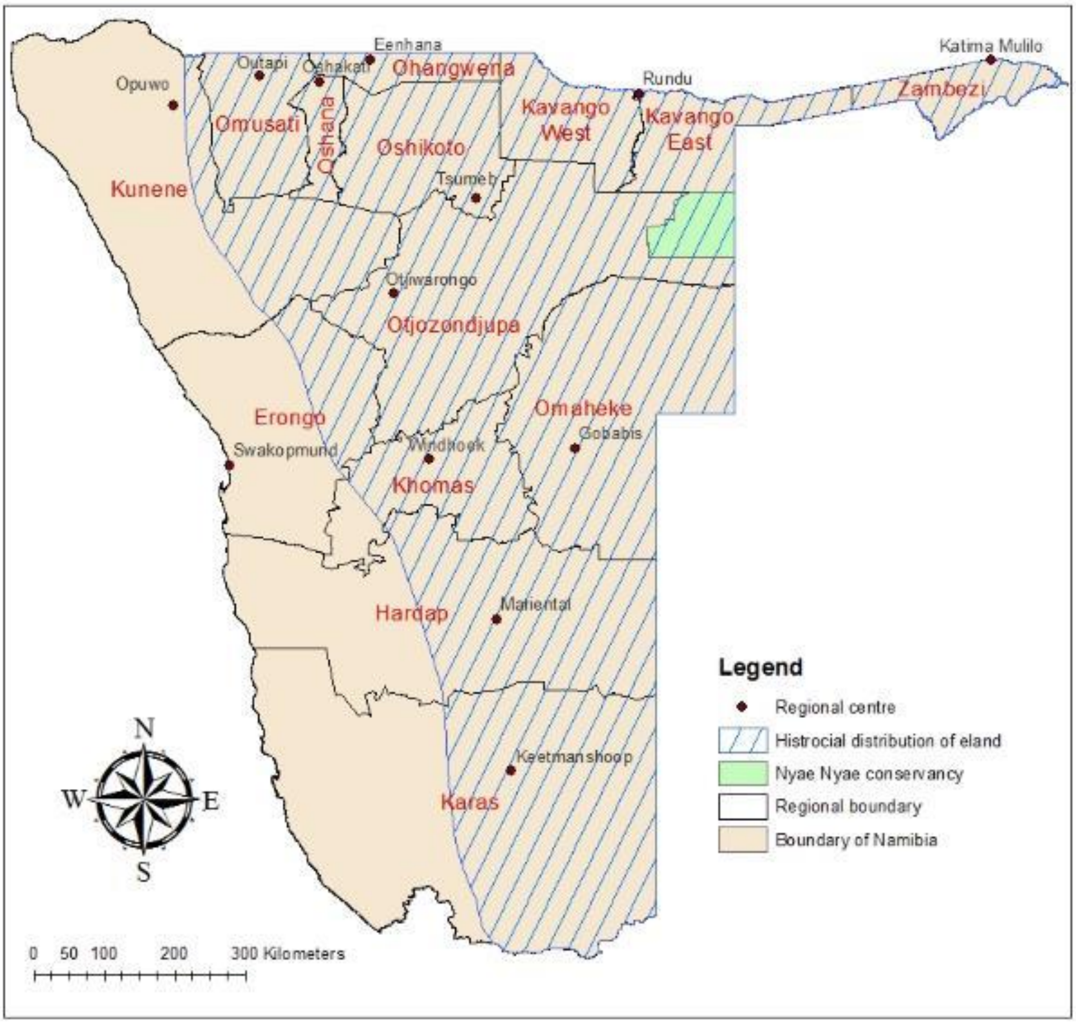
APPENDIX 1: Description of the study species and translocation numbers

(a) Eland *(Taurotragus oryx)*

The eland can be identified by its tan coloured coat with spiral horns that are characteristic of its tribe, Tragelaphini. The eland is one of the largest antelopes in Africa weighing up to a 600 kg (Roodt, 2011; Stuart & Stuart, 2014). Its range of occurrence is around the Eastern and Southern African savannahs and grasslands in about six countries, namely, Namibia, Botswana, Zimbabwe, South Africa, Malawi and possibly Tanzania (Stuart & Stuart, 2014). The eland populations were heavily affected in some parts of these areas where it originally occurred due to wars and competitive land uses such as agriculture, but the species continued to maintain a wide range in the sub-regions of Eastern and Southern Africa (Waltert et al., 2009). In Namibia, the natural range of eland is widespread but it has lower occurrence in desert regions (Brown, 2006; Shortridge, 1934).

As of 2008, total eland population in Southern Africa was estimated to be mainly distributed as follows: protected areas (50%), with some on private land (30%) and 20% in found outside the two mentioned category of land-use. However, population trends in protected areas vary, whilst on private land the population of eland is increasing and elsewhere decreasing (IUCN, 2016). Eland is classified by IUCN as of 'least concern' with a stable population trend. The justification of the IUCN ranking is based on the fact that it is expected that little changes are likely to occur in the management of the species in protected areas and private land (IUCN, 2016).

Eland is easily affected by any expansion of human settlements which could cause contraction in the distribution and free-roaming populations (Underwood, 1981; Verlinden, 1997; Waltert et al., 2009) The IUCN ranking indicates that the eland will be considered as 'conservation dependent' at some point which means that the existing population requires strict management strategies such as keeping the animals in protected areas, translocating them from unprotected areas and promoting ranching on private lands (IUCN, 2016). The species is still considered to be very adaptable and able to survive in a wide range of habitats such as savannah, woodland, montane grassland and semi-arid shrub land (Grange et al., 2012; Watson & Owen-Smith, 2000).The eland engage in seasonal movement patterns between habitats based on food availability but not following any particular roaming pattern (Harris et al., 2009; Verlinden, 1998)



Source: (Brown, 2006)

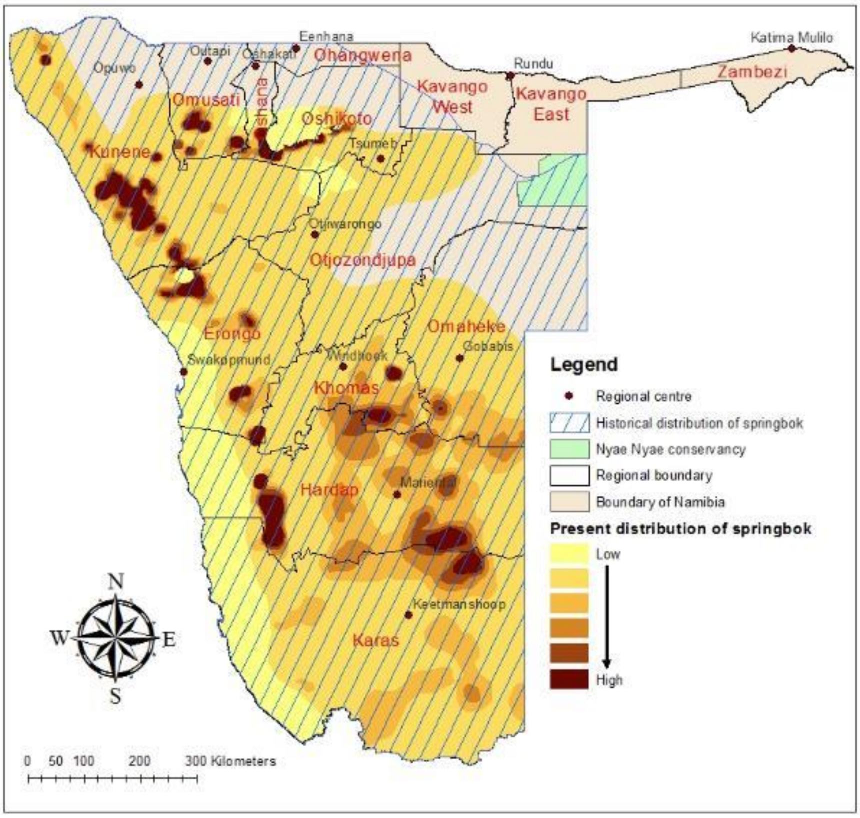
Figure 42: Historical distribution map for eland (Taurotragus oryx) in Namibia based on Shortridge, (1934) work.

Translocation of eland has been carried out since the early 1970s in South Africa and Namibia, originally being translocated mainly into National Parks to save the remaining population (Hofmeyr & Lenssen, 1975), although this success can be hindered by the presence of human disturbances. Translocation of the eland into four National parks in South Africa during the 1970s showed that the eland only failed to be successful in the Bontebok National Park. The Bontebok National Park is very small covering only about 2,700 ha with little woody vegetation and it was concluded the translocation failed because of the unsuitability of the habitat particularly the limited diversity. Another successful translocation case of eland was from Namibia where 85 elands from the farming areas of Mangetti farmlands were moved to the Waterberg Plateau Park in 1972 (Hofmeyr & Lenssen, 1975). Although this translocation was performed to save free-roaming eland populations in farmlands from overexploitation, the main criteria considered were the historic evidence that eland occurred there before and the presence of sound management practice to ensure survival of the translocated individuals.

(b) Springbok *(Antidorcas marsupialis)*

The springbok is a medium-sized antelope which is abundant in Namibia and other Southern African countries. It has a tan colour with black stripes across its sides and down its snout. The body mass of an adult springbok ranges approximately from 26 to 48 kg depending on location, with a female body mass normally being less than 45 kg (Stuart & Stuart, 2014).

The purpose of the translocation of springbok in Namibia and South Africa was mainly to improve the tourism and hunting industries rather than due to being threatened (NACSO, 2013; Novellie & Knight, 1994). According to the distribution map of springbok in Namibia, the Nyae Nyae conservancy area used to be historically inhabited by springbok and the species later disappeared from that area for reasons that seem to be unknown (Mendelsohn et al., 2002).



Source: (Brown, 2006)

Figure 43: Historical distribution and density map for springbok (Antidorcas marsupialis) in Namibia.

In addition to the springbok and eland, other species were also translocated into the conservancy and their founder and release numbers of all the translocated ungulate species in the Nyae Nyae conservancy between 1999 and 2005, are indicated in the Table below.

Common/ species name	**Founder numbers (MET 1998 Aerial Census)**	**Released numbers (1999 – 2008)**
1. Eland (*T. oryx*)	12	268
2. Kudu (*T. strepsiceros*)	283	360
3. Oryx (*O. gazelle*)	429	274
4. Red hartebeest (*A. buselaphus)*	18	541
5. Springbok *(A. marsupialis)*	0	633
6. Blue Wildebeest (*C. taurinus*)	204	116
7. Black Rhinoceros (*D. bicornis*)	0	6