

**AN ASSESSMENT OF THE MANAGEMENT STRATEGIES AND WILDLIFE
POPULATION TRENDS IN NAIROBI NATIONAL PARK**

BY:

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C50/62003/2013

**PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENT OF THE DEGREE OF MASTERS OF ENVIRONMENTAL
PLANNING AND MANAGEMENT, UNIVERSITY OF NAIROBI.**

SEPTEMBER 2016

DECLARATION

This research project is my original work, and has not been presented for a degree or any other award in any other university.

Signed..... Date.....

Kilaha Clara Maria

This research project has been submitted for examination with our approval as University Supervisors

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DEDICATION

Firstly I would love to thank the Most High for his continued Love, Strengthen during my journey. To my most beloved Family, the Kilaha's, who have always given me moral support, prayers and were there for me throughout my study. To my best friend E. Apeu-o, who has been God's most precious gift to me.

ACKNOWLEDGEMENT

The author wishes to take this opportunity to thank her Supervisors namely Dr. Thuita Thenya and Mr. N. M Ochanda for their invaluable support, encouragement and guidance throughout this study. The author also wishes to thank the Kenya Wildlife Service (KWS) family, Friends of Nairobi National Park (FoNNaP) members and key informants for their rich information, which made this study a success. More specifically, thanks go to Dr Samuel Kasiki (KWS Deputy Director- Biodiversity, research and planning department, Moses Lekishon Kenana (formerly KWS Senior Scientist- Southern Conservation Area), Wycliffe Mutero (KWS, GIS scientist), Jared Lumbasi (KWS Research scientist climate change Adaptation), Nelly Palmaris (Nairobi National Park Senior Warden), Thadeus Obari (KWS Research Authorization Officer), Dr. Francis Mwaura (University of Nairobi), Dr. Samuel Owuor (University of Nairobi), Aaliya (FoNNaP) and all those who assisted in one way or another. Many thanks to my colleagues and friends namely: Emmanuel, Shileche, Jasper, Diana, Claude, Bancy, Mercy and Ruth for their support, prayers and encouragements throughout this study.

ABSTRACT

There is a rising concern about the declining wildlife numbers in many protected areas in Africa. Nairobi National Park's unfenced southern area (Kitengela dispersal area) has over time undergone several modifications from an open, vast, communally possessed wet season grazing locale to heavily fragmented private property. The study aimed at analyzing selected large animal (Herbivore and Carnivore) trend numbers from 1970-2013, management techniques being employed by the park managers' overtime and the park's integrity.

Primary data was collected using questionnaires, key informant interviews and schedule observation. Secondary data sources were largely obtained from journal articles, published books, and other published and unpublished reports. Stratified random sampling and purposive sampling were used for sample selection. Both qualitative and quantitative data analysis methods were used. More specifically, descriptive statistics were used to summarise and interpret the findings. A multiple regression analysis was conducted to establish the relationship between the management techniques (Fencing, Maintenance of the Kitengela area, Translocation, Re-stocking, Prescribed burning) and the population numbers of wild animals

The study findings indicated that approximately 90% of the respondents indicated a change in the large animal population numbers and around 85% of the respondents claimed that the change was a decrease. Around 63% of the respondents mentioned that the management practices were conducted in accordance with the regulations in place, and the management techniques have not changed over time. The total animal trend for the 15 herbivore & carnivore species (Eland, Thomson's gazelle, Giraffe, black backed jackal, leopard, cheetah) since 1970 to 2013 indicated some fluctuations with the 1990s experiencing the highest total counts of 42,802. In 1996 and 1997 the Lion population was at its peak with a mean of 8.44. Pearson's chi square ($\chi^2= 52.081$, $df= 9$, $p<0.05$) was statistically significant, where the null hypothesis was rejected and the alternative hypothesis adopted.

To effectively conserve the park this study therefore recommends that wildlife conservation within and outside Nairobi national park should be guided by the implementation of the new Kitengela dispersal area land use policy by the Kajiado county government, which would enable the creation of a buffer zone outside the park. The success to a conserved park will require increased funding for research and monitoring purposes, community educational outreach programmes, purchasing of technological equipments and increasing capacity, in addition to enhanced communication and coordination among stakeholders.

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List of Acronyms and Abbreviations

AWF	- African Wildlife Foundation
CWS	- Community Wildlife Service
FoNNaP	- Friends of Nairobi National Park
IUCN	- International Union for Conservation of Nature
KNP	- Kruger national park
KWS	- Kenya Wildlife Service
NNP	- Nairobi National Park
Pas	- Protected Areas
WCL	- Wildlife Conservation Lease Programme
UNEP	- United Nations Environmental Programme
LUMP	- Land Use Master Plan
SA	- Strongly Agree
A	- Agree
UD	- Undecided
D	- Disagree

CHAPTER ONE: INTRODUCTION

1.0 INTRODUCTION

Park Management is the ability of park managers to direct or control the use of the park's (protected areas) resources, among other things, and providing safe access for visitors while protecting the resource (Lankford, *et al*, 2011). There are two approaches employed for conservation and management of biodiversity in national parks (Adams, 2004) namely: the Preservation approach which aims at excluding human activities considered inimical to the objectives of conserving biodiversity in national park, it's also seldom referred to as the "protectionism approach" or "the fines and fences" approach. It was the most dominant approach until the 1980s, but in some national parks, it has now been replaced with the Community-based conservation approach that allows community to gain economically or socially from parks. The community-based approach was proposed to address the problems associated with excluding human activities from conservation and management of biodiversity (Stolton, *et al*, 2010).

Management of Protected Areas (PA) differs: some are centrally managed by the government, others jointly managed by government and non-governmental actors, by private entities and finally by indigenous peoples and local communities (Dudley, 2008). Protected areas have been categorized into six management categories by the International Union for Conservation of Nature (IUCN) depending on the degree of human intervention (Dudley, 2008). These categories include: Sustainable use of natural resources; strict protection; Ecosystem protection; Conservation of natural features; Conservation through active management and; Landscape / seascape conservation and recreation. There are a variety of protected areas in terms of size, location, management approaches and objectives. Therefore the term denoting a protected area encompasses a range of definitions. The IUCN has a standard definition of PA that has been internationally acknowledged, which is, "an area of land and / or sea specifically dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and finally managed through effective legal or other useful means" (Shadie & Epps, 2008).

Globally recognized as a keystone of conservation strategies, protected areas (Stoner *et al.*, 2007; Gaston *et al.*, 2008) success is greatly vulnerable to the rise of land use changes in adjacent areas, which cut off protected areas and harm their ecological function (Hansen & DeFries, 2007). Protected areas in developing countries face numerous challenges and threats due to the increasing demands placed on their governments to provide for housing, transport, food and other needs. In addition, these governments have inadequate resources thus economic growth is given more priority than conservation. On the other hand, in Africa, protected areas play a fundamental function in the enhancement of social and economic development among the countries. This is due to the fact that wildlife has been recognized as an important economic asset in sub-Saharan Africa, producing huge amounts of income annually and wildlife based investments such as tourism and hunting. For the reason that Africa's wildlife is increasingly valuable as a topic of global commerce, there is increasing marketable attention in securing power over, or access to, wildlife wealthy rural African landscapes. Consequently, rival interests seek to capture the profitable rents and commercial opportunities from a range of forms of wildlife trade and utilization within African societies (UNEP, 2012).

Historically, park management in Kenya tends to be based on the assumption that preserving wildlife by the state in PA for the common good is adequate. Over the last two decades, on the other hand, a number of community members have shown the enthusiasm to conserve wildlife on their own land, ensuing in a wider view that enhances government run protected areas with other attempts (Mungumi, 2012). The area covered by protected areas has grown from 12.1 percent in 1990 to 12.7 percent in 2007 respectively (UNEP, 2009). Globally recognized as a sanctuary for biodiversity protection, national parks and reserves are tactically located in aquatic and terrestrial ecosystems that support wildlife. Kenya is fairly familiar with the issues surrounding environmental conservation accompanied by the ever-declining number of wildlife and forest cover. Thus, conservation of ecosystem, biological diversity and natural places is gravely important to the survival of all people, plants, and animals alike (Beresford & Phillips, 2000).

National parks are highly significant models for environmental management and they will significantly contribute to biodiversity conservation if they are managed effectively (Hockings, *et.al*, 2005). Thus, this study assessed the various management approaches used by park

managers' in-order to improve the state of the park and also the findings of the study will be beneficial to other conservation areas that have been or could be in a similar predicament as Nairobi national park.

1.1 STATEMENT OF THE PROBLEM

The need to have protected areas reserved for wildlife has been driven by land cover and land use changes. Additionally, the aim of such areas is mainly to protect, preserve and conserve nature and wildlife resources sustainably. The establishment of protected areas was as a result of the American national park model, also known as the *fence and fines* approach, that was commonly being applied (Borrini-Feyerabend, 1996, Songorwa 1999, Venema and van den Breemer, 1999). However, as noble as the concept was, it has not been possible to keep all wildlife in protected areas. For example, up to 80% of Kenya's wildlife is found outside protected areas (Matiko, 2000, KWS 2006). Again, these protected areas overtime have become isolated (Newmark, 2008) due to land use changes associated with anthropogenic activities, resulting in an island of conservation.

Nairobi national park ecosystem is located in a fast growing urban area surrounded by different land use practices, mainly settlement, industrial, residential developments and construction of transport corridors. With the north, west and east parts of the park being fenced leaving the Southern part open for animal movement, which over time anthropogenic developments like settlements in the Kitengela areas, increased fencing and the most recent contentious southern bypass and have narrowed the dispersal range for wildlife. These activities in addition to poor enforcement of legal and institutional instruments have led to the isolation of the park leading to an island of conservation (Reid, *et.al*, 2008). This presents significant challenges to the managers of the ecosystem, which calls for innovative ideas so as to maintain faunal population, genetic diversity, flora composition and structures. While the park managers are aware of the drastic changes occurring outside the park, the counter actions taken within the park are not well known and understood.

This study aimed to assess the various management approaches employed by the park managers so as to manage and conserve the animal numbers and also draw future measures or opportunities that would counteract the external human activities and maintain the park's integrity. The results from this research will be useful to other conservation areas that are within close proximity to urban areas and which are likely to experience the Nairobi national park phenomenon in the near future.

1.2 RESEARCH QUESTIONS

The study was guided by the following research questions

1. Has there been a decrease in the home range sizes of certain animal species within the park overtime?
2. Has the total animal population within the park changed overtime?
3. How is the balance between predator and prey within the park?
4. Have the management approaches changed over time?
5. Have there been any changes in the park's management strategies?

1.3 RESEARCH OBJECTIVES

General objective

To assess the conservation and management of Nairobi national park's ecosystem

Specific objectives

1. To assess the dynamism of management approach in the park overtime (1970 - 2013)
2. To analyze the total large animal population trend since 1970 to 2013
3. To determine the opportunities that exists for improved park's management

1.4 HYPOTHESIS

The study will be guided by the following hypotheses:

H₀: There is no significant relationship between the change in population numbers of animal's overtime and ecosystem conservation and management approaches at Nairobi national park.

H₁: There is a significant relationship between the change in population numbers of animal's overtime and ecosystem conservation and management approaches at Nairobi national park.

1.5 JUSTIFICATION AND SIGNIFICANCE OF THE STUDY

This study is hoped to be of significance to other Conservation areas in a likely scenario similar to Nairobi national park are hoped to benefit a lot from the information derived from this study. They are hoped to get more information on the various management approaches and opportunities that could result to a more sustained, improved and conserved ecosystem. Also this study hopes that the findings can help the government make policies and regulations that would better protect the ecosystem.

1.6 SCOPE OF THE STUDY

Geographically, the study was carried out within Nairobi national park situated in Nairobi County, Kenya (Appendix I).

This study assessed ecosystem conservation and management at the Nairobi national park. It also analyzed the trends in the total animal population since 1970 to 2013 and also assessed the dynamism of management approaches in the park overtime. It further determined the opportunities that exist for an improved managed park.

This study collected primary data from the senior management, program officers, KWS rangers and FoNNaP members. These respondents were expected to provide information changes on the large animal trends, ecosystem conservation and management approaches over time and

opportunities that exist for a well conserved park. Equally secondary data (animal trends) was obtained from both published and unpublished materials in relation to my research topic, seasonal calendars, maps, and animal trends records from KWS library.

1.7 LIMITATIONS TO THE STUDY

The scope of this study was limited to assessing the varying management approaches in the park overtime, analyzing animal trends and determining the opportunities that exist for the park's management improvement.

Due to the confidentiality of the park's species data and resources for security reasons, this study encountered difficulties in accessing data on the total animal population trends, the time (year) and number of times certain management techniques were employed in the park. This study overcame these difficulties by building networks with key informants. This made access to the required information much easier. It is recommended in future that KWS makes such information available in a database for academic purposes.

1.8 LITERATURE REVIEW

The literature review is divided into four sections:

1.8.1 Landscape use/land-use changes in a conservation area- This study focuses on the modifications/alterations occurring close to conservation areas brought about by man's activities that eventually upset biodiversity.

1.8.2 Migration of species and its importance- especially the importance and value of a migration corridor to the animal species in a conservation area.

1.8.3 Species population decline- This study looks at the causes of animal species decline in a conservation area, and lastly

1.8.4 Approaches in biodiversity management-which basically entails the various approaches employed in conservation areas with the aim of managing and conserving biodiversity; thus, preventing wildlife decline.

1.8.1 LANDSCAPE USE/ LAND-USE CHANGES IN A CONSERVATION AREA

Land use changes in space and time depending on the prevailing socio-economic and biophysical conditions. It has been depicted as a process in which land value is recognized by innate characteristics such as geographic location, soils and climate, in particular with regard to transportation paths, demand and supply and finally market hubs (Birch, 1968). Land use changes favoring anthropogenic activities have overtime resulted to the reduction and alteration of wild habitat, leading to the extinction of wildlife species and pristine areas. Land use changes can be driven by factors such as economic incentives, poverty, land tenure systems, demographic features development policies and insufficient conservation initiatives (Kideghesho, *et al.*, 2006) which end up destroying species' habitats and diminishing migration corridors, - a good example is, Tsavo-Amboseli region, the Nairobi National Park (Western, 1997) and just about Maasai Mara National Reserve (Ottichilo, 2000, Voorspuy, 1999, Okello and Kiringe, 2004). Land use has a great impact on the conservation of wildlife especially when it leads to range compression that could affect the capacity of migrants species ability to withstand predation, climatic changes and competitive interactions (Ogutu, 2013).

Land use change has also been experienced in Accra – Ghana, in a case study done by Anku (2006), which illustrated a range of impacts that the city had on wetland ecosystems such as the Sakumo wetlands - a conservation area. With an exploding urban population, development and expansion that calls for space which, if improperly planned, would lead to encroachment in the wetland ecosystem for housing developments, and also discharge of municipal effluent into wetlands most likely leading to increased pollution levels. Other impacts and challenges from the study included over-exploitation of wetland resources/services, siltation of wetlands resulting in annual floods and loss of biodiversity and its aesthetic value. The mentioned impacts and challenges facing wetlands in Accra necessitated for a sustainable and integrated management strategy. Corresponding to the strategy, Anku notes that cities can better manage their wetland ecosystems if they plan and implement integrated wetlands strategic programs that recognize wetland values and ensure an effective enforcement of building regulations and pollution control. He further remarks that such programs should be mainstreamed into the city's overall development agenda.

In addition to the urban developments, infrastructure such as roads, are common and widespread features of landscape throughout the world. The main purpose of roads is to ease the transport of goods and populace within different areas, and to offer access to inaccessible areas (Donaldson & Bennett, 2004). Being a positive feature, it can also have negative impacts, for example: Constructed roads close to or within protected areas alter the adjacent habitats in several ways, consequently affecting the value and appropriateness of roadside locale for flora and fauna, and also causes increased edge effects and contribute to the isolation of the protected areas (Newmark, 2008). Similarly, possible effects of these land use changes impacts on animal number populations consist of altered reproduction and mortality rates; local declines in population numbers; and distorted movements and dispersal patterns (Ferris, 1979; Dhindsa *et al.* 1988; Reijnen *et al.* 1997; Kuitunen *et al.* 1998; Baker *et al.* 1998; Huijser & Bergers, 2000).

A good example that has well been documented is Mikumi National Park, Tanzania, it illustrates the impact of a main highway on wildlife distribution. The elephant (*Loxodonta african*), eland (*Taurotragus oryx*), Bohor reedbuck (*Redunca redunca*), black-backed jackal (*Canis mesomelas*), and wildebeest (*Connochaetes taurinus*) were minimally sighted over 500metres in open grassland habitats of the highway than at distances superior than 600 meters (Newmark *et al.* 1996). In West Africa comparable patterns have also been sighted outside protected areas. Obstruction effect of roads on wild animal movement depends majorly on road girth and the concentration of its use. On the other hand, tracks within protected areas are expected to have less impact on animal movements. Impacts of such roads and paths lead to fragmentation and isolation (Newmark, 2008) of wildlife populations one way or another. Such isolations limit access of animals to vital resources and animal movement/dispersal which eventually could result in a reduced gene flow within the population.

1.8.2 MIGRATION OF SPECIES AND ITS IMPORTANCE

Animal migration is the movement of such species over long distances on a seasonal basis. It usually occurs in all major animal groups like the reptiles, birds, amphibians, fish and even mammals (Hugh & Alistair, 2007). Animal movements do not occur in isolation just like all ecological processes, they operate in an environment of complex biotic and abiotic interactions and drivers. In some protected areas such movements are either absent or minimal because of

human presence and land-use changes or activities that lead to a collapse of migration corridors. According to Walker and Craighead (1997), ecological/migration corridors are "...avenues along which wide-ranging animals can travel, plants can propagate, genetic interchange can occur, populations can move in response to environmental changes and natural disasters, and threatened species can be replenished from other areas." The key purpose of ecological or migration corridors are to make easy dispersal between cut off patches and decrease the risk of extinction of a species.

In a review of published papers by Beier and Noss (1998), out of the thirty two studies published in 1997, twenty one of the studies focused on some aspects of animal movement within or through migration corridors, and numerous supported the role of migration corridors in enhancing greater movement. After the review, several new studies have proven that migration corridors augment movement rates of vegetation and fauna between otherwise cut off patches (Coffman *et al.* 2001; Berggren *et al.* 2002; Tewksbury *et al.* 2002; Haddad *et al.* 2003). Whereas, other published studies lacked proof for corridor effects (Rosenberg *et al.* 1998; Bowne *et al.* 1999; Danielson and Hubbard, 2000), in contrast, none of the published studies have indicated that migration corridors reduce movement rates. On the other hand, current published studies have acknowledged the function of connectivity in improving gene flow (Aars and Ims 1999; Hale *et al.* 2001; Mech and Hallett 2001; Kirchner *et al.* 2003).

A further, illustrative study done at Kruger national park (KNP), South Africa, (Ricardo *et al.* 2011) dwelt on the consequences of the migration corridor collapse. KNP contained low numbers of wild animals at its declaration in 1926, as a result of excessive hunting and the 1896 rinderpest epidemic. Down the line, 1946–1990 was the period that had been described as the era of ‘management by intervention’, where fencing turned KNP into a heavily managed ecological island. This was so, because the early management priorities focused on rebuilding wildlife populations through interventions that included: the provision of constant water from boreholes (Gaylard *et al.* 2003) and fencing of the KNP boundaries for disease control purposes, also political demarcations of boundaries begun in the south in 1959, western side, 1961 and concluded with the east and northern sides in 1976 and 1980 respectively (Bengis *et al.* 2003).

The impact of water provision, fencing and management culls of both carnivore and herbivore populations were intense. KNP experienced declines of wildebeest and zebra populations by 87% (Whyte & Joubert, 1988) after the completion of the boundary fence. Similar declines were recorded in Namibia's Etosha National Park between 1955 and 1973, where the wildebeest populations reduced by 85% after fencing the national park (Berry, 1997). The connection linking the migration corridor effects and their effects on the demography of wildlife populations is vital for the suitable use of corridors and dispersal areas in management.

1.8.3 SPECIES POPULATION DECLINE

In a study done by Ottichilo, *et.al* (2001), between 1977 and 1997 on population trends of resident Wildebeest (*Connochaetes taurinus*) and factors influencing them in the Masaai Mara ecosystem, Kenya, they found out that the resident wildebeest population in the ecosystem had reduced from approximately 119,000 in 1977 to about 22,000 in 1997. Their findings were arrived at by analyzing population trends using aerial census data collected through systematic reconnaissance flights. In addition, for the population trend analysis a regression analysis was used. Changes in Wildebeest densities in cropped and non-cropped areas were compared so as to measure the effect of land use changes on wildebeest population. Also, relationship between rainfall fluctuations and population size was used to assess the influence of rainfall on trends. And lastly, cattle densities in cropped and non-cropped areas were compared to get more insights into the competition between cattle and wildebeest for food. The decline was mainly attributed to loss of resident wildebeest wet season grazing ranges as well as loss of calving and breeding ranges to land use changes such as agriculture (Douglas-Hamilton, 1988; Sitati, 1997). Correspondingly rainfall fluctuations (Ogutu, *et.al.*2003) may have resulted into competition between wildebeest and cattle during times of limited food resources and further contributed to their decline.

In another study done on ungulate species with the omission of the wildebeest, by Andanje, (2002) to investigate the factors limiting the abundance and distribution of Hirola, or hunter's antelope, (*Beatragus hunteri*), in Kenya's Tsavo East National Park (TENP) (ex-situ population) and Garissa (in-situ population). Between 1996 and 2000 data was collected on the ex-situ population, with sporadic comparative sampling of the in-situ population. The Hirola were

located by use of ground search, radio tracking and infrequently by use of an aircraft. In TENP the population was found to be stationary while the Garissa population was reducing with about 672 animals remaining in a 5,171-km² range.

Andanje (2002) further stated that mortality in Garissa was linked with disease and poaching while in TENP mortality was principally connected with predation. The Garissa population had decreased as a result of range reduction (Newmark, 2008), caused by human encroachment and further affected by poaching and spread of diseases from cattle. A multivariate analysis was employed to analyze the relationship between the key factors (pressure, competitors, shade tree densities, estimates of predation, food abundance and many more) and variation in the reproduction, size and mortality rates across the studied *Hirola* family groups. Predation pressure (Sinclair & Arcese, 1995) and the amount of exact microhabitats available for shade cover against predators, and food were found to be the main limiting factors in the Tsavo population.

1.8.4 APPROACHES IN BIODIVERSITY MANAGEMENT

In Dadia National Park, in North-Eastern Greece, combinations of landscape approaches (remote sensing and GIS) were used in six case studies (Schindler, *et.al.* 2010). The landscape approaches were performed in the park to show how they aid in conservation and management of biodiversity. The studies aimed at (1) testing the performance of landscape metrics as indicators of biodiversity, (2) modeling of nesting habitat for a flagship species- the Eurasian Black Vulture (*Aegypius monachus*), (3) developing a Geographic Information System approach for a systematic raptor monitoring, (4) evaluation of land-use change, (5) detecting statistical dimensions and spatial patterns of landscape structure, and (6) developing a decision-support system to optimize conservation of biodiversity in managed forests. The results showed that the approaches involving Geographic Information System and integrated statistical approaches proved to be important to understanding the changes of landscape structure with the current biodiversity and the habitat aptness for diverse categories of species. This information was necessary to set up conservation strategies for biodiversity, for example regarding the safeguarding of habitat heterogeneity in both the interior and buffer zone of the Park (Grill & Cleary 2003, Kati *et al.*, 2004, Kati and Sekercioglu, 2006), and for the most favorable of other

ecosystem services for instance timber production. The studies further pointed out that landscape close watch should be incorporated into the ecological monitoring of key and indicator species to assist the evaluation of the management impacts on both wildlife and forest.

Another management approach was pointed out in a study done by IUCN, (1996) in Zimbabwe's Communal Areas Management Program for Indigenous Resources (CAMPFIRE) project that portrayed a good example of an improved system for cropping wild herbivores and carnivores as a way of management. Competing wild carnivores, like lions (*Panthera leo*), were commonly reduced in numbers but not to the extent that the structure and functions of the ecosystem were vanished. In addition, harvesting of primary and secondary producers took place but not to the extent that ecosystem structure and functions were threatened. The project found out that greater ecosystem transformation commonly occurred when intensive agriculture was introduced, (IUCN 1995. Habitually, the values of pristine ecosystems are not considered before anthropogenic activities happen.

This study aimed to look at the various management approaches employed within Nairobi National Park for its posterity despite the rapidly increasing external land use changes.

1.8.5 NAIROBI NATIONAL PARK MANAGEMENT

In the 1970s the Wildlife management in Kenya was under Wildlife Conservation Management Department that was formed after the 1976 merger of the Game Department and Kenya National Parks as per the Wildlife Conservation and Management Act. As of 1990 to date the overall custodial ownership of wildlife is vested in the state, with the Kenya Wildlife Service (KWS) as the designated national institution responsible for the implementation of the wildlife policy. According to the Senior warden Nairobi National Park, Head of Geographic Information System (GIS), Head of Planning & Environmental Compliance, Head of Ecological Monitoring and Biodiversity Information Management, and Senior scientist Southern Conservation Area, the Park is managed scientifically by employing various approaches such as conducting bi-monthly wildlife censuses of ground counts and quarterly in the dispersal area, as well as aerial counts once in every 5years, continuous monitoring of the park's parameters namely (water, vegetation, air), translocation, prescribed burning and control of invasive species. This is equally documented in the past 2005- 2010 NNP management plan (KWS, 2005).

The objectives of the 2005-2010 Management plan include:

- To maintain wildlife migration and dispersal areas
- To protect wildlife through patrols, enforcement of the law and community policing
- To conserve the unique flora, fauna, natural processes and significant values of the NNP ecosystem
- To provide opportunities and information for visitors to experience the park without impairing its resources

In the plan, Management of the Park encompasses:

- i) **Community Conservation Management** entails Human-wildlife conflict management, Control of habitat loss and fragmentation in the wildlife dispersal area, local community involvement in wildlife conservation and stakeholder participation for support or initiation of conservation projects in NNP ecosystem.
- ii) **Habitat Management** in the park is for the purposes of providing optimal wild animal requirements for all species found in the ecosystem, improving the parks' aesthetic value and supporting scientific research. It involves prescribed rotational burning in the grassland plains to provide lush palatable forage for grazers, removal of exotic and invasive species to enhance the park's habitat quality, creation of pollution buffer and restoration of degraded habitats
- iii) **Tourism Management** within the park aims to improve the visitors number so as to develop appropriate targets also to minimize and further eliminate visitors impacts that include off-road driving, over-speeding, animal harassment, feeding and littering and finally to meet the different levels of visitor expectations during their visit to the park.
- iv) **Species Management** aims at controlling the declining animal populations, maintaining existing populations, the de-stocking of excess animal species, reintroducing of the locally extinct species and maintaining sound animal health.
- v) **Security Management** is made possible by the three KWS security units: the investigation, intelligence and wildlife protection units that oversee wildlife, visitor and KWS property security within the ecosystem. They carry out intensive patrols

outside and inside the park and provide security to visitors at the nature trails and picnic sites and enhance the intelligence network.

vi) Maintenance Management within the park aims to ensure good motor able roads all year round for game viewing also rehabilitate signage, signposts, buildings and gates. It also aims to maintain a constant water supply and upgrade the fence system.

vii) Research and Monitoring Management involves targeted research and monitoring so as to provide timely scientific and technical information on ecological and sociological issues for management of the ecosystem.

Given that the management plan has expired, not much implementation was done. For future management excellence within the park, the incoming plan needs to be implemented to the latter.

1.9 THEORETICAL FRAMEWORK

This section contains the review of Island biogeography theory on ecosystem conservation and management.

1.9.1 Island Biogeography Theory

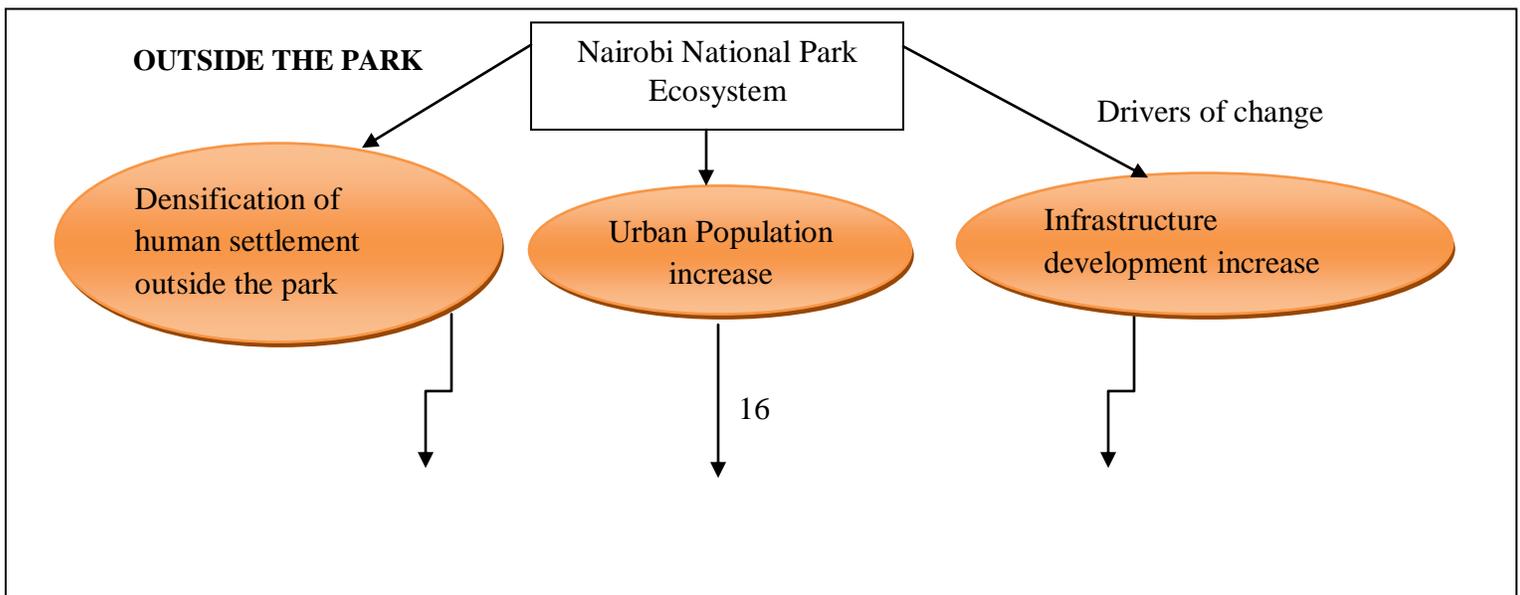
Robert MacArthur and Edward Wilson, (1967) theory of Island Biogeography posits that two processes primarily determine species diversity on an island. That is: extinction and immigration. It explains that as the number of species on a small island increases, the immigration rate decreases and the extinction rate increases. The extinction rate increases with island area (area effect) whereas immigration rate decreases with isolation (distance effect). In addition, equilibrium of species diversity is attained and remains fairly stable when the immigration and extinction rates are equal.

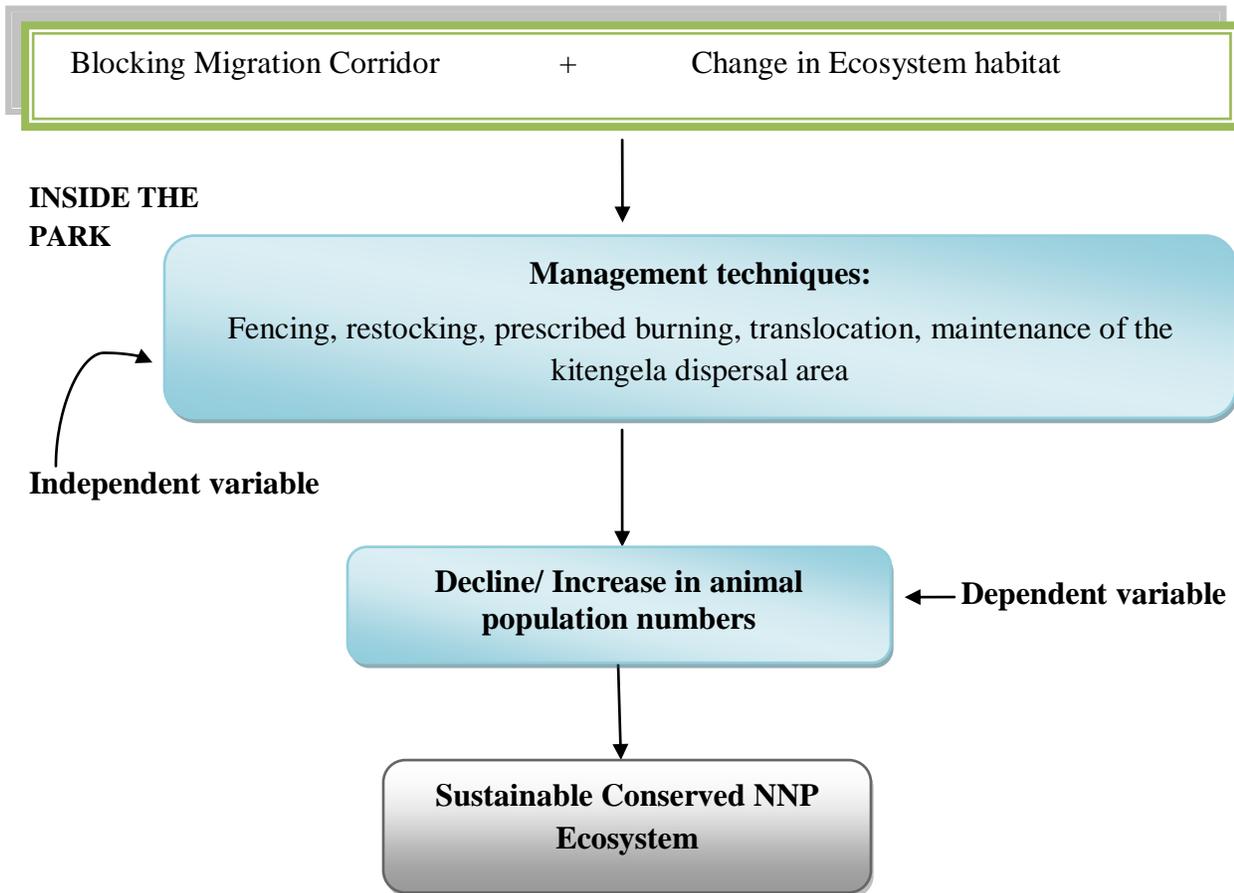
This theory transformed the science of biogeography (Janzen, 1968; Losos, 1996; Heaney, 2000). More fundamentally, the theory transformed ecology. They proposed that ecologists ought to use arithmetic to abridge the natural world and expand logical insight. The theory revolves around the conservation of the islands. It emphasizes on the use of mathematical approach to make sense of key ecological problems that may exist. The theory has been applied to a variety of “habitat islands” such as ponds or lakes, mountain tops, individual plants patches of terrestrial ecosystem and caves. This theory is relevant to this study because the mathematical approach can be essential in understanding how different aspects of the ecosystem can affect the population of flora and fauna on terrestrial patches (protected areas) and how park managers can device approaches to protect, manage and conserve park’s biodiversity.

This study adopted and modified Mac Arthur’s, (1967) Island Biogeography theoretical framework by equating protected areas to true islands analogy, Frank Preston, (1962), which means in a “terrestrial view” that regions bordering the protected zones are entirely unreceptive to species residing within such locales. In this scenario, (fig 1.1) Nairobi national park ecosystem, a protected area, acts as a “habitat island” in an inhospitable sea of environment (Gilpin and Diamond, 1980) that has been modified by man overtime in the form of fencing, settlements, development and different land uses on the north, east and west parts of the park, also the southern parts that has in the recent times been affected by the continual contracting of the vital dispersal area, which in turn has resulted in a change in the species population numbers which could easily become detrimental to future populations, if proper management strategies are not in place to prevent such occurrences. This flow of events or processes pose a great challenge to the park managers, thus, this study aims to assess the available management approaches that are being used so as to maintain the animal population numbers in the park and

prevent their decline, also determine the possible and available future avenues of conservation management for the park so that it remains in a sustainable conserved state, even in the event the park gets to the point where it is completely isolated (collapse of the migration dispersal area).

1.10 CONCEPTUAL FRAMEWORK





Adopted and modified from Mac Arthur (1967)

Fig 1.1: Sustainable Conserved Ecosystem Conceptual Framework

1.10.1 Identification of variables

Independent variables: Management approaches/ techniques (Fencing, maintenance of the Kitengela area, translocation, re-stocking, prescribed burning)

Dependent variable: Total number of animal.

CHAPTER TWO: THE STUDY AREA

2.0 DESCRIPTION OF THE STUDY AREA

2.1 LOCATION

In 1946 the Nairobi National Park was set up on the borderlands between highland farming areas and pastoral grazing lands. The park is 117 square kilometers and located 7 kilometers from the city center. It is known to be the only national park (protected area) globally near a capital city (Tryzna, 2007). According to a study by Bett, *et al*, the park constitutes the wider 2000km² of Athi-Kapiti plains (Bett, *et al*, 2006). Nairobi national park's altitude ranges between 1,533

meters (5,030 ft) and 1,760 meters (5,774 ft) and lies between latitudes 1° 20' -1° 26' S and Longitudes 36° 50'-36° 58' E. It is separated from Nairobi Metropolis by an electric fence on the northern and a live/mesh/barbed wire fence on the eastern and western boundaries respectively, while The Mbagathi River forms the southern boundary of the park. Figure 2.1 and Figure 2.2 represent a map and a satellite image of NNP respectively.

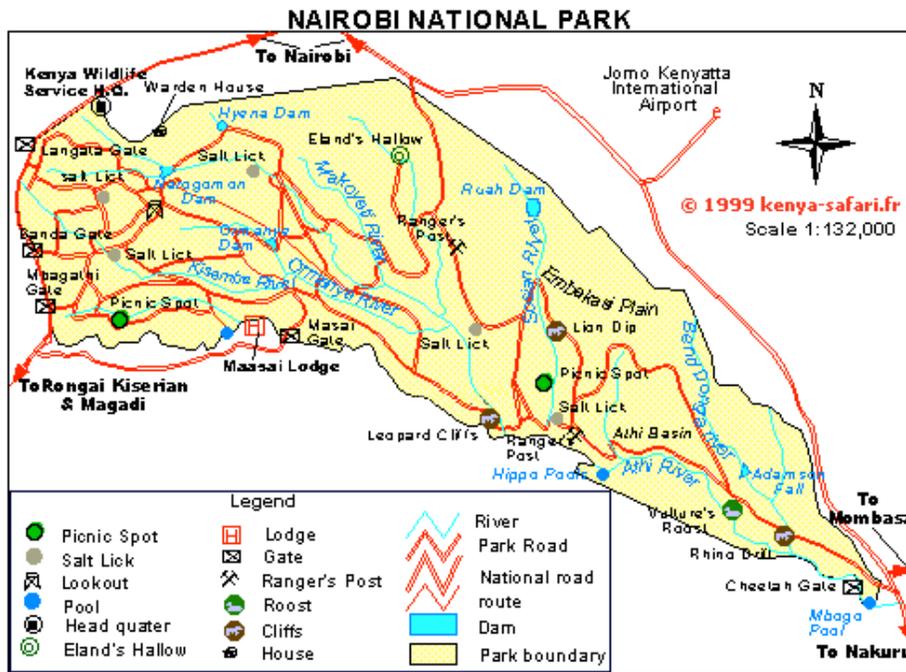


Fig 2.1: Map of Nairobi National Park





Fig 2.2: Satellite image of Nairobi National Park

2.2 CLIMATE

The park experiences a fairly dry climate. It has a bimodal rainfall pattern and receives a mean annual rainfall of between 762 mm on the east side to 911 mm on the west side. The long rains occur from March to May and the short rains from October to December (Bett, *et al.* 2006). The park's maximum number of rain days is 85 (KWS, 2005). It also experiences an annual mean temp of 19.6⁰ C, with a maximum of 25.3⁰ C and a minimum of 13.6⁰ C (Ngene & Kyale, 2002).

2.3 VEGETATION (FLORA)

The park's savannah ecosystem comprises of different vegetation types; the open grassland plains with scattered yellow-barked *Acacia xanthophloea* bushes, the highland dry forest consists of species like *Olea africana*, *Croton dichogamus*, *Brachylaena hutchinsii*, and *Calodendrum*, in the western uplands of the park and a permanent river with a riverine forest on the southern edge, also a wetland vegetation which flourishes along the river valley and watering points. There are areas of broken bush and deep rocky valleys and gorges within the park. The species in the valleys are predominantly *Acacia* and *Euphorbia candelabrum*. Other tree species include; *Apodytes dimidiata*, *Canthium schimperiana*, *Elaeodendron buchananii*, *Ficus eriocarpa*, *Aspilia mossambicensis*, *Rhus natalensis*, and *Newtonia* species.

2.4 WILDLIFE (FAUNA)

The park has a number of wildlife species that include: mammalian species, reptiles (crocodiles and snakes), amphibians, diverse birdlife with 400 species recorded and numerous invertebrates. For example: The white & black Rhino, Wild dog, Lion, Warthog, Leopard, Cheetah, Hyena, Buffaloes, Giraffe, Zebra, Wildebeest, Elands, Baboons and Vervet monkeys found in the forested, open grasslands and riverine areas. The number of animals in the park fluctuates due to seasonal migration.

2.5 LAND-USE

The park's location within the capital city has attracted land prospecting, settlements, urbanization and industrialization. The park is detached from the city by a fence in the northern, eastern and western part. The southern border is open to allow migration in and out of the park through Kitengela and Athi-Kapiti plains (Bett *et al.* 2006). Heavy industry, residential and commercial developments extend right up to the park fence. In the northern section of the park there are tanneries, steel works, a cement plant and a chemical factory. The southern section dispersal area has been subdivided and fenced off into small plots; slums and affluent neighborhoods have been developed in these areas also quarries for mining close to the dispersal area tamper with the pastures and environment in general (Western, 1997). In addition there are presence of livestock farms, eucalyptus plantations and plastic green houses - set up for flower production (Tryzna, 2007). The effect of all these land uses is landscape transformation and habitat fragmentation.

2.6 HUMAN POPULATION

The Nairobi national park ecosystem has in the recent past witnessed a rapid demographic transition due to settlement of humans in this area. The movement of people into the area is because of its close proximity to Nairobi city and the rising demand for residential development thus accelerating land use changes in the ecosystem. Consequently, the main threat to the park with regards to urbanization is urban spread. The city population has grown tremendously. Census figures in 1948 gave the city population to be 119, 000, in 1999 it was 2.14 million and by 2009 census, the city's population was about 3.1 million. Future projections estimate that the city's population will be 3.8 million in 2015 (Rakodi 1997, CBS 2001) and about 10 million by

2020 (Tryzna, 2007; KWS, 2006). The increasing human population in the ecosystem is of particular concern because this is semi-arid savannah grassland. It's a vulnerable environment, which may not be able to support the increasing human pressure due its limited water resources.

2.7 WATER SOURCES

The upper part of the park has a series of drainage tributaries form the Mokoiet river system, which channels its water into Mbagathi River. This river is the major water source for wildlife in the area. Most of the other rivers in the park are seasonal and additional water sources include small dams built along the Mbagathi River, which provide water to the park.

Other attractions present in the park include: the wildebeest and zebra migrations, the Orphanage, the Ivory burning site Monument, diverse bird species, Rhino sanctuaries, the walking trails at hippo pools and the Nairobi safari walk

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 METHODOLOGY AND RESEARCH DESIGN

3.1 RESEARCH DESIGN

A research design is a map of exploration envisaged in order to obtain answers to research questions (Kothari 2004). This study employed a cross-sectional survey research design where both quantitative and qualitative approaches were used.

3.2 DATA SOURCES

Both primary and secondary data sources were used. The primary data included: carrying out scheduled observations, the use of questionnaires (Appendix II and III) and key informant interviews (Appendix IV). Secondary data source included: literature review from both published and unpublished materials in relation to this research topic (journals, books, and reports), using seasonal calendars, maps, animal trends records and census (Appendix V and VI) from Kenya Wildlife Service Library.

3.3 TARGET POPULATION

The study targeted a total population of 136 staff members from the six departments, namely: Biodiversity Planning, Assessment and Compliance, Species conservation and Management, Parks and Reserves, Veterinary and Capture services, Ecological Monitoring and Biodiversity Information Management, Ecosystem and Landscapes Conservation and Management were the target population that was sampled. Also 10 members of Friends of Nairobi National Park, a supporting organization to KWS were incorporated.

3.4 SAMPLING PROCEDURE

The study used Stratified proportionate random sampling. Stratified sampling was used because of the different functions performed by the different departments / offices within Kenya Wildlife Service. The strata (functions) include: Planning of Biodiversity, Conservation and management of species, Ecological monitoring, Monitoring of wildlife diseases, Conservation of landscapes and lastly Support services. The selected KWS departments were:

- Biodiversity Planning and Monitoring,
- Environmental Assessment and Compliance,

- Species conservation and Management,
- Parks and Reserves,
- Veterinary and Capture services,
- Ecological Monitoring and Biodiversity Information Management,
- Ecosystem and Landscapes Conservation and Management, and
- Friends of Nairobi National Park.

Stratified random sampling guarantees inclusion of the different sub groups (strata), which otherwise would be lacking entirely if other sampling methods were employed (Mugenda and Mugenda, 2003). Then a simple random sampling was done in each of the strata (category), which eventually summed up to the intended sample size.

3.4.1 SAMPLE SIZE FORMULA

The sample size for each department was calculated at a 95% confidence level, 5% margin of error and 50% response distribution. The following formula (Krejcie & Morgan, 1970) was used to determine the sample size.

$$S = \frac{X^2NP(1-P)}{d^2(N-1) + X^2P(1-P)}$$

Where:

N = Population Size

S = Sample size

P = Population proportion (expressed as decimal, assumed to be 0.5 (50%) – this provides the maximum sample size).

X = Z value (e.g. 1.96 for 95% confidence level)

d = Degree of accuracy (5%), expressed as a proportion (.05); It is the margin of error

The study sample size was 101 KWS staff/employees and 10 members from Friends of Nairobi National Park.

The study used the Proportionate stratified random sampling, where a similar sampling fraction (0.743) was used across the six departments. The 0.743 was arrived at by dividing the sample size (101) over the target population from the six departments (136), which was then used to get the sample size for each department. This was done by multiplying the sampling fraction (0.743) with the number of staff from each of the six departments (Table 3.4).

Table 3.4 Breakdown of the sample size total as picked from KWS staff

Department	No. of staff	Sample size at 95% confidence level, 5% margin of error and 50% response distribution
Biodiversity Planning, Assessment And Compliance	10	7.43
Species Conservation and Management	51	37.88
Parks & Reserves	8	5.94
Veterinary and Capture Services	54	40.10
Ecological Monitoring and Biodiversity Information Management	10	7.43
Ecosystem and Landscapes Conservation and Management	3	2.23
Total	136	101

3.5 DATA COLLECTION

3.5.1 Questionnaire

Both closed and open-ended questionnaire were self-administered to the 101 KWS staff members (senior wardens, wardens, rangers, scientists, researchers, veterinary specialists) - (appendix II) and FoNNaP (appendix III). This form of collecting data allows for quick feedback of information within a short time and tends to be objective since there is no bias resulting from the personal characteristics.

3.5.2 Key informant interview

Key informant interviews were performed on the (Head of GIS, Head of planning & environmental compliance, senior warden NNP, Head of Ecological monitoring and biodiversity information Management, and finally senior scientist southern conservation area), who were sampled purposively because they are expected to have rich, reliable and accurate information. Semi-structured (questions) interviews were used on the informants (appendix IV), which allowed and gave room for questions to be answered in a flexible manner. In addition, an interview generally yields in the maximum cooperation, lowest rejection rates and offers high response. It combines questioning, cross-examination and probing techniques (Owens, 2002).

3.5.3 Scheduled observation

Scheduled observations were conducted within and outside the park, this enabled the researcher to be able to see and assess the status of the various section of the park and gain first-hand experience of the ecological status and human activities.

3.5.4 Animal Population Trend

For the analysis on total animal trend population as from 1970 to 2013, secondary data sources were used which included: literature review from both published and unpublished materials in relation to this research topic (journals, books, and reports), seasonal calendars, maps, animal trends records and animal trend census that had been conducted since 1970, all of which the researcher got from the KWS Library and offices (Appendix V and VI).

3.6 DATA PROCESSING AND PRESENTATION

The Data collected from the interviews, questionnaire were checked, rechecked and sorted for any errors, gaps as well as irregularities and adjustments made appropriately. The cleaned data was then coded and processed using the Statistical Package for Social Scientists (SPSS) version 18 to generate descriptive statistics that were presented in forms of graphs and tables so as to yield meaningful information.

3.7 DATA ANALYSIS

The processed animal data for Wildebeest and Burchell's Zebra were then analyzed using Pearson chi square; the means and standard deviation were used to indicate the variations within the years (1970-2013) and between decades (1970s, 1990s, and 2000s). A multi regression analysis was done to show the relationship between the management techniques/approaches and herbivore totals (wildebeest and zebras) using 3 decades 1970s, 1990s and 2000s within and outside the park. The analysis was conducted to establish the relationship between the various ecosystem conservation and management approaches and the population numbers of animals at Nairobi national park. The 1980s and 2010s data were not used because of animal data gap and an incomplete decade data as the study mainly focused up to 2013 respectively. Hypothesis testing was done using Pearson chi square. The qualitative data obtained was used to reinforce the quantitative data. Discussion and conclusion on the findings were then drawn with appropriate recommendations.

CHAPTER FOUR : RESULTS AND DISCUSSIONS

4.0 RESULTS AND DISCUSSIONS

4.1 MANAGEMENT APPROACHES / TECHNIQUES 1970 – 2013

According to Dr. Andanje 2015 (former Head of ecosystem and landscape conservation) management within a park is vital in that it provides optimal wild animal requirements for all species, improves the parks' aesthetic value and also for scientific research and monitoring. However, Nairobi national park has been using selected management techniques for animal population and vegetation since the 1970 to 2013. Below are some of the management techniques employed in the park.

4.1.1 TRANSLOCATION

Translocation of wildlife is where the animal is captured, transported and released to a given area (Nielsen, 1988). It is an expensive procedure to undertake and thus done when urgently required. Translocation has been used in the park since the 1970s. According to research scientist, savannah ecosystem Dr. Ngoru, translocation didn't occur as much in the 1970s through to 1980s because animals could move freely from NNP to Amboseli park areas and back to NNP. In the early 1990s to 2000s at the onset of land uses practices in the Kitengela area, animal movement was restricted, the need for increased home range areas/size and the rise of the human – wildlife conflicts led to the translocations of specific animal species during this time. The table 4.1 indicates the translocation cases that took place during the 1990s to 2000s.

Table 4.1 Animal translocation at Nairobi national park

DATE	TYPE OF WILD ANIMAL	FROM	TO	REASON
September 2007	2 female black rhinos	NNP	Oi Jogi game reserve	Enhance breeding of the population and minimize potential fatal fights amongst the males for one female in the game reserve.
March 1996, July and August 1999	23 rhinos	NNP	Tsavo East National Park (TENP)	Regulate NNP population and restock TENP.
February 1992	6 rhinos	NNP	Oi Peteja & Nguila Rhino Sanctuary	Regulate NNP population and restock the respective conservation areas.
October 1992	4 rhinos (3 females & 1 male)	NNP	Nguila Rhino Sanctuary, Tsavo West National	Regulate NNP population and restock the respective conservation areas.

As per (table 4.1) translocation was majorly done during the 1990s, a decade, that had the highest animal population numbers compared to the 1970s, 1980s, 2000s and 2010s. Most of the translocation data was for the rhino and according to NNP management plan 2005-2010, the rhino population is classified under the International Union for Conservation Nature/Species Specialist Group, African Rhino Specialist Group ranking as a Key population category 'B' (population between 51 and 100). The carrying capacity for the Park has been established as 59 and any surplus animals above the management level of 45 animals could be removed for purposes of restocking other rhino sanctuaries and also to regulate animal population within the park. According to Griffith *et al.* (1989) based on a survey of 81 wildlife agencies and organizations (1973-1986), determined that 90% of all translocations were of native game

species and were deemed successful¹ 86% of the time and thus translocation is a viable management tool to reestablish raptor breeding populations.

For the past twenty years, Fischer and Lindenmayer (2000) evaluated 180 case studies and some theoretical papers on animal relocations published in twelve most important global scientific journals. The study restricted its' focus on re-introductions, supplementations and translocations (IUCN, 1996). The study outcome pointed out that re-introductions were the most prevalent type of relocation (116/180); seventy five percent of these were conducted for conservation purposes. On the other hand, supplementations (48/180) and translocations (36/180) occurred not as much often and both were frequently carried out for basis other than conservation. Key to note was that translocations that intended to solve human- animal conflicts usually failed. In the same way, from the study re-introduction success had not changed over the past two decades, nevertheless re-introductions emerged to be more flourishing when the source population was wild. Additionally, more intricate trends were found for the effect of predation and the use of supportive measures that include; predator control prior to release or provision of food or shelter.

In conclusion, there were three primary goals for animal relocations namely: To restock populations, conservation purposes and to solve human- animal conflicts. These are similar reasons adopted by the NNP management. A broad review of the current literature has led to the conclusion that the importance of animal relocations as a conservation tool could be improved through: a) improved monitoring after a relocation; b) improved financial accountability; c) Additional thorough testing for the suitability of the approach in a given case; d) improved effort to publish the results of relocations (success stories), even ones that failed and; e) Establishment of widely used and usually accepted criteria for reviewing the failure or success of relocations. Thus NNP needs to better document their translocation success stories.

4.1.2 RE-STOCKING AND RE-INTRODUCTION

Known as forms of translocation: Re-introduction is the intentional movement of an organism into part of its native range from which it has disappeared or wiped out during the historic times

¹ Griffith *et al.* (1989)., A translocation is a success if it results in a self sustaining population.

(IUCN 1987) due to over-collecting, over-harvesting, human persecution, or habitat deterioration while Re-stocking is the Addition of organisms to an existing population where it previously occurred so as to maintain the desired population (IUCN 1998). In the event NNP becomes fenced cases such as re introduction will be on the rise in the coming years, because the wild species would either decline or disappear from the wild due to habitat deterioration. In February 2003 and January 2004 a total of 44 Reedbucks and 28 Oribi were translocated from Kruger Farm, Eldoret to NNP so as to reduce the population of Reedbucks in donor area and restock NNP.

4.1.3 PRESCRIBED BURNING

The grasslands of Nairobi national park have been managed using prescribed block burning since its establishment in 1946. The burning was carried out for the purposes of providing optimal animal requirements for all species found in the ecosystem, improving the park's aesthetic value and supporting scientific research. The burning was basically done at the end of the dry season on an annual basis in the 1950s and early 1960s, but was not consistent after the late 1960s. Other experimental burns were carried out in the park in 1978, 1988/1989 and 1991 and most recently in 2007 (KWS 2007). Out of the eight blocks each block is burnt after every five years. The burning blocks are separated by road circuits which are also firebreaks meant to prevent fire from spreading from one block to another. Grasslands are burnt to bring forth fresh grass critical to the survival of the grazers. Once burnt, the dry and dead materials are cleared and in so doing closed habitats are opened for certain species of animals that prefer relatively shorter grass and open areas. Before burning, most nutrients are held in the dead or dry plant materials and are often unpalatable and on burning these nutrients are released and made available for recycling. New forbs are also given an opportunity to grow and hence available to the animals (KWS, 2006).

As observed 63.6% of KWS staff (Table 4.1.1) mentioned that any Management practice conducted within the park is done in accordance with the regulations under the Management plan of the park but that is not the case on the ground. For example the park was last burnt in 2007 and in the management plan, prescribed burning was supposed to take place annually. As per Dr. Ngoru, research scientist, mentioned that burning of the park led to loss of biodiversity, thus the

need to stop it. Noting also that no scientific research has been conducted to indicate that burning leads to loss of biodiversity. Consequently, the management started exploring the mowing option that was practiced a while back in the park, since it provides similar advantages as the prescribed burning and a further provision of hay for wildlife but the idea is yet to be tried again. Other than the mowing option, the introduction of white rhinos into the park to graze on the tall grass species has been adopted and it has been a success.

According to park's senior scientist, Kenana who was in charge of the burning program in the park, stated that the park was last burnt in 2007, it was discontinued due to the controversy that surrounded the science behind the burning of the park. Prescribed burning is an intricate tool encompassing several uncertainties: its effectiveness in reducing wildfire risk is not accurate, and its impacts on the ecosystem and climate are multifaceted. In addition, prescribed burning can involve trade-offs for instance; air quality, protection of assets, biodiversity protection and non-intervention in nature (Whittaker & Mercer 2004).

The biggest concern about controlled burns is the effect that it has on the environment, the damage it has on both the healthy and dead vegetation, which affects the source of food of herbivores in that area. This will then force them to move to other areas in search of palatable vegetation, which in turn affects the predators that depend on herbivores for food. It also leads to increased vulnerability of some species like arthropods and birds. According to Reisen & Brown 2009 both prescribed and unintentional fires release toxic gases and particles that affect air quality within a short duration. Such impacts could affect breathing of the wildlife and the people residing close to the park, water quality and the soil particles (Shakesby *et al.*2007).

4.1.4 MAINTENANCE OF THE KITENGELA DISPERSAL AREA

Athi Kaputei Plains (AKP) are critical dispersal and breeding areas for wildlife from Nairobi national park according to the 2005- 2010 NNP management plan, the park management was to work closely with other stakeholders to create a buffer zone where land use is supportive of the park's goals. This was to include very low-density pastoral zoning within the migration/dispersal areas to curb subdivision, fencing and pollution. There are several programmes that have been used to conserve the dispersal area, which include: the **Wildlife Conservation Lease**

programme (WCLP) that was initiated in April 2000, the program requires landowners to sign a contract for a year with the Wildlife Foundation (TWF) which requires them to allow free movement of wildlife within their lands.

The landowners must adhere to certain conditions to ensure their lands are compatible with wildlife range and grazing lands and in return, the landowners are paid an annual fee of Ksh. 300 (US\$ 4) per acre in three installments. Apart from increasing land for wildlife use, it also acts as a tool for mitigating human-wildlife conflicts (Matiko, 2014). It is unsustainable due to its dependency on donor funds and doesn't empower the community instead encouraging dependency. Wildlife Conservation Lease Programme cannot succeed in isolation in the long run. In this regard, there is need for development of a hybrid of conservation interventions that includes the use of consolation programme (livestock compensation schemes), strengthened anti-poaching efforts, community conservancies for ecotourism and conservation easements

The Wildlife Easement Programme is a tool for furthering sustainability of wildlife conservation by restricting human activities that are not compatible with wildlife conservation. An environmental lease is a voluntary legal agreement between a landowner and a land trust or government and a negotiated compensation value is given to the landowner for any loss or diminished value. In 2011 Hon. John Keen signed the first easement deal with KWS whereby part of his land was given to Nairobi national park. Apart from the above innovative programmes, a **Land Use Master Plan (LUMP)** was initiated by various stakeholders including the Kenya Wildlife Services (KWS) in 2011 due to the rapid land use changes outside the park. The LUMP is Kenya's first ever land-use plan for a pastoral area. Once implemented it will help balance economic development and range conservation (Matiko, 2014).

The plan allows only land uses that are compatible with open livestock/ wildlife grazing and consists of different zones that will control unsustainable land use in the area, for example Zone A, includes areas around NNP (5 km from the park boundary) up to the sheep and goat ranch and areas around the Kitengela-Isinya and Isinya-Kiserian roads. This zone has existing developments and has relatively small parcels of land. Developments will be controlled through compulsory land acquisition. Then zone B, which consists of the rest of the interior of Kitengela

that contain relatively large parcels of land and has little developments (KWS, 2005). This will be controlled using WCLP mentioned earlier. According to research scientist Dr. Ngoru, the LUMP is just words on a piece of paper, implementation has become very challenging, in order to keep the migration connections alive the relevant stakeholders should hasten the implementation process with the urgency it deserves. Without the wildlife migration routes the animals in the park will be affected greatly.

In addition, establishment of more connecting conservancies (from the park to the dispersal areas) seem to be the best remaining sustainable option to rescue these critical lands that are key to the survival of Nairobi national park.

4.1.5 CONTROL OF INVASIVE AND EXOTIC SPECIES

An invasive species is non-native to the ecosystem and whose introduction causes or is likely to cause environmental harm. Invasive exotic species can reduce forage resources for animals and cause changes in habitat structure by reducing regenerative capacity of indigenous species. The following are some of the exotic plant species identified in the park, the *Eucalyptus spp* found next to the animal orphanage and opposite the Wildlife Clubs of Kenya and the *Dovyalis caffra* (Kei apple) at the Kingfisher area were planted by the park management in the early 1950s. The Cactus (*Opuntia sp.*) and *Lantana camara*, are exotic invasive species, they pose a serious threat to the indigenous park species. The park management had planned for a total eradication of the species but that was not achieved. In 1998 David Sheldrick Wildlife Trust made funds available for the control of cactus species in the park because herbicides were not being used, plants were removed naturally and dumped elsewhere; unfortunately funds were insufficient to eradicate the cactus species thus it became unmanageable and a nuisance (KWS 2005).

According to the 2005-2010 Management plan all exotic species except for the Kei apple were to be eliminated from the park manually and be replaced by indigenous species. Both the KWS and FONNAP members do the removal of invasive species. As observed 63.6% of KWS staff (Table 4.1.1) mentioned that any management practice conducted within the park is done in accordance with the regulations under the management plan of the park. But that is not the case on the ground. For example the removal of exotic tree species from the park and replacing with

indigenous species by 2010 didn't happen as the park still has exotic tree species of Eucalyptus. Failing to accomplish such activities was due to lack of funds and changes in priority of different KWS activities, at the moment park security is a priority and all funds are directed in that direction, so the removal of invasive species activities are set aside for a later period according to Dr. Ngoru, research scientist.

In a study done by Yusuf *et.al*, (2013) on the Impact of *Lantana camara* on the abundance of native plants in Nairobi national park, the outcome of the study indicated that *Lantana camara* has significant harmful impact on indigenous plant species and could progressively decrease the endemic species within the park, which are the major source of feed for the herbivores in the ecosystem. Such plants have repeatedly become vicious in modifying the habitat structure by reducing biodiversity, decreasing productivity, degrading wildlife habitats and relocating native species (Davies 2011). This can be a likely risk in an ecosystem like Nairobi National Park which is expected to provide sustainable grazing land for its increasing animal population (Tracy & Sanderson 2003). The incursion of L. camara in Nairobi national park is a grave conservation challenge, which requires to be addressed at once since such invasion has harmful impact on species abundance, diversity and could eventually degrade the quality of the habitat.

Table 4.1.1: Nairobi National Park Management Practices

Nature of Management Practices / Techniques	%
Structured (follow laid down laws)	63.6
Unstructured (problem – solution)	25.0

4.1.6 FENCING THE PARK

With options of fencing looming over the park, conservationist are not having that and intend to fight for other options such as creation of a buffer zone outside the park. Restricting wildlife movements to and fro the dispersal area in the face of extreme climate variations and upsurge of developments outside the park is most likely to affect their population numbers and eventually extinction of such species. The park was fenced as early as the 1970s using an electric wire fence

on the North, East and West side, maintenance of the fence has been taking place over the years. Not forgetting other conservation projects such as, the Nairobi Greenline that was launched on 18th February 2010. The Kenya Association of Manufacturers (KAM), KWS among other corporate organizations came up with a joint initiative of planting a 30km long and 50m stretch of indigenous forest trees, which has been a success and continually shields NNP from the growing metropolis.

Despite the above initiative, Kenya Wildlife Service seeks to fence the park entirely (an ongoing debate), which will compel all the wildlife to reside in the park all year long and consequently be protected from the fast growing populace and developments exterior to the park. Several scientists and NNP stakeholders oppose this idea on the scientific basis that isolating the park from its surrounding ecosystem will lead to in-breeding of wildlife, thereby passing on recessive genes, hence a breed of less fit species, which will easily go extinct. Also, wildlife numbers are likely to increase resulting to overpopulation thus degrading the park's environment (Theory of the Island biogeography). As per Dr. Ngoru, research scientist, Lake Nakuru National Park is a good example of a fenced park whose effects as a result of the isolation are very disappointing, the animal population numbers have greatly reduced, which subsequently led to decreased tourists numbers within the park hence lack of revenue for the country as a whole.

Fencing further magnifies the effects of climatic extremes such as droughts on migratory wildlife, for example the fencing of Namibia's Etosha national park (Berry, 1997) and Kruger national park in South Africa (Whyte and Joubert, 1988) led to dramatic declines of the migratory Wildebeest populations. Thus increasing restrictions on wildlife movements in the AKP in the face of climate change such as rising temperatures and droughts is most likely to exacerbate their population declines and probability of extinctions of extinctions (Thomas *et. al* 2004). Complete isolation of the park from the AKP and confinement of Wildlife in the 117 sq km park can be expected to further accelerate Wildlife population declines and species extinction in the park based on predictions of non-equilibrial island bioeographic theory and species – area relationship unless urgent, decisive and resolute steps are taken to halt the current trends of AKP land use (Newark, 1996 2008; Woodroffe and Ginsberg 1998; Brashares *et.al* 2001). With case

studies as above, why should we turn a blind eye in the name of economic developments for NNP?

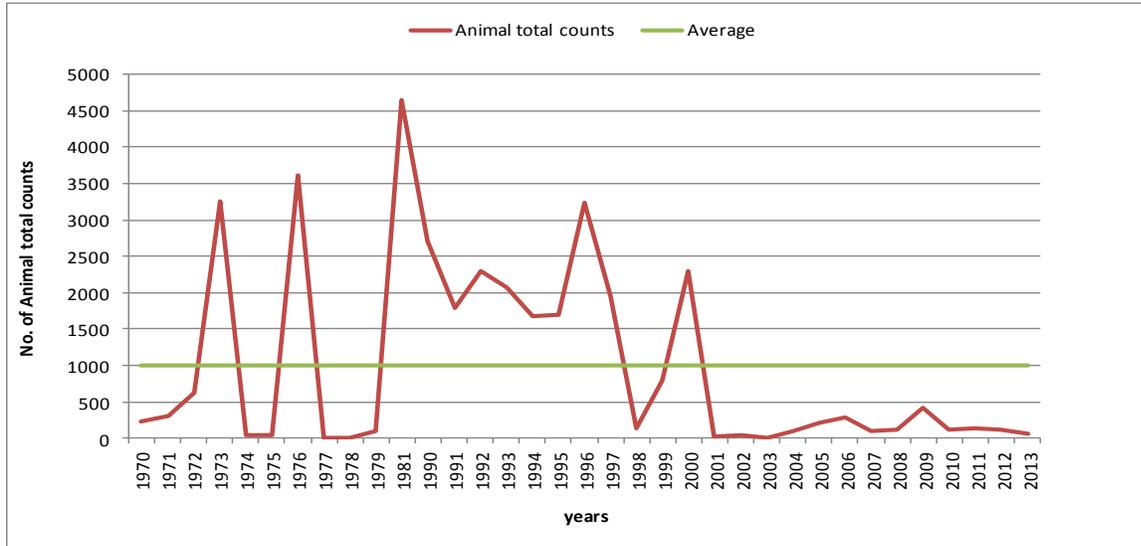
4.2 SELECTED LARGE ANIMAL POPULATION TRENDS 1970-2013

The secondary animal data used was of a 5 year decade period and consisted of selected 14 large animals both herbivores and carnivores in NNP. They include: Herbivores: {Wildebeest (*Chonochaetes taurinus*), Burchell's zebra (*Equus burchelli*), Kongoni (*Alcelaphus buselaphus cokei*), Eland (*Taotragus derbianus*), Buffalo (*Syncerus caffer*), Grant's gazelle (*Nanger granti*), Thomson's gazelle (*Eudorcas thomsonii*), Impala (*Gepyceros malampers*), Giraffe (*Giraffe camelopardolis*) and Black rhinoceros}. The Carnivores: {Lion (*Panthera leo*), Cheetah (*Acynomix jubatus*), Leopard (*Panthera pardus*), Spotted hyena (*Crocuta crocuta*) and Black-backed jackal (*Canis mesomelas*}.

4.2.1 HERBIVOROUS SPECIES (Wildebeest and Burchell's zebra)

A wide range of herbivores in NNP are migratory with the wildebeest and zebra being most conspicuous. There was a notable decrease and variations from the mean (1034.06) of the total population number of the Wildebeest (Fig 4.2) as per the data values. Similarly a study done by Ogutu *et.al* (2013) indicated that Wildebeest numbers within NNP ecosystem dropped from 30,000 in the 1970s to 16000 in the 1980s. The highest Wildebeest population (Fig 4.2) in the park was approximately 4630 as observed in 1981 within NNP. This high population was due to the previous extreme droughts in the 1973-1974 and 1975-1976 that saw a high influx of Wildebeest in the park for the purpose of refuge, and access to artificial watering points. Droughts were also experienced in 1961, 1983- 1984, 1993-1994, 1996, 1999-2000s and 2008-2009 where similar influx into the park was observed. The lowest population count was in 1977,1978 and 2003 with 6, 0 and 1 species recorded respectively (Fig. 4.2), this extremely low count was observed after the 1975-1976 and 1990-2000 drought respectively. These droughts led to drying up of the watering points, man-made dams and river Mbagathi.

A Wildebeest (Intervariation) trend line graph shown below:

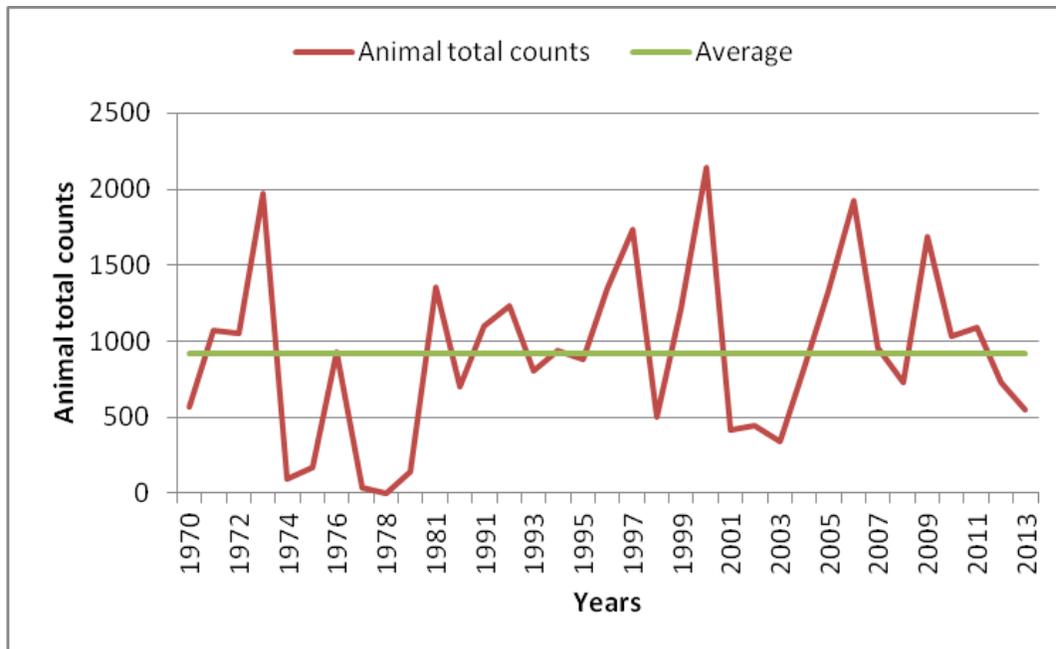


Source: KWS data.

Figure 4.2: Intervariation within the Wildebeest population trends 1970-2013

Wildebeest populations among other ungulates declined during the droughts due to poor physical condition and a lowered immune system caused by malnutrition (Hillman and Hillman, 1977). Also the low counts were as a result of death of the Wildebeest calves that were vulnerable to drought conditions (Casebeer and Mbai, 1974). During the 1997-1998 El Nino, the population within the park decreased due to movements out of the park to safer areas. The continued low counts were observed as from 2000 to 2013 (Fig 4.2) which was exacerbated by the changing land use activities in the AKP which affected their routes to the plains during breeding, calving and wet seasons. Also in 2005 cases of killing and hunting of Wildebeest calves by domesticated dogs and community members on the AKP with the intention to reduce the likelihood of transmission of the Malignant catarrhal fever to their livestock and also wildlife cropping within the AKP ranches lead to a decline in their population numbers during this decade.

An (Intervariation) trend line graph for the Burchell's Zebra below.



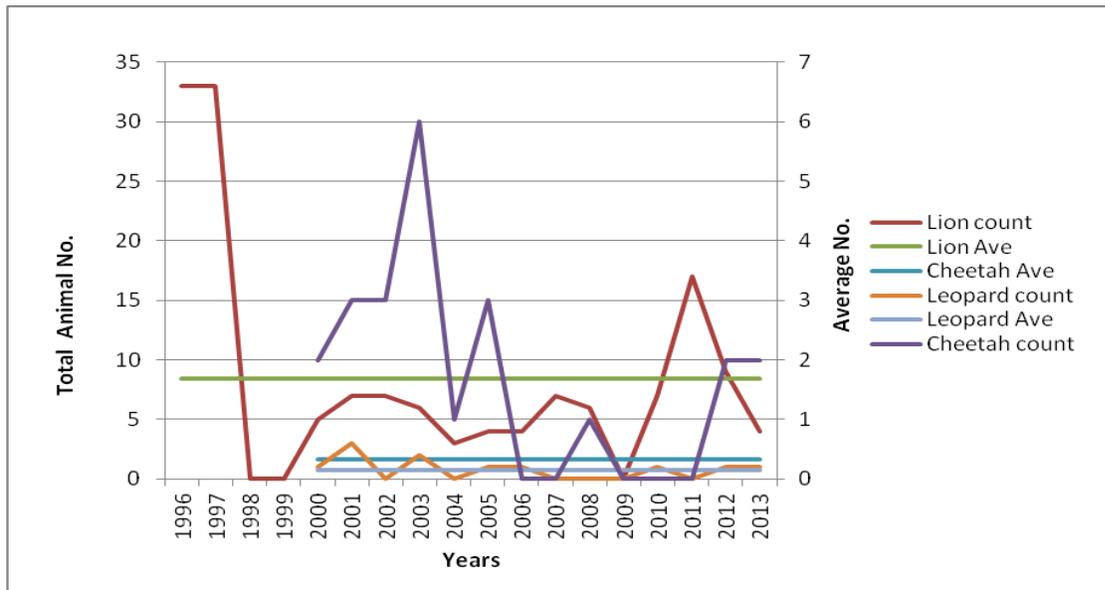
Source: KWS data.

Figure 4.3: Intervariation of the Burchell’s zebra population trends 1970-2013

The data values (Fig 4.3) indicated a uniform fluctuation of the population numbers of the Zebra with a mean of 941.79. This was as a result of various factors like pastoralists in the AKP been more tolerant of Zebras because they don’t transmit diseases to their domestic cattle and also their meat is not favored by many of the locals, also the Zebras find their way around the fences erected in the AKP easily thus avoiding poachers (Nkedianye, 2004). Nevertheless, in some instances the land use changes in the AKP did affect their mobility and flexibility. The 1970s indicated some variations in the numbers as a result of droughts and wildlife cropping that occurred within the private ranches. In addition, compared to the Wildebeests, the Zebras were more resistant to the deteriorating habitat conditions and rebounded after the severe drought of 1975 to 1976 and 1999 to 2000, where in 2000 the park saw the highest recorded (Appendix V) zebra numbers (2142). On the other hand, the drought that led to the Zebra moving out of the Park to the AKP created competition between livestock, humans and other wildlife due to limited resources.

4.2.2 CARNIVORE SPECIES (Lion, Cheetah and Leopard)

A Lion, Cheetah and Leopard trend line graph shown below:



Source: KWS data.

Figure 4.4: Carnivore species² population trends 1970-2013

Lion (*Panthera leo*) records for 1970s and 1980s were not available. The Lion population with a mean of 8.44 was highest in 1996 and 1997 (Appendix VI) with a total of 66 (Fig 4.4) this was greatly experienced during the 1996 drought that led to an influx of migratory herbivores in the park, availability of prey inside the park led to the increase of the pride. The Lion population numbers varied along the climatic seasons. During the El Nino rains in mid October 1997 (Trenberth and Hoar 1996, 1997) 39 Lions trailed migratory herbivores into the Athi Kaptuei Plains only 12 returned. Lions move out of the Park due to scarcity of their natural prey, in their hunting mode state they end up attacking and killing livestock from the local farms and households (bomas) in their search for prey. This leads to community members retaliating by killing the predators.

According to Rudinai (1974) a further 11 lions were killed in 2003 because of livestock depredation. In 1998, 1999 and 2009 none were spotted in the park (Fig 4.4). In 2003 FoNNaP

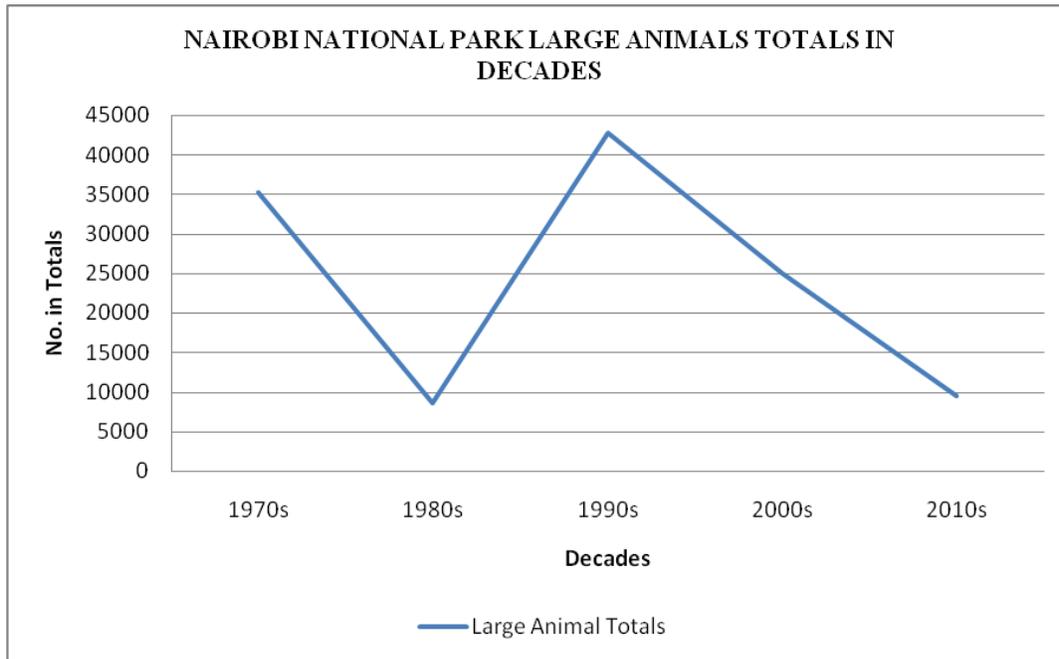
² Lion , Cheetah and Leopard

and The Wildlife Foundation set up a consolation program to pay off livestock owners who had lost their livestock to predators (Lion, Cheetah, Leopard and Crocodile). As a result of the consolation programme the park experienced an increase in the Lion population from 7 to 17 in 2011 (Fig 4.4). According to a research done by Michael Mbithi and David Mascall 2011, the program indicated some success in that human- wildlife conflict within Kitengela area had reduced. Apart from the successes, the program faced several challenges, which were partially salvaged by the famous Richard Turere's Lion Lights Invention a year later. The lights act as a preventive management measure in that the lights are installed in each household (boma) within the Kitengela dispersal area. The lights flicker on and off thereby scaring away stray Lions and eventually saving livestock and preventing Lion depredation. Despite the introduction of the Turere's lion lights, the Lion population declined in 2012 and 2013 due to low prey numbers and also killings that happened outside the park by few community members who were disgruntled of the poor compensation pay, delayed payments from the consolation programme and negative attitude towards wildlife management and conservation.

Compared to Lions, cheetahs (*Acynomix jubatus*) and Leopard (*Panthera pardus*) population is more or less underestimated, not much records/data are available for NNP. The highest Cheetah total population number occurred in 2003 with only 6 recorded having a mean of 1.64 and in some instances no Cheetah was spotted in the park (Fig 4.4). The Leopard population numbers had a mean of 0.79; the population barely rose to 3 in 2001. For much of the years (2002, 2004, 2007, 2008, 2009 and 2011) no Leopard was spotted (Fig 4.4). According to Mutero senior scientist Geographic Information System (GIS), the two cat species (Cheetah and Leopard) have unique habitat behaviors and can go for years without been sighted in the park. As observed their population declined in 2000s – 2013, the decline could have resulted from decreased prey during the wet season or competition from other carnivore species. Cheetahs generally live in low densities - thus having difficulty maintaining a viable population. According to Laurenson (1994) findings on the low Serengeti Cheetah population was due to predation of its cubs by Lions and Hyenas. Leopards are solitary animals and not much research has been done on them.

4.2.3 POPULATION TRENDS OF SELECTED LARGE ANIMAL NUMBERS

Below is a large animal (Wildebeest, Burchell's zebra, Kongoni, Eland, Buffalo, Grant's gazelle, Thomson's gazelle, Impala, Giraffe, Black rhinoceros, Lion, Cheetah, Leopard, Spotted hyena and Black-backed jackal) trend line graph:



Source: KWS data.

Figure 4.5: Population trends of selected large animal 1970-2013

Overall, as observed 93.2% and 100.0% of KWS staff and FoNNAP respondents respectively felt that overtime the park has experienced some changes in the large animal population numbers. And a further 86.4% of KWS staff and a 100.0% of FoNNAP claim the change was a decrease.

In the 1970s -1980s the population dropped from approximately 35,000 to 8,600 (Fig 4.5). This was the time when the 1976 Wildlife Conservation and Management Act came into effect, the Act had some challenges in that the penalties stipulated did not act as a sufficient deterrent to poachers and other wildlife traffickers, also compensation fee for livestock losses, damage and attacks was minimal and benefit sharing and participation by community members was not

clearly spelt out. Subsistence and commercial poaching occurred during this time affecting the rhino and zebra population. The 1973-1974, 1975- 1976 and 1983-1984 droughts led to a decline of animal population like the Kongoni (Coke's Hartebeest), wildebeest, Zebra, Eland, Grant's gazelle, Thomson's gazelle, Impala and Giraffe. The Kongoni had the highest mortality that killed 80% of their population followed by wildebeest and Zebras (Casebeer and Mbai, 1974; Hillman and Hillman, 1977). As observed no record totals for the large carnivores (Lion, Cheetah, Leopard, Spotted hyena and Black-backed jackal). Also the total Wildebeest and Burchell's zebra population declined in the 1970s to 1980s from approximately 8200 to 4630 and 6020 to 1350 respectively.

The early 1990s experienced the highest population numbers approximately 42,800 (Fig 4.5), with the formation of the KWS, new administration, whose role was to safeguard and conserve Kenya's wildlife and the relevant Management plan in place for the Park, the animal numbers rose. Also most of the migratory species and non-migratory species concentrated in the Park during the dry season making it easier for the predators to access prey within the Park. As observed in the late 1990s to 2000s the population was declining from approximately 42,800 to 25,000 (Fig 4.5) due to the 1999-2000 drought that befell the Park, most animals could not recover from this, also the 1998-2000 El-Nino floods that led to the exit of most of the Ungulates from the Park. As observed no totals for the large carnivores (Cheetah, Leopard, Spotted hyena and Black-backed jackal) except for Lions were recorded in the 1990s to 2000s. The late 1996 to 1997 a disease "cattle plague" was detected in the park during the drought. Rinderpest, a viral infection from livestock, infected both the Buffalo and Eland species affecting their populations negatively, which took number years to recover.

As observed in 2000s - 2010s the total population declined from 25,000 to 9,550 respectively (Fig 4.5). It was observed from the appended animal data that exhibited a decline for each species except for the Black backed jackal (Appendix VI) where an increase was observed, most probably because of its omnivorous nature thus enjoying a diverse diet. Kongoni were not spotted in the park at the start of 2005 to 2013. Reasons for animal decline during this decade should not be placed solely on natural factors and climatic seasons changes. Man has equally if not to a larger extent, played a vital role of blocking dispersal routes as witnessed by the rapid

land use changes occurring at the southern part of the park such as: Increased fencing among the private ranch owners and land owners; Increased settlements (plate 1) due to rise in population; Construction of roads, culverts, (plate 2), open quarries and mines (plate 3) leading to wildlife accidents and death; Cultivated farms and other man- made barriers. Wildlife require their dispersal areas to ease their reach for food, breeding areas and surface water especially for species like the Elands, Wildebeest and Kongoni populations.



Plate 1: Residential houses along the southern by-pass



Plate 2: Culverts next to the Park's fence along the southern by-pass



Plate 3: Quarrying activities outside the Park.

Such blockage effects intensify competition for resources between the community, livestock and wildlife, which results to conflicts and death of the carnivore species especially the Lion population as observed in the early 2000s. The population decline was also as a result of wildlife cropping, which took place in the private ranches that were not fenced in the Kitengela dispersal area in the late 2003. According to Senior Scientist, Mr. Kenana, much has been done in terms of discussions, forums with relevant stakeholders on ways to fully recover the dispersal area and eventually have it under the KWS jurisdiction.

4.2.4 PREDATOR (LION) – PREY (WILDERBEEST AND ZEBRA) RELATIONSHIP

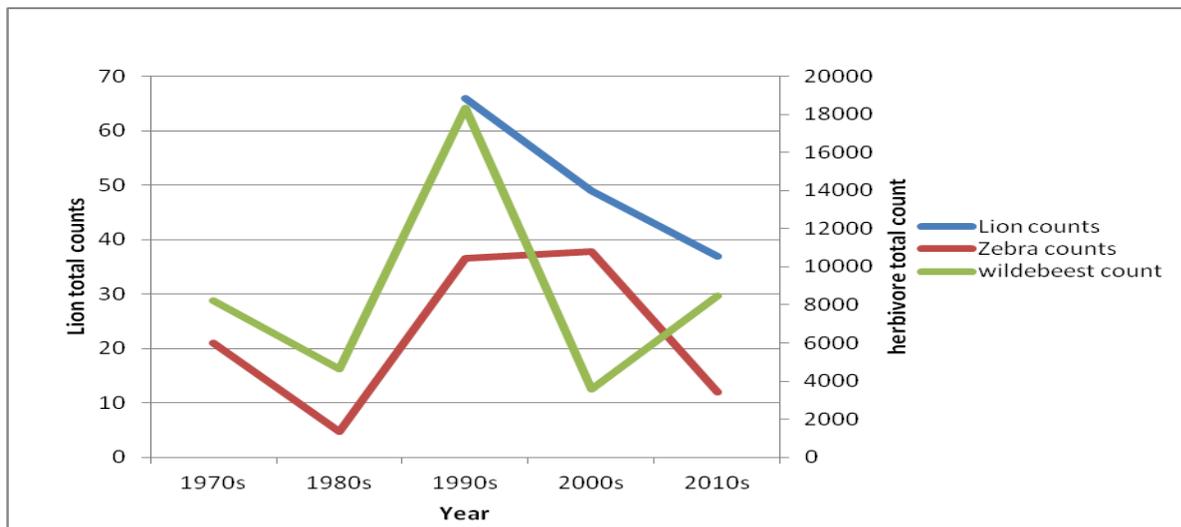
Predator and prey evolve together and the prey forms part of the predator's environment. The relationship between predator and prey has a crucial role to play when it comes to ecological balance. Approximately 70% of the KWS staff said that the Predator – Prey balance was good (Table 4.2) implying the existence of equilibrium on both sides, though there is no- scientific evidence to prove of such equilibrium in NNP.

Table 4.2: Predator- Prey relationship

Ratings	%
Very good	4.5
Good	70.5
Poor	2.3
Very poor	11.4

Figure 4.6 illustrates a simple example of a Lion (predator) and its preferred prey (Wildebeest and Zebra). In order to survive and balance out the predator and prey, the Lion has evolved in speed, stealth, camouflage, a good sense of smell and sight so as to stalk, capture and kill its prey. On the other hand, the Wildebeest and Zebras over the years have evolved to graze in large herds that lead to increased group vigilance (Hamilton, 1971) and a confusion effect when attacked by a Lion or a Pride.

Predator- Prey relationship trend line graph shown below:



Source: KWS data.

Figure 4.6: A Predator (Lion) - Prey (Wildebeest and Zebra) relationship 1970-2013

According to senior warden Nairobi National Park, Nelly Palmaris the Park has never employed any man-made techniques to manage or balance the Predator and prey. The management prefers to let nature take its course and eventually the fittest would survive. This is not the case for one Kruger national Park, whereby the Zebra population was cropped after over utilization of vegetation in 1972 and later the wildebeest species were cropped (Smuts, 1982). This led to an increase of Lions numbers, which were later harvested so as to allow the Wildebeest population to recover. This is an amazing example of the management techniques used to maintain a proper balance within the predator- prey relationship and ecosystem as a whole.

4.3 DATA ANALYSIS

4.3.1 Regression Analysis

A multiple regression analysis was conducted to establish the relationship between the various ecosystem conservation and management approaches and the population numbers of animals (Burchell’s Zebra and Wildebeest) at Nairobi national park.

Table 4.3: Regression Model Summary

Model	R	R Square	Adjusted R Square	Standard error of the Estimate
	0.942 ^a	0.889	0.748	3.014

a. Predictors: (Constant), Fencing, Maintenance of the Kitengela area, Translocation, Re-stocking, Prescribed burning

The (table 4.3) is a regression model summary that establishes how fit the model equation fits the data. The adjusted R² was used to establish the predictive power of the study model and it was found to be 0.748 implying that 74.8% of the variations in population numbers of animals (Burchell’s Zebra and Wildebeest) at NNP were explained by the various ecosystem conservation and management approaches such as translocation, re-stocking, maintenance of the Kitengela area, prescribed burning and fencing leaving 25.2% unexplained. Therefore, further studies should be done to establish the other factors (25.2%) affecting population numbers of animals at NNP.

Table 4.3.1: Coefficients of regression

Model		Unstandardized Coefficient		Standardized Coefficients
		B	Std. Error	Beta
1.	(Constant)	1.403	0.538	
	Translocation	0.768	0.139	0.601
	2. Re-stocking	0.631	0.094	0.556
	3. Maintenance of the Kitengela area	0.364	0.232	0.106
	4. Prescribed burning	0.893	0.13	0.639
	5. Fencing	0.576	0.104	0.459

The Unstandardized coefficients (B) are the regression coefficients. The standard errors are the errors of the regression coefficients. The standardized coefficients (Beta) are what the regression coefficients would be if the model were fitted to a standardized data.

a. Dependent Variable: No of animals

b. Independent Variable: translocation, restocking, maintenance of the Kitengela area, prescribed burning and fencing.

The established model for the study was:

$$Y = 1.403 + 0.768X_1 + 0.631X_2 + 0.364X_3 + 0.893X_4 + 0.576X_5$$

The regression equation above has established that taking all the considered factors into account at a (translocation, re-stocking, maintenance of the Kitengela area, prescribed burning and fencing) constant zero, the population numbers of animals (Burchell's Zebra and Wildebeest) at NNP will be 1.403 at 95% confidence level (table 4.3.1).

The findings presented in (table 4.3.1) also show that taking all other independent variables at zero, a unit increase in translocation would lead to a 0.768 increase in population numbers of

animals at NNP and a unit increase in re-stocking would lead to a 0.631 increase in the population numbers of animals at NNP.

Further, the findings shows that a unit increase in maintenance of the Kitengela area would lead to a 0.364 increase in population numbers of animals at NNP while a unit increase in prescribed burning would lead to a 0.893 increase in the population numbers of animals at NNP when all the other factors are kept constant. In addition, the findings (table 4.3.1) show that a unit increase in fencing would lead to a 0.576 increase in population numbers of animals at the park.

In terms of magnitude, the findings (table 4.3.1) indicated that prescribed burning had the highest influence on population numbers of animals at NNP- in that both the Wildebeest and Zebra are grazers and tend to flock within areas in the park that bear luscious green vegetation especially after a controlled burning of vegetation, followed by translocation, then re-stocking and fencing in order of decreasing strength while maintenance of the Kitengela area had the least effect on population numbers of animals at NNP. All the variables were significant as their P-values were less than 0.05.

4.3.2 Hypothesis Testing

The null hypotheses imply that the variables- ecosystem conservation and management techniques/approaches and population numbers of animals (Burchell’s zebra and Wildebeest) are independent of each other. The study wanted to find out whether there was any notable relationship between ecosystem conservation and management techniques/ approaches and population numbers of animals.

Table 4.3.2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	52.081	9	0.000

The calculated Pearson Chi-Square value is 52.081 (table 4.3.2). The associated P-Value (Asymptotic significance) is 0.000. This value is less than 0.05 (5% level of significance) indicating that there is evidence against the null hypotheses and therefore we reject it and adopt the alternative hypothesis. A conclusion can be drawn from the study that ‘ecosystem

conservation and management techniques/ approaches affect population of animals (Burchell's Zebra and Wildebeest) over time at Nairobi National Park.

4.4 EXISTING OPPORTUNITIES FOR THE PARK

69.2% and 50% of the respondents from Friends of Nairobi National Park (FoNNaP) and KWS respectively (Table 4.4) felt that a well equipped park and its personnel in terms of technology would aid in the park's conservation. Technology such as modernized surveillance cameras and binoculars, computer systems for data input, portable radio handsets for communication with other security wardens, vehicles for eased movement and guns for protection purposes as well a shooting down the poachers.

On the other hand, both FoNNaP and KWS agree (Table 4.4) that if wildlife laws are properly implemented and enforced it would improve the park's management and conservation. Implementation can take off once the necessary regulations are in place. The Wildlife Act 2013 has some of its sections (Compensation; Access, incentives and benefit sharing; Licensing to trade or Engage in Wildlife use; Wildlife security operations and finally Activities in the National parks, community participation, and protection of endangered and threatened ecosystem, habitats and species.) lacking regulations thus delaying the implementation process. In the case of NNP, KWS together with the relevant bodies should hasten the process. KWS has for the first time involved FoNNaP in the formulation process of the new NNP Management plan (2015-2020), where FoNNaP took the lead role in NNP park management committee. This has fostered a stronger relationship between the two conservation bodies, which should continually reflect beyond the implementation and enforcement of the laws.

56.8% and 53.8% of KWS and FoNNaP (Table 4.4) respondents respectively, strongly agreed that conducting game counts and monitoring of species would definitely aid in conserving the Park. FoNNaP is involved in the monthly game counts within the park just as much as KWS. This monitoring of species would enable park Managers know which species are on the decline or on the increase and device appropriate ways to manage such affected populations. There is need for a wildlife inventory database for the park, to avoid future data gaps and relying on individual's memory.

Table 4.4: the Level of agreement or disagreement for an improved managed Park

Nature of Opportunities	%							
	SA		A		UD		D	
	Kws	Fonnap	Kws	Fonnap	Kws	Fonnap	Kws	Fonnap
A well equipped Park ecosystem with proper Technology will improve the park's conservation	43.2	30.8	50.0	69.2	2.3	0	0	0
The government's conservation policies greatly impact the park's operation	22.7	30.8	65.9	61.5	2.3	7.7	6.8	0
An efficient welfare system for KWS staff	22.7	46.2	56.8	53.8	4.5	0	13.6	0
Visitor entry in the park should be controlled.	9.1	30.8	31.8	61.5	18.2	7.7	38.6	0
Conducting counts and monitoring of Species (flora and fauna).	56.8	53.8	40.9	46.2	0	0	0	0
The Wildlife Conservation Lease Program has led to the Acquisition of the Kitengela dispersal area	9.1	38.5	11.4	53.8	20.5	7.7	54.5	0

According to 56.8% and 53.8% (Table 4.4) KWS and FoNNaP respectively felt that KWS staffs' require an efficient welfare system, which is well supplemented in the 2005- 2010 management plan for NNP, where all staff members are encouraged to be members of Nairobi Park Welfare Association (NAWA), which mainly supports members who have financial problems and other welfare matters like health and processing of leave approval allowances. This offers a sense of care and reassurance, which stems into an efficient workforce that can manage the park.

31.8% KWS staff and 61.5% of FoNNaP (Table 4.4) respondents felt the need to control visitor entry into the park to prevent degrading the environment and overcrowding around animals and feeding them which stresses the animal and lead to change in animal behavior which can pose as a danger to visitor. Only 15 vehicles are allowed in the park in relation to its size and carrying a visitor for a free ride is not allowed as was initially in the 1970s. Such controls would enhance security of the visitors, monitoring of the visitor’s activities and Management of the animals and conservation of the environment.

53.8% of FoNNaP agreed that the Wildlife Conservation Lease Program (WCLP) has led to the Acquisition of the Kitengela dispersal area while 54.5% of KWS staff disagreed (Table 4.4). Despite the high enrollment with WCLP, it has shown to be unsustainable, it’s short term and thus once the funds run out the programme would collapse. Other options need to be looked into like the Easement program, wildlife conservancies and also encourage members to participate in the county local land use planning initiatives.

Table 4.4.1: Priority for the Park Management Programmes

Management Programmes	High %		Medium %		Low %	
	KWS	Fonnap	KWS	Fonnap	KWS	Fonnap
Increased funding management	84.1	100.0	11.4	0	0	0
Research and Monitoring	86.4	84.6	6.8	15.4	2.3	0
Policies /legal frameworks	34.1	61.5	38.6	30.8	20.5	7.7
Staffing/Recruitments	29.5	76.9	56.8	15.4	6.8	7.7
Personnel Training	22.7	84.6	65.9	15.4	4.5	0
Community Education /Awareness	65.9	92.3	22.7	7.7	6.8	0
Deployment of Technology	75.0	100.0	15.9	0	2.3	0

Policies and legal frameworks were ranked both as a high priority and medium priority by 61.5% FoNNaP and 38.6% KWS staff respectively (Table 4.4.1). Most of all KWS Key informants mentioned that various wildlife and Environmental laws and regulations exist and hence no need for more laws, the focus should be on the implementation and enforcement of the already existing laws by the relevant officials. Also once the new NNP Management Plan 2015-2020 is finalized, the park managers should ensure that all the activities stated in the Plan are accomplished within the stipulated time lines. There is need to invest in enforcement of laws rather than drawing new ones.

Recruitment of new KWS staff members and training of Personnel was ranked a high priority, 76.9% and 84.6%, by FoNNaP respondents and medium priority, 56.8% and 65.9%, by KWS staff respectively (Table 4.4.1). The KWS has a huge number of temporary and casual workers who are waiting to be absorbed by the Service; this is coupled by the fact that office space is lacking. Within the Headquarters three quarters of the staff are non-uniformed while the rest are uniformed staff members. The service should invest in training of its staff members so as to build their capacity in different areas. The NNP has four senior wardens and a number of rangers, though this number is said to be small compared to the 117km sq. park. There is need to absorb dedicated conservationists and temporary workers who are well trained and equipped by the Service.

Increased funding was ranked a high priority (Table 4.4.1) by both KWS staff and FoNNaP respondents. Funds are used for research and monitoring purposes, community educational outreach programmes, purchasing of technological equipments and increasing capacity (staffing). Deployment of technology to enhance and facilitate NNP conservation activities was ranked a high priority (Table 4.4.1) by both KWS staff and FoNNaP respondents. Introduction of a new technology is dependent on the availability of funds and the urgency of the situation. At the moment Poaching is an urgent issue so funds have been set aside to purchase the relevant technology to curb the menace such as drones, hi- tech cameras and binoculars. There is also need to develop a database for NNP that will be efficient and easy to retrieve. The President Uhuru Kenyatta at the KWS Headquarters recently launched a forensic laboratory for wildlife, this great addition will aid in the Management and conservation of Wildlife.

Research and Monitoring was ranked as a high priority as well, (Table 4.4.1) reason been the Park can only be effectively managed if proper research is carried out by KWS in collaboration with other learning institutions and organizations. As indicated in the NNP Management Plan 2005-2010 research studies in and outside the Park have aided in the analysis of wildlife population dynamics and movement patterns and also aid in the reduction of human –Wildlife conflicts within Nairobi National park ecosystem. Also research on Habitat utilization has provided useful information that would be used in habitat management programs. The Management Plan points out that such research studies would be able to identify the causes of animal decline and also provide information on species population, health status, mortality rates, sex ratios, and their seasonal change. This information would be an indicator of population stability. In the 1980s studies on rhino home range sizes within the park were conducted and now rhinos are well managed within the park. Research on other individual species is vital, the findings would aid in the wildlife management.

Monitoring within the Park is vital; KWS in collaboration with FoNNaP have been conducting bi-monthly wildlife censuses in the Park. Apart from the ground counts, there is need for continued aerial survey on vegetation and animal distribution in the ecosystem. The water sources quality close to the Park require constant monitoring for pollution levels from the industries and institutions, thus the need to liaise with NEMA to enforce EMCA Act 2015 requirements on pollution. According to Kenana, Senior research scientist, on-going monitoring activities involve: Collaring of mature Lions within the Park so as to monitor their behavior and movements, blood is also drawn out to check the health status. Also periodic ear notching of newborn- rhino calves is done. On habitat management, the manual removal of invasive species by FoNNaP and KWS is an on- going process; discussions are underway among KWS scientists on whether to adopt biological methods as a way to control invasive species. Regular Clean-ups within the park by KWS and FoNNaP were restarted last year and proper waste management systems have been employed in the Park so as to ensure its sustainability.

Community education and awareness was ranked a high priority in ensuring conserved NNP (Table 4.4.1) by both KWS staff and FoNNaP respondents, NNP is managed using the

ecosystem approach of Management, whereby the neighboring community members to the Park play a big part when it comes to conservation of Wildlife. Being close to the Park does not mean that the community members are informed on matters concerning Wildlife. It requires efforts from the KWS through the Community Wildlife Service Department and other Non-governmental bodies like FoNNaP to educate and raise awareness on various issues that would affect and enhance the park's Conservation. Both FoNNaP and KWS work together when carrying out- reach programmes to schools, tertiary institutions, and village forums. The Community Wildlife Service department is also using conservation education to create awareness among policy makers, landowners and local communities who are involved in wildlife conservation and management. The two bodies (KWS & FoNNaP) are seeking new ways through which all the stakeholders are involved in decision-making concerning the NNP ecosystem.

CHAPTER FIVE

5.0 SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

As observed both KWS staff and FoNNaP respondents mentioned that large animal total population since the 1970- 2013 had changed, and the change was a decrease. The causes of animal decline ranged from natural events like droughts, floods to man-made activities occurring outside the park, which have greatly affected the NNP migratory species especially during the wet season. Intensive land fragmentation, subdivision and fencing of the already subdivided land parcels have led to the blockage of the dispersal area. In addition, this has led to depredation of the Lions within the dispersal areas, but their numbers have recovered since then due to the introduction of the consolation programme, lion lights initiative and the Wildlife conservation Lease programme. Wildlife diseases such as Rinderpest in 1997 affected the buffalo population, also cropping of Wildebeest calves in the dispersal area affected their numbers. The park has never piloted a research on Predator- Prey relationship, thus lacking management techniques to balance such relationships but rather relying on nature to take its course.

The park management since the 1970 to 2013 has dealt with variations of large animal numbers in different ways but their end goal was to ensure that wildlife within the park was well conserved. From sport hunting restrictions to stiffer penalties for wildlife crime offenders such as illegal poaching which had affected the rhino population in the park overtime. The park management has in the fullness of time employed the same management techniques within the park like translocation, re-stocking of animal species and habitat management techniques (control invasive and exotic species) which has been carried out in the park manually. Despite the fact that prescribed burning was last achieved in 2007 due to internal debates on the relevance of the technique. It is important to conduct a scientific research on the effects of burning on herbivore populations and on the entire ecosystem. Nonetheless, other management options to be adopted are been thought through such as mowing, use of biological methods to control invasive species and lastly the creation of a buffer zone outside the park whose attributes are similar to those of the park that will allow for an alternative grazing section for livestock other than inside the park.

Both KWS staff and FoNNaP agreed that wildlife laws and management plans are vital for wildlife conservation in NNP. However FoNNaP respondents ranked wildlife policies and regulations as a high priority, 61.5%, and KWS staff ranked it as a medium priority, 38.6%, when it comes to conserving NNP. The differing views were that laws are already in place thus no need for more laws rather more focus should go into implementation and enforcement of those laws. Together KWS and FoNNaP strongly agreed that research and monitoring of animal species would definitely aid in maintaining the park in addition, it was also ranked as a high priority. Due to their reliance on funds, KWS role in community education and awareness, purchase and deployment of technology were all ranked as a high priority by most of the respondents for a conserved NNP.

5.2 CONCLUSION

It's visible that Nairobi national park animal numbers have varied since the 1970s to 2013, other than due to natural factors man also has played a critical part. For example in the 1970s the animal numbers were approximately 35,000. This numbers shot up in the 1990 (approximately 42,800), with entrance of the Kenya Wildlife Service. The population numbers took a dip in the 2000s to 2010s, i.e 25,000 to 9,550 respectively. The park managers have employed both species and habitat management techniques (Translocation, re-introduction, removal of invasive species, prescribed burning and the adoption of the WCLP as well as the easement programme) in out of the park overtime to ensure a balance in the ecosystem. It has been challenging in delivering the desired outcome due to lack of continuous funds, prioritization of the various activities, improved staff capacity and welfare structures as laid out in the management plan.

It's worth noting that the future well being and integrity of the park is widely recognized by conservationists to flourish on condition of a continued accessibility of the wet season dispersal area. The greater challenge therefore is to secure the Kitengela dispersal area and all migratory routes by the creation of a buffer zone and negotiating with the neighboring communities that will be affected by this a compensation fee will be offered. There is also a call for formation of new partnerships with all stakeholders, designing new and innovative management mechanisms

for conservation of wildlife in the dispersal area and development of new financing mechanisms to support these activities. The NNP management should not only focus on the outside but on the inside as well. More investment should go into research and monitoring, and more exploration should be done on the Predator- prey relationship within the park.

5.3 RECOMMENDATIONS

5.3.1 RECOMMENDATIONS FOR MANAGEMENT ACTIONS

1. Park management should ensure implementation of all the management strategies and programmes as prescribed in the management plan within the specified time frames.
2. Park management should undertake research, survey, monitoring and evaluation activities this will then inform the park managers when the systems are departing from the desired state.
3. Policy makers to hasten the process of formulating the necessary pending regulations as per the Wildlife Conservation and Management Act 2013, which once in place NNP will hopefully better manage its resources and its engagement with the community.

5.3.2 RECOMMENDATIONS FOR FURTHER STUDIES

In the event that KWS decides to fence the park or claim back critical parts of the Kitengela dispersal areas by creating a buffer zone outside the park, then there is need to conduct research on other possible areas like:

1. Habitat and species management approaches in order to supplement the already existing ones being employed in the park.
2. Predator- Prey relationship within the park, this would be of importance as it would aid in effectiveness of animal species Management.

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7.0 APPENDICES

7.1 APPENDIX I: Letter for a research permit at Nairobi National Park

KENYA WILDLIFE SERVICE 

ISO 9001:2008 Certified

KWS/BRM/5001

25 February 2014

Ms Clara Maria Kilaha
P.O.Box 10660-00200
NAIROBI
e-mail: clara.m.kilaha@gmail.com
mobile: 0728543094

Dear *Ms. Kilaha,*

PERMISSION TO ADMINISTER QUESTIONNAIRES ON ENVIRONMENTAL PLANNING AND MANAGEMENT IN NAIROBI NATIONAL PARK

We acknowledge receipt of your letter dated 25 February 2014 requesting for permission to administer questionnaires to KWS management staff on a project titled: '*An Assessment of Nairobi National Park Ecosystem Conservation and Management*'. The study will generate data and information to enhance conservation and management of Nairobi National Park and its environs.

You have been granted permission to administer the questionnaires from **March to April 2014**. However, you will abide by the set KWS regulations and guidelines regarding acquisition and dissemination of information. You will also be required to use the information for research and educational purposes only and that the information will not be passed to a third party without the consent of the Director-General KWS.

You will submit your MA thesis to the KWS Deputy Director, Biodiversity Research and Monitoring on completion of the study.

Yours *sincerely,*


SAMUEL M. KASIKI, PhD, OGW
DEPUTY DIRECTOR
BIODIVERSITY RESEARCH AND MONITORING

Copy to:

- SAD & Head Ecosystems & Landscape Management
- Head Planning & Environmental Compliance
- Senior Scientist, SCA
- Senior Warden, Nairobi National Park

P.O Box 40241-00100, Nairobi, Kenya. Tel: +254-20-6000800, 6002345. ISDN: +254-020-3992000/1000
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Email: kws@kws.go.ke Website: www.kws.go.ke

7.2 APPENDIX II: Questionnaire for Kenya Wildlife Service Staff

Dear respondent,

You have been randomly selected to participate in this research on an Assessment in Ecosystem Conservation and Management at Nairobi National Park. The information you provide is meant for academic purpose only. Thank you for our willingness to participate.

Instructions to the respondent

1. Please answer all questions
2. Please note that no answer is wrong and no answer is right, all answers will be treated As equal
3. The information gathered will be treated with absolute confidentiality

SECTION A: ORGANIZATION CHARACTERIZATION

1. Please indicate your **gender** (Tick as applicable)

Male []

Female []

2. Please indicate **years of working** at KWS (Tick as applicable)

Less than 1 year []

1-5 years []

6-10 years []

Over 10 years []

3. Kindly indicate your **department** within the KWS (Tick as applicable)

Planning, Assessment and Compliance []

Species conservation and Management []

Parks and Reserves []

Veterinary and Capture services []

Ecological Monitoring and Biodiversity Information Management []

Ecosystem and Landscapes Conservation and Management []

4. Please indicate your **position?** (Tick as applicable)

Senior warden [] Warden [] Assistance Warden [] Scientist [] Veterinary

Specialists [] Ranger [] Other _____

SECTION B: MANAGEMENT APPROACHES

1. Kindly state the **current size** of Nairobi National Park in Km²?

2. In your opinion, has the size of Nairobi National Park changed overtime? Yes[] No[]
3. a) If yes, kindly state which section of the park experienced such changes?.....
 b) And in which **year** did the change take place?.....
4. After how long were the below mentioned management techniques employed in the park overtime. Kindly indicate **1, 2,3,4,5 times....**or **0** (if it never happened at all) and Not Applicable (N/A) where necessary.

Management technique	1970s	1980s	1990s	2000s	2010s
Translocation					
Re-introduction of captive breeds to the wild					
Maintenance of the kitengela dispersal area					
Breeding in captivity					
Prescribed Burning					
Re-stocking					

Culling					
Fencing					

5. In your opinion, how would you **describe** the above mentioned management approaches?(Tick as applicable).**Structured** (follow laid down laws) []

Unstructured (problem- solution) []

6. How **many** management plans does Nairobi national park have?

b) Kindly state which management plan is **currently** been used by Nairobi national park.....

c) In your opinion do the goals and objectives of these management plans **change** overtime? Yes [] No[]

SECTION C: ECOLOGICAL CHANGES

1. In your opinion, has the total population of large animal species **changed overtime** (1970-2013)?

Yes []

No []

2. Kindly state in your opinion, the intensity to which the following factors have led to a decline in the numbers of large animal population in Nairobi National Park from the 1970- 2013. Fill in appropriately using: **High, Medium** and **Low**.

	1970s	1980s	1990s	2000s	2010s
Habitat Destruction					
Wildlife diseases					
Poaching (subsistence &commercial)					
Increased fencing					

Drought					
Land use changes (quarrying, settlements, flower farms)					
Invasive species					
Land fragmentation (subdivision of group ranches)					
Weather /climate changes					
Consumptive use of wildlife					
Livestock incursions					

3. Please indicate the type of species (**flora or large fauna**) and the decade that they were affected by the following factors.

Factors	Species (Flora or large Fauna)	Decade (1970s - 2010s)
Habitat destruction		
Invasive species		
Wildlife diseases		
Land use changes (quarrying, settlements, flower farms)		
Land fragmentation (subdivision of group		

ranches)		
Poaching (subsistence & commercial)		
Drought		
Human and livestock incursions		

4. In your opinion, how has the management of the Park dealt with the above causes of large fauna and flora decline and increase overtime (1970- 2013)

1970s.....
.....

1980s.....
.....

1990s.....
.....

2000s.....
.....

2010s.....
.....

5. How would you **rate** the balance between predators and prey in NNP?

- Very good []
- Good []
- Average []
- Poor []
- Very poor []

6. What management techniques does the NNP use to **maintain** a proper balance between predators and prey?

.....

SECTION D: EXISTING OPPORTUNITIES

1. From the following Park opportunities, show your level of disagreement or agreement to each of the following statements based on the following: Strongly Agree- (**SA**), Agree- (**A**), Undecided- (**UD**), Disagree- (**D**) with the following statements. Please indicate by use of a tick,

Opportunities	SA	A	UD	D
A well equipped Park ecosystem with proper Technology will improve the park’s conservation				
The government’s policies, in regard to conservation and management greatly impact the park’s operation.				
The management staff of KWS require an efficient welfare system so as to ensure an improvement in the Parks management.				
For improved management in the park, visitor’s entry in the park should be controlled.				
Conducting counts and monitoring Species (flora and fauna) ensures an improved park ecosystem.				
The Wildlife Conservation Lease Program has led to the Acquisition of the Kitengela dispersal area				

2. Kindly state in your opinion, what management strategies are in place for an improved conserved NNP?
-

3. Kindly indicate the priority (**High, Medium and Low**) of the following management programmes for Nairobi National Park to ensure for an improved conserved ecosystem. (Tick as applicable).

Management Programmes	High Priority	Medium Priority	Low Priority
Increased funding management			
Research and Monitoring			
Policies /legal frameworks			
Staffing/Recruitments			
Personnel Training			
Community Education /Awareness			
Deployment of Technology			

7.3 APPENDIX III: Questionnaire for Friends of Nairobi National Park

Dear respondent,

You have been randomly selected to participate in this research on An Assessment in Ecosystem Conservation and Management at Nairobi National Park. The information you provide is meant for academic purpose only. Thank you for your willingness to participate.

Instructions to the respondent

1. Please answer all questions.
2. Please note that no answer is wrong and no answer is right, your opinion counts.
3. All answers will be treated equally.

3. The information gathered will be treated with absolute confidentiality.

SECTION A: ORGANIZATION CHARACTERIZATION

1. Please indicate your **gender** (Tick as applicable)

Male []

Female []

2. Please indicate **years of working** with FONNAP (Tick as applicable)

Less than 1 year []

1-5 years []

6-10 years []

Over 10 years []

SECTION B: MANAGEMENT APPROACHES

7. Kindly state the **current size** of Nairobi National Park in Km²?

8. In your opinion, has the size of Nairobi National Park changed overtime? Yes [] No []

9. a) If yes, kindly state which section of the park has experienced such changes?

b) And in which **year** did the change take place?

SECTION C: ECOLOGICAL CHANGES

1. In your opinion, has the total population of large animal species of Nairobi National Park changed overtime (1970-2013)? Yes [] No []

2. Was it an increase [] decrease [] or both []

3. Kindly state in your opinion, the intensity to which the following factors have led to a decline in the numbers of large animal population in Nairobi National Park from the 1970 - 2013. Fill in appropriately using: **High, Medium** and or **Low**.

	1970s	1980s	1990s	2000s	2010s
Habitat Destruction					
Wildlife diseases					
Poaching (subsistence & commercial)					

Increased fencing					
Drought					
Land use changes (quarrying, settlements, flower farms)					
Invasive species					
Land fragmentation (subdivision of group ranches)					
Weather /climate changes					
Consumptive use of wildlife					
Livestock incursions					

4. Please indicate (i) the type of species (**flora or large fauna**) and (ii) the decade that they were affected by the following factors in Nairobi National Park.

Factors	Species (Flora or large Fauna)	Decade (1970s -2010s)
Habitat destruction		
Invasive species		
Wildlife diseases		
Land use changes(quarrying, settlements, flower farms)		
Land fragmentation (subdivision of group ranches)		
Poaching (subsistence &commercial)		
Drought		
Human and livestock incursions		

5. In your opinion, how has Kenya Wildlife Service management dealt with the above causes of large fauna and flora decline overtime (1970- 2013)

1970s.....
.....

1980s.....
.....

1990s.....
.....

2000s.....
.....

2010s.....
.....

SECTION D: EXISTING OPPORTUNITIES

4. Kindly state in your opinion, what management strategies are in place for an improved conserved Nairobi National Park?

.....

5. From the following Park opportunities, show your level of disagreement or agreement to each of the following statements based on the following:

Strongly Agree- **(SA)**, Agree- **(A)**, Undecided-**(UD)**, Disagree-**(D)** with the following statements. Please indicate by use of a tick,

Opportunities	SA	A	UD	D
A well equipped Park ecosystem with proper Technology will improve the park's conservation				
The government's policies, in regard to conservation and management greatly impact the park's operation.				
The management staff of KWS require an efficient welfare system so as to ensure an improvement in the Parks management.				
For improved management in the park, visitor's entry in the park should be controlled.				
Conducting counts and monitoring Species(flora and fauna) ensures an improved park ecosystem.				
The Wildlife Conservation Lease Program has led to the Acquisition of the Kitengela dispersal area				

6. Kindly indicate the priority (**High, Medium and Low**) of the following management programmes for Nairobi National Park to ensure for an improved conserved ecosystem. (Tick as applicable).

Management Programmes	High Priority	Medium Priority	Low Priority
Increased funding management			
Research and Monitoring			
Policies /legal frameworks			
Staffing/Recruitments			
Personnel Training			
Community Education /Awareness			
Deployment of Technology			

Thank you for your assistance and cooperation

7.4 APPENDIX IV: Questions for Key Informant Interviews at the Kenya Wildlife Service

1. How long have you been working at KWS?
2. What is your department within the KWS?
3. What is your position at KWS?
4. How many times were the below mentioned management techniques employed in NNP?

Management technique	1970s	1980s	1990s	2000s	2010s
Translocation					
Re-introduction of captive breeds to the wild					
Maintenance of the kitengela dispersal area					
Breeding in captivity					
Prescribed Burning					
Re-stocking					
Culling					
Fencing					

7. How would you describe the management approaches of the park from 1970-2013?
8. How has the Park management dealt with the causes of large animal increase or decrease overtime (1970- 2013)
 - 1970s
 - 1980s
 - 1990s

- 2000s
- 2010s

9. What management techniques does the NNP use to maintain a proper balance between predators and prey?
10. Using the following opportunities categories, what factors should KWS invest in so that the park doesn't lose its ecological integrity?

Opportunities Categories	Factors
Technology	
Policies	
Human resource	
Visitors in the park	
Species(flora and fauna)	
Acquisition of the Kitengela dispersal area	

11. What management strategies are in place for an improved conserved NNP?
12. How would you prioritize the following management programmes for Nairobi National Park which will ensure for an improved conserved ecosystem?

Management Programmes	High Priority	Medium Priority	Low Priority
Increased funding management			
Research and Monitoring			
Policies /legal frameworks			
Staffing/Recruitments			

Personnel Training			
Community Education /Awareness			
Deployment of Technology			

7.5 APPENDIX V: NNP Herbivore counts

NAIROBI NATIONAL PARK LARGE ANIMAL COUNTS (1970- 2013)

HERBIVORES

Year	Wildebeest	B. Zebra	Kongoni	Eland	Buffalo	G.gazelle	T.gazelle	Impala	Giraffe	B.rhinoceros
1970	234	568	1397	74	67	345	247	524	91	
1971	311	1073	1683	120	75	350	118	574	96	
1972	623	1051	2004	132	83	458	191	565	86	
1973	3252	1971	3329	284	91	425	243	815	103	
1974	40	93	179	15	99	341	141	533	84	
1975	34	167	149	27	107	204	116	487	57	
1976	3618	927	212	103	115	141	65	278	48	
1977	6	32	131	22	123	262	177	391	61	
1978	0	0	0	0	0	0	0	0	0	
1979	96	141	217	110	139	284	202	696	95	
1981	4636	1351	530	302	155	208	39	1354	58	
1982										
1983										
1984										
1985										
1986										
1987										
1988										
1989										
1990	2717	705	383	183	182	136	153	758	122	
1991	1781	1097	427	185	197	110	112	623	100	
1992	2297	1236	366	93	202	103	67	537	73	
1993	2066	804	220	22	132	59	38	312	48	
1994	1669	935	357	100	150	124	167	666	86	
1995	1702	882	396	88	131	101	53	433	65	
1996	3227	1346	511	173	98	116	153	689	93	
1997	1951	1732	462	56	83	96	107	462	43	
1998	128	504	210	39	65	34	40	180	43	
1999	790	1209	489	90	133	86	87	397	63	
2000	2301	2142	566	99	110	93	149	475	71	17
2001	16	417	356	47	118	82	77	330	71	21
2002	31	443	303	84	164	52	110	238	60	33
2003	1	336	221	124	133	46	61	170	69	27
2004	106	824	327	140	133	58	58	231	70	17
2005	214	1329	0	171	298	83	82	234	63	16
2006	289	1926	0	188	244	73	55	223	78	11
2007	94	961	0	91	144	44	72	210	85	6
2008	108	728	0	168	270	48	68	368	101	13
2009	408	1688	0	199	270	79	160	576	134	0
2010	116	1030	0	164	313	84	149	518	104	13
2011	132	1091	0	154	253	117	222	563	94	11
2012	114	733	0	139	405	84	188	741	101	8
2013	50	549	0	75	153	55	154	710	73	8

DATA GAP

7.6 APPENDIX VI: NNP Carnivore counts

NAIROBI NATIONAL PARK LARGE ANIMAL COUNTS (1996- 2013)

CARNIVORES

Year	Black-				
	Lion	Cheetah	Spotted hyena	backed jackal	Leopard
1996	33				
1997	33				
1998					
1999					
2000	5	2	0	9	1
2001	7	3	1	3	3
2002	7	3	1	2	0
2003	6	6	1	4	2
2004	3	1	2	3	0
2005	4	3	2	2	1
2006	4	0	1	3	1
2007	7	0	5	0	0
2008	6	1	3	3	0
2009	0	0	0	0	0
2010	7	0	1	3	1
2011	17	0	1	4	0
2012	9	2	1	2	1
2013	4	2	2	27	1

7.7: APPENDIX VII: NNP Management Approaches / Techniques

MANAGEMENT TECHNIQUES	1970s	1990s	2000s	Total	Average
Translocation	3	6	20	29	9.67
Re-stocking	2	6	11	19	6.33
Maintenance of the Kitengela area	0	0	8	8	2.67
Prescribed burning	8	11	18	37	12.33
Fencing	1	6	7	14	4.67