EFFECTS OF HORTICULTURAL FARMING IN KITENGELA-ISINYA AREA ON WILDLIFE CONSERVATION IN THE NAIROBI NATIONAL PARK

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DECLARATION

I declare that this is my original work and has not been submitted for examination to any other University.

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This project report has been submitted for examination with our approval as the university supervisors.

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DEDICATION

This work is dedicated to my two daughters Vanessa Nyamori and Favour Nyamori.

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ACRONYMS

ASALS: Arid and Semi-Arid Lands.

BWCA: Benoue Wildlife Conservation Area.

DDE: Dichloro- Dipheryl- Dichloro

DDT: Dichloro-Dipheryl-Dichloro-Ethane

EIA: Environmental Impact Assessment

EMCA: Environmental Management & Coordinating Act

KWS: Kenya Wildlife

HWC: Human Wildlife Conflict

IBA: Important Bird Areas

IUCN: International Union for Conservation of Nature

SPP: Species

MWA: Minimum Viable Area

NCA: Ngorongoro Conservation Area

NNP: Nairobi National Park

WHO: World Health Organization

UNEP: United Nations Environmental Programme

NEMA: National Environmental Management Authority

PAS: Protected Areas

ILRI: International Livestock Research Institute

LSHF: Large Scale Horticultural Farms

SSHF: Small Scale Horticultural Farms

WRI: World Resource Institute

ABSRACT

The future of wildlife in Kenya and its conserved ecosystems largely depends on the current and future planning for land use in the adjacent areas or dispersal regions. All national parks including the Nairobi National Park, as they now exist are in some degree or other dependent on the relationship between land use changes and the wildlife in the surrounding areas. Horticultural farming around the Nairobi National park presents such a case that this study has dwelt on. This study investigated the effects of horticultural farming around the Nairobi National Park on wildlife conservation and management, its three main objectives are: To investigate the nature of pressure from horticultural farming activities on wildlife habitat near the Nairobi National Park. Secondly, is to find the types of conflicts between the farmers and the migrating wildlife around the park. Lastly, to examine the differences between the large scale horticultural farming and small scale farmers and its effects on wildlife in the dispersal area around the park. The study made use of both secondary and primary data with the sample size being 26 small scale farmers and 10 large scale farmers. The large scale farmers were purposively sampled-targeting all the farmers while the small scale farmers the study sampled were 26 randomly picked out of the possible 193 farmers in the dispersal area. This was because they produced similar horticultural crops. The research design adopted a descriptive research design since the study gathered both qualitative and quantitative data. The study found that: There has been a steady increase in human population (settlements) around the conservation area greatly attributed to horticultural farming leading to habitat loss for wildlife. Large scale farming contributed more to population increase than small scale farming in the dispersal area; land fragmentation and fencing were a major threat to the survival of wildlife species around the conservancy blocking the migratory species from accessing the Athi-Kapiti plains where they breed. The two major types of human wildlife conflicts the study found out were: crop raiding and damage to property. The most problematic wildlife to the farmers were flocks of birds targeting different crops and pests on the farms, other species of wildlife were antelopes ,elands ,zebra, hares ,wildebeest ,warthogs and wild dogs. Lastly the study highlights recommendations and areas for further research or gaps in the study. The recommendations include: Land use changes and zone management to cater for the migration corridor, establishment of a protected area in partnership with the community and the KWS and enhanced compensation resulting from human-wildlife conflict as well as payment for eco-system services whereby the community gets compensated for conservation efforts. Some of the research gaps that this study identified were: research on use of pesticides and other agro-chemicals on wildlife in the dispersal area. Effect of water extraction for farming with relation to underground water flow, system recharge and ecological sustainability around the park and Studies should be done on effects of pastoralism around the park and its compatibility to wildlife conservation.

CHAPTER ONE: STUDY BACKGROUND

1.0 Introduction

In Kenya, human–wildlife conflicts challenge wildlife conservation especially in the surroundings and within the Nairobi National park, Tsavo East and West, Amboseli game reserve, Mount Kenya, Meru National Park and Aberdare National park among other areas. Where wildlife range outside parks and conflict with the local communities conflicts between wildlife and the surrounding communities arise.

Local opinions is contributor to conservation efforts and hence the need to monitor local concerns as they relate to conservation and wildlife resources, and decision making. Local opinion's is determined by benefit system, wildlife-human conflict and land use changes. For the native and non-natives in these areas, opinion about wildlife conservation is determined by presence or absence of compensation for wildlife damages.

Nairobi National park, the first national park in Kenya was established in 1946, and with a coverage of 117 sq. km and situated at border of three counties: Nairobi city county-Kajiado county-Machakos county (Katampoi *et al.*, 2004).

The positioning of the park makes the park one of the most unique park to be situated within the vicinity of Capital city. Sustainability of the park is however threatened by the by pressures emanating on rural-urban migration, changes in agriculture land uses, population growth. These pressures and threats have had considerable impacts along wildlife migratory corridors. Despite this there exists no documented study that has attempted to study this dynamics (Kwadha 2009).

Changes in land use have been taking place for many years around the Nairobi national park since its establishment. However, the pace of change has been increasing rapidly especially since independence in 1963. Omondi (1981) states that the trend of land use is expected to continue and it is anticipated that all aspects of land use will be dominated by human increase within the period 1983-2003 unless conservation measures are done and rural-urban migration checked.

In the wildlife conservation sub-sector, land use policies and utilization of wildlife resources will need to be harmonized for sustainable local and international benefits. Sustaining the parks reserves and wildlife dispersal areas that support such parks is therefore a crucial and urgent necessity if the benefits are to be maintained or improved. Kenya can boast of spectacular parks and reserves where wildlife thrives.

One of these really unique parks is Nairobi national park. The wildlife sector in Kenya contributes substantially to the GDP of the Kenyan economy (5% of GDP) and as a foreign exchange earner (May, 1992). However, in Kenya wildlife is found both within parks (30%) and outside parks (60%) further justifying the need for conservation efforts across the country.

Jari (1982) further affirms that the growing number of settlements and activities in these areas have conflicted with the predominant land use. The modifications in the eco-system are continuous and this has caused ecological imbalance. Most parks in Kenya are presently facing this land use problem inflicted by man's aspirations to increase production at the detriment of the existing land use which in the case of the Nairobi national park happens to be conservation of the wildlife.

Goldberg (1986) says that the IUCN category park model has dominated the natural resource conservation, more so wildlife since 1940s. This model places more emphasis on identification of resources, physical characteristics, designation of protected areas, human displacement and outlawing human settlement. The model process has the potential to lead to local resentment in protected areas concerning conservation of resources such as wildlife. Okello & Kiringe (2004), claim that Kenya has approximately 50 protected areas covering 8% of the land, with each model facing its own unique challenges partly attributed to local community exclusion.

The involvement of local communities (surrounding a conservation or park) and their traditions promotes ownership in conservation efforts and not necessarily through legal means. The Pastoral lifestyle of Maasai in Kenya, is accompanied with co-existence with the wildlife in their communal lands, which also dub as migratory routes in their communities. Despite, the concessions provided by local communities for wildlife, the benefits emanating from wildlife have failed to trickle to the communities for the reason that existing wildlife communities do not account for local community needs (Johnson, 1987).

Surrounding communities around the conservancies and protected areas have in the recent past been shifting to agro-pastoralism. As a consequence human-wildlife conflict have intensify, more so on water use as agriculture and wildlife compete for the limited water resources (Barrow *et al.,* 1993). The conservation crisis has been compounded by increase in number of group ranches, subdivisions of arable land and the leasing of land to immigrants for farming. In addition, cultivation along riverine areas has destroyed wildlife habitats.

The conflict is not only in agro-pastoralism; in the 90s the number of cattle among the Maasai and pastoralists communities was twice the viable commercial stocking rate. Although the Maasai areas have experiences droughts, the livestock herd has maintained a stable population, and in some cases even increased. This has resulted in pressure to seek for grazing land in protected areas and national parks leading to more conflicts, especially during the dry season (Ngethe *et al.,* 1994). The perpetual nature of these conflicts coupled with lack of conflict resolution framework has only fomented negative opinions among the locals on conservation of wildlife resources and endangered wildlife that range outside protected areas. (Goldberg *et al.,* 1986).

1.1 Statement of the Problem

A number of consequences are linked to land use changes within the wildlife migratory corridors. These include: modification of natural environment along the migratory routes, and also blockage of their seasonal migration in and out of the park leading to

overcapacity within parks. Migration or death resulting from ensuing conflicts and changed environment significantly reducing the wildlife population.

With the exception of blocking the migratory paths of the wildlife, excessive use of pesticides and other agricultural chemicals by the horticultural farms has negative impacts to the environment. The toxic activity of a pesticide should be limited to its intended target organism, such as *Lepidoptera* larvae or beetles in the case of an insecticide. However, this limitation does not always occur. Sometimes non-target plants, insects or other animal species may be adversely affected by the pesticide.

In the parks case, birds of prey fall victim to this harmful effect as they feed on these larvae and other smaller rodents through their complex food chain. They ingest these pesticides and as a result have weakened egg shells (leading to little hatching) and most perish from this pesticide ingestion. The potential hazard to humans and wildlife is obviously a major concern following pesticide application.

New health problems which have been in existence before the period of excessive use of pesticides can crop up if pesticides are not used in the right way. Horticultural farming around the Nairobi National Park through pesticide and fertilizer use may adversely affect water resources used by both the wildlife and pastoralists; these resources include the Mbagathi River, Mukoyiet River, Olmany River and other water holes in and around the park. Soil erosion as a result of the farming and surface water flow (discharge) leads the pesticides and fertilizers flowing into the adjacent water sources.

Nairobi National parks location in close proximity to the city of Nairobi is unique; a feature associated with numerous benefits as well as these challenges. There aren't any identified levels of compatibility of urban land uses with wildlife conservation. There is however threats of rapid expansion of the city as well as population increase with associated activities encroaching the parks boundaries and the wildlife dispersal areas.

Horticultural farming is responsible for this increase in population around the park with the increase in farm workers and settlements around the park, such include large scale irrigation farming (cut-flowers) that include J Dave, Isinya flowers, Desire roses, Mboga Tuu and Maasai flowers pose a challenge to sustainable conservation of the park. Horticultural farming in the area around the park is therefore responsible for the increase in human population around and in the migratory corridors thus aggravating the human wildlife conflict.

According to the KWS (2005), the Kitengela-Isinya dispersal area is in block D which is a wildlife dispersal area meant for conservation of the migratory wildlife. However, over the recent past horticultural farming has been on the increase in this block/area thus intensifying the conflicts between the farmers and wildlife. Farms contributed to 222 of the 849 developments in the dispersal area occupying a total of 5.9km2 of the total 32.56km2 of the land in this block. In spite of this land use change no study has been done on effects of horticultural farming on the surroundings of the Nairobi National Park

The most notable conservation challenge associated with increased horticultural farming around the Nairobi National park is habitat loss, death of wildlife species that might invade the farms through poisoning, trapping and killing using crude weapons. Blocking of the migratory route by the farmers through fencing prevents calving of the herbivores in the Athi-Kapiti plains. Increased horticultural farming on both large and small scale is partly responsible for over extraction of water and water resources around the park and as such leading to scarcity of the same resource and other resources leading to decrease in wildlife numbers both in and around the park.

1.2 The Overall Objective of the Study

The main objective of the study is to find out land use changes in respect to horticultural farming and its effect on- the environment and on migration of the wild animals in the wildlife dispersal region around the Nairobi National park.

1.2.1 The Specific Objectives Are:

1.2.2 To investigate the nature of pressures from farming activities on wildlife conservation near the Nairobi National Park.

1.2.3 To find out which are the main types of conflicts between the farmers and the wildlife around the Nairobi National park.

1.2.4 To examine the differences between large scale and small scale horticultural farming and its impact to conservation of wildlife in the dispersal area around the NNP.

1.3 Justification of the Study

The Nairobi National park is considered as one of the fragile environments that faces destruction from the expansion of the horticultural industry both from the use of pesticides and the blockage of the wildlife migratory paths by the emerging cut-flower industries around Kitengela-Isinya region.

A number of conflicts has been witnessed in the land adjacent to Kitengela Conservation area, east of the Nairobi national park. These conflict ranges from wildlife-farming conflict, urban settlement-wildlife conflicts and other smallholder faming-wildlife conflict. The location of Nairobi national park within Nairobi City County has led to the park being called “park within a city”. The park attracts not less than 100,000 annual visitors attracted by the more than 100 species of wildlife and Kenya’s largest black rhino sanctuary. The area is an important dry season refuge for Kenya’s wildlife (KWS 2007).

Much as the Kitengela–Isinya Conservation Area has the recognition as a "wildlife conservation area", most of the lands in surrounding areas are in private hand and not legally protected for conservation purposes. The ecological importance of Kitengela-Isinya area as a wet-season wildlife dispersal area is under threats due to urban settlements, subdivision and fencing of lands, horticultural farming and Export Processing Zones. Without Kitengela dispersal areas, the seasonal migration wildlife is disrupted. (Kwadha 2009).

Therefore, with the increase of horticultural farming and the supposed use of pesticide this study aims at identifying the direct and indirect impacts that the industry has on the wildlife from Nairobi national park. The large cut-flower farms like: P J DAVE, Isinya flowers, Desire Flora, Maasai flowers, Duango and Mboga Tuu among others around Kitengela-Isinya region having expanse greenhouses and farms that are put up across the migratory paths of the wildlife especially the wildebeests, gazelles, zebras, various bird species, wild cats among other migratory species in and out of the park.

Ecologically, it is a very important atmospheric ventilator for the city and also constitutes part of the Athi River and Tana River watersheds. The park is an Important Birds Area (IBA) with over 400 species, conserves two Major ecosystems: highlands dry forest and the savanna. It is a dry season refuge for most herbivorous. All these roles have however been threatened by the urbanization and the land use change such as growth of major irrigation and the rise of the cut flower industry in Isinya sub-county.

The importance of conserving and preserving wildlife corridors is evidenced on the role that such corridors play in maintaining biodiversity, helping in population interbreeding, increasing habitat amount for species and provision of access to larger habitats that act as sources for food and shelter.

Despite the importance attached to wildlife corridors they cannot substitute for protected areas or the National parks, for instance Nairobi National park. The study will add emerging issues related to the extent and trends the land use changes have taken in the area especially with respect to the increase in the horticultural industry in the area of study. It will establish any relationships between the horticultural farms, use of pesticides and population of migratory wildlife in the Nairobi National Park. This study aims at identifying the currents impacts and long term effects of this continued farming in the region.

1.4 Research Hypothesis

In order to achieve the above objectives, the following hypothesis was used as a guide.
Ho: There is no significant difference between increase in the number of small scale horticultural farmers and the population of major migratory species around the Nairobi National park.
H1: Alternative.

1.5 Scope of Study

The study area is located in two counties: the county of Nairobi and Kajiado. Nairobi national park covering 117 sq. km is within the city of Nairobi which makes the Nairobi city county. It lies between 2^0 18"" S, $2^0$20" S sand 36^0 23" E, 36^0 28" E (KWS 2006). The western, eastern and northern sides of the park are fenced. The southern side opens to the wildlife migratory corridor. The corridor is 36^0 44""E, $36^0$54" E and 1^0 40" S, $1^0$25" S and is part of the greater Athi-Kapiti plains in Kajiado district of the former Rift-valley province. It is made up of three sub-locations: Kitengela, Isinya and Olturoto within Isinya (1066.3 sq. km) Sub-county of Kajiado County.

1.6 Operational Definition of Terms

Pesticide: Any chemical agent used for control of specific organisms such as insects, Pests and fungi etc.

Ephemeral water: Water that lasts only for a short period of time.

Eutrophication: The process of being well nourished/rich in dissolved nutrients.

Herbicides: Chemicals used to kill or inhibit the growth of undesirable plants (Weeds) in croplands or forests.

Insecticides: Agricultural chemicals used to eliminate various insects, which may damage crop growth and reduce crop yields.

Fungicide: Chemicals that control fungal pathogens by using copper, Sulphur, Organo-mercury and organo-sulphur compounds and antibiotics.

Rodenticide: It controls rodent pests and some commonly used rodenticides are Redsquill, sodium (mono) fluoroacetate, fluoroacitamide, zinc phosphate etc.

Nematicide: Chemical that controls nematodes and the halogenated hydrocarbons commonly used soil fumigants.

Conservation: long-term preservation of social-cultural property and natural resources through examination, documentation, treatment and preventive care.

Flora: Plant life occurring in a particular region or time, generally the naturally occurring or indigenous- native plant life.

Fauna: Animal life of any particular region or time.

Human-wildlife conflict: Refers to the interaction between wild animals and People and the resultant negative impact on people or their resources and wild animals.

Bio-piracy: Is a situation where indigenous knowledge of nature, originating with indigenous peoples, is used by others for profit, without permission from and with little or no compensation or recognition to the indigenous people themselves.

Climate change: Is a change in the statistical properties of the climate system when considered over long periods of time.

Invasive species: Is an organism or plant that is introduced into a new environment where it is not native.

Ornithology: The scientific study of birds.

Ungulates: Any animal that has hoofs**.**

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Threats to sustainability of conservation areas are not a new concern. Modern farming techniques, urban sprawl and urbanization have long been one of the major forces shaping the world, and it will continue to do so. According to Kerr, (2007), urbanization and land use changes that affects protected areas takes several forms that are not mutually exclusive.

Some of these forms include urban sprawl; Ribbon development; urban intensification and infill; coalescing regions; Tourism developments; second-home and retirement development; growing settlements within protected areas; and informal settlements. National parks the world over have grown and developed differently depending on various geomorphic and anthropogenic factors affecting them and their establishment.

2.1 Horticultural farming.

Horticulture can generally be defined as the science and the art that involves growing of vegetables, fruits, flowers or ornamental plants. The word horticulture is derived from the root word *hortus, a* garden and *cultura* meaning culture. It's under culture that we find cultivation of the soil or earth; the development, improvement or refinement of the mind, interest tastes, ideas etc. (Relf, 1992)

According to Sinclair (2003); Horticulture is the promotion of wellbeing of individuals through the art and science of growing vegetables, flowers, fruits, trees and shrubs. These definitions thus place horticulture as a broad production of plants including their products such as medicines, food, oxygen and ornamental products essential for man's survival.

2.2 Horticultural Production in Kenya

Kenya produces a large variety of horticultural commodities, including temperate and tropical vegetables, fruits and cut-flowers. They originate from ten major horticultural areas situated in 21 of the 42 counties of the country. Most production is rain fed but irrigated vegetables and flowers cultivation can be found in some drier parts of the country like Kajiado district. Vegetables and fruits are grown both for home and for sale in order to generate income while cut-flowers are only cultivated for sell. (Dijkstra & Magori 1992).

The Kenyan climates & soils are suitable for growing many species of vegetables, fruits and flowers. Today approx. 250,000 hectares of land are under production for fruits and vegetables, both by small-scale and large scale farmers.80% of the horticultural growers belong to the former category and 20% to the latter. The large scale entrepreneurs concentrate mostly on export commodities, while the small –scale farmers normally focus on the domestic market.

Every horticultural crop needs its own climatic conditions, humid or dry, hot or cold which mean that regions are suitable for specific species .Many crops can be grown under irrigation, but rain fed production is most common. Horticultural production areas are distributed throughout the country including areas adjacent to Wildlife gazetted areas like the Nairobi National Park; with the exception of the Northern part (Dijkstra 1991).

Horticultural farming in Kenya is significant to its economy. The exports to most of the neighbouring nations and foreign countries earn the country foreign revenue and improve on the country's GDP. . The horticulture sub-sector contributes to 2% of annual GDP by generating approximately US $ 1 billion annually. (Odunga 2011). The Kenyan horticultural sector is a vibrant industry that has global recognition. Besides, it is major contributor to employment and food security.

Kenya history in producing horticultural crops for export and domestic markets is well known and favoured due to suitable climatic conditions. As people and flower farms alter their natural environment to support their biological, cultural, social and economic needs they create new conditions which affect the ecosystems health (wildlife), vitality, productivity, life-expectancy and convenience. Environment alteration from horticultural farming should be undertaken with careful consideration to avoid negative effects. For example, creating conditions for the spread of parasitic related diseases in the course of otherwise beneficial land-use changes, like irrigation works, construction works construction of dams, burgeoning tourism and migration of people for employment should be put into consideration while expanding and practicing horticultural farming. Increased production and use of new chemicals and radio-active material in farming which would affect both man and wildlife. Should be discouraged as well as the discharging of waste material into the eco-system contribute to the introduction of harmful biological and chemical materials which might pass from one area to another (Essam & Manzur, 1982).Related to this, the horticultural industry and its expansion in Isinya region and its environments could be a great threat to the environment and the fragile Nairobi national park eco-system.

2.3 Impact of Horticultural Pesticides on wildlife.

Pesticides are toxic chemicals and when they come into contact with vulnerable non-pest species, they can kill them. Animals are exposed to pesticides in the crop (through spray drift), or if a pesticide is washed or drifts into a water course. It also affects the soil capacity to filter, buffer, degrade, immobilize and detoxify. Presence of pesticides in soil is associated with negative effects on soil organisms, human and animal health. Pesticides can move off-site, contaminating surface and ground water and cause adverse impact to both aquatic ecosystems and the environment in general, Ramachandra (2006).

He further states that: excessive use of fertilizers causes eutrophication, changes in soil pH, contamination of ground water, etc. In addition, pesticides being poisonous, they

affect the environment in one or various forms, most common of all being bio-accumulation in food chain and ground water contamination.

Secondly, pesticides may be applied carelessly, so that they damage wildlife in the surrounding areas. Thus when an herbicide is applied wrongly, in windy conditions some is sure to drift on to the road side verges, hedges and nearby gardens. When pesticides are sprayed from the air, either by fixed wing plane or helicopter, it is almost impossible to avoid contaminating some land outside the crop, Ramachandra (2006).

Thirdly, chemicals properly and carefully used may be transported by living animals or other means to other areas where their effects may be serious. Thus a bird may eat grain treated with an insecticidal seed dressing and then itself be eaten by another predator. Chemicals may be washed off the land into streams and then carried into the lakes where fish may concentrate them in their bodies with fatal results. Some chemicals may be very toxic but unstable, when they will only have effect near the point of application. Others may be less acutely toxic but more chemically stable, sometimes far from the ones with long term effects, sometimes far from where they were actually used on the farm, Ramachandra (2006).

Fourthly: Pesticides may alter the genetic make-up of pest and other populations by killing only the more susceptible individuals, so that resistant strains are produced. This may present serious problems, so that pests become more difficult to control. Insecticides constitutes the commonly used in the developing countries where they are mostly used in high value crop (Montage, 1998).

Determining factors are altitude, precipitation and availability of surface water. The latter is conditional in case of irrigation. Rain fed horticulture is normally harvested during one or two periods a year, but some vegetables and fruits are available the whole year round.

In case of irrigation, harvesting depends on the length of the growth cycle and a possible seasonality of water supply.

As people and flower farms alter their natural environment to support their biological, cultural, social and economic needs they create new conditions which affect the ecosystems health (wildlife), vitality, productivity, life-expectancy and convenience. Environment alteration should be undertaken with careful consideration to avoid negative effects. For example, creating conditions for the spread of parasitic related diseases in the course of otherwise beneficial land-use changes, like irrigation works, construction works construction of dams, burgeoning tourism and migration of people for employment. Another example is increased production and use of new chemicals and radio-active material in farming which would affect both man and wildlife. Again the expanding world trade and the discharging of waste material into the eco-system contribute to the introduction of harmful biological and chemical materials which might pass from one area to another (Essam & Manzur, 1982). Related to this, the horticultural industry and its expansion in Isinya region and its environments could be a great threat to the environment and the fragile Nairobi national park eco-system.

The survival and productivity of all wildlife population is dependent on knowledge of wildlife nutrition as a component of both wildlife ecology and management. According to Robbins (1993) it is difficult to identify the earliest interest in wildlife nutrition since it‟s an extremely young area of investigation on:

1. Economic ornithology officially begun in 1885 in the United states when congress instructed the Dept. of Agriculture to initiate “the study of (the) interrelation of birds and agriculture, an investigation of the food habits, and the migration of birds in relation to both insects and plants.
2. Similarly, early attempts to understand wildlife productivity based on correlations to soil fertility were not adequate to develop an understanding of nutritional interactions and therefore provide a base for meaningfully altering the animal-environment interaction.

Mellanby (1981), Argues that if asked in what way modern farming was a danger to wildlife, most people would pick on the use of chemical sprays; As the Royal commission on Environmental pollution said in 1979 in its seventh report on agriculture and pollution. The use of toxic chemicals by the farmer as a principle weapon against pests and disease attack and against weeds would commonly be regarded as the most worrying of the development that characterize modern agriculture. Carson (1962) further alerted public opinion to the possible effects of pesticides on wildlife and on birds in particular, he believes that scientists are irresponsible in the way that they produce more and more deadly chemicals, that the chemical industry is criminal in the way it markets these substances, and that farmers are to blame for the way in which they slosh them about all over the country side.

Pesticides are harmful to wildlife in several different ways. These chemicals are all, to a lesser or greater extent poisons and although many are particularly toxic to the target pests and comparatively less toxic to other creatures (thus some sprays against bean aphids are less lethal to bees which pollinate).

In the economy of the world and within each nation, horticulture is a basic industry. It is an important source of the food supply of the world. In the United States, approximately 3% of the cropland is in commercial production of horticultural crops against 83% for the food crops, 6% for cotton and 4% for all other crops. With intensive production the low percentage of cropland in horticulture provides a large portion of the food supply. This feature of horticultural crops, high production per unit of land, offers promise for the future of expanding population. Arid and semi-arid areas which have been developed for irrigation have been also become important horticultural zones, (Denisen 1979). He argues that humankind has been plagued by ravages of pests on crop plants since the dawn of history. The losses due to pests of horticultural crops are in billions of dollars annually throughout the world. The losses are composed not only in the yield of crops ravaged by pests but also in costs to combat pests and the extra man-hours of labour required for control. Based on available data the environmental impacts on (wildlife,

pollinators, natural enemies, fisheries, water and development of resistance) and social costs (human poisoning & illness) of pesticides use reach about 8 billion each year.

The introduction of exotic crops in an area comes with their own problems for they tend to replace the traditional crops. The exotic crops are mainly hybrids, which for optimal production require use of pesticides, fertilizers and irrigation water. According to Balk and Koeman (1984), in an early development stage countries using small quantities of traditional cheap products (pesticides) e.g. some of which are available in Kenya such as organochlorine insecticides. As the level of development increases, the range of products widens and the choice of products and application procedures develop to higher levels of sophistication, with the increase of pesticides in developing countries, the risks to the environmental also increase. The use of chemicals in pest control has a poor reputation due to the deleterious environmental effects of a number of pesticides that have been noted in the past decades. The most common side effects have been: mortality in non-target species and the diversity of eco-systems, a reduced reproductive potential in birds (known for DDT), fish and other organisms: and the development of resistance in the non-target species, Balk and Koeman (1984).

In an attempt to control the environment and to make it more productive for the growing population, dangerous chemicals have been introduced to kill pests and weeds such as aldrin, dieldrin, dichloro-diphenyl-dichloro-ethane (DDT), dioxin, 2 4-D, 2-4-5-T and many others (Shrader 1991). These chemicals are used extensively especially in the horticultural farms around the Nairobi national park and as a result have a direct negative impact on the wildlife in and around the park.

2.4 History of National Parks & wildlife conservation areas.

Kwadha (2009), states that the idea of national parks is old having started over 100 years ago. The initial development is associated with early human activities especially industrialization. It was observed that human activities were exerting pressure on certain species of animals and plants, which were beginning to disappear. Similar pressures were being experienced on eminent geological features which were being disrupted by human

forces. The idea started in the USA where the first National park, Yellowstone National park, was established in 1872 but become legally recognized in 1886.It‟s establishment followed worries that were expressed by John Muir (founder of sierra club) that," All of the United States of America will be covered by industry, urbanization, or agriculture". Through the club, Muir crusaded and succeeded in convincing the then president, Roosevelt, to help set aside and protect a wilderness area where man is secondary to nature. In Canada the first proto type national park was created in 1885 and it was the establishment of Yellowstone national park that encouraged similar establishments elsewhere in the world.

In Europe national park movement started in Great Britain in the late 1920s following the developments in USA and Canada. In 1949, an Act of the national parks and access to the country side was passed to conserve resources of the wild and the beautiful country. (Park and Cloke, 1985). In Britain there was careful control of new developments to the best satisfaction of all interests involved in the area. Parks were mostly on privately owned land but planned with local national objectives, allowing co-existence with other land uses like mining and farming (Rita, 1981). In Germany efforts to set up parks for protection of nature started in 1898 but the first park, Naturschatz park lune-burge,was however private and established in 1921. As a form of land classification, national parks were officially recognized in Germany by the state of Bavaria in 1969 when it set aside its first national park in Bayerischer Wald. National parks in Germany were established on land that had undergone intensive human activities over a thousand years. This differs remarkably with the Kenyan situation where they were set aside just about the same time the European had settled in the country and the land had not been subjected to intensive cultivation. In Asia, the Japanese established their first park in 1931 by designating twelve areas of conservation. In India, the idea only began in 1952 with the establishment of Indian Board of wildlife to conserve and control wildlife through national parks and sanctuaries, (Omondi, 1984).

In the African continent initial protection of wildlife started in the Sabi game reserve in the year 1892 by the then president Kruger of South Africa. In Kenya conservation

efforts started in 1907 by the creation of the Kenyan game department. By 1937 an ordinance was legislated strengthening laws concerning protection of wildlife in Kenya (Otuoma 2004). In the year 1945- ordinance no 9 was developed which led to a board of trustees mandated to protect areas of wildlife interest such as game reserves and National parks. This led to the creation of Nairobi National park in 1946. The ordinance later became the Royal National parks of Kenya ordinance, which later became the National Parks of Kenya Act. It is under this Act that most of the protected areas in Kenya were established. The term "Royal National Parks of Kenya" was bestowed by King George VI and dropped at independence in 1963. More and more national parks were created to be managed by the Kenya wildlife service"s established in 1989.

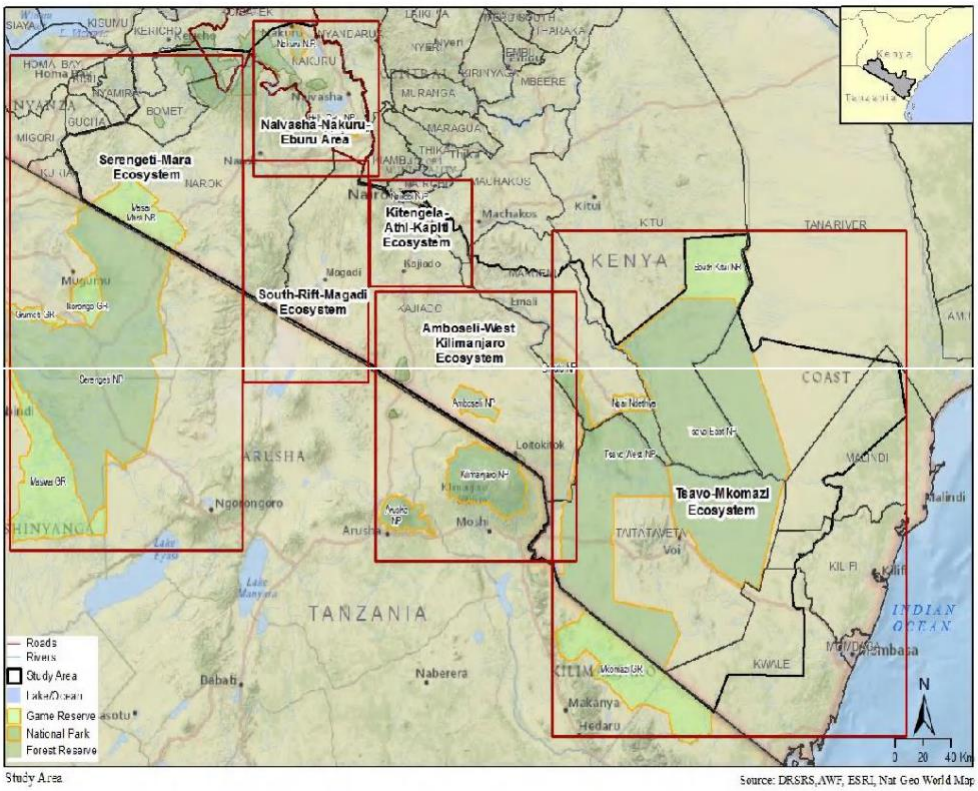

Figure 1: Southern wildlife conservation Areas in Kenya-Including the Kitengela Athi-Kapiti wildlife dispersal area.

Source KENYA VISION 2030 Flagship Report on wildlife conservation (2012).

2.5 Wildlife Movements - Dispersal and Migrations

The migration and movement of wildlife species is essential for sustaining herds or their species and their resilience in the face of disease invasion, rainfall scarcity and predation.

External and internal factors lead to dispersal and migration of wildlife. Internal factors include breeding and avoidance of inbreeding while external factors including; fires droughts, floods, extensive soil erosion, resource scarcity (water and food), competition for mating, predation and disease (parasitism). The ultimate function of dispersal is enhancement of survival of the various species (Sinclair 1992).

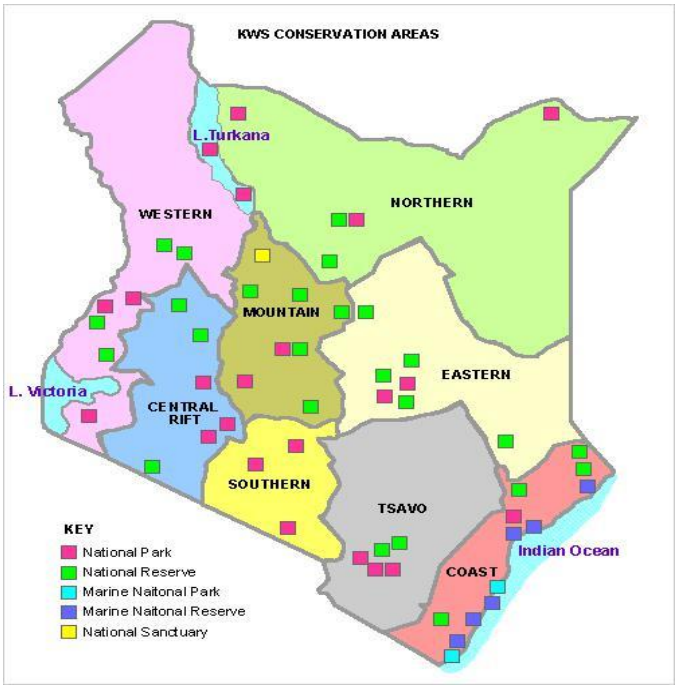

Figure 2: Conservation areas of Kenya**.**

Source KWS (2013)

Migration can be defined as the systematic movement of animals or wildlife from one location to another, including a return trip (Bolen & Robinson 1995). These are regular movements to breeding areas and mostly in search of water and food because of the variability of rainfall, temperatures and vegetation in terms of quantity and quality (Bolen Robinson 1995). Fryxell & Sinclair (1988) suggested that migrations of large herbivores in response to seasonal variations in resource availability and quality, as a means of enhancing access to high quality food and reducing the risk of predation. Dispersal among wildlife is largely viewed as the distribution of wildlife populations over a spatial territory. Wildlife migrates on a daily basis (local resident movement) and change habitat seasonally (dispersal, migration) because of various factors within their

home ranges (Sinclair 1992). Highlights 3 categories or patterns of movements, namely, resident, migratory and dispersal systems, where dispersal refers to wet season dispersal and dry season concentration of animals in a range as witnessed in and around Nairobi National Park. Today, because of human activities around and in protected areas, wildlife habitats have experienced degradation.

According to McKinnon (1986) National parks and game reserves can't have a rigidly defined boundary and the idea that these boundaries will not change in the near future is impossible to imagine. Wildlife corridors enable them to respond to variations or changes in their environment through migration. A wildlife corridor is a continuous natural protection that exists in secure pathways frequented by wildlife species. Corridors work best when sparsely developed as it allows for it to be populated with vegetation. Wildlife corridors increase the amount of habitat available for species and effectively reverse habitat fragmentation. Two types of corridors exists, large type of corridors refers to large expanses of undeveloped habitats spread over large distances, a case in point is the corridor for Nairobi national park stretching as far as slopes of Mt Kenya and Kilimanjaro. (Prins *et al*., 2000).

Figure 3: Nairobi National park wildlife dispersal region indicating wet season And dry season dispersal region.

Source: ILRI (2012)

Key:

Dry season dispersal region

Wet season wildlife dispersal region.

The land use planners are faced with the challenge of having right size that fits in boundaries created by humans and not land with ownership patterns, and this invariably affect the wildlife populations. According to wildlife management institute of Kenya (2005), the appropriate size of a wildlife corridor ought to vary based on number of species involved through not yet determined. In Alaska, studies have shown that different wildlife species need different kilometres, with largest mammal needing large number of kilometers in comparison with smaller mammals.

Small scale wildlife corridors are another form of corridors that mostly serves the riparian species and birds. These corridors create recreation opportunities and linkages. If possible rural and urban parks should be joined with a corridor. Wildlife corridor due to their vulnerability should be sustainably managed, and this might means avoiding the use of pesticides in areas along these corridors.

In the reserve or parks characterized by areas of high biodiversity and nodes, migration is expected to be constant throughout the time, and where there is absence of migration population is established along the corridors. Nodes that are connected by corridors can be smaller than the Minimum Viable Area (MVA) resourced with food, water and nesting sites (Bush 2000). Thus it is evident that corridors are more than highways as they form continuous habitat that ensures survival of wildlife. This relationship between nodes and corridors is witnessed in the wildlife dispersal area around the Nairobi National Park in areas that wildebeest calve during the wet season as they move in and out of the park.

2.6 Impact of Human population on wildlife conservation.

In the USA, population explosion and border fencing/protection has affected wildlife migratory routes further hampering routes connectivity. (Bush 2000). This fragmentation is attributed to urban sprawl, building over unprotected rural land between a city and a protected area, sometimes surrounding it. However; in this case the reason behind protection was not bio-diversity protection, but rather for water supply or flood control purposes, to preserve landscape, or to provide outdoor recreation. Urban population changes were therefore only examined in relation to its impacts on these reasons behind protection.

The impact of habitat fragmentation was just observed and no empirical determination was carried out and relations established between the population growth changes and wildlife habitat fragmentation due to urban sprawl or other effects such as agriculture. Habitat fragmentation squeezes animals into ever diminishing areas. As these areas are further reduced, the effects are more likely to affect the survival of an entire species. The impact will be rapidly experienced if the species inhabits a small area. Even though this may not be the case with migrating animals found around the Nairobi National park as their population exists elsewhere outside the park, their continual survival in the park will be severely affected, (Otuoma 2004).

Rapid population growth in North Carolina averaging 34000 people annually has been impacting on watersheds and wildlife ecosystems. The continued increase has led to reduced habitat quality and quantity and negatively affected listed and sensitive species (Kerr 2007). In Ecuador; Galapagos Islands have experienced population increase largely due to high in-migration. Between 1982 and 1998, the overall annual population increased from 6.0 percent to 6.4 percent. People moved to take advantage of the then growing tourism industry. This increase resulted in increased pressure on the marine life and introduced new species that have threatened the islands fragile ecosystems. Pressure on the marine ecosystem was due to waste being dumped into the sea. It is also vital to recognize the role tourism plays in the economy of the state through foreign earnings, and direct and indirect creation of employment opportunities. The report by Kerr (2007) gives an example of how to study human population changes, by looking at size and rate of growth and relating the issue to conservation areas. However, like the above study from California' s, it did not examine the trend of the pressure resulting from the human population changes as a result of agricultural activities or horticultural farming for that case.

According to Chen *et al.*, (2008) enormous changes in land use pattern have occurred in China, having been caused by rapid growth of large cities with accompanying accelerated growth of industrialization, high speed economic development, massive urban housing and infrastructure investment.

These have contributed to substantive conversion of green fields and prime agricultural lands into industrial and residential uses in many cities in China. These major land use changes including agriculture and urbanization have impacts on the peri-urban and urban population growth which increased by 3.9% per annum between 1986 and 2000 rising by 222 million during the nineteen nineties. In seeking sustainability in the face of such growth, they argued for encouragement of compact cities in China and a check to the rapid land use change. It was argued that compact cities would help save land and encourage preservation of green fields and arable lands. That, this way encroachment into the countryside (urban sprawl) would be prevented and thus maintain the bio-diversity. In their analysis of the relationship between different forms of land use change and environmental externalities, they found that increased human population density was positively related to though statistically weak-to urban externalities.

Another impact of human population growth on conservation is the reduction of land under forest cover. In Malawi, population growth of 3.2% per annum in many regions has forced farmers to expand their production by clearing new areas of forest. According to World forest movement (2002), Malawi might be considered a good candidate to demonstrate that population growth may not be a direct cause of deforestation but an indirect cause occasioned by population increases and pressure on forests.

In Ngorongoro conservation area (NCA), Tanzania, a rapid growth of pastoral population was documented from 8500 people to over 18000 people in 1978. According to Madulu, (2004), this poses a big challenge of ensuring long-term biodiversity, productivity and sustainability of the Ngorongoro Conservation Area. In another related case, expansion of settlement into Masawa game reserve was attributed to increased human population through in-migration and high internal population growth. Human population grew from 1.5 million in 1948 to over 3.3 million in 1978. Another big threat to protected areas that he was able to identify was deforestation. Agricultural expansion, brick burning, lumbering and charcoal burning instigated this in the case of Masawa area and are similar to the case reported by Word Rainforest Movement (2000) in Malawi. Even though these activities contribute to economic gains, they render themselves, in the process unsustainable just as they do to the conservation of the protected area.

Brick, charcoal burning, and lumbering directly lead to tree felling. For agricultural land, the same will be done to create space on the fertile forest land. Unlike the above mentioned case studies, the case of Nairobi National Park population and its environs, human population increase has been attributed to rapid urbanization around the park and increase in activities such as horticultural farming, residential settlement, mining and pastoralism but to a lesser extent.

The Meru National park in Kenya has witnessed an increase in the immigration of farmers from the surrounding potential ecological zones into its buffer zones or protected regions. There was a population increase from 1.56 million in the 1979 to 2.9 million people in the 1999 within the buffer zone area. Apart from the size, wildlife management institute of Kenya report (2005) also analyzed population density which changed from 51-125 persons per square kilometer to 126-500 people per square kilometer. The result is that areas which formerly served as communal grazing land and wildlife dispersal areas have been subjected to sustained fragmentation and alterations as the migrant households take up land for settlement and crop cultivation. According to Otuoma (2004) this situation has led to reduced livestock/wildlife resource base and increased competition among wildlife, livestock and agriculturalists hence human-livestock-wildlife conflicts. The conflicts according to Otuoma (2004) were due to land use changes especially the expansion and intensification of arable farming and sedenterization of wildlife, and natural increase in animal numbers. Decline in livestock resources was attributed to deaths from diseases carried by wildlife and livestock attack by wildlife among other causes.

On human population policy in Kenya, He argued that a policy discouraging rural urban migration had directly led to increased human population in high potential areas. The consequence was their migration into ASALs due to pressure on land and the need for alternative land for settlement and crop cultivation.

Increased human population as a result of agriculture also increases human-wildlife conflicts. According to Nyeki (1993), human settlements increase of more than 75% due to population growth over two decades in Ijara district had the impact of increased conflict between wildlife and people.

Settlements and farms took up vital wildlife grazing lands causing human-wildlife conflicts over these land resources. Animosities between and within local ethnic groups were also attributed to the increased human wildlife conflict in the area. In examination of Tsavo wildfires, Muasya (1998) found that they were caused by increased human activities of charcoal burning which were taking place outside the park. He found that fire used by herdsmen to kill ticks on grasses and by farmers to clear land for cultivation got out of control to burn wildlife forage and some crawling and slow moving animals to death and caused injuries to others. Such fires also forced migration of wildlife from one affected area of the park to another area. Other impacts of such fires were frequent interference with park management activities with a lot of resources redirected to fire fighting. A difference emerged between these two situations and the current study area. In the case of the wildlife migration corridor, though the native communities were pastoralists with practices similar to the above, their interaction with the urbanites and both urban social-cultural and economic forces might have had them change significantly. Muasya (1998) found that the area population composition has changed with the native only constituting 47%. The threats of wildfires remain, but likely from different causes such as arson, motor accidents among other causes.

These studies and reports give examples of impacts of human population changes and land use changes on wildlife and conservation areas. Even though increased incidences of fires in the Tsavo were attributed to increased human activities due to population growth, no empirical examination of changes in both human population growth and wildlife population dynamics were carried out. The study areas adjoining the Meru and Tsavo parks and in Ijara were also rural in character and so were the examined human activities. Kwadha (2009) reports that similar studies from other countries like Mexico, USA and Zambia only give generalized impacts covering large areas or even the whole nation without any specificity. These therefore only give examples of impacts of human population increase on a protected area but not within an agricultural intensification context. This study therefore aims at filling this gap that addressees land use change in the wildlife dispersal area and narrows down to the impact of agriculture and conservation.

2.7 Land use changes, Human activities and conservation areas.

Human land uses are major causes of wildlife habitat loss throughout the world. Human settlements and associated activities in general have impacts on the natural environment in a number of ways, which are varied in nature and in their intensity. Urbanization is associated with increased intensity of human settlement and hence increased intensity of impacts. Settlements including urban development impact on the environment through direct and indirect consumption of land, water, wildlife, vegetation and the associated disposal of both domestic and industrial wastes. All these modify the natural processes in the environment in one way or another, according to Shrader (1991), urbanization is often blamed for habitat degradation.

Adams *et al.,* (2006), in their attempt of reviewing urban wildlife management observed that developers most of the times fail to take into account the surrounding wildlife community, which lead to management challenges. This they attributed to the population
shift from rural to urban areas (urbanization). They also noted, however, that as Americans have become urbanized, so has their curiosity about wildlife increased in attracting wildlife in order to improve their quality of life. One of the most profound effects of urban development (land use change) on the population dynamics of wildlife is habitat fragmentation that creates islands of habitats or patches in affected areas. These patches affect animal behavior, reproductive patterns, survivability, immigration and emigration or dispersal capabilities, and foraging activities.

Omondi (1984) recognizes that in Nairobi the urban population already enjoys this kind of desired opportunity. However, there seems to be less recognition of the value of the existing wildlife and instead the urban population and land use change pressure is threatening the sustainability of the same in the national park. It is under such context that associated impacts should be examined towards enhancing parks prosperity. Following the development in environmental management legislations in Kenya such as Environmental Management and Coordination Act (EMCA) of 1999, urban developers are expected to take into consideration the wildlife communities in their surrounding areas through carrying out EIA prior to commencement of the development.

Conservation efforts are challenged by agricultural land use changes. Pfeiff et *al.*, (2001) used satellite images and social surveys to examine land use changes in Cerru Azul Meambar National Park in Honduras. In this Study the attempt was to draw a relationship between population change and agricultural intensification to understand the impact of conservation policies. They found that intensification of agricultural production increased with human population density. This led to greater opposition to forest conservation efforts in the area. They concluded that in areas with intensified agricultural land uses, due to increased human population density, environmental conservation efforts are unlikely to succeed. Environmental conservation and even restoration is in direct conflict with agricultural intensification.

The island of Sal in Cape Verde has several terrestrial protected areas and one marine natural reserve. Tourist resorts complexes are built on the island whose impacts are still unclear. Land use changes due to overgrazing and introduced species have already caused severe loss of natural habitats and stressed a number of endemic plant and animal species, (Trzyna 2007). In Cameroon, rapid population of both wildlife and human has depleted agricultural land thereby magnifying the conflict. Human loss occasioned by elephant population is part of the conflict that has increased. Elephant damage to crops has doubled between 1992 and 1993 in the Kaélé and Mindif areas and caused increasing loss of human life. (Tchamba, 1999).

The design of sustainable conservation requires knowledge of conflicts between people and protected areas. Weladji and Tsamba (2008) identified the crop damage and loss of income from such damage as among the leading causes of conflicts crop between local people and the Benoue Wildlife Conservation Area (BWCA). The use of co-management has been suggested as a way of mitigate the human-wildlife conflict.

In Kenya many studies have been carried out especially on human wildlife conflicts, which have been identified as threats to the future of wildlife conservation in many areas. Similar threats have also been identified in the conservancies. Some of the studies concerning the conflicts between communities, pastoralists and farmers in the wildlife dispersal region include:

Butle *et al.*, (2008) in his study demonstrated the depletion of traditional grazing grounds near Amboseli National Park (Kenya) through conversion into cropland reducing the size of wildlife corridors. The authors proposed for introducing an ecosystem services payment scheme that compensates pastoralists through benefit scheme factoring the land use. Omondi P. (2008) also studied the human-wildlife population conflicts around and Maasai Mara, in Kenya.

The study further affirmed the role of growth in human populations, changing land use patterns and wildlife perception from the Maasai community as key sources of conflicts. The land use profile indicated poor agricultural lands in the lowlands and high potential lands in the uplands. To address the conflict, the study proposed conflict management policies to curb crop damage, loss of livestock and fight over the limited resources in wildlife ecosystem.

2.8 Damage from Problematic Animals (wildlife) and mitigating Their Impacts.

The elephants (*Loxadonta africana*), cape buffalos (S*ynceruscaffer*), spotted hyenas (*Crocuta crocuta*), lions (*Panthera leo*), leopards (*Panthera pardus*), gazelles (*Gazella thomsonii* and *Gazella granti)* zebras *(Equus burchelli)* and hippopotami *(Hippopotamus amphibious)* were all considered by respondents to be problem wildlife (Mwangi, 2000). Out of the wildlife, the elephant was identified as the largest contributor to the damage from problematic animals with damage mostly occurring in dry seasons.

The impacts arising from these problematic mammals depend on type of crops grown and land use in the surrounding areas. Omondi, (2008). However, this is not the case with the conflicts associated with the Nairobi National park where much of the damage to agricultural practices and conflict occurs during the wet season when the wildlife migrates out of the protected area in the dispersal region.

Most of the locals residing around the national parks have negative attitude, and have attributed wildlife benefits to the government and know tourism investors. A few members mentioned education and commercial benefits related to wildlife.

In Kenya many studies have been carried out especially on human wildlife conflicts, which have been identified as threats to the future of wildlife conservation in many areas. Similar threats have been identified in the urbanizing areas of the country.

Studies on the industrial land use activities impacts on Lake Nakuru National park found industrial pollution to be a threat especially to the wildlife (foundation for the parks establishment in 1968) and Park to pollution by chemicals such as Lindane, chlordane and DDT (Mhlanga and Mares 1976).

Mwangi (2002) in a study of partnerships in urban environmental management also noted the environmental effects of rapid expansion of Nakuru town as well as agriculture around the town. He specifically identified environmental concerns arising from the relationship between Lake Nakuru Park and residential cum agricultural expansion. However, the two parks are slightly different in that Lake Nakuru is completely fenced while Nairobi is not thus the interactive intensity with urbanization (change of land use) between the two conservancies.

Water and the environment are considered polluted when there chemical, physical and biological compositions are altered in their condition making them less suitable and harmful to public health and other uses (WHO, 1972). Although environmental pollution can at times be accidental with grave consequences, in most cases it is caused by the uncontrolled disposal of sewage and other liquid wastes from individuals, farms (flower farms mostly) and industries. A significant portion of waste disposal from flower farms is linked to human settlements and population growth in their areas of operation. The organic matter contained in untreated domestic sewage consists primarily of carbohydrates, proteins from animal matter and miscellaneous fats and oils. Ngene *et al*., (2004), the specific classes of organic compounds found in sewage include amino acids, fatty acids, soaps, esters anionic detergents, amino sugars, amines, amides and others (WHO Scientific Group on the treatment and disposal of wastes 1967). Pollution from agricultural practices is due to animal wastes, material eroded from land, plant nutrients, inorganic salts and minerals resulting from irrigation, herbicides and pesticides. To these may be added various infectious agents contained in wastes.

Horticultural farming in the surroundings of the Nairobi national Park is a great contributor to waste disposal in the region. This greatly affects the wildlife both flora and fauna directly and indirectly through food chain consumption of horticultural chemicals and pesticides.

2.9 Biological Significance of Animal Movements and Theory

The best documented movement of African ungulates is the seasonal migration (Sinclair 1979; Fryxell& Sinclair 1988).

Migration of the ungulates occurs in response to seasonal changes, and often leads to seasonal movement accompanied with strong seasonal concentration in a given area (local resident movement).

Studies documenting ungulates migration have been documented in the Mara-Serengeti ecosystem and the Amboseli ecosystem (Fryxell & Sinclair 1988).

Migratory animals must satisfy their nutritional needs by moving sometimes over great distances, to access the best quality food resources available at any given time (Kutilek 1979). Seasonal change in forage nutritional quality is a push factors for migration. However, not all ungulates migrate as some do not and instead utilized existing food resources (Western 1973). Wildlife population may increase or decrease dynamically with rainfall. Plenty of rainfall may lead to population increase as improved range condition is enabled by the growth of forage and abundant water necessary for physiological functions. However, excess water as a result of flooding may exterminate populations directly or indirectly through water logging of the vegetation and making food unavailable. The *El Niño* weather phenomenon, which brought excessive rainfall in East Africa in 1998, claimed both human and animal life through flooding. The abundance and distribution of wildlife populations will vary with food supply, seasonality, predator activity and a host of other biotic and abiotic factors (Morrison *et al.,* 1992). Water is a critically important resource that determines the survival of any animal, particularly in the arid and semi-arid environments. Water is the most important limiting factor to the abundance and distribution of wildlife in the savannahs of East Africa, especially in the dry seasons. The importance of water to the survival of wildlife has been discussed widely in literature (Western 1975). The effect of water on wildlife and livestock, and dependence on it is crucial to both the species. Most of the water-dependent species are grazers while browsers tend to be water-independent. Presence of large water sources allow wild animals to spread out during rainy and lack of water sources leads to dispersal.(Western 1975).

The seasonal movements of large mammals between dry and wet season ranges are attributed to water availability, pasture condition or combination. Dry season concentrations are due largely to water availability.

Sinclair (1979) noted that most animals were concentrated close to the Ewaso Nyiro River during the dry season. Other factors such as availability of minerals, avoiding predation and competition also influence animal movements.

Large mammal communities are ultimately limited by food supply through mortality and reproductive stress (Mwangi & Western 1998). The abundance of large savanna herbivores has been related to rainfall as the single most environmental variable affecting ungulates, which determines the amount of food available, particularly in the dry season (Sinclair, 1979).

Changes in rainfall patterns influence vegetation dynamics and hence ungulate populations. Droughts on the contrary diminish the wildlife species leading to movement of animals seeking for survival. A case in point on the impacts of drought is the well documented movement of animals in Serengeti-Mara ecosystem due to lack of rainfall.

Mara ecosystem where the wildebeest, Burchell's zebra and Thomson's gazelle migrate between dry season and wet season ranges in the Masai Mara Ecosystem in Kenya and Serengeti Ecosystem in Tanzania. Differences in migratory movement patterns can be related to the differences in food requirements of animals. Food supply determines migratory patterns, which is largely dependent upon rainfall and yearly variation in migration is also related to rainfall.

Animals move to certain areas to obtain more protein or energy or minerals and avoid other areas because of floods and pests such as tsetse fly. Migration reduces competition between animal species, especially the grazers at critical times of the year (Hilborn & Sinclair 1979). Other biological processes that influence herbivore dynamics are competition and predation. Intra- and inter-specific competitions occur when there is same dietary need. The diversity and abundance of herbivore communities in African savannah ecosystems have been linked to habitat preference amongst different species and partitioning and differentiation of resources.

Jarman & Sinclair (1979). Furthermore, the feeding habitats of some species will enhance food availability to others through facilitation, for instance among wildebeest, Burchell‟s zebra and Thomson‟s gazelle during migrations.

Animal movements (annual, seasonal and daily, and local and long distance) by both wild and domestic herbivores systematically exploit environmental discontinuities. Predation influences the dynamics by regulating populations of ungulates. Sinclair (1995) suggested that large herbivore populations are regulated more by food supply than predation because of their large size (e.g. buffalo, rhino and elephant), while predators regulate others.

Species like the wildebeest escape predation through migration. Human activities disturbances are one of the most significant causes of loss of wildlife habitat which affects the population of wildlife species negatively. (Ottichilo, 2000). Livestock also are a factor in wildlife habitat as there grazing can lead to loss or increase of some vegetation suitable for wildlife.

For the case of the Nairobi National Park and its surroundings horticultural farming has contributed greatly to land fragmentation by fencing and sub-dividing the wildlife corridors. However, as noted by Ottichilo (2000), several factors contribute to wildlife reduction and key among them is land fragmentation while horticultural farming has greatly contributed to this especially in the surroundings of the Nairobi National Park.

2.10 Wildlife and People - Conflicts and Conservation

Biodiversity is facing widespread competition with humanity for space and resources (Primm *et al*., 1995). Many species are increasingly coming into conflict with people, and this is particularly true for large mammals, some of which are either critically endangered or have declined rapidly. Others, such as the African elephant inflict considerable impacts on people and are the position of being simultaneously an endangered species (IUCN, 2000) and a pest in other places.

Protected areas, the cornerstone of modern biodiversity conservation has gone some way in protecting species. However, they have been limited in completely resolving human-wildlife conflicts as they cannot wholly lead to avoidance of destructive human impacts (Brunner *et al*., 2001). Equally, they serve their purpose when wildlife are within the protected area but when dispersed they increase conflict.

Although wildlife biodiversity is a national heritage and one of the major economic pillars in the country, today, the wildlife in protected areas are practically confined or secluded by human activities. This has been aggravated by increasing human population high settlement densities and the expansion of agriculture along rainfall gradients.

The limiting of wildlife to protected areas put pressure on the existing resources within such reserves. As a consequence wildlife may be dispersed as they seek for resources in areas dominated by human-dominated landscapes in search of forage and water result to conflict and damages.

All these may lead to animosity towards wildlife and conservation. An analysis carried out by KWS (2000) has shown that wildlife conflicts continues to increase around many protected areas - high intensities in Tsavo West-Chyulu, Maasai Mara NR (Transmara and Narok area), Laikipia (Rumuruti area), OlDonyo Sabuk and Lamu South. However, human wildlife conflict around the NNP is not as pronounced as the above mentioned conservancies. Key to the resolution of human-wildlife conflicts around protected areas is the development of appropriate strategies for securing wildlife dispersal areas and migratory routes/corridors. This may include encouraging the harmonious co-existence of people and wildlife, putting in place mitigation measures and ensures community participation in conservation and deriving benefits, and increasing wildlife space with compatible land uses.

2.11 Wildlife Species around the NNP

Wildlife connections and linkages (corridors) are usually designed with "umbrella" species in consideration. In this study, some key species - Birds, wildebeest, plains zebra, giraffe, antelopes and buffalo were selected to represent different feeding ecologies, migration strategies, body sizes, life history characteristics and vulnerability to human disturbance. The species together with pastoral livestock have large influence on the ecological dynamics of ecosystems and play a critical role in shaping habitat mosaics that underpins species diversity.

2.11.1. Wildebeest (*Connochaetes taurinus mearnsi* Burchell)

The blue or common wildebeest is a large antelope and can attain a body mass of 168-274 Kg. Wildebeest are territorial animals, highly gregarious in mobile aggregations or dispersed in sedentary herds. Wildebeests are often graze together and are water dependent, requiring long drink (1-2days) of water within 15-25 Km radius. Wildebeests often graze together with other species (plains zebra, Thomson's gazelle, Grant's gazelle, kongoni). Wildebeest's migration is beneficial to other species that remain behind to feed on the grass.

In East African, the wildebeest range is found along the ranges bounding Lake Victoria, extending from Serengeti in Tanzania in Kenya to Mara in Kenya. These range include shrubs and bush-covered savannah, grasslands and open woodlands (Estes 1991).

They are found in open, shrubs and bush-covered savannah, thriving in areas that are neither too wet nor too arid. They occur in dense bushes to open woodlands and floodplains, but prefer grasslands which are sometimes overgrazed. Large herds numbering into thousands may be observed in the Serengeti equatorial plains of Tanzania in their annual migration to Kenya‟s Mara region. The Serengeti boasts over 1.4 million wildebeests, with migratory individuals moving from the short grass plains after the rainy season to seek higher grasses in wetter areas ranging over a 30,000 Km^2.

The grasslands bordering alkaline lakes or pans are particular their dry season habitat choice. In Kenya, the wildebeests are found in Narok and Kajiado counties, occurring both inside and outside protected areas including Amboseli and Nairobi National Parks, Maasai Mara National Reserve and the wider dispersal areas. However, in recent years the wildebeest range is continuously declining and populations reducing due to land use change (high settlement densities, expansion of agriculture, fences), increasing livestock numbers (pastoralist sedenterization), drought and bush meat poaching.

Since the 1970's the Mara ecosystem resident population has been depleted, with land use, large scale farming and human-population growth contributing to these changes. (Ogutu *et al.*, 2009). The populations in Nairobi National Park and Athi-Kaputei plains, and Amboseli nearly crashed as a result of the 2009 drought which also affected most of the large wild grazers and pastoral livestock.

2.11.1.1 Distribution and Trends of Wildebeest in the Athi-Kaputei Ecosystem

The Athi-Kaputei ecosystem covers about 2100 km^2 and comprises of the Nairobi National Park and Kitengela conservation area, with the park covering about 115 km^2. In the 1970s, the Athi-Kaputei ecosystem contained the Second largest wildebeest population (around 30,000 animals) in the country (Ogutu *et al*., 2009).

This population has since declined to less than 4,000 (DRSRS, 2011 census). The Athi-Kaputei ecosystem zebras and wildebeest migrate between NNP and calving grounds in the Athi-Kapiti plains. Nairobi NP is the dry season refuge for a number of large wild herbivores including eland, kongoni, Thomson's gazelle and impala.

The wildebeest migration between Nairobi NP and Athi-Kapiti plains seem to have collapsed from 1961 to 2009, when their population of 5000- 10000 had declined to less than 800 animals in 2001-2009 (Ogutu *et al*., 2009). This study aims at identifying the relationship between the migratory wildebeest (their population trends) and horticultural farming around the Nairobi National Park especially along the migratory corridor.

2.11.2. Burchell's Zebra (*Equus Burchelli Gray*)

The plains zebra mainly inhabits the shrub and wooded grasslands, and feed almost exclusively on grasses, but may occasionally eat herbs, shrubs, twigs, leaves and bark. Grasses constitute over 90% of the diet. The Burchell‟s Zebra adults are limited to their range in places within water sources as they lactating females consumer two daily trips to water points (Estes 1991). They tend to be the first grazers to move in the grazing succession thereby opening up the herb layer for the other grazers and show low selectivity compared to the other grazers such as the wildebeest and kongoni (Gachoki 1981). In the Athi-Kapiti plains, the zebra takes between 17-20 species of grass with a greater variety in the dry season.

The plains zebra is are mostly common in cooler environments. However, during harsher weather they migrate periodically in research of vegetation although not all move (Maddock 1979). In Kenya, the plains zebras are found in Narok, Nakuru, Kajiado, Machakos, Kitui, Taita-Taveta, Tana-River, Garissa, Kwale, Kilifi, Lamu, Laikipia, Samburu and Isiolo counties, with highest concentration in the Mara and Tsavo ecosystems.

2.11.2.1 Distribution and Trends of Plain's Zebra in the Athi-Kaputei Ecosystem

The Athi-Kaputei is home to a large population of zebras (plain), which are distributed throughout the Athi-Kaputei ecosystem. Unlike the wild beasts which have been on a decline, Zebra population has witnesses a steady rise in their numbers.

Herds of zebras are commonly seen around Konza in Kaputei North. (Kwadha, 1999). The population had reached high peaks in Nairobi NP during the droughts of 1993, 1996-97, 1999-2000, 2005-2006 and 2008-2009. (ILRI, 2011).

2.11.3. Common Giraffe (*Giraffa camelo pardalis Linnaeus*)

The giraffe is the largest and tallest ruminant, standing at 5-6 m. The males weigh 1.2 tons (1,200 Kg) and females (830 Kg). They are noted for their extremely long neck and legs, and prominent horns. The giraffe is an ideal species for examining the feeding ecology of animals because it can reach for high foliage unavailable to most other herbivores.

The giraffe as browser mostly inhabits the savannas, grasslands, and open woodlands where they move across large swaths of land in search of different vegetation types (Parker & Bernard 2005). Girrafes prefer the leaves of leguminous plants. They also exhibit stable populations in comparison other large mammals (KWS 2000). The giraffe is classified as least concern (IUCN), however it has been extirpated (destroyed) from many parts of former rangelands and some sub-species are now classified as endangered.

2.11.3.1 Distribution and Trends of Giraffe in the Athi-Kaputei Ecosystem

Distribution of giraffe in the Athi-Kaputei manifest mixed densities, with high density found in Kaputei North and around Konza-Kisaju areas while low population are found in the NNP and Machakos ranches (FoNNP, local communities and ILRI ground count in 2011).

The high density areas of the giraffe population are mostly found near the riverine areas and shrub ecosystem. From a population of over 800 giraffe population in Athi-Kaputei ecosystem the current population has reduced to than 500 in recent years. (KWS, 2000).

The giraffe pollution within Nairobi NP (estimated as more than 100 animals) has exhibited a stable population, while those outside have slightly been on the decline. Giraffe population is the region is not correlated with seasonality. Ogutu *et al*., (2008) has shown that the number of newborns giraffes in the Mara-Serengeti ecosystem was best correlated with the late dry-season rainfall averaged over the preceding 5 years, but older giraffes were correlated with the wet-season rainfall averaged over 1-5 years.

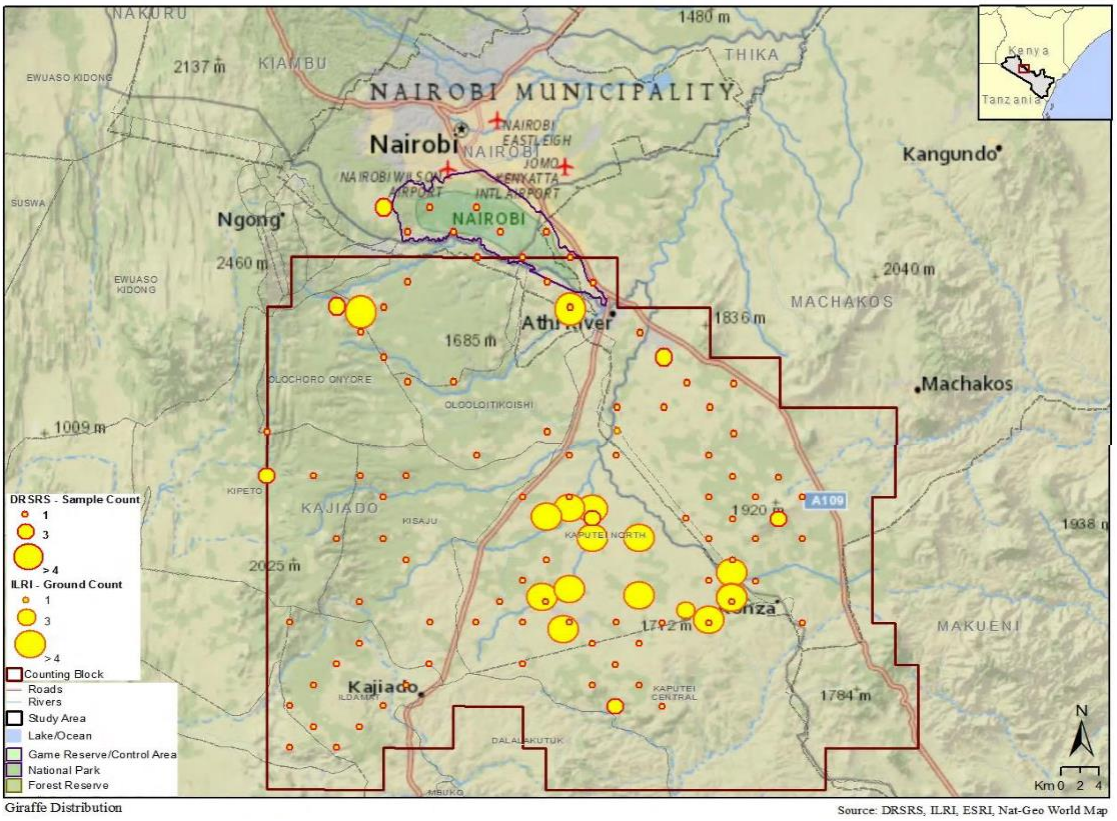

Figure 4: Aggregated number of giraffe in the NNP-Athi-Kapiti wildlife dispersal areas.

Source: DRSRS& ILRI.(2001)

2.12 Human Activities around the Nairobi National Park.

NNP being a protected area is characterized by a wide range of human activities around it. Due to close proximity to the city of Nairobi, pollution is a major threat to the park. The main source of pollutants is the industries and human settlements to the North and Northeastern side of the park boundary. Industrial and domestic effluents find its way into the parks wetlands while plastics and other litter blows it from areas of heavy human settlements next to the park (Gichohi 2002).

The local people graze cattle along the borders of the park in protest of watering their cattle in Mbagathi River. This occurs each year during dry season (August to late October) to the West of the park is the opulent Karen residential area. Land use activities here include intensive vegetable and crop farming, training institutions, shopping centers and recreational areas. The Mombasa railway and highway runs along the Eastern boundary all the way from the city of Nairobi to Athi River town separating the park

from Embakasi plains. Land use activities in the Embakasi plains include the Jomo Kenyatta International Airport, Industries, residential areas, shopping centers, restaurants, slums and grazing land. (Ngene 2002).

The Athi River forms the Southern Boundaries of the park while Ongata Rongai shopping center sprawls southwards separating Karen from Kitengela Conservation Area. Historical evidence suggests that the Maasai grazed their cattle here and had co-existed with wildlife harmoniously. Recently increased farming and fencing have been observed thereby making dispersal of wildlife difficult. (Ngene, 2002).

The park‟s topography reflects the limits of a series of lava flows which divides the park roughly into 3 different soil and vegetation zones (Gossling, 1974). Within each zone, however, the soils are influenced more by the local topography than the underlying rock. The topography of the park is broken by a number of streams which run from the Environmental Implication of Agricultural Activities.

Around the NNP several land use changes have affected wildlife conservation in and around the park. The migratory wildlife are most affected because they interact and are directly and indirectly affected by the land use changes in their eco-system. Some of these land use changes include: quarrying, settlements, industrial establishments, planted vegetation, boreholes, flower farms and other smaller horticultural farms. This study narrows down to horticultural farming as one of the major land use change around the Kitengela conservancy and its effect on migratory wildlife in the area.

Table 1: Environmental implication caused by various agricultural activities.

Impact → / Activity ↓	Land use	Soil Erosion	Soil salinization	Energy cost	Surface H_2o Quality	Ground H_2o	Slope stability	Soil pollution	Landscape	Disease carrier	Public health	Ecosystem
Type of crops	√				√	√		√	√			√
Irrigation	√	√	√	√	√	√		√	√	√	√	√
Drainage	√			√	√	√						√
Fertilizer					√	√		√			√	√
Pesticides					√	√		√			√	√
Intensive Agriculture		√	√	√	√	√			√	√	√	√
Farming					√	√			√	√	√	√
Ploughing	√	√		√			√		√			√
H_2O source	√		√	√	√	√		√	√	√	√	√

Indication the environmental implication caused by various agricultural activities.

Source: Ramachandra (2006)

2.12.1 Challenges Facing Wildlife Conservation in and around the Nairobi National park

In Kenya, The Kenya Wildlife Service (KWS) manages and conserves its wildlife for the Kenyans people and the whole world.Over Kenya and many other countries in the whole world face multiple challenges in wildanimal and biodiversity preservation. There are many challenges including: climate change; environmental degradation and destruction, loss of natural forest depletion, the volatility of the tourism market, and human wildlife conflict. Wildlife in Kenya, since the first national park was set up in 1946, has decreased dramatically, with some species on the verge of extinction such as black rhino. The conservation of Kenya's wildlife is facing management

problems. In Nairobi National Park, the following are the major threats to wildlife conservation.

2.12.1.1 Urbanization

According to Budung, (2013) study on the impact of urbanization on sustainable conservation of Nairobi National Park; many land uses changes in Isinya, the southern part of the park has occurred which have had negative effects on conservation on the southern part of the park. Policy shifts from communal to private ownership, then subdivisions and sales culminating in the current developments have been exacerbated by rapid population growth with density and lack of land use plan for the area. Dominant land uses on the southern side of the park include residential, irrigated large-scale floriculture and quarrying. Rising human population density in Isinya has been found to negatively correlate with the population of migratory wildlife in Nairobi National Park. Urbanisation and changing land use has affected wildlife by both fragmenting their migratory corridor and posing environmental risks of pollution and soil erosion. Trends show a constant decline in population of migratory wildlife in the park having concurrently started with a shift in the human population composition in Isinya, in the 1990s.

2.12.1.2. Destruction of wildlife habitats

Wildlife habitats provide an important resource base for rural people's livelihoods. However, rapidly increasing populations and other complex socio-economic factors have put enormous pressure on the limited productive land forcing the rural poor to resort to poor land use practices for subsistence. Poor cultivation methods, deforestation, charcoal burning and overgrazing are four main factors causing severe wildlife habitat degradation (UNEP 2000).

2.12.1.3. Pollution

Pollution by humans continues to cause drastic modifications to wildlife habitats. The introduction of solid wastes and other pollutants into water and land intentionally or accidentally negatively affects wildlife populations causing their death or impairment. Effluent and industrial waste from factories located along the park's northern boundary contaminate the park's surface and ground water systems (NEMA, 2009).

2.12.1.4. Off road driving

This is taking place in the open grassland plains particularly in the Athi river basin and Embakasi plains. Tourists drive close to animals (mainly the big cats and rhinoceros) to take photographs or to view the animals at close range. In the year 2001-2002, park management and conservation during the normal park patrols observed thirty (30) incidents of –off road driving. Many other cases however go on unnoticed (KWS 2002). Off road driving degrades wildlife habitat and decreases aesthetic appeal of the park. To address this problem, the park management has erected sign posts informing drivers not to drive off the road. Punitive measures to prevent off road driving include warning the culprit with the game drive; immediate expulsion from the park; and barring the culprit from game drive in all park for three months, to minimize the infringement of park rules, tour companies on their part conduct tour guide refresher courses where observance of park rules and regulations are emphasized.

2.12.1.5. Loss of dispersal & migration areas for wildlife:

The Nairobi N. Park and Athi-Kapiti surroundings are surrounded by the herbivore migration which occurs yearly. The southern plains to the park are very important grazing areas during both the dry and the wet season. Slightly before Nairobi city was established, large herds of wild animals moved with the rainfall patterns and moved across the landscape from the Tanzania end of Mount Kilimanjaro to the Kenyan Mount Kenya, the migration is as great a migration as the one that happens or takes place on the Serengeti. As the city of Nairobi become bigger the National park became the northernmost limit of the animal's migration. However the migrating wild animals can still reach the southern grazing lands/pastures by migrating through the parts of the Athi plains called the Athi-Kitengela plains.

The grazing lands are still very significant to their migratory routes, however the increase in man’s population and the resulting needs for land/pasture threatens to delink this traditional migratory route from the park to land further south. Nairobi National park's migratory wildlife is also threatened by changing patterns of settlement, fencing, and their closeness to Machakos, Kajiado and other industrial towns (IUCN 2006).

According to the KWS Corporate Structure (2005) the various land use that were digitized from the spot image were summarized in table 2. **Table 2**: Summary of land-use from spot image**.**

Land use	**No. of developments**	**Total area .km^2**
abandoned quarry	2	0.0506
building	47	0.1037
cleared land	459	9.2637
clustered building	11	0.2742
farm	222	5.9972
industrial land	2	4.4047
flower farms	12	0.8224
Kitengela town	4	3.5327
Mavoko municipality	1	4.9639
Ongata Rongai	9	0.8373
Planted vegetation	76	2.0081
quarry	4	0.3093
boreholes	35	-
total	849	32.5678

Source: KWS (2005)

2.12.1.6. Size of Protected Areas (PAs):

The protected areas around the conservancies are too small to enable ecosystem sub-processes which the wild animals and their populations depends on. Thus, the continued increase in wild animal populations is resulting in increased pressures on the environment that is degrading the parks ecology and environment. The limited park space and restrained wildlife populations within the park are straining the survival of species at the hard edges, of the conservancies especially when the land use in the surrounding the fenced parks is not matching with the conservation efforts. Common is this problem with the Nairobi National Park where the size of the conserved area is smaller to accommodate the wildlife population. (Wakhungu 2006).

2.12.1.7. Human-Wildlife Conflict:

The Nairobi National Park lies four miles south of Kenya's capital city, with just one fence keeping wild animals away from humans. This makes for a lot of human-animal conflict, especially between lions and cattle farmers. Turere (2013) was raised to see lions as the enemy because they killed his families' main source of income, their cows. So when he was 11, Turere came up with a solution to save his cows, and unintentionally save the lions through community sensitization on the importance of the wildlife and benefits from the same (Turere 2013).

The Nairobi National Park is left porous on the southern edge to allow unrestricted entry and exit of animals, which wonder back south towards the slopes of Mt Kilimanjaro around the Amboseli. Unfortunately, due to increasing human encroachment, the large herds that were previously sighted grazing, hunting, and roaming to and from the Nairobi plains are no longer visible.

Saving land for animal migration corridors and containing suburban sprawl is a necessity. We have finite resources in terms of the land that we can expand into; Nairobi should not have grown all the way to Kitengela, Rongai, or Ngong, and the pain of this sprawl is not only causing us agonizing travel to work, but also severe human-wildlife conflict at the edges of the Nairobi National Park (KWS 2009).

2.12.1.8. Climate change:

Globally, the climate is changing resulting in direct physiological impacts on individual species, changes in a biotic factor, changed opportunities for reproduction and recruitment and altered interactions among species. (Owino *et al*., 2012) carried out a research on Patterns of Variation of Herbivore Assemblages at Nairobi National Park, Kenya, 1990-2008. Their findings showed that, wildlife, especially mammals populations dynamics in many conservation areas were influenced by ecosystem processes and increasingly by climate change. They assessed the patterns of variation in abundance of eight herbivore species (African Buffalo, Eland, Burchell's Zebra, Wildebeest, Giraffe, Grant's gazelle, Thomson"s gazelle and Impala) at Kenya's Nairobi National Park using

population counts data over the period 1990-2008. Overall, the eight herbivores abundances declined within the Park with significant declines in Wildebeest Grants gazelle and Impala. Seasonality had effects on herbivore numbers and assemblages at the Park with the numbers of individual species increasing within the Park during dry seasons compared to wet seasons.

Between 1977 and 2002, the wildlife populations in the plains to the south of Nairobi National Park fell by over 70%.

Particularly hard hit were migratory animals such as wildebeest, which traditionally graze in the national park during the dry season and move south in search of new pasture during the wet season. From nearly 40,000 migrating animals in the 1970s, wildebeest numbers have fallen to about 1000 today (ILRI 2010).

2.12.1.9. Invasive alien species

Invasive alien species are a major threat to wildlife resources particularly in arid and semi-arid areas and aquatic ecosystems. *Parthenium hysterophorusis* is an invasive species that is affecting Nairobi national and Maasai Mara National Reserve (KWS 2011).

2.12.1.10. Over speeding

Two accidents involving resident visitors in private cars have occurred in the park in 2001-2002. Nabwire (2012) says these accidents have been caused by over speeding and have resulted in injuries to both people and wildlife. Over speeding has been going on despite measures putting place by the park management. These measures include erecting signposts in strategic points to inform motorists the allowed speed (30kph) along the park

roads, and construction of road network designed with long bends and raised culverts to discourage speeding.

2.12.1.12. Feeding animals

Some visitors have been feeding baboons and velvet monkeys to entice them to come closer so that they can take close photographs. This is common at Mukoyiet picnic site and leopard cliff. The animals have become habituated and they occasionally have tourists who visit his picnic sites. Some tourists have lost their documents and valuable to baboons at Mukoyiet and grievous bodily harm has been inflicted on others (KWS 2011).

2.13 Theoretical Framework

2.13.1 Island biogeography theory of ecosystem conservation and management.

Robert Mac Arthur & Edwin Wilson, (1967) theory of Island Biogeography posits that two processes primarily determine species diversity on an island or habitat. 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 or habitat area (area affected) whereas immigration decreases with isolation (distance of migrating species).In addition equilibrium of species diversity is attained and remains fairly stable when immigration and extinction rate are equal.

This theory transformed the science of biogeography (Janzen *et al.,* 1968). More fundamentally, the theory transformed ecology and habitat fragmentation. They proposed that ecologists ought to use arithmetic to bridge the natural world and expand logical insight into conservation. The theory revolves around the conservation of Islands and conservation areas. It emphasizes on use of mathematical approaches to make sense of key ecological problems that may exist in conservation. The theory has been applied to a variety of "habitat islands" such as ponds or lakes, mountain tops, individual plant patches of terrestrial ecosystem and caves. It is relevant to this study because the mathematical approach on the decrease of wildlife and increase of horticultural farmers 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 parks biodiversity.

This study adopted Mac Arthur's (1967) Island Biogeography theoretical framework by equating protected areas to true islands analogy. Frank Preston, (1962), further claims that, "in a terrestrial view-region bordering the protected zones is entirely un receptive to species residing within such locales. In this scenario, Nairobi National Park ecosystem, a protected area, acts as a "habitat island" in an inhospitable sea of environment 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. Significant to this land use change is horticultural farming which this study seeks to address.

2.14 Conceptual Framework

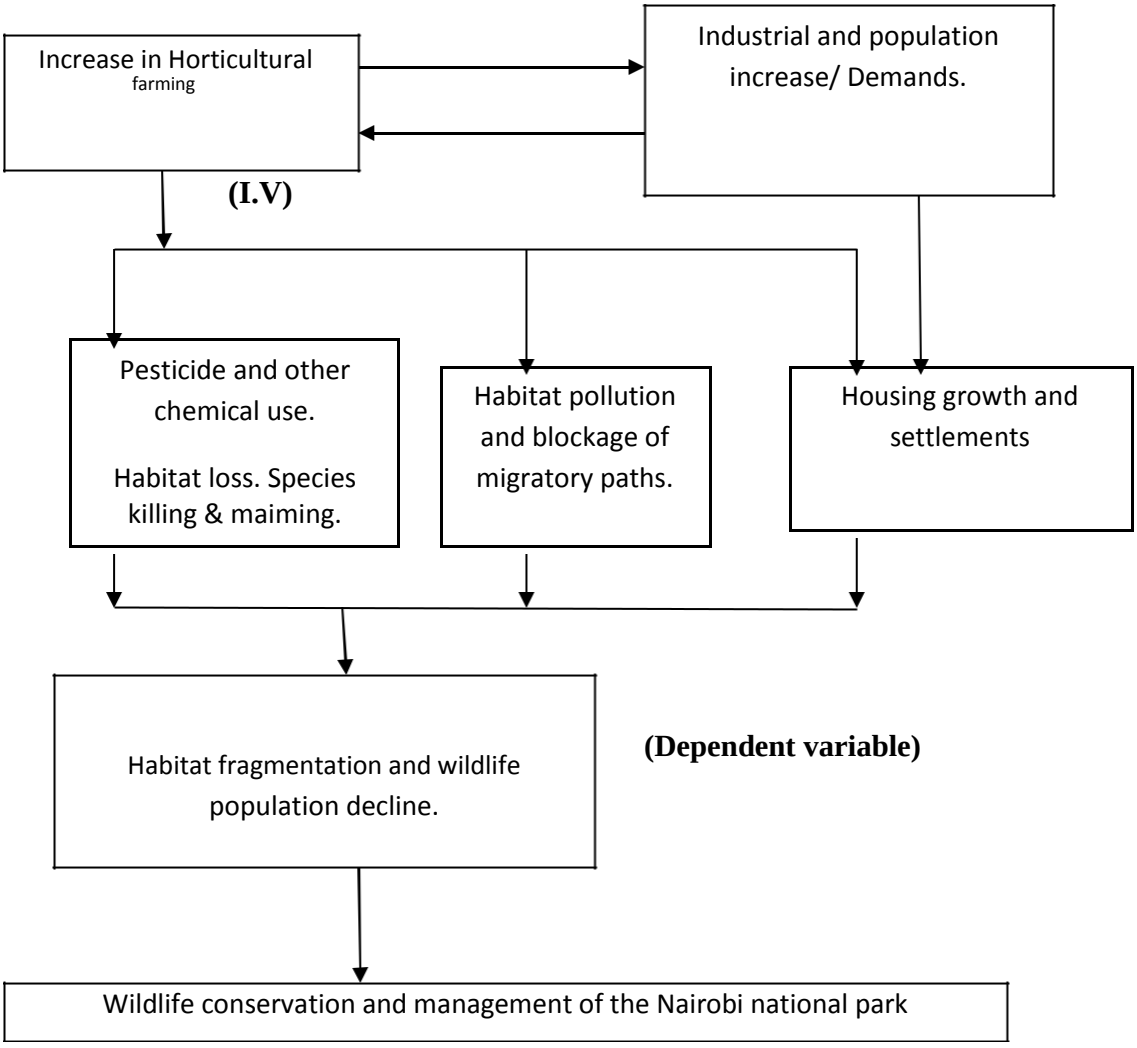

Figure 5: Conceptual Framework

(I.V) INDEPENDENT VARIABLE

⟶ Arrow points to the affected parameter

Conceptualization of the effects of horticultural farming on Biodiversity conservation and management of the Nairobi national park.

Source: Researcher (2015)

CHAPTER THREE: STUDY AREA

3.0 Introduction

This chapter discusses the study area which is the surroundings of the Nairobi National Park where much of the horticultural farming is taking place. It focuses on the administrative and geographical location, climatic conditions, topography and drainage, fauna and flora, economic activities and social-cultural activities of the communities in the study area.

3.1 Administrative and Geographical Location

The study area is situated in two counties: the county of Nairobi and Kajiado. Nairobi national park covering 117 sq. km is within the city of Nairobi which makes the Nairobi area county. It lies between 2^0 18"" S, $2^0$20" S and 36^0 23" E, 36^0 28" E (KWS 2007). The western, eastern and northern sides of the park are fenced. The southern side opens to the wildlife migratory corridor. The corridor lies between 36^0 44""E, $36^0$54" E and 1^0 40" S, $1^0$25" S and is part of the greater Athi-Kapiti plains in Kajiado County of the former Rift-valley province. It is made up of three sub-counties: Kitengela, Isinya and Olturoto (1066.3 sq.km) division of Kajiado county. Some of the large scale flower farms found in this region that could have a direct impact on the wildlife migration and habitat include: P J DAVE in Isinya, Isinya Roses, and Desire Flora and Maasai flowers.

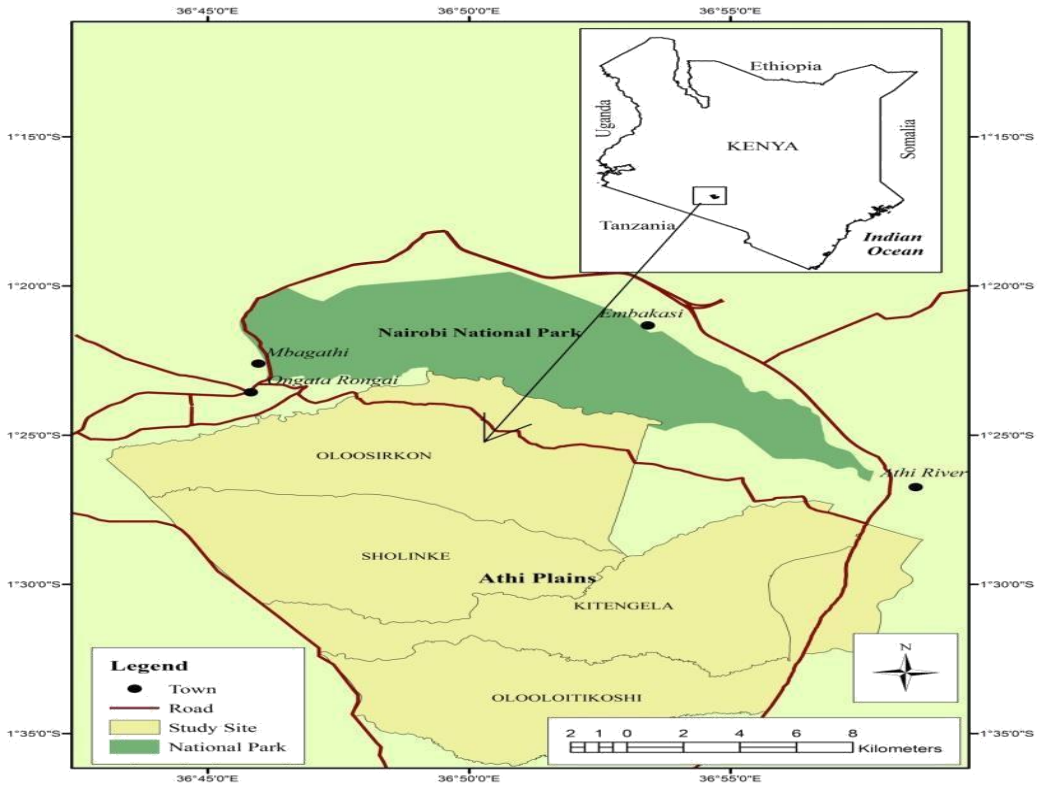

Figure 6: Nairobi National Park and its immediate surrounding the study area**.**

Source KWS (2012)

3.2. Size and Location

NNP was estimated in 1946 and is situated 8km South of Nairobi city. It covers an area of 117km^2. The park is geographically at an elevation of 520-1700m, Gichohi (2002). The park has been fenced with an electric chain fence in the North Eastern, North Western and South Western boundary. Mbagathi River forms the South Eastern boundary. Gichohi (2002) further says that this section is unfenced for wildlife movement to and from the park at different seasons.

3.3 Climatic Conditions

Nairobi N. P experiences a mean annual rainfall of between 500mm-800mm. The highest rainfall (850mm) is received at the Western part of the park (forested area), while the 55

lowest (500mm) is received at the Athi River basin towards cheetah gate. The annual mean temperature is 19.6^{o}c while mean maximum and minimum temperatures are 25.3^{0}c and 13.6^{0}c respectively, Ngene (2002).

lowest (500mm) is received at the Athi River basin towards cheetah gate. The annual mean temperature is 19.6^{o}c while mean maximum and minimum temperatures are 25.3^{0}c and 13.6^{0}c respectively, Ngene (2002).Hillman and Hillman (1977) determined a rainfall gradient approximately aligned with the altitude of the area. The rainfall gradient of 50-70mm per year is continued into the plains to the South in Isinya and Kajiado with the highest total of 75-100mm per year being experienced in the North and West of Nairobi and around Ngong.

The area usually experiences two rainfall seasons. The long rains fall in April to May while short rains occur from late October to late December. A distinctive feature of the climate in the area is the occurrence of a marked spell of dry season from June to August before the onset of the short rains, (Hillman and Hillman 1977).

3.4 Topography and Drainage

Gichohi (2002) States that NNP consists of several rolling plains with gently undulating gradient. To the wooded North West of the park is the highest elevation with an altitude of approximately 1752m the land decreasing towards the Embakasi plains with the lowest elevation being approximately 1508m in the Eastern and Central parts of the park. The land slopes further South East into Athi Kapiti River basin through a number of gorges. The Mbagathi River along the South Eastern boundary of the park is the only permanent water source. However, several perennial streams drain into the park for which Mukoyiet and Olmany are most noticeable, Korir, (2006). About 5 dams provide water for wildlife in the park though many dry up in the drought years except three; Hyena Dam, Olmany Dam and Athi Basin Dam.

3.5 Geology and Soils

Volcanic rocks of middle and upper tertiary form the basis of soils in NNP. Phonolite and alkaline trachyte lavas occur across the park and parts of the Athi-Kapiti plains. Tertiary sediments cover the Southern part of the park while calcareous and non-calcareous black clay soils derived from colluviums cover most of the rest of the park. Some other areas are characterized by dark grey brown calcareous clay loams associated with old lacustrine

deposits. The valley slopes have shallow, yellow brown or reddish clay. The forests have red friable clays. Ngene *et al*., (2002)

3.6 Fauna

NNP has a high diversity of fauna. The most common among the 400 species recorded since 1946 include the Maasai Giraffe (Giraffa camelopadolis maaica), lion (Panthera Leo), Leopard (Pantherapardus), spotted hyena (Crouta crocuta), Buchell‟s zebra (Equus Burchelli), the wildebeest (Cannochaetes Taurinus), Thompson Gazelle (Gazella Grantix), Impala (Gepycerosmelampus), Eland (Tautotragusderbianus) and Coke‟s Hartebeest (Alcelaphus Buselaehus), Cheetah (Acynomixjubatus),Crocodiles (Crocodilus militia), baboons (Papiohamadryas), velvet monkeys (Chlorocebus pygerythus) and hippos (Hippotomous amphibious) occur commonly in the parks wetland. The fluctuation in the wildlife biomass in the park is due to migration of the zebra, wildebeests and elands (Rudnai, 1974), following rainfall patterns. Animals migrate out of the park during the wet season and return during the dry spell. This is mainly attributed to water logging due to the landform and soils. Rainfall as suggested by Western *et al.*, (2009) is the main factor which contributes to wildlife migration to Serengeti and NNP. In Nairobi unlike other areas outside the park there is a permanent supply of water due to the presence of dams. In some other cases carnivores such as lions and cheetahs move out of the park in pursuit of migratory species, Hackel, (1999).

The number of most of the plain game fluctuates a lot during the year as they migrate in and out of the park into the Kitengela region. The park is usually ideal for viewing rhinos which although uncommon in the other parts of the country are easily seen here. Carnivores found in the park include lions, leopards, cheetahs and the servile cat. The Mbagathi River harbours the Hippopotamus, while baboons and velvet monkeys are common in the forested and riverine areas. Reptiles include crocodiles found in some dams and Mbagathi river, snakes and lizards. The park is rich in Bird species with over 400 species having being recoded. Richness in birds‟ species depends on the season of the year. Northern migrants e.g. Montagu European mash and pallid harriers pass through in March and April depending on the whether the rainfall has been plentiful or poor and

upon availability of both insectivorous frugal voodoos birds, suitable prey for raptors. Augur buzzard is the commonest raptor in the park. The king of the scavenging birds, marabou stork is common around the park dams. Ostriches are wide spread in the park and can easily be seen. Others include guinea fowls, the green and scared ibis crested cranes, koori blustered and secretary birds.

3.7 Flora

Past studies have shown that the vegetation types in the park mainly consist of deciduous forests and riverine thorn forests; shrubs and grass lamed with scattered trees with bushes cover about 90% of the park area and is mainly the poorly drained black cotton soils of the plain. The common types of grasses include: Pennisetummezianum, Themedatriandia, Sterna spps, Bothriochloainsculpta and Digitariamacroblefora. Acacia drepanobium occurs in stands of short bushes (Korir, 2006).

The deciduous forest cover about 45% of the park area and is found mainly in the well-drained loam soils of the hills around the parks headquarters the common plant species in this area include: Croton megalocarpus, Olea Africana and Dombeyaburgesiae. The riverine thorn forest is characterized by Acacia xanthophloea and Acacia kirkii (Ngethe *et al*., 1994). The bush land has a variety of habitat including dry streambed, rocky gorges where dominant shrubs are croton dichagamous, Grewia smiles and hibiscus spp.

3.8 Economic activities

The natives of the surroundings of the Nairobi National Park where the study was conducted are traditionally pastoralists. Livestock rearing is a major economic activity providing a source of livelihood for many residents especially the native Maasai. The dairy farmers in the county mainly sell their milk in the urban centers like Kitengela and other centers. Beef and goat meat are sold in the towns forming a major economic activity in the area. Other economic activities in the surroundings of the Nairobi National Park include: commodity selling mostly in the towns, quarrying, real estate development, sand

harvesting .Due to the expansive land available in the surroundings of Nairobi National Park irrigation farming has developed and is still expanding in most parts of Kajiado County where this study has covered. Much of it is done in green houses and on intensive irrigation. Some of the large scale horticultural farms found in Kajiado county that are of economic importance include: Prima rosa farm, Sian roses, Carnatian plants, Desire florations, P.J flora, Guango, charm flowers, Mboga tuu, Isinya roses among others. These farms contribute greatly to employment opportunities among the locals and as a foreign export earner to the country.

CHAPTER FOUR: STUDY METHODOLOGY

4.0 Introduction

This study makes use of both secondary and primary data. This study benefits from previous research in the southern conservation area of the Nairobi National Park. Primary data was obtained from a sample of 26 small scale horticultural farmers and 10 large scale horticultural farmers. A combination of simple random sampling and purposive sampling were used to collect data from the population.

Primary data collection methods used was: Questionnaires, oral interviews, telephones interviews of the KWS personnel and farm managers, photographs and field observation. Existing Secondary data such as remote sensed data was used in the creation of buffer zones. Digital maps such as the population census, vegetation maps, relief, geology and soil maps were used for analysing and categorizing the data. The type of maps used was in a scale of 1:50,000. The Kenya Wildlife Services (KWS) and Orthnological Department at the National museums provided data on animal census, rainfall data and also maps.

4.1 Research Design.

The study adopted a descriptive research design since the study gathered both qualitative and quantitative data that describes the impact of horticultural farming on wildlife management and conservation in the Kitengela conservation area. The descriptive research portrays an accurate profile of people, animal numbers and number of farmers carrying out the farming in the region. It allows one to collect qualitative data which can be analysed quantitatively using descriptive and inferential statistics (Saunders *et al.*, 2007). The researcher considers this design appropriate since it facilitates gathering of reliable and accurate data that clearly describes the impact of horticultural farming on the migratory wildlife in the Kitengela wildlife dispersal area.

4.2 Data Collection.

The data needed was collected broadly through both primary and secondary sources. Primary data was collected through interviews, administering questionnaires designed for different respondents which included the managers in large scale farms, farmers and employees in both the large scale and small scale farms. Primary data was also gotten from field observation, photographs of the surroundings of the Nairobi National Park especially in the area affected by the encroachment of the large scale horticultural flower farms and small scale farms. Oral interviews were conducted on natives to establish human wildlife conflict in the area as well as on farm workers who included farm managers, security officials and grounds men on both the large scale farms and small scale farms.

4.2.1 Study population and sampling technique

The study collected information from a total of 36 corespondents.10 large scale farmers and 26 small scale farmers who were picked randomly in the wildlife dispersal area. Simple random sampling was used because the farmers produced the same type of crop while purposive sampling was done on the large scale farmers because they were easily accessible because of the farm sizes. These large scale farms were the total number of farms in existence having large farms of 5 acres and above and who hired external labour throughout the year. The small scale farmers interviewed were 26 small scale farmers from the region. The population of all the farmers in the wildlife dispersal region of Kitengela-Isinya was estimated to be 422 (KWS 2010). The sample of 36 farmers was arrived at from the following formula adopted from Israel (2009).

$n=N/1+ N (e)^2$……Equation 1.

Where n=desired sample size for the study area
N=total population in the study
e=desired margin error (in this case 10%)

The independent variable in this research was the horticultural farmers both on a large scale and small scale who are on the increase in the wildlife dispersal area. The dependent variable in the research was the migratory wildlife that is being directly affected by the increase of the farmers along their migratory paths.

The secondary data used was from population census (KDHS Reports 2010), from KWS reports and from an analysis of temporally varied Landsat satellite images indicating land use changes in the region as well as preparing current up to–date images. The study also borrows greatly from previous research/studies done in the area on HWC though none of the studies had conclusively handled effects of horticultural farming on the migratory species.

4.3 Data Analysis

The data collected was examined and checked for completeness and clarity of information. Numerical data collected using interview, questionnaires and secondary data was coded and entered in the computer and analyzed using the Chi Square. This is because the data collected comprised of both qualitative and quantitative data, hence, it is easy to use and flexible to perform statistical tests using non-parametric techniques like Chi-square, which is used to establish relationship between two variables both of which are categorical in nature.

$$\text{Chi square } (X^2) = \sum^{N} \frac{(O\,ij - Eij)^2}{iE\,ij} \quad \text{……..Equation 2}$$

Where $O\,ij$ = Observed frequency of the cell in the i^{th} row and j^{th} column.

$E\,ij$ = Expected frequency of the cell in the i^{th} row and j^{th} column.

The Chi Square tested the relationship between the increases in the number of horticultural farmers to the decrease in the number of wildlife in the wildlife migratory area.

Bar graphs and pie charts were generated using the spss programme. Results of interviews were critically assessed in terms of each response and examined in accordance with the main objectives of the study and thereafter presented in narrative excerpts within the report. The null hypothesis was tested using Chi Square which was used to establish the difference between increase in small scale horticultural farmers in the dispersal region and the reduction of migratory wildlife in the region.

4.4 Study Limitations

The study encountered several challenges that included:

4.4.1 Uncooperative respondents.

Some of the respondents were not willing to disclose information especially on the nature of conflicts encountered with wildlife in the process of farming. It was most difficult to get information from the management/owners of large scale horticultural farmers, who feared victimization especially from KWS and other relevant authorities.

4.4.2 Limited data.

There was limited data on effects of pesticides on wildlife. The affected species were mostly birds of prey and hatchings that were affected through their food chain. There is scarce data on the same because most of the birds from the park have a wide dispersal area/range.

4.4.3 Financial limitation

The study required much funds especially during data collection during the wet season when the wildlife migrate out of the park.

CHAPTER FIVE: RESULTS AND DISCUSSIONS

5.0 Introduction

This chapter deals with results and discussions of the research work investigating the effects of horticultural farming on wildlife conservation and management in the surroundings of the Nairobi National park. The chapter narrows down to; duration of farming by the farmers, type of horticultural production, fencing types, human wildlife conflicts, problematic wildlife, human wildlife dynamics around the conservancy among others.

5.1 Age and years of farming in the conservation area.

The study sampled out 36 respondents from Isinya sub-county comprising of Sholinke, Oloosirkon and Kisaju sub-division where the horticultural farming is practiced next to the wildlife dispersal region. This region where the farming takes place happens to be both a migratory corridor and a wild dispersal area. The average years of farming of the 36 respondents (both small scale and large scale) were 10 years and it ranged between 20 years and 12 months. Even as the study was being conducted more farms were being established and fencing of parcels of land in a view to begin farming was being done. Table 3 summarizes the respondents years of farming by the scale of farming.

Table 3: Respondents years of farming by size of farm.

Scale of Horticultural farm	**Number of respondents**	**Minimum Years**	**Maximum years**	**Mean number of years**
Large scale farmers	10	7	20	13.5 years
Small scale farmers	26	9 to12 months	15	7.5 years
Total	**36**			

SOURCE: Field data (2019)

Table 3 shows that most of the respondents have been farming for the last 13years for large scale farmers while the small scale farmers have been farming for the last 7 ½

years. The data identifies the period of farming in terms of years the farmers have been practicing and also the expansion of new farms in the migratory area over the recent past. This data on the number of years the farmers have been farming indicates that human activities have been on the increase in the conservancy region and thus affecting wildlife conservation around the conservancy. The number of years the farmers have been farming indicates existence of pressure from horticultural farming on the conservation of wildlife in migratory routes or dispersal area in general which the first objective of the study.

5.2 Fenced Farms

Increased sub-division and fencing of land in the broader Isinya-Kitengela wildlife dispersal area has negatively affected wildlife conservation in the region. Most of the famers have opted to fence their farms. However, except for those who have fenced off some land for homes that act as homesteads as they practice the farming. Majority of the small scale farmers have fenced most of their farms and were grappling with the problems of perennial repairs as wildlife repeatedly destroyed the fences. The most notable were those on the migratory corridors of wildlife (especially wild beast) which have been passing through the same route for a long time. The wildlife always passed through the same area often destroying the barbed wire fences, chain link and hedges.

However, apart from the wildlife that passes through part of the farmlands in the dispersal region, some of the farmers have also fenced their farms as a result of pastoralism in the region. A number complained of livestock invading their farms and as a result they have improvised thorn fences placed in-between the barbed wire to prevent goats and wildlife from accessing their farms. The data on fencing clearly indicates the existence of human wildlife conflict in the migratory corridor and the fences are a form of barrier or hindrance to the wildlife migrating to and from the Nairobi National Park. Barbed type of fencing was the most common among the large scale and small scale farmers, the reason given by farmers was to prevent the wildlife accessing their farms. This form of fencing only increases habitat loss for the migratory animals and as a result

negatively affects conservation of the key migratory species. This is shown on plate 1 through 5.

Plate 1: Barbed fencing near the wildlife conservancy on large scale farms**.**

Source: Field data (2015)

Plate 2: Hedge combined with chain link on SSHF next to the conservancy**.**

Source: Field data (2015)

Plate 3: Combination of thorn (hedges) and barbed wire fence next to the conservancy. 66

Source: Field data (2015)

Plate 4: Chain link& barbed wire fencing Maasai flowers (large scale horticultural farm)

Source: Field data (2015)

Plate 5: Barbed wire fencing on a small scale farm growing French beans next to the Conservancy**.**

Source: Field data (2015)

Table 4 shows that the main reason that the farmers in the conservation region are fencing their farms is preventing the wildlife in the dispersal region from getting in to their farms and destroying their crops. However, some of the farmers had other reasons that included: boundary allocation, livestock as a result of pastoralism and boundary owner demarcation. Fences are a potential threat to migratory wildlife as they both prevent free movement as well as injure the migratory wildlife in the dispersal area. The continued use of fencing be it barbed, chain link or hedges around the dispersal area has negative implications to wildlife conservation through death of the wildlife, habitat loss and prevention of breeding by curtailing movement which happens in the dispersal area.

This is a hindrance to conservation efforts around the Park. Majority of the large scale farmers 60% indicated that they chose one form of fencing or another because of wildlife interference while 77% of the small scale farmers had their fences because of wildlife interference. The use of various forms of fences is therefore prevents migration and interferes with the breeding cycle of wildlife in the dispersal area.

Table 4: Table showing Nature of Fence, Reason for Fencing and Size of Farm.

NATURE of the Farm	TYPE OF FENCE USED BY THE FARMERS					REASON FOR FENCING		TOTALS
	barbed	chain link	hedges	combination of two or more fences		Wildlife interference reasons	Others reasons for fencing plus Combination	
LARGE SCALE FARMS	2	2	3	3	TOTAL 10	6 (60%)	4(40%)	10
SMALL SCALE FARMS	10	1	10	5	26	20 (77%)	6 (23%)	26
TOTALS	12	3	13	8	36	26	10	36

Source: Field data (2015)

5.3 Type of horticultural products farmed in the area.

The main horticultural crops in the area were broadly categorized into 2 sub-sections. Export crops that are; cut-flowers (carnations and roses), export vegetables (French beans, cowpeas) and orchards. Domestic consumption horticultural products that include: kales, spinach, capsicum and tomatoes. All the small scale horticultural farmers interviewed were involved in the farming of a form of vegetable, while majority of the large scale horticultural farmers were involved in the production of cut-flowers and export vegetables.

The land sizes owned by the farmers have also dictated the type of horticultural production as well as the scale of the same. The differences in land sizes can be explained by the different method of acquiring land hence the agricultural production type and systems involved in each. The agro-ecological conditions are also a determining factor in terms of the crops grown in the Kitengela wildlife dispersal region. Though the large scale farmers have their productions in controlled settings (greenhouses) and some in open farms, the moderate or warm temperatures facilitate this production as well as the calcareous and non-calcareous black cotton clay soils in the region surrounding the NNP. The type of crops grown is significant to this study because it establishes the nature of conflict between the farmer and the wildlife. Particular horticultural crops like vegetables attract wildlife like the grazers (herbivores) and the flowers like the carnation attract birds thus intensifying the conflict. Both scales of production had vegetables production as a major crop on their farms. This in essence attracts the wildlife which in return increases the conflicts. Figures 7 & 8 have outlined the main type of horticultural crops grown in Isinya-Kitengela wildlife dispersal region by both the large scale and small scale farmers.

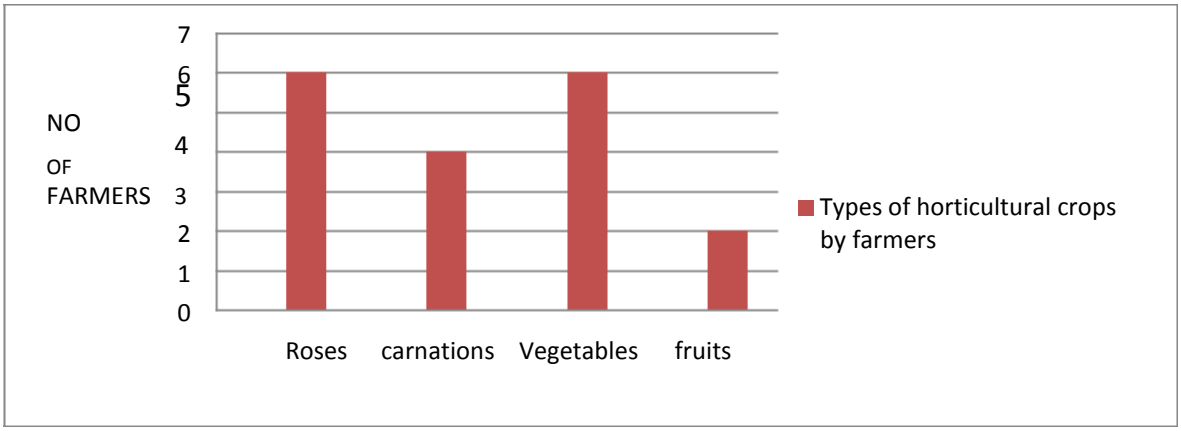

Figure 7. Horticultural crops grown by large scale farmers**.**

Source: Field data (2015).

Table 7 indicates the crops grown by large scale farmers with vegetables and roses being the most grown/produced horticultural crop. The crop production type establishes the nature of conflict the farmers would have with the wildlife as different wildlife would feed on different forms of crops thus intensifying the human wildlife conflicts in the area.

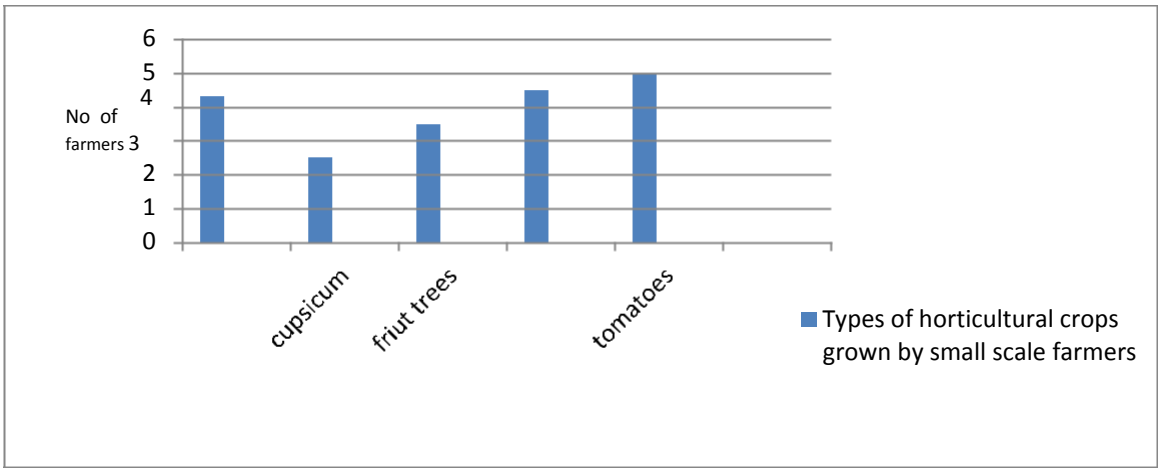

Figure 8. Horticultural crops grown by small scale farmers**.**

Source: Field data (2015)

Plate 6. Large scale carnation flower and French beans farm next to the wildlife dispersal area**.**

Source: Field data (2015)

5.4 Human wildlife conflict in the study area.

The nature of the human wildlife conflict involving horticultural farmers in the area is both direct and indirect depending on the scale of farming, the crops being produced, nearness to the migratory corridor and the fencing type. The conflict culminates in potential harm to all involved but for the case of horticultural farming versus wildlife management and conservation the latter is more affected and even killed in the farms. Conflicts generally arise from economic losses to agriculture, destruction of fencing and crops in general. However in the study area various forms of conflict have been experienced. They include: Competition for resources such as pasture (land space), crop

raiding, damage to infrastructure, threat to life, when the predators follow the herbivores out of the park into the farm lands.

Figure 9 indicates the nature of conflicts experienced in the dispersal area. Crop raiding is the most prevalent form of human wildlife conflict in the study area with most respondents especially the small scale farmers experiencing crop losses to wildlife (both the small herbivores and large herbivores). The large scale farmers are reported to have a problem with birds that flock in their farms especially in search of water and some for nesting purposes. Most farmers have reported having killed some of the species through traps and snares, chased them away using local crude weapons or destroyed their nesting grounds for the case of birds. This information on forms of conflicts between the farmers and wildlife highlights the HWC in the surroundings of the Nairobi National Park. For the small scale farmers damage to property and crop raiding were the major conflict whereas for large scale farming the major conflicts were competition for the migratory route and damage to property as indicated in Figure 9. As the conflicts persist they lead to reduced numbers of migratory wildlife and consequently reducing the wildlife in and around the Nairobi National Park.

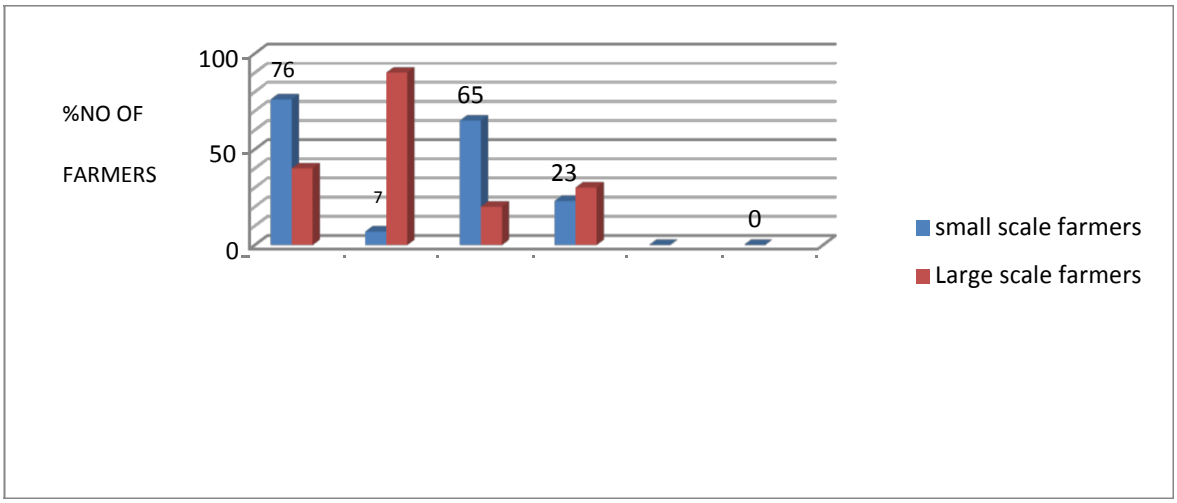

Figure 9: Forms of conflicts experienced between the large scale and small scale horticultural farmers and Wildlife in the dispersal region. **Source:** Field data (2015)

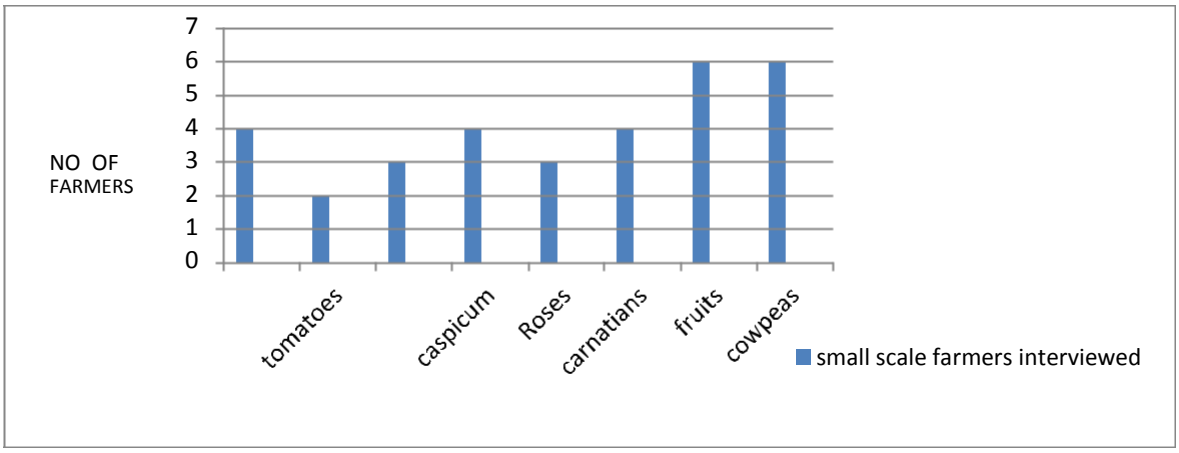

Figure 10: Major crops affected in the area by the Human wildlife conflict in the dispersal area (Small scale horticultural farmers**). Source:** Field data (2015)

Figure 10 indicates the type of crop affected by the migratory wildlife around the Nairobi National Park with fruits and cowpeas being most affected crops in the dispersal area whereas tomatoes being the least affected crop in the dispersal area as reported by 2 small scale horticultural farmers.

5.5 Most problematic wildlife affecting the farmers and crops.

The majority of farmers in the dispersal area considered: birds, antelopes, zebras, hares and Wild beasts as the most problematic animals affecting their farming. 50% of the farmers rated birds as being the most problematic. The second most problematic wild animal in the dispersal region was found to be the gazelles and impalas at (20%), Zebras and Gnu (20%) and other rodents plus carnivores at (10%).

According to the large scale farmers the most problematic wildlife affecting their farms and the crops they grew were the birds that flocked to the crops especially those grown outside the greenhouses. Some reported interference from animals such as Impalas, zebras and at times wild dogs that strayed into their farms. This information on problematic animals implies the existence of human wildlife conflict around the park. If the conflicts are not well managed then wildlife conservation would become a problem and hence the number of migratory animals will be affected.

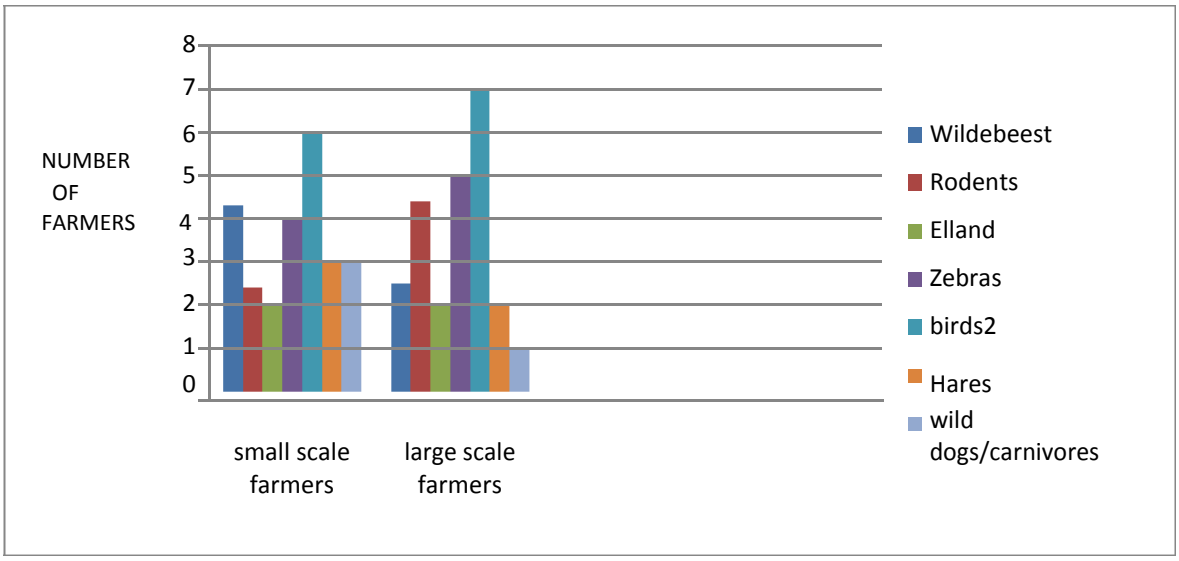

Figure 11: Most problematic wildlife affecting both large scale and small scale farmers in dispersal region

Source: Field data (2015)

The ranking between wildlife affecting the small scale farmers and the large scale farmers reflects the differences in the farm production and scale of production to the wildlife being affected. It is however worth noting that the proximity to the migration corridor by the farmer also influenced the type and number of wildlife that affected the farm/ had conflict with the farmer.

Large scale farmers were mostly affected by flocking birds, hares and smaller herbivores while the small scale farmers were affected by bigger herbivores like the zebras, impalas and birds flocking into the area.

In general different farmers cited different reasons for having reduced HWC in their farms and these included; improved security, fencing, reduced frequency of wildlife, and production of non-food crops that wildlife would feed on and being cited a distance from the dispersal area.as demonstrated in figure 12.

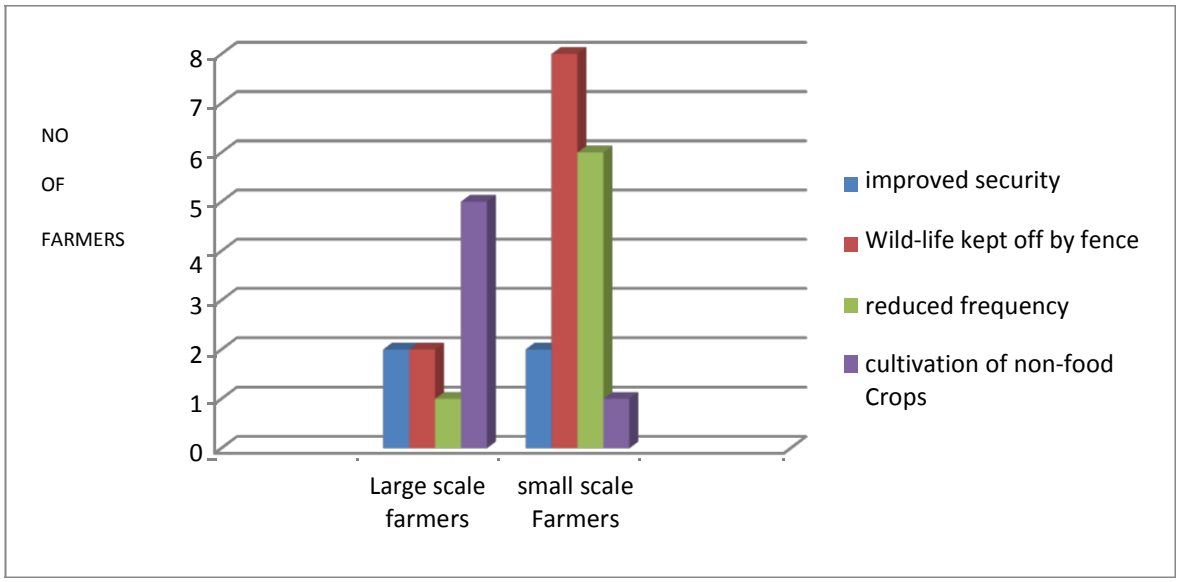

Figure 12: Reasons for reduced Human Wildlife Conflicts.

Source: Field data (2015)

In terms of percentages the reasons advanced by majority of the respondents for the reduction in Human wildlife conflict include; Wildlife kept out by settlement/fencing 67%,improved security 12% ,lack of forage or food for wildlife 11% cultivation of non-food items 5% while the total correspondence who said they were far from the dispersal area were 5%. This implies that with increase in settlements in the dispersal region the conflicts arising from settlement will increase over time and eventually totally prevent migration of the wildlife in and out of the park.

Plate 7: Zebras grazing next to a LSHF in the background.

Source: Field data (2015)

Photo 8: Superb starlings feeding on fruits

Source: Field data (2015)

The information on reduction of HWC indicates that though there was a reduction in conflicts between the farmers and the wildlife in the dispersal region, the conflict still exist but have been reducing as a result of reduction of wildlife numbers in the migratory corridor which is still attributed to the farming around the Park. This inevitably means that the wildlife numbers around the park have been on the decline over the years.

5.6 Years both small scale & large scale farmers started Farming in the Dispersal Region

In terms of migration into the region 85% of the respondents said they migrated from other parts of the country to settle within this dispersal area while 15% of those interviewed considered themselves as natives. 21% of the total sample has lived in the respective areas for more than 21 years and 20% between 16-20 years. 34% of the respondents have been farming and living for a period of 6-10 years. Only 25% of the respondents have less than 5 years in their current farm holding. The greatest percentages of the farmers are immigrants into the dispersal region. This data indicates that the wildlife corridor has over the years been reduced due to this immigration causing pressure in the conservancy and negatively affecting the conservation of wildlife in the region. This immigration has also resulted in population increase in the dispersal region leading to increased land fragmentation and habitat loss for the wildlife.

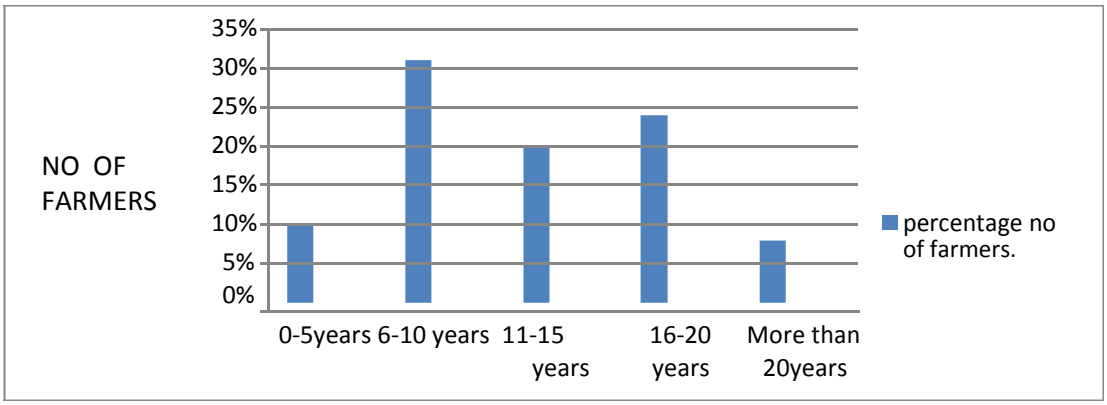

Figure 13: Percentage number of farmers in respect to the number of years in farming
Source: Field data (2015).

The main method of acquiring land in the area of study was through purchase. However in Empakasi sub-county that has a number of farmers, the majority of the respondents had inherited the land where they were practicing the farming. This is a reflection of the more than 20 years that they have been practicing farming in the region transferring the land down generations. The human population density in Isinya sub-county increased 8 folds between 1979 and 1999; from an average of 5 to 42 people per square kilometer. However this analysis from the Kenya Demographic Health Survey (2009) at the time did not feature the impact of horticultural farming in general.

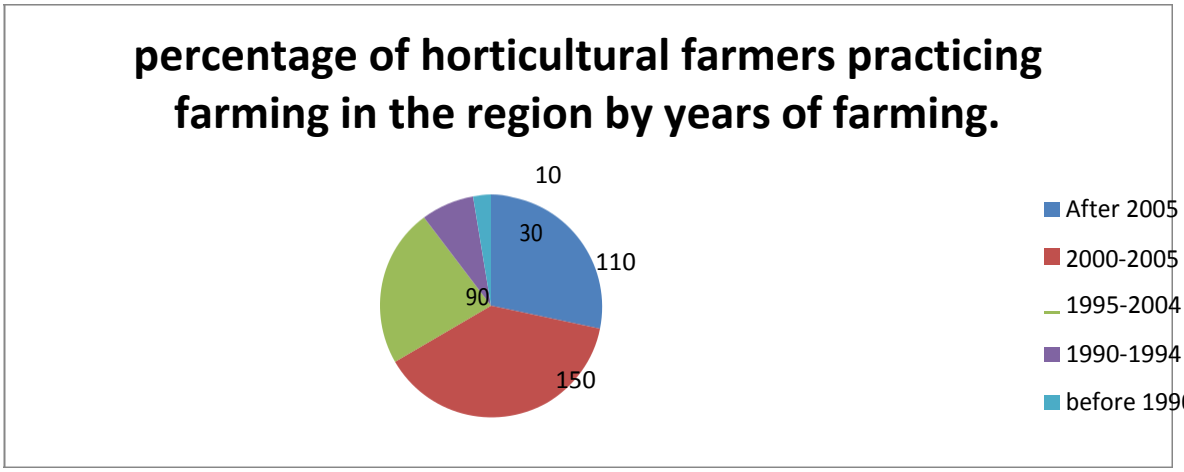

Figure 14: Percentage number of horticultural farmers by years of farming in the wildlife Kitengela wildlife dispersal area.

Source: Field data 2015

From the field survey, majority of immigrants coming to farm 41.6% and 30.5% representing both large scale and small scale horticultural farms settled in the area

between the year 2000 and at time of the data collection (2015).The population trend shows a constant increase in their numbers in the area**.** Figure 15 shows the estimated number of workers in the 10 large scale horticultural farms from the field interview carried out in the region. This implies that horticultural farming is a major contributor to population increase and immigrants from the bulk of the population at (41.6%) around the conservancy. This leads to increase in the HWC in the surroundings of the Nairobi National Park.

Plate 9: Photo of employees from a LSHF farm in the Kitengela dispersal area.

Source: Field data (2015)

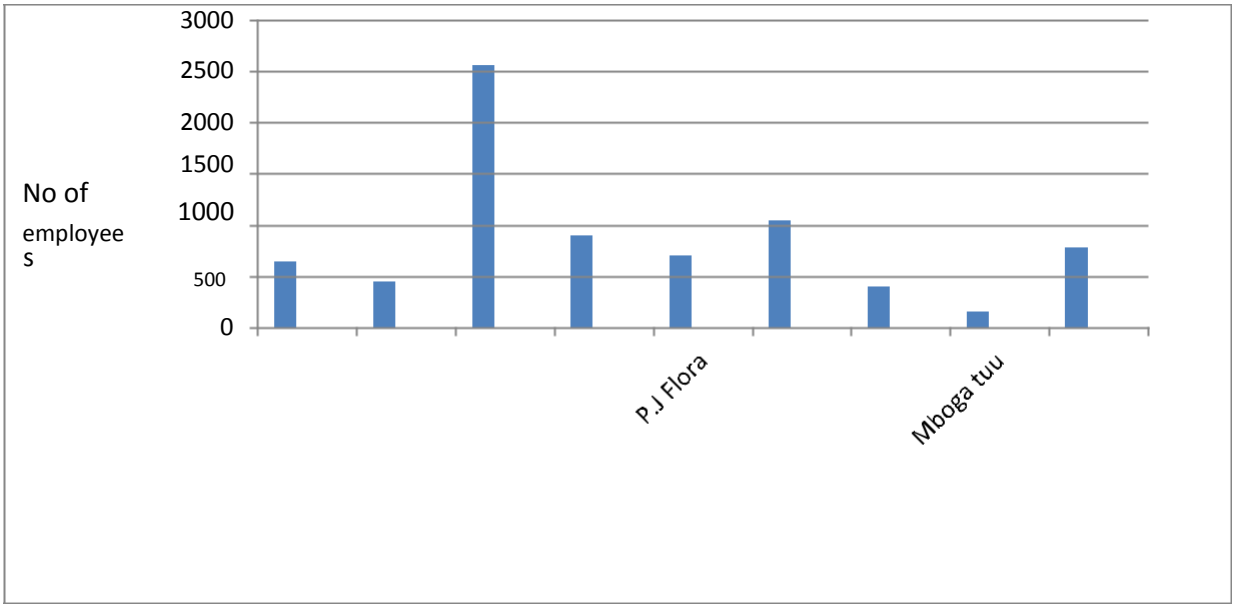

Figure 15: Estimated number of employees in the large scale horticultural farms

Source: Field data (2015)

5.7 Size of the land owned by both the L.S.H.F &

S.S.H.F The Farmers

From the field survey carried out in the wildlife dispersal region 55% of the respondents had farm land of less than 1acre, while 30% of the respondents had land sizes of between 2-3 acres and these category represented the small scale farmers in the dispersal region. The large scale farmers had large parcels of land with the largest farm being on an 80acres farm. This represented 15% of the correspondents. This represents and indicates the levels and nature of land fragmentation in the dispersal area directly attributed to horticultural farming in the dispersal area and its negative effects on wildlife in the dispersal area. Most of the dispersal animals are greatly affected by habitat loss as a result of this.as indicated in figure 16.

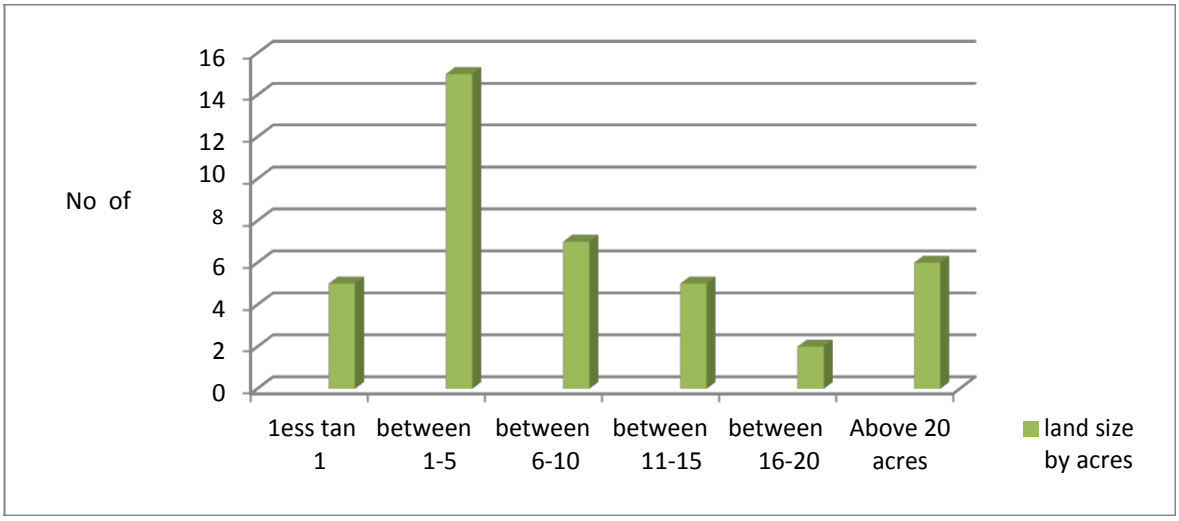

Figure 16: Land size owned by the horticultural farmers.

Source: Field data (2015)

The method of land acquisition by majority of the farmers surveyed was through purchase representing 85% of the respondents. In the same region i.e. Isinya sub-county 15% of the farmers had inherited their current farm parcels with a majority of the parcels being transferred to the second and third generation of farmers. The inherited land owners practicing agriculture (horticulture) formed only 15 % of the respondents. This indicates the migration trends of the farmers involved in horticultural farming and as a consequence increase in population into the dispersal area. This population increase has

led to land fragmentation leading to lesser habitat especially for the grazers in the wildlife dispersal area and also increased the Human wildlife conflicts in the area.

5.8 Population Trends of Migratory Animals

Nairobi National Park is a home to many animal species that are in the park and also migrate out of the park. Based on the average total between 2008-2013 there has been a fluctuation in terms of animal population. The common animals like the impala have been increasing for the last five years but most other species are on the decline especially the bird species that flock out and into the park. Other affected species that are also on the decline include: the hartebeest, zebras and the eland. Some of these species are reportedly killed in the dispersal region. Some of the species reported to have been killed on the farms or cited by farmer as dead carcasses near farms are summarized in figure 18. Table 5 indicates wildlife counts in the park between 2008 and 2013 but does not include the species outside the park in the dispersal region. The reduction in the counts over the years and across particular species is an indication of migration of some species out of the park at the time of the census further suggesting that more efforts should be placed in conservation as some entire species migrate out of the park.

Table 5: The Annual Average Total Animals Report by the Kenya Wildlife Service between 2008-2013.

Common Name	The annual average total animals				
	2008	**2010**	**2011**	**2012**	**2013**
Aardwolf	270	313	13	40	13
Banded Mongoose	4	13	1	8	3
Black-bellied Bustard	18	3	3	2	3
Blue or White Bearded Wildebeest	70	103	132	233	50
Burchell‟s Zebra	98	109	191	293	549
Bushbuck	1	1	20	9	3
Common Ostrich	14	11	1	31	44
Common Reedbuck	68	77	9	23	12
Eland	9	16	5	22	15
Giraffe	48	8	10	21	33
Grant's Gazelle	12	442	94	101	55

Grey Crowned-Crane	312	1	117	107	29
Hartebeest	316	217	114	201	80
Hartlaub's Bustard	64	2	526	520	1
Helmeted Guinea fowl	33	518	23	35	81
Impala	222	410	94	120	710
Kirks' Dikdik	57	14	37	74	72
Kori Bustard	2	1	56	7	4
Long-crested Eagle	6	51	3	44	14
Marabou Stork	17	16	17	13	14
Marsh (African Water) Mongoose	1	2	14	5	1
Martial Eagle	2	1	3	9	1
Red Lechwe	2	1	0	0	0
Sable Antelope	3	1	1	14	0
Secretary bird	1	2	2	4	5
Serval	27	14	11	34	19
Slender Mongoose	68	19	17	51	11
Spring Hare	7	2	2	2	1
Suni Antelope	26	8	4	3	1
Thomson's Gazelle	67	18	29	77	54
Warthog	11	7	20	15	12
White-backed Vulture	5	4	6	17	2
White-bellied Bustard	8	12	10	8	2
White-tailed Mongoose	12	10	16	14	1
Yellow-necked Spur fowl	2	4	1	8	26
Total	2558	3401	3582	3892	2598

Source: KWS 2013

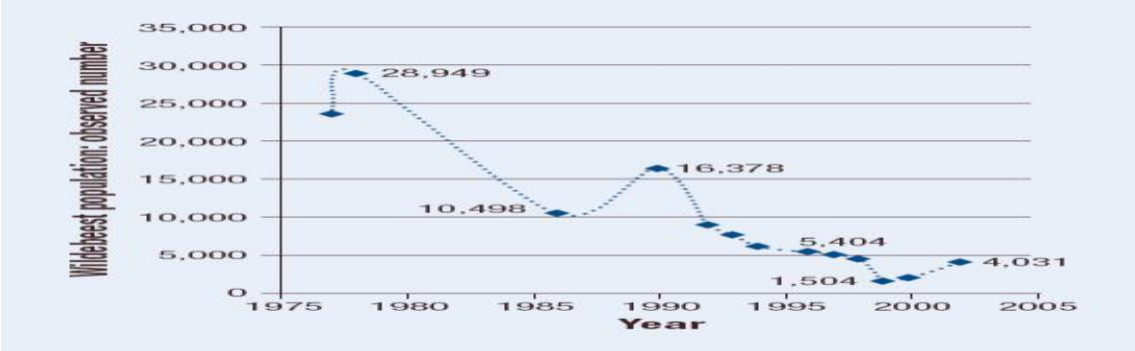

Figure 17: Trend in wildebeest population in the Kitengela dispersal area.1977-2002

Source: World Resource Institute &ILRI (2003)

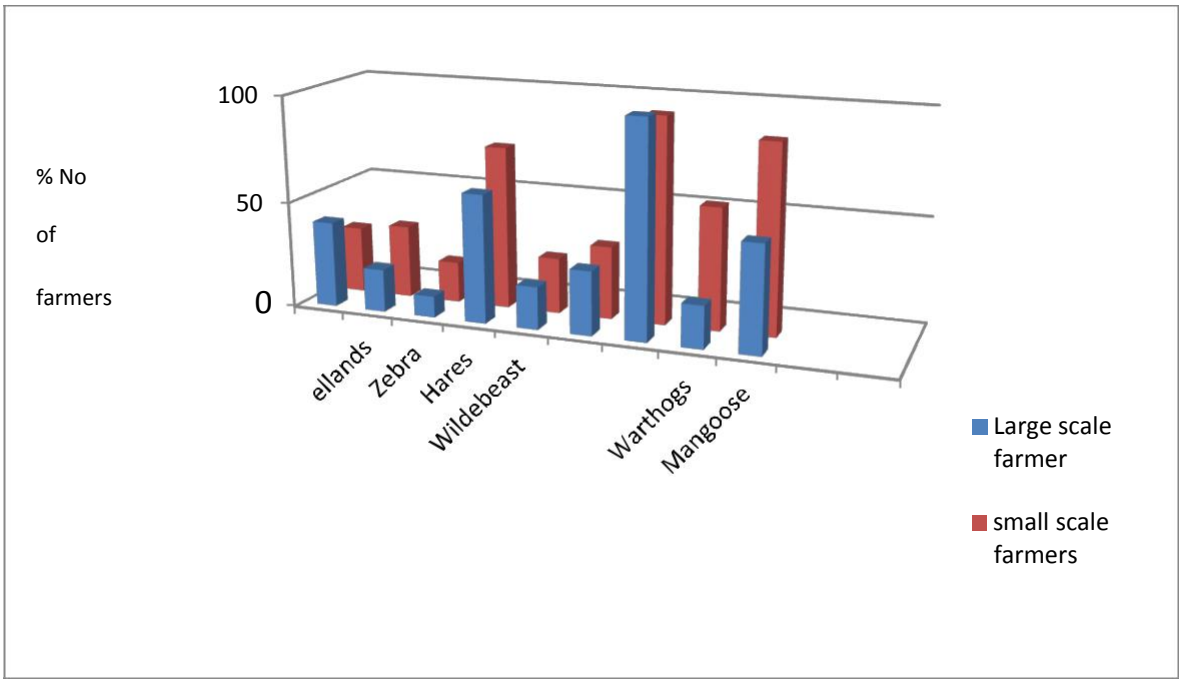

Figure 18: Type and number of wildlife killed by the farmers (farm workers) in the Wildlife dispersal region in the period of farming.

Source: Field data 2014

A comparison between the number of farmers in the dispersal area (Kitengela conservancy) and population of two migratory species of the Nairobi National Park shows a constant decline in the migratory species and the farmers‟ population over the years. The population of Zebras in the nineteen nineties and wildebeest in the nineteen eighties has been on the steady decline as the population of immigrant and native farmers has been on the steady increase into the dispersal area.

5.9 Wildlife-human population dynamics

The population of farmers and generally humans has been on the increase in Isinya division where the study was undertaken. The average increase has been 8 to 50 people per square kilometer. Of the farmers interviewed 10 were large scale farmers employing 155 workers (minimum) and 2600 workers (maximum) number of workers. The small scale farmers had an average of 3-8 members of the family all of whom lived on the farm land. For the large scale farmers majority of the employees resided in the environs with 55% interviewed residing in Kitengela town.

Comparing the population trend of wildlife numbers in the dispersal region (especially zebras and wildebeest that are greatly affected) and the human population in the region, as indicated in figure 19, there has been a steady increase in human population while the zebras and the wildebeest began declining in the nineteen eighties and year two thousand respectively. Human population has been steadily increasing from 5330 in the year 1979 to over 44800 in the year 2009.Within the same period of time, zebras decreased from 42310 to just about 1676 This period corresponds to the time when majority of immigrants moved in to the region.

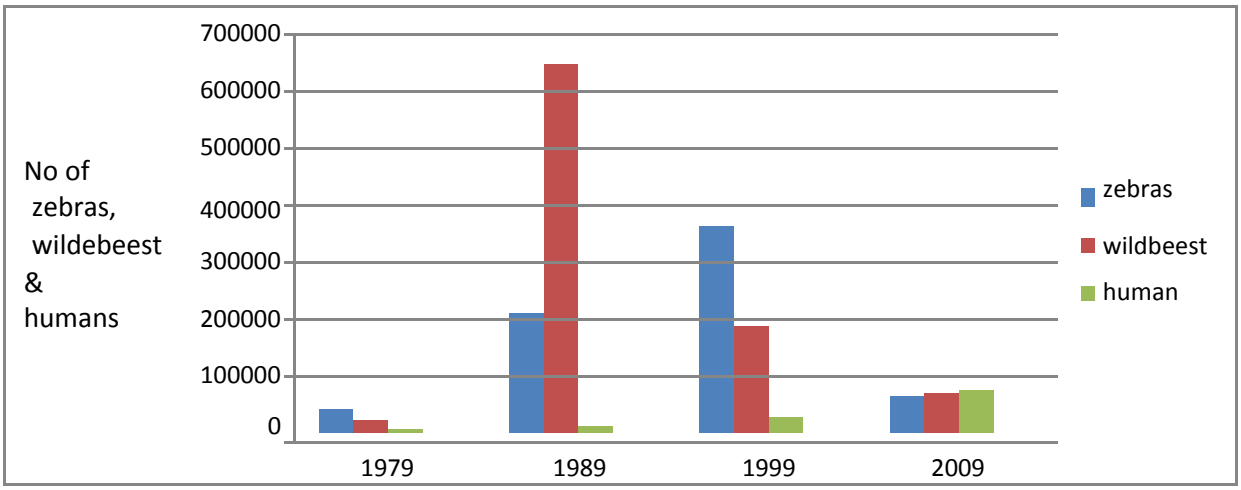

Figure 19: Variation in the population of migratory wildlife (zebra &wildebeest) to human population in the Nairobi National park between 1979 -2009.

Source: KWS (2012)

Table 6. Variation of popular migratory wildlife to human population between 1979 to 2009.

	1979	**1989**	**1999**	**2009**
zebras	42310	21050	36370	1676
wildebeest	22848	64646	18802	2500
Human	5330	11449	28324	44800

Source: Analyzed from the census data of 1979, 1989, 1999 and 2009. (KDHS)

The population census used as indicated in table 6 included all inhabitants irrespective of them being farmers or settlers in the region. However; farming has contributed immensely to the increase in human population in the region. This is reflected in the

number of immigrants working in the large scale horticultural farms. There is a correlation between the farmers/population increase in the conservancy in that as population of human beings increased that of wildlife reduced significantly.

5.10 Hypothesis Testing

The study aimed to find out if there is no significant difference between increased number of small scale horticultural farmers around the NNP and the population of migratory wildlife in and around the park. The small scale farmers were randomly interviewed thus used for the probability testing.

Characteristics of horticultural farmers Interviewee Opinions in Regards to land Use changes and the Human wildlife conflict around the Nairobi National park.

Table 7: Chi square test for independence between increased small scale horticultural farming and wildlife conservation.

	More wildlife (n)		**Less wildlife (n)**	
	Observed	Expected	Observed	Expected
Before 1990	8	15.635	15	10.964
After 2005	21	14.464	9	17.035

Source: Survey Data (2014-2015)

$$X^2 = \sum \frac{(O-E)^2}{E} = \frac{8-15.635)^2}{15.635} + \frac{(21-14.464)^2}{14.464} + \frac{(15-10.964)^2}{10.964} + \frac{(9-17.035)^2}{17.035}$$

$$= 10.738$$

Critical value; df= (c-1) *(r-1) = (2-1) (2-1) =1; sig level, 0.05, thus $X^2_{critical} = 3.841$

The X^2 test indicates that the calculated value (10.738)> critical value (2.688), therefore the null Hypothesis was rejected.

This means that there is a relationship between the population of migratory wildlife around the NNP and the increasing population of small scale horticultural farmers around the conservancy. The more the small scale horticultural farmers increase around the conservancy the greater the decrease of the migratory wildlife in the dispersal area.

CHAPTER SIX: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.0 Wildlife-human population dynamics and its effects on migratory wildlife.

The population of farmers and generally humans has been on the increase in Kitengela and Isinya Sub-counties where the study was undertaken. The average increase has been 10 to 55 people per square kilometre between the years 2014-2015 when the study was conducted. Of the farmers interviewed 10 were large scale farmers employing an estimated 155 workers (minimum) and 2600 workers (maximum) number of workers for the large scale farms. The small scale farmers had an average of 3-8 members of the family all of whom settled on the farm. For the large scale farmers majority of the employees resided in the environs with 55% interviewed residing in Kitengela/Isinya and Kisaju town and its environs. Thus this makes horticultural farming one of the contributors to population increase in the wildlife migratory corridor in the long run blocking /harming the migratory wildlife in totality. With the steady increase in human population, wildlife especially the migratory species over time have been reducing and partly attributed to horticultural farming as the human wildlife conflict intensify and blockage of their migratory route also intensifies.

6.1 Fencing and its effects on wildlife conservation around the Park.

All the farmers interviewed during the research period had their farms fenced with the majority claiming the interference from wildlife, domestic animals and property demarcation. 6 of the 10 large scale farmers interviewed claimed wildlife as a threat to their practice while 4 claimed a combination of both wildlife and other reasons like boundary allocation and interference from pastoralists. The majority of the large scale farmers chose barbed wire and chain link as a form of fencing to keep off the wildlife and reduce the HWC. The majority of SSHF also gave wildlife as a reason for fencing and the type of fence used. 20 farmers claimed wildlife made them choose the type of fence to be used.

6.1.1 Effects of fencing on Wildlife conservation and protection in the dispersal area

The effect of fencing is that it acts as a trap or snare to the wildlife trying to access or move out of the farm once in. Some of the wildlife deaths reported is as a result of being trapped in the barbed wires and thereafter killed or maimed.

The fences also prevent the wildlife from migrating to and from the expanse Athi-Kapiti plains from the NNP via the Kitengela- Isinya dispersal area. The dispersal area and migratory route are significant because it's in these plains that breeding takes place especially for the larger herbivores i.e. the Zebra and wildebeest during the wet season.
Further blockage of the migratory route will adversely affect the wildlife populations as the breeding will be reduced, reducing the number of herbivores and as a result disrupting the complex carnivore-herbivore food chain. This will eventually intensify the HWC because the carnivores will prey on domestic animals around the park.

6.2 Human Wildlife conflict as a result of horticultural farming.

The study established both direct and indirect conflicts involving the migrating wildlife and the horticultural farmers in the Kitengela-Isinya wildlife dispersal areas. The most obvious indirect conflict witnessed is that of habitat loss and competition for land space. Other conflicts that arise as a result of horticultural farming are discussed in sub-section 5.2.1 and 5.2.2.

6.2.1 Crop raiding.

This affected more small scale farmers than large scale farmers with 17 of the 26 farmers interviewed reporting various forms of crop raiding by the wildlife.3 of the 10 large scale farmers reported crop raiding on their farms. These large scale farmers are the ones who had productions outside the greenhouses. The most affected crops were; spinach, kales, French beans and capsicum on both the small scale and large scale farms.

6.2.2 Damage to property.

Damage to property was the greatest reported HWC reported in the area of study. 19 of the 26 SSHF complained of damage to fences, water pipes and other farm infrastructure

while 3 of the LSHF farmers complained of destruction to their greenhouses, fences and other infrastructure. The least HWC experienced in the area during the period of the study was threat to life with only 1 LSHF (farm manager) reporting a threat to life while 3 of the SSHF reported threats to their lives as a resulting of wildlife in the dispersal region.

6.3 Most Affected/Problematic animals to the horticultural farmers.

The study found various wildlife Spps (fauna) affected by the horticultural practice at both the small scale and large scale levels. Both scales of farming complained of being affected by flocks of bird Spps that frequent their farms targeting fruits, flower buds and vegetables. Some indirectly interfere with the growth of the crops as they target the pests and larvae on the crops thus making them a menace. The most common bird species flocking and nesting on the farms include: Black bellied bustard, grey crowned-crane, helmeted guinea fowl, red Lechwe, superb starling and the secretary birds. Most farmers interviewed destroyed the nests, destroyed the birds‟ eggs and in some instances trapped some of the bird species entering their farms. The most affected species being the helmeted guinea fowl, cranes and secretary birds. However, this study couldn't ascertain the decrease in the number of raptors and other birds of prey as a result of pesticide use around the NNP or the dispersal area.

6.4 Differences between LSHF and SSHF on wildlife conservation & management around the NNP.

The study identified different effects to wildlife conservation and management as related to the nature of farming (either LSHF or SSHF) around the NNP. Key differences identified included:

6.4.1 Effects of fencing between LSHF & SSHF on wildlife conservation.

The LSHF had larger pieces of farm land and as such contributed to greater habitat loss than the SSHF. The fences used deny the migratory wildlife especially the wildebeest and zebra from accessing the expanse Athi-Kapiti migratory areas. With continued fencing especially of large parcels of land, land fragmentation is increased and in the long run

total blockage of the migratory corridor. This is evident with the continued acquisition of large parcels of land some as large 80 acres within the migratory corridor. Some of the LSHF use chain link to fence off the farm denying the wildlife accesses to and fro the park. The blockage of this migratory route is detrimental to the migratory species and their survival because the wildebeest, heart beast, zebra and eland migrate to the Athi-Kapiti plains during the wet season to breed as well as forage. Total elimination to the plains will in the long run affect the breeding cycle and possibly cause extinction of some species.

6.4.2 Differences in population increase as a result of either LSHF or SSHF and its effects on wildlife conservation and management.

The large scale farmers employ more workers than the small scale farms whose labour force comprises mainly of family members. The 10 LSH farms on average employ 1200 workers. The Kenya Demographic Health Survey (2009) indicates that the population of Kitengela and Isinya division to be 44,800 people. LSH Farms thus contribute 26.78% of the population in Kitengela and its environs and by large contribute to habitat loss through settlements, bio-diversity/habitat loss and segmentation. This adversely affects the species numbers and their reduction or extinction.

6.4.3 Comparison between LSHF and SSHF to wildlife killed or maimed around the farm.

The study found varied differences between the 2 scales of farming and wildlife conservation and management in respect to their deaths around the NNP. The wildlife Spps affected also differed in magnitude between the two forms of agricultural productions plus the proximity of the farms to the migratory corridor.

Generally small scale farmers reported more killings and maiming to the wildlife than the large scale farmers, largely attributed to the type of production on the farms, green housing and type of fence used. There were more killings of antelopes, elands, zebras, hares, birds, warthogs and mongooses by the small scale farmers than there were by the large scale farmers. Over the period of farming carried out by the farmers the least

number of species killed or injured by the farmer were the carnivores, zebras, giraffes and wildebeests. The large scale farmers reported only 2 zebras and 4 wildebeest in total over the years they had been farming while the Small scale farmers reported a total of 5 zebras and 7 wildebeest either killed or maimed respectively. Both scales of farming reported various destructions to birds‟ nests plus destruction of birds‟ eggs during the period of the study.

6.5 Conclusion

Continued horticultural farming in the surroundings of the Nairobi National park is detrimental to wildlife conservation and management especially around the park and more so to migratory species. Habitat loss is the greatest threat to this wildlife conservation around the park and its future sustenance. The migratory wildlife will continue to follow an ancient migratory route in and out of the park especially during rainy seasons, with continued habitat loss through fencing and farm establishments, the migratory wildlife face species elimination and by greater extent entire wildlife (fauna) loss. This will come from elimination of particular species in the food chain which eventually affects the entire web.

Human population increase as a result of horticultural farming in the wildlife dispersal area is a potential threat to conservation in the area. This increase in human population escalates human wildlife conflict and threatens the already fragile eco-system.

Measures must be taken to retain and protect the migratory wildlife and their corridor. Expansion of farms more so large scale must be checked to control large parcels of land being fenced off thus blocking off the corridors. The fences used must be wildlife friendly to prevent injury and allow access especially to the migratory wildlife along their corridor.

6.6 Areas for further research/gaps in knowledge

Use of pesticide, fertilizers and other agro-chemicals around the NNP and its impacton the environment and wildlife in the dispersal region. Specific attention should be to birds of prey and pollinators and its impact on flora. Effects of water extraction for farming with relation to underground water flow, system recharge and ecological sustainability around the park.

Studies should be done on effects of pastoralism around the park and its Compatibility to wildlife conservation, livestock-wildlife disease transmission and wildlife sustainability.

Invasive plant species around and in the park, waste generation around and in the Park due to urban sprawl should be studied comprehensively.

Effects of the Standard gauge railway system, Northern corridor transport system expansion and its effects on wildlife around and in the park.

6.7 Recommendation to the policy makers.

6.7.1. Land use changes: zone management.

Land is one of the most important resources in Kenya as it is the base upon which activities like agriculture, wildlife conservation, urban development, human settlement and infrastructure are carried out. The zoning plan in the Kitengela–Isinya area indicates that the zone under which the farming is taking place is in zone D meant for wildlife conservation, promotion of eco-tourism and wildlife promotion. However, horticultural farming has intensified over the years in this zone thus making wildlife management a difficult practice and a matter of urgency. Policy makers ought to gazette this particular zone and it should be left for wildlife conservation. The native community should be restricted from further sub-dividing the land but compensated for the same land.

6.7.2. Protected area management and partnerships

Most of the protected area i.e. NNP was established without due regard to surrounding landscapes. Consequently, the boundary of the protected area and the wider landscapes is becoming distinct, being separated by fences and other barriers to deter wildlife movements outside these areas. In terms of the wildlife and habitat management, the rigid boundaries around the park have compromised the integration and effectiveness of the dispersal areas and migratory corridors outside the protected areas. There is need to create more protected space around the park and broadly redefine the protection status of the majority of wildlife populations existing outside the park and reserve. This could be achieved by enhancing the partnerships between the local communities living adjacent to protected area and park's management authorities‟ i.e. the KWS.

6.7.3 Human-wildlife conflict and compensation:

Increasing human wildlife conflict is a major problem in wildlife areas. Acute water shortage and inadequate dry season pasture has severely affected wildlife, livestock and humans. As competition for the meagre resources continues, the human wildlife conflict levels rises around the NNP. In addition to the climate variability that is responsible for the low plant biomass productivity, the increased human-wildlife conflicts have been attributed to extension of human activities in wildlife areas as is the case of the dispersal area around the NNP. Currently, compensation for wildlife damage is paid by the government. The amounts payable, which relates to human injury or death, crop damage and livestock predation has been very low. Although the new compensation bill has adjusted high payments, it is still not commensurate to the losses incurred by the communities living in wildlife areas. In addition, the bureaucratic process for compensation payment does not favour the large majority of the farmers especially the small scale horticultural farmers hence they will continue to maim, kill or poison wildlife that stray into their farms.

6.7.4 Enhancing/encouraging Community Conservancies

The post-privatization land reconsolidation for wildlife especially on migratory corridors and livestock mobility is taking place in conservancies around many protected areas in

Kenya to benefit local communities whose land is occupied by wildlife through community-private partnerships. This needs to be enhanced and insisted on if the wildlife in the dispersal area around the NNP is to be protected.

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APPENDIX I

APPENDIX I: SMALL SCALE HORTICULTURAL FARMERS QUESTIONNAIRE/INTERVIEW SCHEDULE

Questionnaire number……..date……

NOTE: The information that you will give here will be strictly for academic purposes and will be treated with high confidentiality. Your assistance will be highly appreciated.

SECTION A: RESPONDENTS DETAILS

1. Farm name (optional)…….

2. Name of the respondent (optional)……

3. Year started farming……..

4. How many people are involved in your farming business? .....

5. What is the nature of your land tenancy?

☐ Owner Occupier ☐ rental

6. How big is the size of your farm (in acres)? .....

7. Were you born here? ☐ Yes, in the year 19…. ☐ No

8. If No, when did you move to this area?

☐ Before 1969 ☐ 1969-1979 ☐ 1979-1989

☐ 1989-1999 ☐ After 1999.

SECTION B: LAND ISSUES; GENERAL LAND & PESTICIDE USE.

9. What attracted you to settle in this area if you are not a native? .....

……

……

10. Did you encounter any problems in acquiring this piece of land from any Organization?

☐ Yes (answer Q 13 & 14) ☐ No (skip 13 & 14)

11. What were the major problems? .....

……

12. How did you solve the problems above? .....

……..

13. What occupied this land before you started farming on it? .....

14. Is your farm fenced? .....

15. Why did you fence it? .....

16. Do you rear any livestock? ☐ Yes (answer Q 17&18) ☐ No

17. If Yes above specify which type of livestock and numbers…….

……..

18. Which akaricides do you use on livestock? ……...

……

19. How do you spray/apply the pesticide on your livestock? **.....**

……

20. Do you grow any crops on your farm? ☐ Yes (answer Q 21& 22) ☐ No

21. If yes above specify which types of crops you grow on the farm ……

……...

……

22. Which crop pest affects your crops on the farm? ……

……

23. How do you spray your crops? ……

24. How do you dispose of the farm chemical containers and other farm chemical wastes?

.....

25. What do you intend to use the land for in the future? ……

……..

SECTION C: HUMAN WILDLIFE INTERACTION AND THE FUTURE.

26. What can you say about the number of wildlife in the area?

When you first settled? ☐ Many ☐ Few

Nowadays ☐ Many ☐ Few

27. What can you say about the variety of wild animals in this area?

When you first settled. ☐ Many ☐ Few

Nowadays. ☐ Many ☐ Few

28. What are the major benefits you have experienced from the wildlife around here? ……

……..

29. Has any wildlife strayed into your farm? YES ☐ NO ☐

30. If yes above. Which? .....

31. Which crops were targeted by the wildlife? …….

……...

32. Did any other organization help you solve the wildlife problem? If Yes How?

……..

33. What long term solutions would you suggest to solve the problem?

……...

……

34. How do you intend to manage the wildlife problem if it persists in future?

……

……

35. Would you relocate when compensated to another area to give way for wild-animals?

☐ Yes No ☐

THANK YOU

APPENDIX II: ORGANIZATIONAL QUESTIONNAIRE / INTERVIEW

Questionnaire Number……. Date……..

NOTE: The information that you will give will be used strictly for academic purposes and will be treated with high confidentiality. Your assistance will be greatly appreciated.

RESPONDENTS DETAILS

Organization Name (optional) _____

Designation of Respondent_____

Name of respondent (optional) _____

SECTION A: LAND USE &CONSERVATION ISSUES

1. What are the roles of your organization in brief? .....

   ……...

   ……...

2. Which land use activities have been/are being carried out in the corridor area?

   ……

3. What do you think has encouraged the above land use activities in the area?

   ……

   ……

4. What farming related problem have/are being experienced while promoting conservation in the area? .....

   ……..

   ……..

5. What benefits do the area residents gain from the wildlife in the area?

   ……

   ……

   ……

6. Which human-wildlife conflicts are common in the area?

……

……

7. What factors are encouraging these conflicts?

……

……

8. What impacts do the above land-use changes and human wildlife conflicts have on:

(a) Wildlife habitat? …….

……

(b) Wild life population & movement (give examples of the seriously affected Species)? ……

(c) Natural water sources in the area? ……

……

……

9. Do you have a system of monitoring any of the above challenges?

……

10. If allowed to continue, what do these activities imply on the conservation and Sustainability of the Nairobi National park? ……....

……

……

11. How are you handling these conflicts for the benefit of both people & wildlife?

……

……

……

12. With the increase of horticultural farming and other land use changes, which land Uses can be allowed in the area? ……..

……

……

SECTION B: MANAGEMENT

13. Who has been responsible for the uncontrolled farming in the region?

    ……

    ……

14. Do you have consultation with the authority concerning the farming practices especially the big flower farms? ……...

    ……

15. If Yes, What have been the achievements of these consultations towards enhancing conservation? ……...

    ……

    ……

16. What is your organization doing in the area towards solving the conservation Challenges posed by the changing land uses in the area?

    ……...

    ……...

    ……...

17. What difficulties are being experienced by the organization in addressing these Challenges? ……..

    ……..

    ……..

18. What can you suggest as the better policy intervention towards managing these Challenges posed by increasing horticultural farming?

    ……..

    ……..

    ……..

19. Which department /organization should be responsible for this to succeed?

    ……..

20. What roles should these departments play in the new set up? ……

    ……..

    ……...

……

……

21. Which wild animals in your view have been greatly affected by chemical Poisoning originating from the farms both small scale and large scale farms?

……

……

……

THANK YOU

APPENDIX III: LARGE SCALE HORTICULTURAL FARMERS

QUESTIONNAIRE/INTERVIEW SCHEDULE

Questionnaire number……..date……

NOTE: The information that you will give here will be strictly for academic purposes and will be treated with high confidentiality. Your assistance will be highly appreciated.

SECTION A: RESPONDENTS DETAILS

1. Flower /Horticultural Farm name (optional)……

2. Name of the respondent (optional)……

3. Year started farming……..

4. What is your responsibility in the farm? .....

5. What is the nature of your land tenancy?

☐ Owner Occupier ☐ rental

6. How big is the size of your farm (in acres)? .....

7. Were you originally established here? ☐ Yes, in the year 19…. ☐ No

8. If No, when did you move to this area?

☐ Before 1969 ☐ 1969-1979 ☐ 1979-1989

☐ 1989-2000 ☐ After 1999.

SECTION B: LAND ISSUES; GENERAL LAND & PESTICIDE USE.

9. What attracted you to settle in this area if you are not a native? .....

……

……

10. Did you encounter any problems in acquiring this piece of land from any Person or member of the community?

☐ Yes (answer Q 13 & 14) ☐ No (skip 13 & 14)

11. What were the major problems? .....

…….

12. How did you solve the problems above? .....

……..

13. What occupied this land before you started farming on it? .....

…….

14. Is your farm fenced? ☐ Yes ☐ No (skip 15)

15. Why did you fence it? .....

16. Specify which types of horticultural crops you grow on the farm ……

……...

……

……

……

17. Which crop pest affects your crops on the farm? ……

……

……

18. How do you spray your crops? ……

……..

……...

19. How do you dispose of the farm chemical containers and other farm chemical wastes?

.....

……

……

20. What do you intend to use the land for in the future? ……

……..

……..

SECTION C: HUMAN WILDLIFE INTERACTION AND THE FUTURE.

21. What can you say about the number of wildlife in the area?

When you first settled?	☐	Many	☐	Few
Nowadays	☐	Many	☐	Few

22. What can you say about the variety of wild animals in this area?

When you first settled.	☐	Many	☐	Few
Nowadays.	☐	Many	☐	Few

23. What are the major benefits you have experienced from the wildlife around here? ……

……..

24. Has any wildlife strayed into your farm? YES ☐ NO ☐

25. If yes above. Which? .....

26. Which crops were targeted by the wildlife? ……

……...

27. Did any other organization help you solve the wildlife problem? If Yes How?

……..

.. ……

28. What long term solutions would you suggest to solve the problem?

……...

……

29. How do you intend to manage the wildlife problem if it persists in future?

……

……

30. Would you relocate when compensated to another area to give way for wild-animals?

☐ Yes ☐ No

31. What can you suggest as the better policy intervention towards managing these challenges posed by increasing horticultural farming in the Isinya region?

……..

……..

……..

THANK YOU FOR YOUR ASSISTANCE