EFFECTS OF THE ROTHSCHILD GIRAFFE ON THE BIOPHYSICAL AND SOCIO- ECONOMIC ENVIRONMENT: A CASE OF GIRAFFE CENTER SANCTUARY IN NAIROBI COUNTY

JUDITH KHAYELI SEMBE

A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTERS DEGREE IN ENVIRONMENTAL PLANNING & MANAGEMENT OF THE UNIVERSITY OF NAIROBI

2015

DECLARATION

This research report is my original work and has not been submitted for examination in any other university.

Sembe Khayeli Judith **Date**
C50/80098/2012

This research report has been submitted for examination with our approval as university supervisors

Dr. Francis Mwaura
Senior Lecturer **Date**
Department of Geography & Environmental Studies,
University of Nairobi

Parita Suresh Shah
Tutorial Fellow **Date**
Department of Geography & Environmental Studies,
University of Nairobi

DEDICATION

I dedicate my work to all giraffe researchers and conservationists that they may extract and/or utilize any relevant information that would promote the conservation of giraffes in this planet.

ACKNOWLEDGEMENT

I would like to thank the almighty God for His grace and guidance from the start to the completion of this work. My deepest gratitude goes to my university supervisors Dr. Francis Mwaura and Ms. Parita Shah for their time, patience and guidance throughout my academic research. I wish to appreciate AFEW Kenya for first granting my permission to conduct the study and providing financial support. I also wish to thank the Idea Wild for donating equipments and book which were very useful in this study. I pass my gratitude to Ms. Tiffany Mwake at University of Nairobi for the assistance in data entry and organisation. Much appreciation also goes to the lecturers of the EPM course at University of Nairobi, the staff members at the Giraffe Center Sanctuary, Dr. Julian Fennessy of Giraffe Conservation Foundation, Mr. Musembi of the LARMAT Department at UoN, Mr. Ngale of Wildlife Clubs of Kenya, Mr. Dru Johnson of American Conservation Experience, friends and relatives for their counsel, support and encouragement accorded during the study period.

LIST OF ABBREVIATIONS

AFEW	African Fund for Endangered Wildlife
cm	Centimeter
EE	Environment Education
EPM	Environment Planning and Management
Ft	Feet
G.c	*Giraffa camelopardalis*
GCF	Giraffe Conservation Foundation
GCS	Giraffe Center Sanctuary
GiD	Giraffe Database
GPS	Global Positioning System
Ha	Hacter
ICT	Information Communication and Technology
IGWG	International Giraffe Working Group
IUCN	International Union of Conservation Network
KWS	Kenya Wildlife Service
LARMAT	Land Resource Management and Agricultural Technology
M	Meter
N.d	No Date
N.P	National Park
NGCST	National Giraffe Conservation Strategy
No.	Number
NWCM	National Wildlife Conservation and Management Policy
OB	Occurrence Book
PA	Protected area
PCQ	Point Centered Quarter
Popn	Population
SPSS	Statistical Program for Social Sciences
UoN	University of Nairobi
Vol	Volume
WCED	World Commission on Environment and Development
WCMD	Wildlife Conservation and Management Department

ABSTRACT

The population of Rothschild giraffes in Kenya dropped to fewer than 130 animals in the 1970s. The only way to prevent their complete extinction was translocation to enclosed areas. In 1979, three giraffes were introduced to GCS in order to start the Rothschild giraffe breeding program. This subspecies is facing challenges in enclosed ecosystems. In GCS, some areas are highly degraded due to over utilization by giraffes. Also there was an increase in giraffe deaths in the past four years. The aim of the study was to establish the effects of Rothschild giraffe utilisation to the density, height and diversity of grass, herbs and woody species in GCS, determine the effects of giraffe concentration to the soil cover at GCS, determine the socio economic benefits of Rothschild giraffe and to identify challenges facing the sanctuary management.

Data collection was carried out during the month of February to April 2014 which was preceded by a reconnaissance survey to identify areas in the sanctuary that were highly utilised by the giraffe. Thereafter, purposive sampling was used to set three transect lines for the study in the highly utilised areas. The Point Centred Quarter Method (PCQ) was thereafter used for biophysical analysis along transects. At every PCQ point, the GPS reading, dung assessment, signs of giraffe and browsed species were recorded. Other biophysical parameters recorded were the number and types of grasses, herbs, woody species and number of canopy layers. The nature of soils was also recorded at each point. The data on socio-economic benefits and challenges facing the sanctuary was derived from secondary sources in the GCS which included monthly reports, annual reports and the occurrence book for a period of five years (2009-2013). The variables were income generation, types of funded community conservation initiatives and types of funded school initiatives. This data was analyzed using frequencies tables, percentages and Pearson's Chi- square tests was used to test H_0 stating that there is no significant relationship between the status of the biophysical environment and giraffe concentration in GCS.

The results revealed that the greatest form of giraffe utilisation in the sanctuary was browsing (51.4%), followed by a combination of walking and browsing (26.8%) and finally walking (21.7%). The density of all the woody species varied and the three highly preferred species had the highest density as follows; *Rhus natalensis* (583 trees/ ha), *Psidia puntulata* (525 trees/ha) and *Croton dichogamus* (330 trees/ ha). There was one

invasive woody species that is *Lantana camara* which had a density of 58 trees/ ha. There was a decreased giraffe activity with the increase of herb height and herb diversity. Comparable to herbs, there was decreased giraffe activity with the increase in height and diversity of grass. Giraffe presence is able to cause soil erosion to a small extent (9%)

The analysis of the socio- economic variables displayed that the sanctuary generated significant revenue from the Rothschild giraffe through tourism. This income was used to fund community and school conservation initiatives in different areas of the country including wildlife conservation (33.3%), environment education (22.2%) and project operation costs (19.0%). The main challenges faced by the sanctuary were stray predators (17.2%), giraffe sickness (13.8%), giraffe deaths (13.8%) and drought (13.8%).

This study concluded that the endangered Rothschild giraffe has more positive than negative effects to the Giraffe Center Sanctuary environment and therefore efforts for its breeding and conservation should continue. The sanctuary management should continue stocking the giraffe at optimum populations. While Kenya Wildlife Service should support capacity building in the sanctuary in order to address the challenges experienced. There should be research to evaluate the impact of Giraffe Center Sanctuary to the conservation of other wildlife species and determine the carrying capacity of the sanctuary.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

There is one species of giraffe (*Giraffa camelopardalis*) subdivided to between six and nine morphologically variable subspecies. The nine subspecies are the Angolan giraffe, Kordofan giraffe, Masai giraffe, Nubian giraffe, Reticulated giraffe, Rothschild's giraffe, South African giraffe, Thornicroft's giraffe and West African giraffe (Fennessy 2007).

The Rothschild giraffe (*G.c rothschildi*) was first described by Lord Rothschild. It was ranging freely and abundant across Kenya, Uganda and Sudan. Now extinct in Sudan, there are only thirteen populations of Rothschild's giraffe remaining in Uganda and Kenya (Fennessy 2007).

The population of Rothschild giraffes in Kenya dropped to fewer than 130 animals in the 1970s. At that time there was a high increase in human population and their native habitat was fertile. Land fragmentation became so high with the increasing need for agricultural land. This increased their vulnerability. The only way to prevent their complete extinction was translocation to enclosed areas (Umbertoh 2007)

As at 2010, the population of Rothschild giraffe was less than 670 individuals in the wild. Over 400 of these giraffes are located in Kenya and so the country has a clear and important role to play in the conservation and protection of this sub-species in its habitat. The IUCN declared the Rothschild giraffe sub species as endangered in June 2010 (GCF 2010)**.** It is the second most imperilled giraffe sub-species after the West African giraffe. Brenneman *et al* (2009) warned about the extinction of Rothschild giraffe in the wild in the next fifty years if the current threats facing them will continue.

In 1979, most of the population was introduced in enclosed areas such as Lake Nakuru National Park, Ruma National Park, Mwea Game Reserve and Nasalot Game Reserve with the help of the Game Department (current KWS). In the same year, three giraffes were also introduced to GCS in order to start the Rothschild giraffe breeding program. To date, the sanctuary's main objective is to increase the endangered Rothschild giraffe population through providing a habitat that would enhance natural breeding and repatriation of calves. The Rothschild giraffe in this sanctuary is also used to promote ecotourism (Njagi 2009).

The giraffe has a high economic significance due to its evolutionary uniqueness and the symbolic value associated with this. Its silhouette is both unmistakable and evocative and is mainly used for advertisements for example it's a logo for the Olympic Games and football's FIFA World Cup. It also generates high economic benefits through tourism. Apart from economic benefits, the giraffe is an agent of change in habitats and landscapes. It can open up areas and promote the growth of new forage for itself and other browsers mainly through pollination and dispersal of seeds (Giraffe Conservation Foundation 2013).

1.2 STATEMENT OF THE PROBLEM

The study conducted an assessment of the effects of the endangered Rothschild giraffe to the biophysical and socio economic environment at GCS in Nairobi County. The study assessed both positive and negative effects. Precise knowledge of these effects is necessary to contribute towards an improved management strategy within the sanctuary as well as increase awareness about the importance of the Rothschild giraffe to the environment.

The scenario of introducing the remaining herds of Rothschild giraffe in 1970s and 1980s into closed ecosystems replenished their dwindling population, however this giraffe sub species still faces a number of threats and their population has started to decline (Fennessy 2007). Brenneman *et al* (2009) suggested that indeed, high browsing pressure may be contributing towards population decline of the giraffe in Lake Nakuru National Park which have dropped from an estimated 153 individuals in 1995 to 65 in 2009. The decline was due to problems related to decreased food availability from over consumption of acacia species. There was also evidence of high acacia de-barking in the park.

There is also a wide knowledge gap in the society about the potential contribution of the giraffe to the socio- economic environment. This is evidenced by increased incidences of human-wildlife conflict, loss of habitat and poaching as mentioned by Wildlife Direct (2007).

The GCS has greatly contributed to impoverishment of the Rothschild giraffe population through its breeding program. Giraffes in the sanctuary however are not exempted from facing equal challenges that other enclosed populations have. It is evident from the sanctuary patrols that some areas are highly degraded due to over utilization by giraffes. In the past four years, there was an increase in deaths of giraffes in this sanctuary due to short illnesses suspected by the KWS to be food related and stray predation.

There was urgent need to determine how the giraffe utilise this sanctuary and its effect on the biophysical and socio economic environment. In the biophysical, it was important to determine what vegetative species do giraffes browse and the browsing effects to food availability, diversity and growth of all the other plant species in this sanctuary. It was also important to determine the challenges facing the sanctuary management whose knowledge will be useful in drafting future management strategies.

The key research questions for the study were as follows;

a) What are the effects of Rothschild giraffe utilisation to the density, height and diversity of grass, herb and woody species in the GCS?

b) What are the effects of Rothschild giraffe concentration to the soil cover at GCS?

c) What are the socio- economic benefits of Rothschild giraffes?

d) What are the challenges facing the management of this sanctuary?

1.3 RESEARCH OBJECTIVES

The general objective of the study was to assess the effects of the endangered Rothschild giraffe to the biophysical and socio- economic environment of GCS.

1.3.1 Specific objectives

i. To determine the effects of Rothschild giraffe utilisation on the density, height and diversity of grass, herb and woody species in the GCS.

ii. To determine the effects of Rothschild giraffe concentration on the soil cover at GCS.

iii. To identify the socio- economic benefits of Rothschild giraffe.

iv. To identify the challenges facing the management of this sanctuary.

1.4 RESEARCH HYPOTHESIS

H_0: There is no significant relationship between the status of the biophysical environment and giraffe concentration in GCS.

H1: There is a significant relationship between the status of the biophysical environment and giraffe concentration in GCS.

1.5 JUSTIFICATION AND SIGNIFICANCE OF THE STUDY

Private ranches and sanctuaries have a role to play in conservation largely by maintaining natural areas of habitat and by providing resources to support reintroduction programs for threatened or endangered species. The Giraffe Center sanctuary has benefitted conservation of the endangered Rothschild giraffe through the breeding program.

The findings will inform the GCS management about the status of the biophysical environment especially in terms vegetation species diversity and preferred browse and browse availability for the giraffes. It will also help the sanctuary to prioritize and balance allocation of funds to different conservation projects thereby increasing the socio economic benefits of the Rothschild giraffe. The sanctuary management will use the findings to design future strategies to solve the challenges facing the sanctuary. All this will lead to an optimal habitat for the giraffes and therefore improve on the breeding program.

The findings of this study will increase public understanding about the biophysical and socio economic impacts of the Rothschild giraffe. The findings will also increase understanding about the challenges faced by private sanctuaries while conserving endangered wildlife species therefore policy makers will be able to make calculated management decisions thereby promoting effective stewardship of endangered wildlife.

1.6 SCOPE AND LIMITATIONS OF THE STUDY

The study was conducted strictly within the premises of the GCS in Karen Nairobi. The effects of giraffe on the biophysical environment were derived by assessing giraffe concentration and utilization along three transects. The key biological variables considered were the species diversity, plant height, woody distance from PCQ and canopy layers. The physical dimension considered the soils status. Under the socio-economic environment, the study considered secondary data sources within the sanctuary for a period of five years, 2009- 2013. The sources included monthly reports, annual reports and OB records.

The first limitation experienced was little knowledge about the vegetative species types in this giraffe sanctuary. A lot of time and energy was spent on labelling the species before transfer to herbarium for identification. Secondly, the sanctuary had no proper order and consistency in storage of secondary data and a lot of time was consumed in digging out archives.

1.7 RESEARCH ASSUMPTIONS

The research assumed that the giraffes occupied and utilized the sanctuary equally in all seasons and their population is at the maximum carrying capacity of the sanctuary. It was also assumed that the giraffe is the only browser in this sanctuary. Finally the study assumed that the secondary sources of data were accurate and without bias.

1.8 OPERATIONAL DEFINITIONS

Endangered: a small population with a high risk for extinction.

Biological environment: biotic and a biotic components for example plants and soils in GCS.

Socio- economic environment: the welfare and development of the people influenced by the Rothschild giraffe in GCS.

Biophysical environment: the diversity, distribution and height of grasses, herbs and woody species in the GCS. It also implies number of canopy layers and appearance of soils in the GCS.

Giraffe utilization: the browsing and walking of the giraffe in the sanctuary.

Hoofmarks: marks left behind by giraffe while walking. Also used in place of giraffe walking

Giraffe concentration: occupancy or coverage of giraffes in GCS.

Challenges: Problems faced by GCS management while conserving the Rothschild giraffe.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the available literature and empirical literature the giraffe. The major themes considered in the literature review include the following; a) giraffe history and distribution, b) giraffe biology, c) captive breeding of giraffes, d) the concept of habitat, e) impacts of wildlife to the environment, f) an overview of wildlife legislation in Kenya, g) the empirical literature and research gaps. The last part presents the theoretical and conceptual frameworks.

2.2 Giraffe History and Distribution

Giraffe are in the mammalian order Artiodactyla (even toed ungulates), containing over 180 species and have the most diverse array of large land-dwelling mammals alive. Artiodactyla are native to all continents except Australia and Antarctica. They belong to the family of Giraffidae, consisting of two living genera (Okapia and Giraffa) and two species (*Okapia johnstoni* and *Giraffa camelopardalis*). Both species are native to the African continent. The giraffe is further taxonomically divided into subspecies (Pellew 1984).

Dagg and Foster (1976) recognize nine sub species of giraffes. Kingdon, (1984) however grouped giraffe into four regional populations: Somali arid, Saharan, Northern Savannah and Southern Savannah. These four populations incorporate eight of the nine subspecies and the home range of Rothschild giraffe falls in the overlap between the first three populations. Kingdon (1984) describes the Rothschild giraffe as a possible hybrid. Fennesy (2007) explained the disagreement of experts on the exact number of giraffe sub species whereby some sub species may merit to being classified as distinct species. This research is however still ongoing.

Giraffe occur in a wide variety of savannah habitats ranging from scrub to woodland that provides an adequate range and supply of browsing plants (Skinner and Smithers 1990). They do not occur in forest and are generally not associated with open plains. The West African giraffe inhabits the driest hottest and more open African habitat, where as the Nubian giraffe and Reticulated giraffe are found in habitats of North-East Africa

(Kingdon 1984). The home ranges of several subspecies overlap, and sub species hybridization occurs in the wild especially in the absence of geographic barriers such as mountains or large water bodies (East 1998). For example intergrades have developed particularly between *G.c. rothschildi* and *G. c. reticulata* in central Kenya and between *G. c. reticulata* and *G.c. tippelskirchi* in eastern Kenya (Jolly 2003). Table 2.1 shows the 2007 population estimates for the giraffe sub species in Africa.

Table 2.1: List of giraffe sub species and their population estimates as at 2007

Giraffe Sub-Species	**Population Estimates**
Angolan giraffe (*G. c. angolensis*)	< 20,000
Kordofan giraffe (*G. c. antiquorum*)	< 3,000
Masai giraffe (*G. c. tippelschircki*)	< 40,000
Nubian giraffe (*G. c. camelopardalis*)	< 250
Reticulated giraffe (*G. c. reticulata*)	< 5,000
Rothschild's giraffe (*G. c. rothschildi*)	< 670 (endangered)
South African giraffe (*G. c. giraffa*)	< 12,000
Thornicroft's giraffe (*G c. thornicrofti*)	< 1,500
West African giraffe (*G. c. peralta*)	< 250 (endangered)

Source: Fennesy (2007)

Today, the important safety havens for giraffe in Africa include but are not limited to Waza N.P and the adjacent hunting zones in Cameroon, Zakouma N. P. in Chad, Southwest Niger, Murchison Falls N.P. (Uganda), the Mara/Serengeti ecosystem (Kenya/Tanzania), Laikipia (Kenya), South Luangwa N.P. (Zamibia) and in Southern Africa countries like Etosha N.P. (Namibia), Okavango Delta (Botswana), Hwange N.P (Zimbabwe) and Kruger N. P. (South Africa) (Fennesy 2007).

2.3 Giraffe Biology

The giraffe is the biggest ruminant and the tallest mammal complete with a striking coat pattern. The exact pattern is unique to each individual as a fingerprint and the coat pattern is maintained throughout life. The colour may vary with season or with age (Kingdon 1984). Adult giraffe reach heights of 4.0m-5.5m and weigh from 550kg -1930kg (Jolly 2003). Kingdon (1984) suggests the most prominent feature of the giraffe is its height. Wild giraffe are non-territorial, social animals living in loose, open herds ranging in size from a few animals up to 50 individuals (Jolly 2003).

They browse on trees and shrubs of a variety of species but are highly selective. The height of the giraffe gives it access to a variety of vegetation on which to browse unlike the other browsers. The tongue of the giraffe possesses greater mechanical power than any other ungulate tongue. The free end of the tongue is pigmented black in order to protect it from the sun (Dagg and Foster 1976). Giraffes browse on over 100 species of plants their choice of plants is determined by local and seasonal availability (Jolly 2003). However, the orders *Combretaceae*, *Terminalias* and *Mimosoideae* provide the bulk of their browse (Pellew 1984b).

The more obvious factors influencing giraffe's forage preferences are the presence of aromatic substances, the abundance and size of leaves, the shape of thorns, and the physical accessibility of a tree and its growth form (Kingdon 1984). Food availability varies with the time of year and is plentiful in the hot wet months during which the giraffes are more particular and select preferred species on which to browse, with the acacia family (*Mimosoideae*) being their most preferred. Acacias leaves have high protein content (Skinner and Smithers 1990).

The giraffe uses both sight and smell to select browse plants. The smell is importantly used after dark. Giraffe ruminate while standing, walking or sitting, the throat bulges as the food is brought up to the mouth and re-chewed (Kingdon 1984). They may drink water at intervals of three days or less when water is available, but some of their moisture needs are met by consuming green leaves and dew. They also lick the ground for salt and mineral deposits (Dagg and Foster 1976).

2.4 Captive Breeding of Giraffes

In most cases giraffes in captivity are fed a pellet ration, lucerne hay, browse branches and small amounts of fruit and vegetables. Pellet rations are made from a variety of cereals and grains, with vitamins and minerals added. Giraffe as browsers requires a high protein level that is; pellet rations with protein levels of 15-25 %, and lucerne hay with protein levels of 15-20%. The volume of food offered should be 1.5- 2% of the giraffes body weight, for example at 2%, a 1000kg giraffe requires 20kg of food daily. Browse should be provided as much and often as available because it is the giraffe's natural diet. Pregnant, lactating and young growing giraffe require a diet containing at least 18 % protein (Wiens 1984).

Jolly (2003) proposes that giraffe in captivity, should be fed at a height of 2–3m above the ground, which will necessitate keeper access to hay feeders for cleaning. Old hay stalks, lucerne or pellet dust should not be allowed to accumulate in or under hayracks. Hay racks should be emptied on a weekly basis. Food buckets and troughs should be washed out and scrubbed with water daily and a fresh clean supply of water is required at all times, water troughs should always be cleaned.

Kingdon (1984) emphasized that record keeping is an important part of animal husbandry. Records should provide a complete history of each animal in captivity. Examples of daily records are; information on the animal's origin for example the place of birth or capture, date of birth or capture, other relatives of the animal and translocation to other parks. There should be information on sex, age, body weight and growth. Finally, there should be information on housing for example name of enclosure, other inhabitants, time period in this and other enclosures, seasonal housing routines, diet and feeding, behaviour, health, breeding and progeny of each animal.

The animals can be identified using a unique feature, size, coat colour, pattern, ear tag or microchip or by house name. If possible, each individual should be assigned an Animal Record Keeping System (ARKS) number which is an identity number for that individual whilst at a particular zoo. ARKS numbers can be used to identify each individual via computer databases worldwide (Jolly 2003).

Giraffes have no unique diseases, but are susceptible to most contagious diseases of domestic ruminant livestock, including clostridial diseases, leptospirosis, brucellosis, anthrax, pasteurellosis, John's disease and tuberculosis. Hoof problems have been encountered in giraffe and are thought to be related to diet and or substrate. Overgrown hooves can impair movement and lead to complications such as sprained tendons and arthritis. Preventative medicine programs should include regular faecal collection (for identification and treatment of internal and external parasites), weighting of the animal and blood collection if possible. Preventative medicines such as drench, clostridial vaccines, vitamin and mineral supplements should also be administered (Jolly 2003).

2.5 The Concept of Habitat

Krausman (1999) defined a habitat as the resources and conditions present in an area that produce occupancy, including survival and reproduction, by a given organism. Leopold (1933) explained that a habitat is more than vegetation or vegetation structure. It is the sum of the specific resources that are needed by organisms. These resources include food, cover, water, and special factors needed by a species for survival and reproductive success. Krausman (1999) adds that a habitat includes the resources provided to allow an animal to survive. Thus, migration and dispersal corridors and the land that animals occupy during breeding and non breeding seasons are habitat

2.5.1 Habitat use

Krausman (1999) defines habitat use as way in which an animal uses the physical and biological resources in a habitat. Habitats may be used for foraging, cover, nesting, escape, dens, or other life history traits. The various activities of an animal require specific environmental components that may vary on a seasonal or yearly basis. A species may use one habitat in summer and another in winter. This same habitat may be used by another species in reverse order.

Several interacting factors have an influence on habitat selection for an individual for example competition, cover, and predation. Competition is involved because each individual is involved in intra specific and inter specific relationships that partition the available resources within an environment (Krausman 1999). Competition may result in a species failing to select a habitat suitable in all other resources or may determine spatial distribution within the habitat (Wiens 1984). Predation also complicates selection of habitat. The existence of predators may prevent an individual from occupying an area. Survival of the species and its future reproductive success are the driving forces that presumably cause an individual to evaluate these biotic factors. A high occurrence of competition and predators may lead to an individual choose a different site with less optimal resources. Once predators are removed, areas with necessary resources can then be inhabited (Krausman 1999).

2.5.2 Habitat preference

According to Krausman (1999), habitat preference is the consequence of habitat selection, resulting in the disproportional use of some resources over others. Habitat preferences are most strikingly observed when animals spend a high proportion of time in patches within the habitat.

2.5.3 Habitat availability

Habitat availability is the accessibility and availability of physical and biological components of a habitat by animals. Availability refers only to the quantity of available resources in the habitat, irrespective of the organisms present (Wiens 1984). Similarly, Jolly (2003) suggested that vegetation beyond the reach of an animal is not available as forage, even though the vegetation may be preferred. Measuring actual resource availability is important to understand wildlife habitat, but in practice it is seldom measured because of the difficulty of determining what is and what not available. Consequently, quantification of availability usually consists of a measure of the abundance of resources in an area used by an animal, rather than true availability (Wiens 1984).

2.5.4 Habitat quality

Habitat quality refers to the ability of the environment to provide conditions appropriate for individual and population persistence (Krausman 1999). Wiens (1984) explains that habitat quality is a continuous variable, ranging from low (based on resources only available for survival), to median (based on resources available for reproduction), to high (based on resources available for population persistence). He further explains that habitat quality should be linked with demographics and not vegetative features if it is to be a useful measure (Krausman 1999).

2.6 Impacts of Wildlife to the Environment

2.6.1 Positive impacts

The entire range of wildlife activities produces revenues and brings added value which contributes to the gross national product (GNP). These activities include the consumptive uses of wildlife whereby the wildlife resource is exploited by removing a certain quota of either live or dead animals for example hunting and the non-consumptive uses of wildlife whereby values are derived without removing the resource for example tourism. In 1989, the wildlife GNP varied from high levels of US$131.7 million in Zimbabwe to low levels, such as US$30 million in the Central African Republic. In the Côte d'Ivoire, the informal wildlife sector reached 99.5% of the wildlife GNP, while in Zimbabwe the official wildlife sector reached 94.7% of the estimated wildlife GNP. In Tanzania and Kenya, wildlife tourism is either the first or second largest foreign earner (Chardonnet *et al* 2002).

About 8% of the Kenya's land mass is protected area for wildlife conservation. Protected areas are gazetted landscapes/seascapes that have been surveyed, demarcated and gazetted either as National Parks and/or National Reserves. The protected areas embrace various types of ecosystems namely: forests, wetlands, savannah, marine, arid and semi-arid. They comprise of 23 terrestrial National Parks, 28 terrestrial National Reserves, 4 marine National Parks, 6 marine National Reserves and 4 national sanctuaries. Each of these ecosystems requires different conservation priorities and measures (KWS 2013).

Sindiga (1995) stated that the wildlife component in Kenya yields substantial and increasing economic returns to the country. Most protected areas in Kenya are located in the arid and semi-arid areas; a zone that comprises over 87 percent of the national land. Wildlife resources contribute directly and indirectly to the local and national economy through revenue generation and wealth creation. For example, in the financial year ending 30th June 2006, wildlife accounted for 70% of the gross tourism earnings, accounted for 25% of the Gross Domestic Product (GDP) in Kenya and more than 10% of total formal sector employment. In addition, wildlife resources provide important environmental goods and services for the livelihood of the people and productive sectors. GoK (2012) explains that any adverse impacts on the ecosystem can dramatically and negatively alter humans' capacity to survive.

Soltau (2003) appreciates the impact of protected areas on local society and economy. He agrees to a concern raised by the international conservation community in the Durban Accord "that many costs of protected areas are born locally – particular by poor communities – while the benefits accrue globally". This congress made the commitment that protected area management should strive to reduce and in no way increase poverty

Wildlife also plays critical ecological functions that are important for the interconnected web of life supporting systems. For example when a mega herbivore such as the elephant disappears from regions within its original distribution area, the ecosystems tend to change. Open habitats become subject to bush encroachment and eventually turn into forests. This encroachment can cause the disappearance of some savannah species but also allows the forest wildlife to thrive (Chardonnet *et al* 2002). Kenya's major water towers are found in wildlife-protected areas Sindiga (1995).

2.6.2 Negative impacts

In most cases, the inception of protected areas has necessitated the removal of people. However some more recent parks have involved careful compensation arrangements for people moved to make way for conservation. Evictions frequently occasion expense, hardship and impoverishment. Previous assessments of biodiversity conservation in the context of poverty alleviation suggest that protected areas did not reduce poverty, but on the contrary increase the poverty of the rural populations (Soltau 2003).

Wildlife has also negative impacts on the ecosystem. Elephants in Aberdares National Park of Kenya are, for example, known to destroy the *Acacia seyal* near the ponds where other animals gather at the end of dry season thereby endangering the survival of the giraffe which rely on this tree for food. Other negative ecological effects on habitat include damages caused directly by large herbivores, overgrazing and over browsing by wildlife. An example is when there was a population crash of the elephant and other herbivores in the Tsavo East National Park in Kenya after a severe drought due to exceeding carrying capacity and mismanagement practices (Chardonnet *et al* 2002).

2.6.3 Challenges facing wildlife conservation in Kenya

The Kenya Wildlife Policy (2012) explains that one of the major challenges facing Kenya is the loss of biological diversity. Land use changes favouring agriculture and rural and urban development have led to the reduction and modification of wild areas, resulting in the extinction of or threat of extinction to wildlife species and natural areas which serve as habitat. So far, many communities consider the presence of wildlife on their land as a burden rather than an opportunity for gaining benefits.

Tourism has been shown to affect habitats, animals and local communities. Uncontrolled and unregulated tourism in some wildlife areas is a source of concern for a variety of perceived or actual ecological and social impacts, including wildlife disturbance and displacement, habitat damage and pollution. Much of this impact is due to ignorance or a lack of effective management and control (Roe *et al* 1997).

Majority of parks in Kenya are not equipped to minimize the negative impacts of tourism. National Parks and National Reserves lack trained guides, interpretative information, lecture rooms and infrastructures to manage visitors. For example, the ‘Big Five’ euphoria promoted Kenya’s tourist economy in the 1960s through safari hunting. Today, it is doing more harm than good. Traffic jams are forming around prides of lions in the vastness of Kenya’s wildlife areas thereby limiting conservation (Muthee, 1992).

2.7 Overview of Wildlife Legislation in Kenya

Kenya is rich in natural resources, including a vast array of wildlife. Because of its species’ richness, endemism and ecosystem diversity, it is categorized as a mega-diverse country under the Convention on Biological Diversity (GoK, 2012).

By the 1970's, the Kenya conservation policy relied on both command-and-control and on a wide array of economic incentives. Within the network of PAs, the state enforced its property rights by controlling access and the nature and pace of activities and development. For land outside the PAs, incentives to landowners to maintain the wildlife resource included sport hunting, trapping for export, cropping, and tourism; a vast secondary industry of arts and crafts, tanning, and trophy preparation; and an array of schemes to compensate landowners for the depredations of wildlife, including loss of grazing, crop damage and loss of life and property (Norton 2000).

The Wildlife Conservation and Management Act of 1976 was enacted to provide a legal and institutional framework for the management of wildlife (GoK 2012). During this time, all consumptive uses of wildlife and the associated trades in wildlife products were prohibited and all compensation schemes were abandoned as being ineffective and corrupted. Conservation policy now relied solely on command and control (Norton 2000).

The Act amalgamated the then Game Department and the Kenya National Parks to form a single agency, the Wildlife Conservation and Management Department (WCMD), to manage wildlife. Subsequently, in 1989 through an Amendment of the Act, KWS was established to replace WCMD (GoK 2012). The gradual erosion of institutional capabilities and motivation to enforce property rights either inside or outside the PAs led to the following years to be characterized by outrageous poaching especially of high value species such as elephant and rhinoceros. Furthermore, the removal of all incentives for landowners to invest in and conserve wildlife led to the pernicious eradication of wildlife throughout the rangelands of Kenya (Norton 2000).

Contrary to Norton (2000), the Kenya Wildlife Policy (2012) analyzed the previous wildlife policy and wildlife Act of 1976 and summarized that it succeeded in enhancing wildlife conservation in the country; significantly reduced wildlife poaching especially of endangered species such as elephants and rhinos; established a unitary institution; the Kenya Wildlife Service (KWS), to be responsible for wildlife conservation and management countrywide; and established the Kenya Wildlife Service Training Institute (KWSTI) that continues to play an important role in human capacity development.

The policy however points out that the 1976 Act did not adequately achieve the following;

- Reducing conflict between people and wildlife.
- Achieving the desired goal of adopting an integrated approach to wildlife management.
- Realizing the desired goal of mainstreaming the needs and aspirations of landowners and communities in wildlife areas into wildlife conservation planning and decision making processes.
- Ensuring greater protection or conservation of wildlife within the protected and outside protected areas.
- Realizing the desired goal of putting in place a regulatory framework for wildlife utilization.
- Realizing the desired goal of analysis and application of research data in the management of wildlife resources and
- Did not put into place mechanisms to monitor and ensure the implementation of the Policy and law.

These inadequacies have contributed to the current threats and challenges facing wildlife conservation in Kenya leading to drafting of the Wildlife Bill 2011 which is now the Wildlife Conservation and Management Act 2013 after the President ascended to it.

The Kenya Wildlife policy provides a framework that has key elements in wildlife management which includes;

- Enactment of a comprehensive wildlife law to implement this policy.
- Mainstreaming of wildlife conservation into national land use systems.
- Decentralization of wildlife conservation planning.
- Implementation and decision-making processes to the county level. Wildlife conservation and management will be ecosystem-based; communities shall participate in wildlife conservation and management through establishment of community wildlife conservation areas and sanctuaries.
- Mainstreaming research and monitoring in wildlife conservation and management.
- Provision of appropriate incentives and user rights to communities and other stakeholders to promote sustainable wildlife conservation and management.
- Innovative measures to mitigate human wildlife conflict.
- Establishment of the Wildlife Compensation Fund to broaden the financial resource base for compensation of wildlife damage to human, crop, livestock and property.
- Regional and international cooperation in the conservation and management of shared wildlife resources (Kenya Wildlife Policy 2012).

The Wildlife Conservation and Management Act 2013 therefore holds the hope for future conservation of wildlife in Kenya. It was developed in a participatory approach where communities living in wildlife areas were required to give input. It therefore provides guidelines for improved management of wildlife resources. Part II of the act states that; all wildlife found in Kenya is vested in the state on behalf of and for the benefit of the people of Kenya.

In Part III, the act allows the Cabinet Secretary to draft a National Wildlife Conservation and Management Strategy in every five years through public consultation. This means that the act is promoting cooperative management. The National Wildlife Conservation and Management Strategy shall describe the principles, objectives, standards, targets, indicators, procedures and institutional arrangements for the protection, management, use, development, conservation and control of wildlife resources (GoK 2013).

The act also advocates for registration of Community Wildlife Associations and Managers. The purpose for these associations shall be to facilitate conflict resolution and cooperative management of wildlife within a specified geographic region or sub-region. The bill gives KWS and Wildlife Conservation Area Committee mandate to grant user rights such as wildlife-based tourism; commercial photography and filming; educational purposes; research purposes; cultural purposes; and religious purposes. Issuance of user rights will increase accessibility to benefits accrued from wildlife (GoK 2013).

In 2010, lead stakeholders including the KWS formulated the National Giraffe Conservation Strategy which is supposed to raise awareness of the plight of the giraffe and provide national guidance on the conservation and management of all the three giraffe sub species in Kenya. The guidelines define the role of the government, conservation partners and other stakeholders whilst raising awareness about the population trends occurring within Kenya. Kenya clearly has a large role to play in giraffe conservation given that it is home to three sub-species and one of giraffe sub-species (*G.c. Rothschild)* is classified as ‘Endangered’ by the IUCN Red List (KWS undated).

2.8 Empirical Literature Review

Most studies conducted about giraffes specialized on population densities, feeding behaviour or preference of giraffes in relation to their habitats. Previous studies have focussed a lot on wild giraffes except for Pellew (1984b) who conducted a research on feeding strategies of captive giraffes in Serengeti National Park, Tanzania.

According to a study by Leuthold and Leuthold (1972) in Tsavo National Park, Kenya, the giraffes browsed at a level higher than two meters in 63 % of the time in the dry season compared to 33 % in the wet season. Pellew (1984a) studied food consumption and energy budget of giraffes in Serengeti National Park. He found out that giraffe are capable of negatively affecting the vegetation of the area they inhabit and that there are several choices a giraffe makes that will decide how well giraffes sustain themselves and meet the requirements for body growth and reproduction. He summarized the alternatives into how they make their choice of habitat and food items and the time spent on different activities. He also found out that giraffes have similar rates of food intake as other African ungulates but their intake is qualitatively better with a higher crude protein intake.

Milewskiet *et al*. (1991) explained how branches on living acacia plants that had their thorns removed suffered greater herbivory due to over browsing by giraffes and goats. This result was substantiated by Gowda (1996), who found that an increase in spine density of *Acacia tortilis* decreased the feeding rate of goats. A decrease in biomass loss was also found as a result of decreased feeding rate although the goats had changed their feeding technique from pruning shoot tips to picking leaf clusters in order to compensate for the food loss.

Ginnett and Demment (1997) tested a hypothesis linking sex-related size dimorphism to differences in foraging behavior of giraffes. The finding showed that males spent less time foraging than females, but more time ruminating. Males had a longer per-bite handling time, but took larger bites and consequently had a shorter handling time per gram of intake. Bond & Loffell (2001) concluded that introduced giraffe at the Ithala Game Reserve in the Kwa-Zulu Natal Province of South Africa have altered the species distribution and composition of the savanna ecosystem, through differential mortality of *Acacia davyi* which was the highly browsed species in this nature area.

A study on the impact of giraffe, rhino, and elephant on the habitat of a black rhino sanctuary in Kenya by Birkett (2002) found that giraffe have the greatest impact on the three to five meter size class of trees. This caused the tree density of the park to decline by two percent per annum if giraffe browsing was combined with that of elephant (*Loxodonta africana)* and black rhino (*Diceros bicornis*). They studied through recording height specific browse impact data for 1,075 trees of the dominant species, the whistling thorn (*Acacia drepanolobium*).

Parker (2004) studied the feeding biology and potential impact of introduced giraffe (*giraffe camelorpadalis*) in eastern cape Province, South Africa. He found that giraffe browse utilization was highest where giraffe density was highest. However, several species were more heavily browsed than others even when giraffe density was low, suggesting that giraffe are capable of negatively affecting the indigenous flora of the province.

Dharani *et al* (2007) conducted a study of the browsing impact of large herbivores on *Acacia xanthophloea* in Lake Nakuru National Park, Kenya. The finding of this study showed that although heavy browsing reduced the height and canopy of trees, it did not kill any trees and seedling regeneration took place simultaneously. They further explain that the presence of large herbivores impacted some considerable browsing pressure but *Acacia xanthophloea* habitat would continue to remain in balance in the presence of recruitment of seedlings and saplings. A study on feeding behaviour of giraffe was conducted in Mokolodi Nature Reserve, Botswana by Blomqvist and Reberg (2007). The study addressed different aspects of feeding modes, feeding preferences, time allocation between different activities and the differences between males and females. They concluded that giraffe mainly utilizes the canopy above two meters from the ground. They also identified the most preferred species to giraffe as *Acacia spp* and *Spirostachys africana* compared to *Combretum spp* and *Pelthopherum africanum.*

Pringle *et al* (2010) studied the ecological importance of large herbivores in the Ewaso Ecosystem in Kenya. Their broad conclusions included; the removal of large herbivores has a net positive effect on the densities and/or activity levels of other populations, although not all species respond. Secondly, taxa increasing in density, biomass, or local habitat usage following removal of large ungulates included the woody and herbaceous plants, small mammals, lizards, snakes, and at least some species of birds and arthropods. Lastly, reduction or elimination of large mammals from the system freed the primary production for use by other consumers (and, by extension, the consumers of those consumers), either as energy or as habitat.

Finally, Owino *et al* (2011) conducted a research on patterns of variation of herbivore assemblages at Nairobi National Park. They assessed the patterns of variation in abundance of eight herbivore species including giraffes. Their methodology included individual counts of all the plains game species. Out of the eight species, the annual abundance index for giraffes was the lowest. Even though they identified possibility of counting errors, they acknowledge that patterns of variation of giraffes were partly attributed to their ecology whereby their distribution is correlated to browse quality and availability.

2.9 Research Gaps

The above review reveals that many of the previous researchers concentrated on the feeding behaviour and height specific impacts of giraffes on vegetation. Even though the results are generally comparable, the shifting vegetation and differences in environmental conditions have led to some differences. This clearly illustrates the variability of giraffe utilization habits. It is therefore difficult to draw conclusions for successful giraffe population management without area-specific data.

The present study considered the effects of the giraffe on the social and economic environment unlike for previous researchers who concentrated on vegetation impacts. Most of the previous studies based their measurements on the growth rate of marked trees or plots through direct observations and actively following the giraffe, this study assessed the impact on vegetation through dung assessment and observation of signs of giraffe utilization. There has been no scientific study to determine the environmental effect of the giraffe especially within an urban setting which is the case in this study.

2.10 Theoretical and Conceptual Framework

2.10.1 Animal-plant interactions

Batzil (1994) reviewed animal-plant interactions as first to involve behavioural and physiological adjustments of individual plants. The results of such adjustments may lead to changes of individual fitness leading to changes in the distribution and abundance of wildlife populations. The resulting activities of these populations then feed back onto the plants. Furthermore animals individually affect soils, nutrient cycles and other environment factors. Figure 2.1 shows the Batzil model.

The arrows in Figure 2.1 indicate casual pathways for change, which can be negative or positive. Mammals directly respond to food and cover provided by plants. Mammals influence plants directly (by immediately damaging or facilitating plant success) or indirectly (by affecting substrate or landscape).

The Batzil model was expounded by Luken (1990) who introduced more pathways through which animals can influence plants and thus succession. They include trampling, eating foliage and seeds, and defecation. Animals also function as dispersers of seeds and other plant disseminules. In addition, most management activities can change the path of succession. It is easy to predict the course of succession when single management impact is applied. However, multiple impacts render prediction highly difficult for example a series of shrub control, exclusion, burning, and finally grazing by wild and domestic animals.

Luken (1990) therefore advised managers to consider these pathways in order to make accurate predictions concerning the outcome of planned wildlife conservation activities on specific sites. And when studying animal- succession relationships or when planning management based on such a study, one must consider the surrounding vegetation associations and seral stages and their possible influence on the area of interest that is the broader landscape- scale perspective. This is illustrated in Figure 2.2.

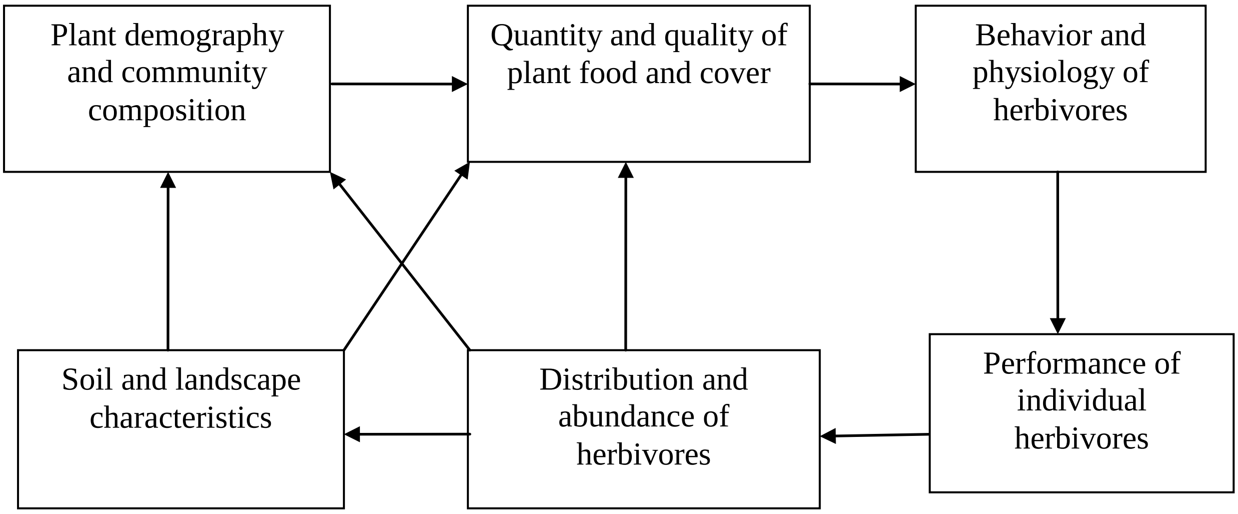


Figure 2.1: Model of interactions between mammalian herbivores and the biophysical environment

Source: Batzil (1994)

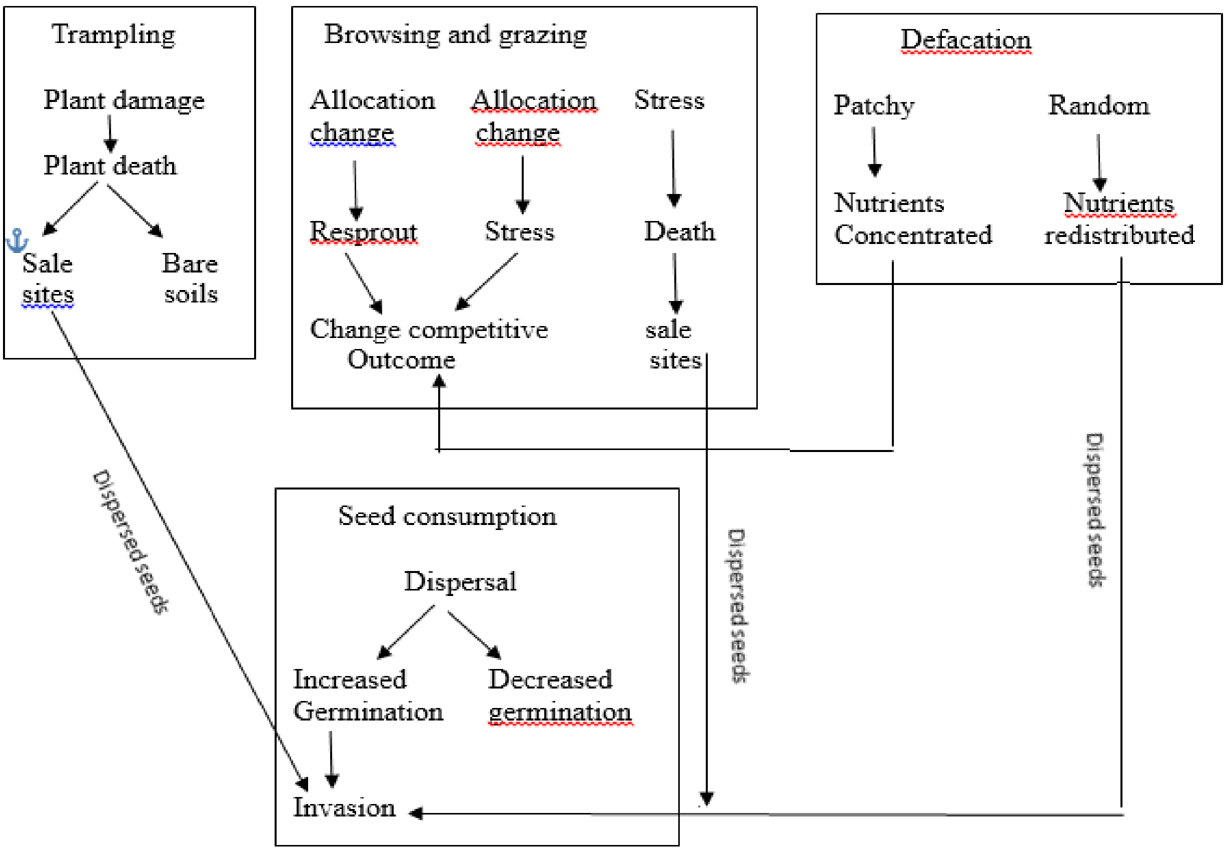


Figure 2.2: Various activities associated with grazing or browsing animals and their possible effects on plants
Source: Luken (1990)

2.10.2 The theory of ecotourism

The theory of ecotourism gained popularity in the last decade. Ramser (2007), explains that this concept was first defined by Hector Ceballos- Lascurain in 1980s as

> *'Travelling to relatively undisturbed or uncontaminated natural areas with the specific objective of studying, admiring and enjoying the scenery and its wild plants and animals as well as any existing cultural manifestation (both past and present) found in these areas'*

More recent definitions include more than one dimension, particularly through adopting the pillars of sustainable development. This change is well manifested in the actual definition by the International Ecotourism Society, whereby ecotourism is defined as "*responsible travel to natural areas that conserves the environment and improves the well-being of local people*" (Ramser 2007).

The term sustainable development reached popularity with the publication of the 1987 Brundtland report, where it is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, cited in Ramser 2007). Sustainable development relies on three dimensions which are the social, the ecological and the economic sustainability.

There is thus a close relationship between ecotourism and sustainable development. Ecotourism can be distinguished from nature tourism by its emphasis of conservation, education, traveller responsibility and active community participation. Thus, the concept of ecotourism presents an option towards sustainable development as it promotes a form of tourism that is harmless for the natural and cultural environment and supports economic growth. Ecotourism does however not lead to a sustainable development in all studied cases (Ramser 2007). Often, negative impacts are of social or ecological nature.

2.11 Conceptual Framework

Figure 2.3 shows the conceptual framework adopted from the Luken (1990) model and the theory of ecotourism. The Luken (1990) model does not show the effects of wildlife to the socio economic environment, an aspect that was adopted from the theory of ecotourism.

For this study, the Rothschild giraffe at GCS was regarded as a tool/ attraction that can be able to promote ecotourism hence sustainable development. Ecotourism can contribute to sustainable development if it is economically viable and environmentally sensitive. Therefore the framework provides a basis for studying the effects of giraffe to the three aspects of environment.

The biological impacts are understood as when the giraffe provides an opportunity for plant re growth through sustainable browsing and contributing manure or demote plant re growth through over browsing, soil erosion or trampling on plants. The giraffe has also an effect on conservation of other wildlife.

The social effects of giraffe are realized through offering opportunity for tourism and environment education. The economic impact is understood as a giraffe offering an opportunity for income generation through tourism. This has also a multiplier effect of funding for conservation projects that promote both income generation and employment amongst beneficiaries as well as promote conservation of other wild species.

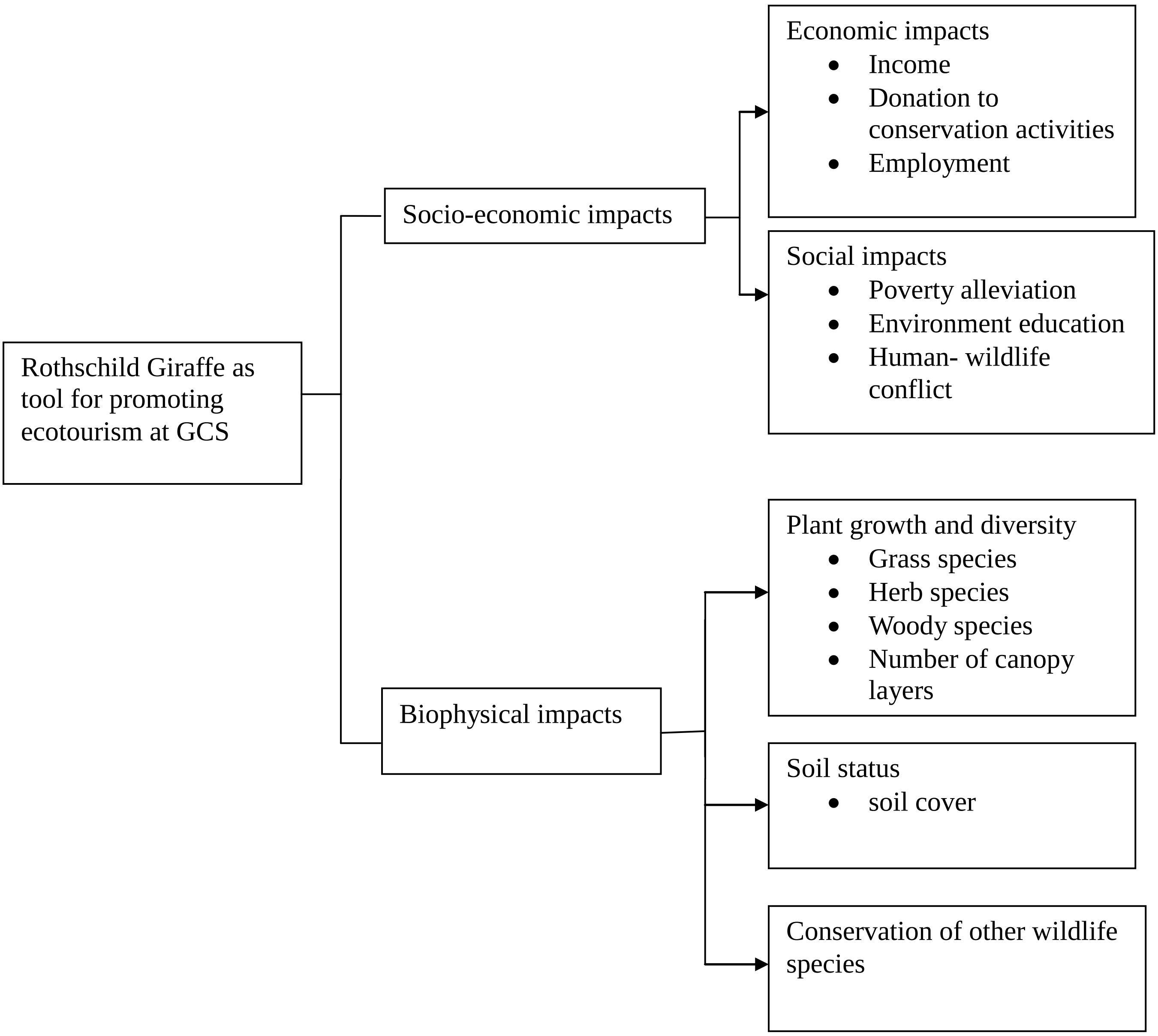


Figure 2.3: The conceptual framework
Source: Researcher (2015)

CHAPTER THREE

STUDY AREA

3.1 Introduction

This chapter describes various aspects of the study area. These aspects include; the location and size, the physiography, flora and fauna and socio-economic activities of the study area.

3.2 Location and Size

The GCS (1º 22' 33"E; 36º 44" 45"S) is located in Karen location under Langata Sub County and Nairobi County. It can be accessed using Langata road or Ngong road at approximately18 km from Nairobi Central Business District. It lies at an altitude of 1,774 m above sea level. It is a natural forest with an area of approximately 90 acres divided by a public road into 20 acres and 70 acres (Giraffe Center undated). Figure 3.1 provides a location map for the study area.

The location and proximity of the GCS to the Nairobi Central Business District puts it at a strategic place for enhancing ecotourism. The accessibility increases visitor population hence influence the socio economic impacts. The altitude promotes favourable climatic conditions to the giraffe and natural vegetation thereby making the sanctuary favourable for giraffe existence that leads to derivation of its effects to the biophysical and socio economic environment.

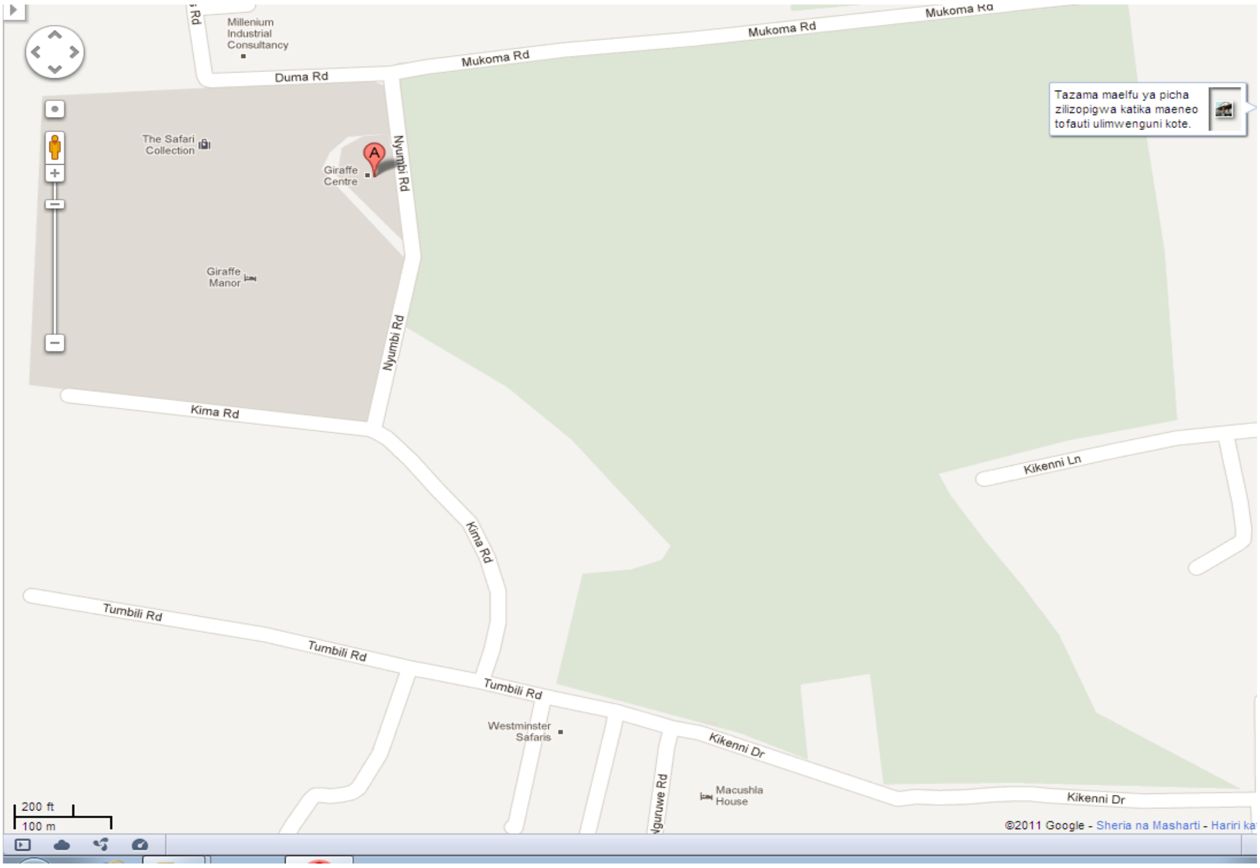


Figure 3.1: Location map of GCS

Source: Google maps (2015)

3.3 Physiography

The upper section of the big portion in the sanctuary comprises of lava rocks that were derived from the former Ngong volcano (Oyake *et al* n.d). The sanctuary has both loam and red cotton soils. The loam soils are covered in the big portion while the red soils are mainly found in the small portion (AFEW undated).

The area experiences a moderate subtropical climate with two rainy seasons. The long rains are experienced during March to June while short rains take place from October to December annually. The mean annual rainfall ranges between 850-1050 mm (CBS 2001). The mean daily temperature ranges between 12 and 26°C. It is usually dry and cold between July and August, but hot and dry in January and February (CBS 2001). The mean monthly relative humidity varies between 36 and 55 per cent (CBS 2001).

3.4 Flora and Fauna

GCS has two types of distinct vegetation. These are dry upland forest and open grassland. The dry upland forest has wide diversity of several woody species which include *Croton spp, Acacia spp, Ochna holsti, Olea Africana, Markhamia lutea, Podo spp, Brachylaena huilensis, Ficus spp, Euphorbia spp, Sesbania sesban, Opuntia spp, Dombeya spp,* and*Teclea spp.* The herbaceous plants include *Justicia spp, Commelina spp, Draceana spp, Hibiscus spp,* and *Asparagus spp*. The open grassland is occupied with a few grass species for example elephant grass (AFEW undated).

The giraffe is the main faunal species in the sanctuary. The giraffe population in the sanctuary is 10 animals. This constitutes of 3 adult breeding females of ages 8-17 years, 6 young adults between ages of 1-4 years and one calve which is less than 8 months. In terms of sex, the sanctuary has 7 female and 3 male giraffes (Researcher 2014). There are over 178 species of birds, 9 species of small reptiles and over 50 species of insects. The sanctuary provides a habitat for mammals like dik dik, bush baby, mongoose, hyraxes, warthogs and hyenas (Giraffe Center n.d).

The rich flora in this sanctuary provides adequate browse for the giraffe. This promotes the survival and interaction of the giraffe with the environment. Giraffe presence has promoted ecosystem balance through opening up the landscape thereby increasing accessibility of the giraffe and other mammals. Increased giraffe occupancy has led to over browsing in some areas thereby affecting the distribution and diversity of the vegetative species. Increased accessibility of areas in GCS has increased warthog population thereby attracting stray predators like the lions and leopards which impose a security challenge in the sanctuary.

3.5 Administrative set up

The sanctuary management comprises of 7 Board of Directors elected from a pool of 25 board members. The board of directors is answerable to the members and has the final decisions concerning the sanctuary management issues. There is one Chief Executive Officer who coordinates both the staff and animal welfare issues and is answerable to the board. In total there are 36 employees in the sanctuary however only 20 employees work directly with the giraffes and sanctuary biodiversity.

The management controls the movement of giraffes in the two sanctuary portions by allowing the giraffes to cross every morning and evening. There is also control of the quantity of food ration that the giraffe should receive from hand feeding thereby promoting browsing. All this strategies affect allocation time and hence the effect of giraffe on vegetation in the sanctuary.

3.6 Socio-Economic Activities

The GCS carries out tourism as shown in Plate 3.1. The giraffe is used as a tool for income generation in the sanctuary. The sanctuary is open to public seven days a week and all visitors are required to purchase a ticket on entry. The tickets are priced according to the nature of the tourists which depends on citizenship and age category.

Other socio economic activities within the sanctuary include shopping and dining at the gift shop and tea house respectively (AFEW 2010). Tourism in the GCS has an influence on the socio economic benefits of the Rothschild giraffe because the sanctuary utilises the income for furtherance of conservation work in communities and schools within Kenya.

Karen location has a population density of 1592 persons per square Kilometre (KNBS 2013). The residential is mainly gated community or hotels and there is limited human activity in this area thereby promoting the security of giraffes against poachers. A high security ensures maximisation of the effects or contribution of the giraffe to our environment.

Plate 3.1: Tourism activity at GCS

Source: Researcher (2015)

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This chapter describes the study design, sample size and sampling procedure, data collection and data analysis. The sampling procedure describes the steps that were followed in selection of the sample while the section on data collection describes the tools that were used to collect data from the samples. The section on data analysis explains the formula and procedures that were used in analysis of the collected data.

4.2 Study Design

The research was based on a sample survey using a case study and the use of both qualitative and quantitative data. The study attempted to shed light on the effects of Rothschild giraffe to the biophysical and socio economic environment using the case of GCS. The sample used were based on a non- probability frame.

The modal instance sampling under purposive sampling approach was used to determine transect details as informed by the reconnaissance. This transects were used to collect data about the biophysical effects. The modal parameters used were giraffe dung, giraffe hooves and browsed species.

Purposive sampling was also used to determine the duration and years to be included in deriving socio economic effects and challenges in GCS from secondary data sources. The study chose to use secondary sources that would inform about the socio economic impacts of the Rothschild giraffe. The parameter considered here was nearness of the data to the year of study which would increase relevance. The study therefore chose to collect data from secondary sources within five year duration of 2009- 2013.

4.3 Data Collection Instruments

The biophysical data was collected along transects using the Point-Centered Quarter (PCQ) method. The PCQ is a distance method for sampling vegetation characteristics (Mueller, 1974). The area around each point was divided into four equal quadrants by making use of a second line perpendicular to the transect line (Figure 4.2). The accuracy of the PCQ method increases with the number of observation points. Basically a minimum of 20 to 30 observations is recommended for better output (Herlocker, 1999; Mwaura & Kaburu, 2008). This method was highly preferred because it does not require laying out of plot boundaries, is not time consuming and eliminates personal error from judging whether boundary individuals are inside or outside (Mitchell 2007). At each point, a radius of 5 meters was used to mark an imaginary quadrant surrounding the point. In a clockwise manner, the quarters were numbered one to four. The PCQ method is illustrated in figure 4.2.

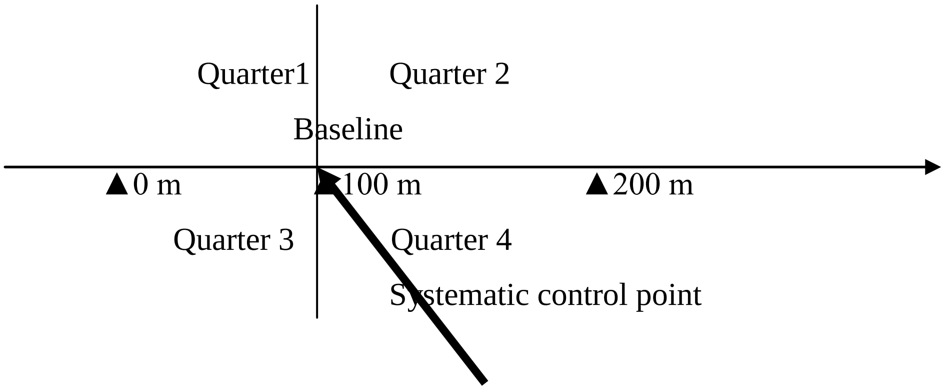


Figure 4.1: An illustration of the Point-Centered Quarter (PCQ) method

.

The socio economic effects were derived from secondary data sources using well detailed and progressive data sheets. These included the AFEW nature trail guide book, visitors' record books, monthly report databases and the funded projects' reports. The challenges facing the sanctuary were derived from OB records. In these records, all reports about incidences involving the giraffe were collected.

4.4 Sample Size and Sampling Procedure

The sampling procedure involved a reconnaissance survey to determine the sanctuary sections that were highly utilized by giraffes. This was determined through observation of the magnitude of several giraffe parameters to include dung, hoofmarks and browsing. During the reconnaissance, the heights of grasses, herbs and woody distance were measured and their frequencies used to develop the plant height and distance levels in the sanctuary score sheet. The number of canopy layers and status of soil was also observed and used for the same purpose.

In the sanctuary score sheet, grass and herb distances were 0-40 cm, 41-81 cm and > 81 cm. The number of grass species was 0-1, 2-3 and >3. The number of herb species was 0-3, 4-7 and >7. The nearest woody distance was 0-70cm, 71-141 cm and > 141cm. The number of woody species was 0-1 cm, 2-3 cm and > 3 cm. The canopy layers were 0-1 layers, 2-3 layers and >3 layers.

The sample size comprised of three transects labelled as transect 1, transect 2 and transect 3. All the three transects were located in the big section of the GCS. The transect length varied. Transect 1 was 732 m, transect 2 was 830 m and transect 3 was 653 m. The first PCQ point for each transect was located at a common giraffe crossing point. It was marked as zero and not sampled. The progressive PCQ points were located upon counting a minimum of 20 steps. One step was equivalent of 1 m. The number of steps along transects were varied in sections that showed similarity of vegetation diversity. The total number of observation points was 16 for Transect 1, 21 for Transect 2 and 15 for Transect 3 which translated to 52 sample points. The alignment of the three transects is shown in Figure 4.1 and the transect characteristics are outlined in Table 4.1.

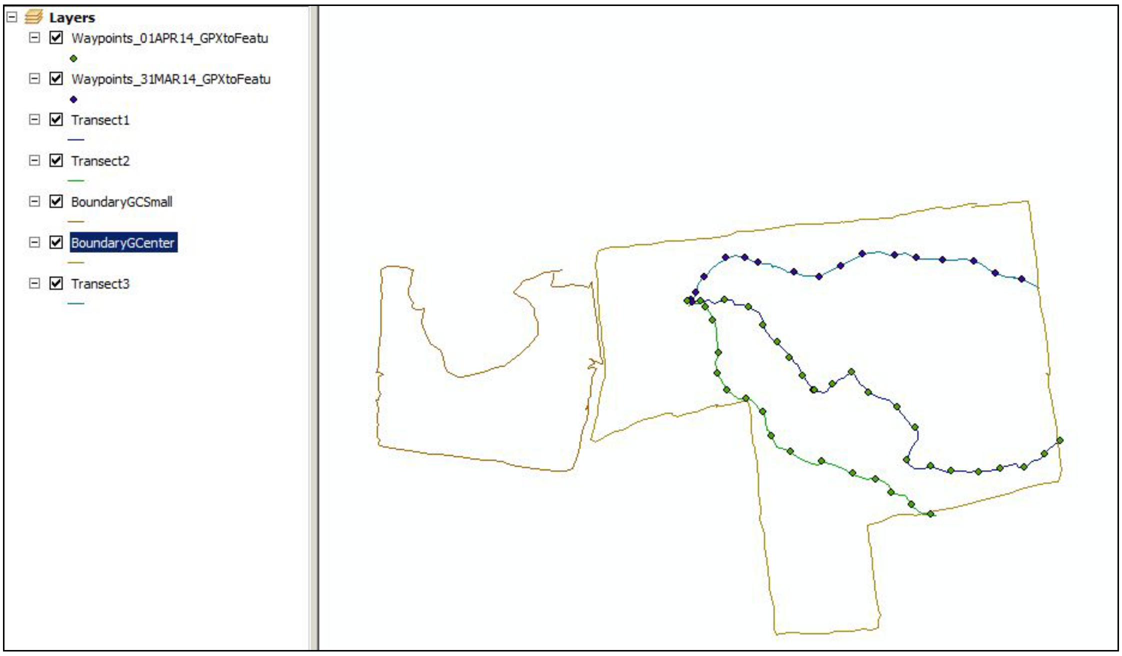


Figure 4.2: The alignment of the PCQ transects and observation points
Source: Researcher (2015)

Table 4.1: Transect characteristics

TRANSECT	CHARACTERISTICS
Transect 1	a) Was closest to the northern boundary of the sanctuary. b) It ascended from Gogo river through a thick forest with tall trees to meet a section of scanty vegetation before closing at a grass land near the North East boundary. c) Near to a giraffe water point d) The forest subsection had three canopy layers e) presence of loam and red soils
Transect 2	a) Was sandwiched between transect 1 and 3 b) It ascended from Gogo river through a thick forest with tall trees to meet a section of shrub vegetation before passing through a thick forests to the South East boundary of the GCS c) Possessed four to five canopy layers d) Presence of loam and red soils
Transect 3	a) Located close to the southern boundary of GCS b) Climbed from the Gogo river through thick forest with tall trees to open rocky land characterised by scanty vegetation mainly occupied by shrubs c) Possessed mainly two- three canopy layers d) It was the shortest transect

Source: Researcher (2015)

In each quarter, the biophysical variables included a) grass height, b) number of grass species, c) herb height, d) number of herb species, e) woody distance to the point f) number of woody species g) number of canopy layers and the soil cover. All the measured plant species were labelled and the unidentified ones were taken to the herbarium for identification. The giraffe variables recorded in each quarter were a) the presence of dung, b) signs of giraffe feeding or walking and the browsed species. The GPS coordinate of each point was recorded too. All the measurements were recorded in a field forms

The socio economic variables included the annual population of visiting tourists, annual revenue, annual number of schools funded, amount donated for conservation initiatives annually, annual number and types of community conservation projects. The variable for challenges facing GCS derived from OB records was the type and frequency of giraffe related incidences per year.

4.5 Data Analysis

The tool of measure for the biophysical data was the density, height and diversity of the grass, herbs and woody species and soil cover. All these were measured against giraffe utilisation or concentration using the magnitude of the respective frequencies except for the density of woody species. The variables of the socio economic effects of Rothschild giraffe and challenges facing GCS were also measured using frequencies. These included annual income, types and quantity of supported community projects, types of funded school projects and types giraffe incidences.

The absolute density of an individual species is the expected number of trees of that species per square meter (or hectare). The absolute density of woody species was calculated using the formula below;

$$\text{Absolute density} = \frac{10{,}000\text{m}^2\ \text{ha}^{-1}}{(X\ \text{m})^2\ \text{tree}^{-}}$$

$$\text{Where, } x = \frac{\text{sum of nearest neighbour distances}}{\text{Number of quarters}}$$

The frequencies of all variables were calculated using SPSS version 21. There were two database sheets, one for the biophysical data and another for all the secondary data sources that informed about the socio economic effects and challenges in GCS. The data from individual transects was combined to derive frequencies that reflected on the whole area.

The null hypothesis stating that there is no significant relationship between the status of the biophysical environment and giraffe concentration in GCS was tested using Pearson's Chi square static formula as shown below;

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Where; X^2 refers to Pearson's Chi Square

O_i is the nth number of observed value

E_i is the nth number of the expected value

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 INTRODUCTION

This section presents the key findings and discussion of the study. The section is divided into three sub-sections. These are findings, hypothesis testing and discussion. Both the findings and discussion sections report about the Rothschild giraffe habitat utilisation, effects on grasses, herbs and woody species and their browse preference. These sections also describe the density of woody species in their habitat, the socio economic influence of the Rothschild giraffe and challenges facing the sanctuary management. It also considers the effect of giraffes on the soil environment. The section on hypothesis testing explains the results of the statistical test.

5.2 RESULTS

5.2.1 Habitat use

In table 5.1, the average highest type of giraffe utilisation in the sanctuary was browsing with an average percentage frequency of 51.4%. This was followed by the combination of walking and browsing at 26.8%. The least type of utilisation was walking at 21.7%. The study established that transect 1 was highly utilised for walking and browsing at 55.1% followed by walking at 30.6% and finally browsing at 14.3%. Both transect 2 and 3 were highly utilised for browsing at 66.7% and 81.3 % respectively. In transect 2, walking was 17.5% and walking and browsing was 15.8%. In transect 3; the second highest type of utilisation was walking (15.6 %) followed by walking and browsing (3.1%).

Table 5.1: Types of giraffe utilization

Signs of giraffe utilization	Transect							
	Transect 1		Transect 2		Transect 3		Average (Overall)	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
hoofmarks	15	30.6	10	17.5	5	15.6	30	21.7
browsing	7	14.3	38	66.7	26	81.3	71	51.4
hoof & browsing	27	55.1	9	15.8	1	3.1	37	26.8
Total	49	100	57	100	32	100	138	100

Source: Researcher (2015)

5.2.2 The effects of Rothschild giraffe on the biophysical environment

5.2.2.1 The effect of Rothschild giraffe on distance and height of woody species

In the woody distance level of >141cm, walking had the highest frequency of 54.5% followed by combination of walking and browsing at 54.1% and the least utilisation was of browsing at 47.9%. In the level of 71-141 cm, the highest utilisation was the combination of walking and browsing at 37.8%, followed by walking at 36.4% and then browsing at 33.8%. The woody distance of 0-70 cm had the least activity. There was 18.3% of giraffe browsing, 9.1% of walking and 8.1% of walking and browsing. Figure 5.1 shows the percentage frequency of woody species against giraffe utilisation.

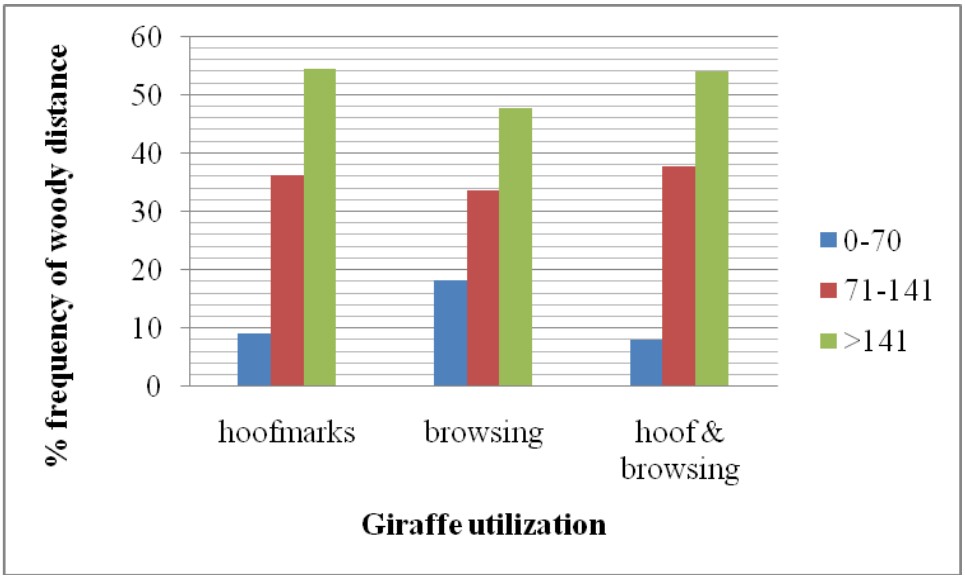


Figure 5.1: The percentage distance of woody species against giraffe utilization
Source: Researcher (2015)

The percentage frequency of giraffe walking was 13.6% for 0-1 woody species diversity scale, 68.2% for 2-3 and 18.2% for >3. Browsing was 4.2% in woody species diversity scale of 0-1, 45.1% in 2-3 and 50.7% in >3. Finally walking and browsing was 18.9% for 0-1, 48.6% for 2-3 and 32.4% for >3. Table 5.2 shows the number of woody species and signs of giraffe utilisation.

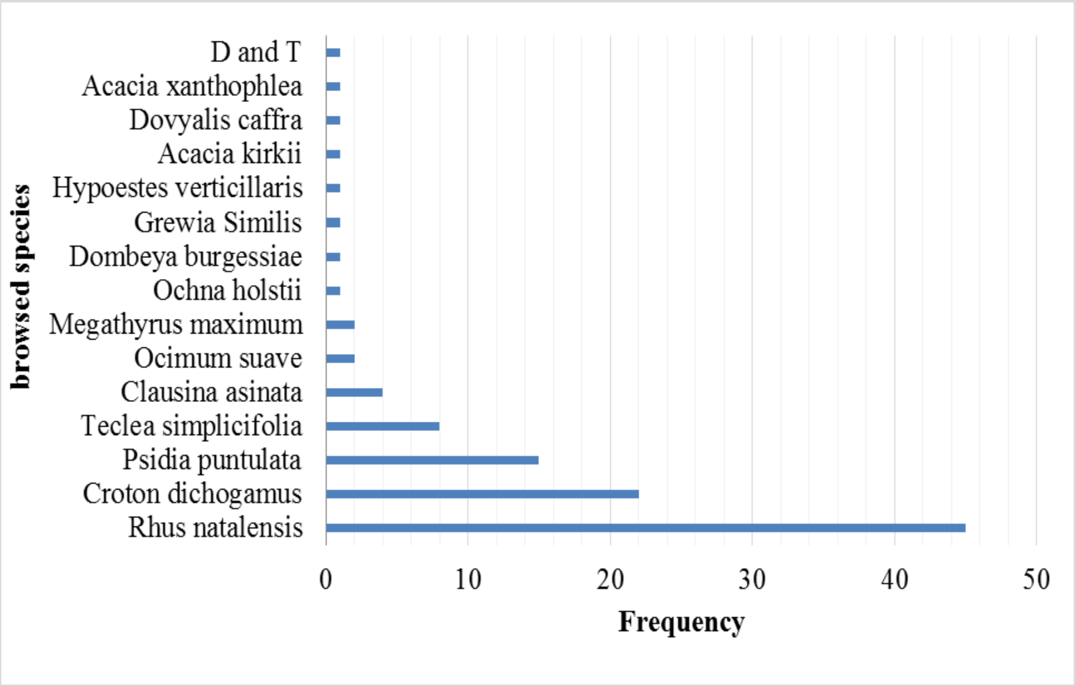
Table 5.2: The number of woody species and signs of giraffe utilization

Total number of woody species in PCQ quarter	Signs of giraffe utilization					
	Walking		Browsing		Walking & browsing	
	Count	%	Count	%	Count	%
0-1	3	13.6	3	4.2	7	18.9
2-3	15	68.2	32	45.1	18	48.6
>3	4	18.2	36	50.7	12	32.4
Total	22	100.0	71	100.0	37	100.0

Source: Researcher (2015)

5.2.2.2 Browse preference

The study established that fourteen types of woody species were browsed by the giraffe. The highly preferred was *Rhus natalensis* (n= 45), followed by *Croton dichogamus* (n=22) and *Psidia puntulata* (n=15). The only browsed grass species *Megathyrus maximum* (n=1). Quite a number of other species including *Ochna holstii, Dombeya burgessiae, Grewia similis, Acacia Kirkii* among others had equal preference by the giraffes of (n=1). Figure 5.2 shows the types of browsed species at GCS and plate 5.1 shows a Rothschild giraffe browsing on *Acacia xanthophlea* at GCS.



Key: D and T= *Dombeya burgessiae and Teclea Simplicifolia*

Figure 5.2: Types of browsed species at GCS

Source: Researcher (2015)

Plate 5.1: Rothschild giraffe browsing on *Acacia xanthophlea* in the Giraffe Center Sanctuary

Source: Researcher (2015)

5.2.2.3 The density of woody species at Giraffe Center Sanctuary

Table 5.3 shows the frequency per quarter, proportion and densities of different woody species in the GCS. *Rhus natalensis* had the highest density of 583 trees/ ha followed by *Psidia puntulata* (525 trees/ha), *Croton dichogamus* (330 trees/ha) and *Clausina asinata* (311trees/ha). The study also identified one invasive species which was *Lantana camara* which had a density of 58 trees/ ha. Quite a number of species were all found to have a low density of 19 trees/ ha. These were *Opuntia spp*, *Crotalaria agatiflora*, *Dovyalis caffra*, *Euphorbia candelabrum*, *Lantana trifolia*, *Nerium Oleander* and *Vangueria madagacanensis*.

Table 5.3: The density of woody species in Giraffe Center Sanctuary

	Woody Species	Frequency/Quarter	Proportion	Density (Trees/ha)
1	*Opuntia spp*	1	0.006	19
2	*Crotalaria agatiflora*	1	0.006	19
3	*Dovyalis caffra*	1	0.006	19
4	*Euphorbia candelabrum*	1	0.006	19
5	*Lantana trifolia*	1	0.006	19
6	*Nerium Oleander*	1	0.006	19
7	*Vangueria madagacanensis*	1	0.006	19
8	*Acacia kirkii*	2	0.011	39
9	*Aloe rabiensis*	2	0.011	39
10	*Combretum molle*	2	0.011	39
11	*Elaeodendion buchananii*	2	0.011	39
12	*Euphorbia tirucali*	2	0.011	39
13	*Strychnos heningsii*	2	0.011	39
14	*Teclea tricorcapa*	2	0.011	39
15	*Acacia xanthophlea*	3	0.017	58
16	*Croton megalocarpus*	3	0.017	58
17	*Dombeya goetzei*	3	0.017	58
18	*Guinea fowl scratcher*	3	0.017	58
19	*Lantana camara*	3	0.017	58
20	*Grewia Similis*	4	0.022	78
21	*Dombeya burgessiae*	5	0.028	97
22	*Ocimum suave*	5	0.028	97
23	*Hypoestes verticillaris*	7	0.039	136
24	*Teclea simplicifolia*	8	0.045	156
25	*Ochna holstii*	10	0.056	194
26	*Brachylaena huillensis*	13	0.073	253
27	*Clausina asinata*	16	0.09	311
28	*Croton dichogamus*	17	0.096	330
28	*Psidia puntulata*	27	0.152	525
30	*Rhus natalensis*	30	0.169	583
	Total	178	1	3,460

Source: Researcher (2015)

5.2.2.4 The effect of Rothschild giraffe to the canopy

The presence of giraffe dung was highest (58%) in the GCS areas where the woody canopy was characterized by 2-3 layers, 31% for areas with 0-1 layers and lastly 11% for areas with >3 layers. Figure 5.3 shows giraffe presence in the different levels of canopy.

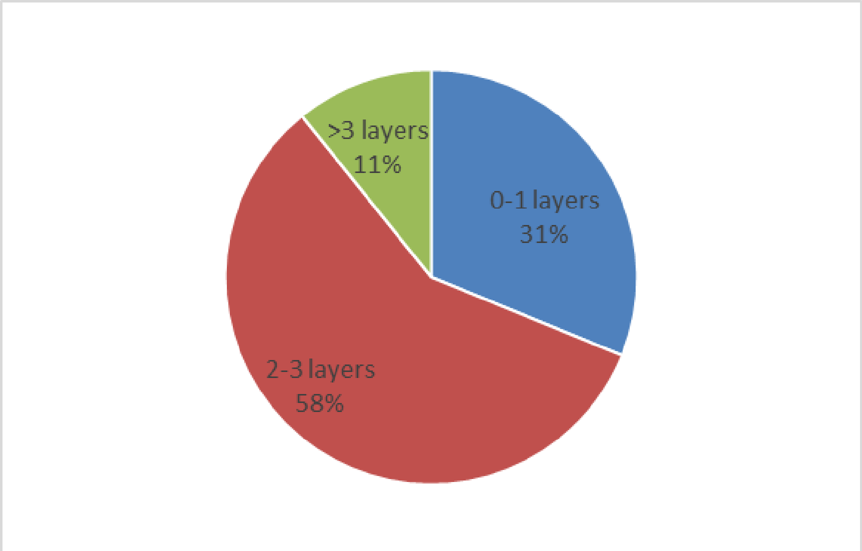


Figure 5.3: Giraffe presence and woody canopy layers

Source: Researcher (2015)

5.2.2.5 The effect of Rothschild giraffe on height and diversity of herb species

The study recorded 15 herb species in the GCS for which the highest frequent herbaceous plants were *Justicia spp (*35%) and *Solonum incanum (*18.5%). *Commelina benghalensis* and *Oldeniandia scolulorum* had a frequency of 9.0% and 9.5% respectively. The least frequent herb species were *Draceana afromontana* (1.0%) and *Conyza Stricta* (1.0%). Table 5.4 shows the percentage frequency for the herb species.

Table 5.4: The percentage frequencies of the measured herb species

Nearest herb species to the PCQ point	Frequency	%
Justicia spp	70	35.0
Commelina benghalensis	18	9.0
Draceana afromontana	2	1.0
Justicia flava	11	5.5
Vernonia spp	4	2.0
Gloriosa superb	4	2.0
Senecio syringifolia	5	2.5
Oldeniandia scolulorum	19	9.5
Momordica foetida	5	2.5
Pellaea longipilosa	5	2.5
Plectranthus spp	9	4.5
Conyza stricta	2	1.0
Hibiscus fuscus	4	2.0
Asparagus spp	5	2.5
Solonum incanum	37	18.5
Total	200	100.0

Source: Researcher (2015)

The study established that giraffe walking was maximum (100%) in the GCS areas with a herb height of 0-40 cm and therefore 0% in areas with 41-81cm and >81cm herb cover. Giraffe browsing was 97.1% in the 0-40 cm, 2.9% in the 41-81cm and 0% for areas with herbaceous cover of >81cm. Finally the combination of walking and browsing had 94.3% in 0-40 cm, 5.7% in 41-81 cm and 0% in >81cm. Figure 5.4 shows the percentage frequency of herb height against giraffe utilisation.

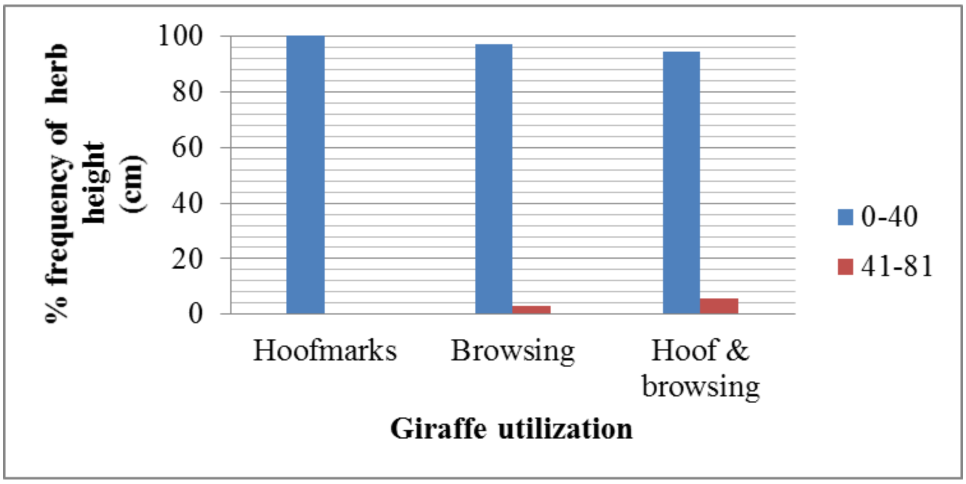


Figure 5.4: The percentage frequency of herb height against giraffe utilization

Source: Researcher (2015)

In terms of herbaceous species diversity, giraffe walking had 96.3% for areas with 0-3 herb species, 3.7% for >7 and 0% for the 4-7 herb species diversity scale. Browsing was common in all the diversity scales and also decreased with increasing number of herb species. It was 84.3% for 0-3, 14.3% for 4-7 and 1.4% for >7. Walking and browsing was high in 0-3 herb diversity scale (97.1%) followed by 4-7 (2.9%) and 0% for >7. Figure 5.5 shows the number of herb species against signs of giraffe utilisation.

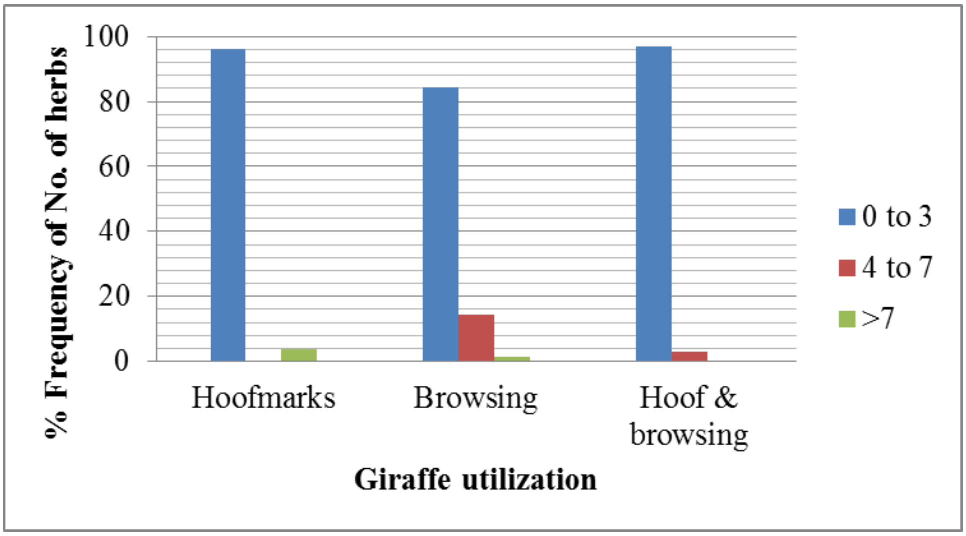


Figure 5.5: The number of herb species against signs of giraffe utilization

Source: Researcher (2015)

5.2.2.6 The effect of Rothschild giraffe on height and diversity of grass cover

The study recorded a total of 6 grass species with *Megathyrus maximum* (42.3%) as the most frequent followed by *Themeda triandra* at (27.5%), *Cyperus rotundas* (15.3%), *Sporobolus pyramidalis* (6.9%), *Setaria plicatilis* (5.3%) and *Echinochloa Haploclada* (2.6%) in that order. Table 5.6 shows the percentage frequency of the measured grass species. Table 5.6 shows the percentage frequency of measured grass species.

Table 5.5: The percentage frequency of measured grass species

Nearest grass species to the PCQ point	Frequency	%
Megathyrus maximum	80	42.3
Themeda triandra	52	27.5
Echinochloa Haploclada	5	2.6
Cyperus rotundus	29	15.3
Setaria plicatilis	10	5.3
Sporobolus pyramidalis	13	6.9
Total	189	100.0

Source: Researcher (2015)

Giraffe walking was most common (76%) in areas where the grass cover was 0-40 cm, 20% in areas with 41-81 cm and 4% in areas where the cover was >81 cm. Giraffe browsing had 69.7% for 0-40cm height cover, 28.8% for 41-81cm and 1.5% for areas with a grass cover of >81 cm. Finally, walking and browsing was 58.3% for 0-40cm height cover, 33.3% for 41-81 cm and 8.3% for areas with a grass cover of >81 cm. Figure 5.6 shows the maximum height of grass against signs of giraffe utilisation.

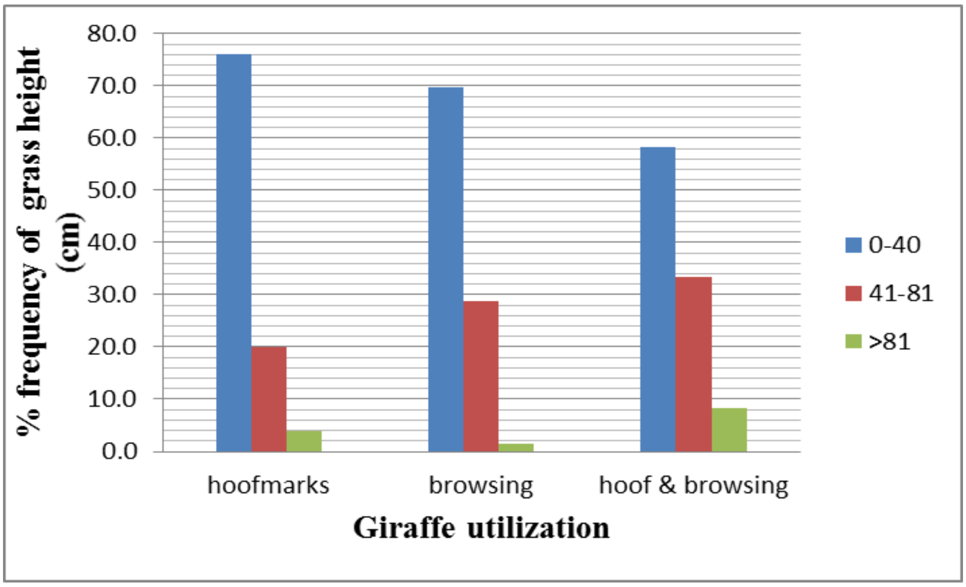


Figure 5.6: The maximum height of grass against signs of giraffe utilization

Source: Researcher (2015)

In terms of grass diversity, there was 88% of walking in the 0-1 grass diversity range and 12% in areas with 2-3 species. Browsing had 78.8% in areas with 0-1 species and 21.2% in areas with 2-3 species. The combination of walking and browsing had 72.2% frequency in areas with 0-1 species and 27.8% in areas with 2-3 species. All the three aspects of giraffe utilisation had 0 frequency in the scale of >3 species. Table 5.5 shows the number of grass species and signs of giraffe utilisations.

Table 5.6: The number of grass species and signs of giraffe utilization

No. of grass species	Signs of giraffe utilization							
	hoofmarks		browsing		hoof & browsing		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
0-1	22	88.0	52	78.8	26	72.2	100	78.7
2-3	3	12.0	14	21.2	10	27.8	27	21.3
Total	25	100.0	66	100.0	36	100.0	127	100.0

Source: Researcher (2015)

5.2.2.7 The effect of Rothschild giraffe on soil cover

Figure 5.6 shows the distribution of the giraffe in relation to the soil condition in the GCS. The presence of giraffe dung was (76%) for areas with no evidence of soil erosion', 15% for areas which were characterized by bare ground but no evidence of soil erosion and 9% for areas characterized by bare ground with evidence of soil erosion.

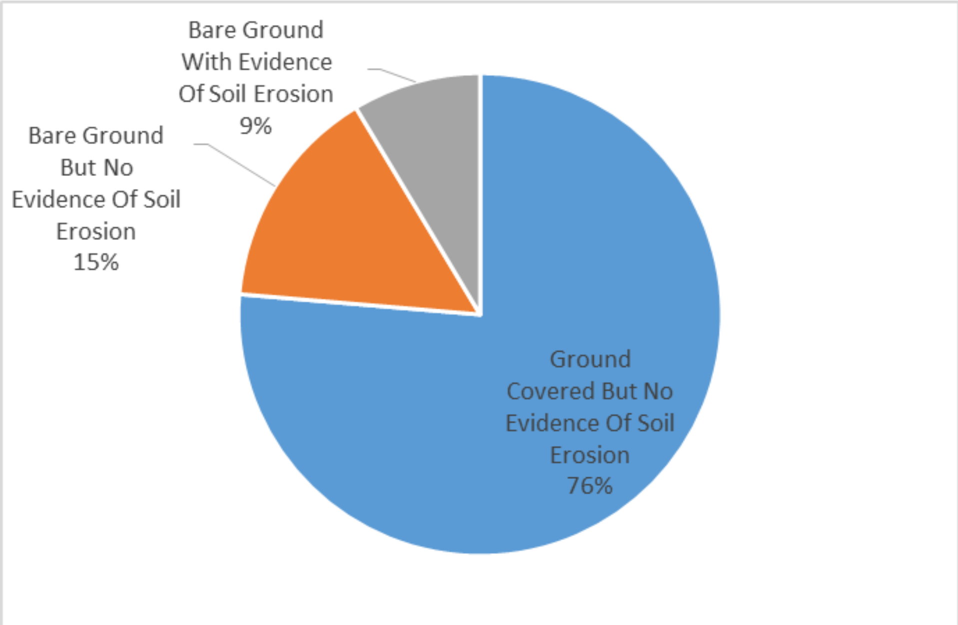


Figure 5.7: Giraffe presence and soil status

Source: Researcher (2015)

5.2.3 The socio economic benefits of Rothschild giraffe

5.2.3.1 Income generation

The study found out that the Rothschild Giraffe is the main source of income generation in the GCS through tourism. The organisation allows visitors of all nations to come and interact with the giraffe after payment of entry fee. In 2009, the income was Kshs 43.522 million which increased spontaneously up to Kshs 58.945 million in 2011. The income received dropped in 2012 to Kshs 56.948 million and later increased to Kshs 67.353 million in 2013. Figure 5.8 shows the annual revenue for the period 2009-2013 at the GCS and Plate 5.2 shows ecotourism activity at GCS.

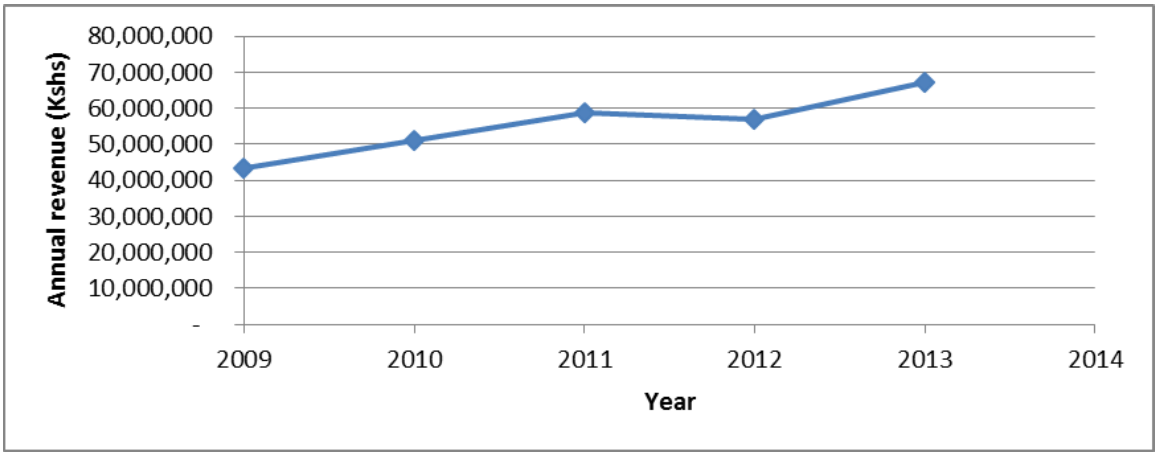


Figure 5.8: Annual revenue at the Giraffe Center Sanctuary (2009-2013)

Source: Researcher (2015)

Plate 5.2: Ecotourism at Giraffe Center Sanctuary

Source: Researcher (2015)

5.2.3.2 Support of community conservation initiatives

The study found out that the GCS offered financial support to various organisations who implemented the identified community based conservation initiative around the country. Figure 5.9 shows that most of the income generated in was used in funding of wildlife conservation projects (33.3%), environment education (22.2%) and project operation costs (19.0%) in that order of magnitude. The GCS also dedicated funds towards marine conservation (9.5%) and forest management (4.8%). Finally and to a least extent, income generated by giraffes was used to support water conservation (3.2%), energy conservation (1.6%), waste management (1.6%) and environment research (1.6%). Figure 5.9 shows the supported conservation initiatives at GCS and Plate 5.3 shows support for community conservation by the GCS in Narok County.

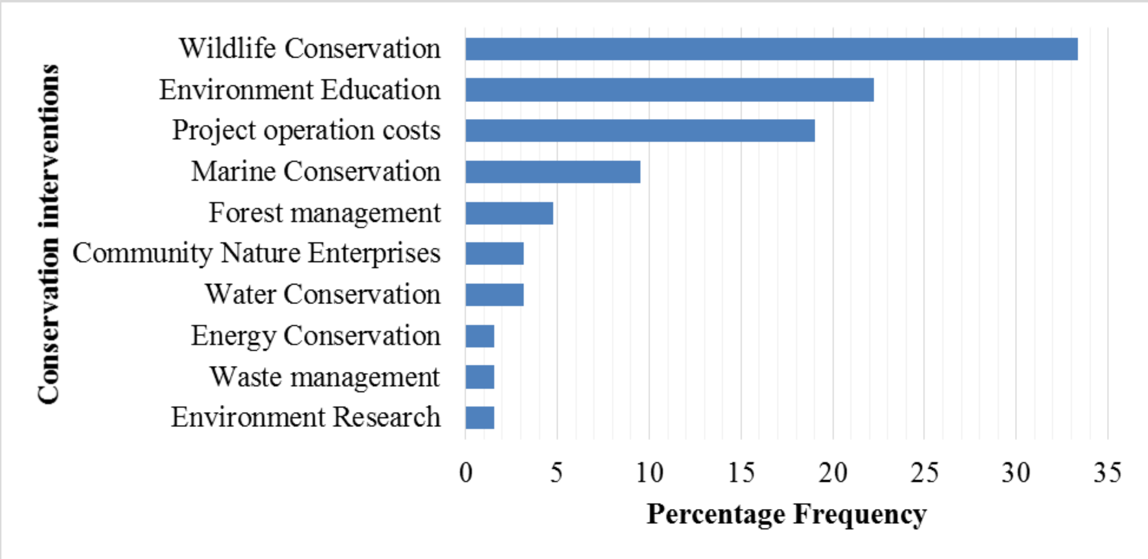


Figure 5.9: The supported conservation initiatives at Giraffe Center Sanctuary

Source: Researcher (2015)

Plate 5.3: Support for community conservation by the GCS in Narok County

Source: Researcher (2015)

5.2.3.3 Support for school environment projects

The secondary records showed that the GCS was supporting a number of school based environmental projects. The mean number of schools' projects that were supported was; a) school greening and water harvesting (11), b) school greening (6), c) environment awareness (3), d) food security (2), e) energy (1), f) ICT (1), and g) waste management

(1). Figure 5.10 shows the mean number of supported schools environment projects and Plate 5.4 shows the support for school environment projects

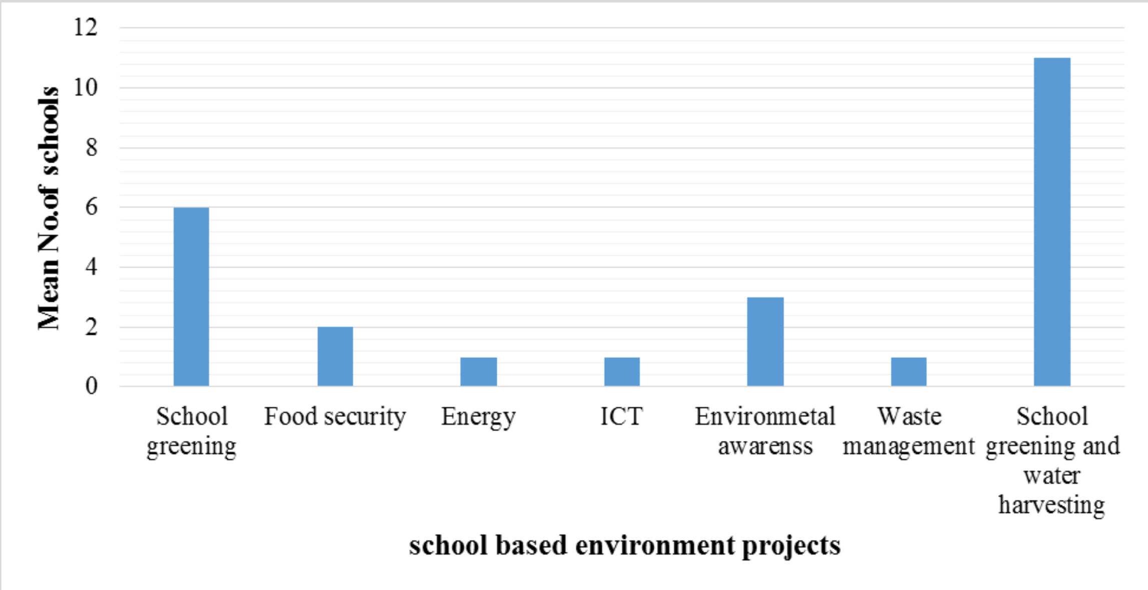


Figure 5.10: Mean number of supported schools environment projects

Source: Researcher (2015)

Plate 5.4: Support for school conservation projects in Kyamuledu Primary, Machakos County

Source: Researcher (2015)

5.2.4 The challenges faced at Giraffe Center Sanctuary

The findings showed that the conservation of the Rothschild giraffe at the GCS had its share of challenges as indicated in Figure 5.11. The biggest challenge was that of invasion by stray predators (17.2%). Other challenges were giraffe sickness (13.8%), giraffe deaths (13.8%), and prolonged drought (13.8%). There were also challenges of invasive species

(10.3%) and maintenance of sanctuary fence line and ground (10.3%). Finally there were challenges of giraffe injuries (6.9%), tourist injuries (3.4%) and tress passers (3.4%). Figure 5.11 shows the challenges faced at GCS.

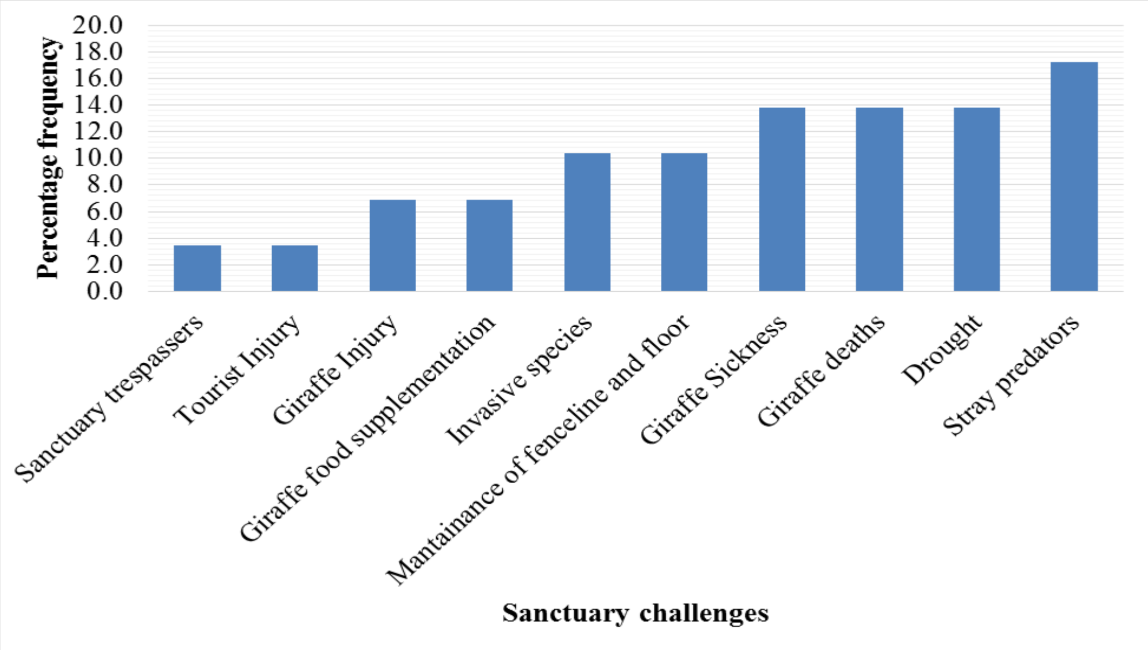


Figure 5.11: The challenges at Giraffe Center Sanctuary

Source: Researcher (2015)

5.3 HYPOTHESIS TESTING

The Pearson's Chi-square test was used to determine if the observed giraffe concentration in the GCS was significantly different from the expected in relation to the status of the biophysical environment and giraffe concentration in the Giraffe Center Sanctuary. Eight variables of the biological environment were tested against the presence of giraffe as shown in Table 5.7. Table 5.7 shows that majority of the variables were statistically significant (p-value <0.05) and they included; the presence of woody cover (0.000), the soil cover (0.001), the number of grass species (0.004), the number of canopy layers (0.029) and the distance of woody species from point (0.049) in order of strength. The H_0 was rejected and H_1 that is there is a significant relationship between the status of the biological environment and the giraffe concentration in the GCS was adopted.

Table 5.7: Pearson's Chi-Square tests

Biophysical environment status	**linear by linear association**	**Pearson Chi-Square**	**Degrees of freedom**	**p-value**
Presence of woody cover	13.133	13.197	1	0.000
Soil cover status in quarter	10.32	14.124	2	0.001
No. of grass species	8.116	8.159	2	0.004
No of canopy layers in quarter	4.852	7.092	2	0.029
Distance of woody species from point	5.674	5.778	2	0.049
Max. grass height (cm)	3.528	2.497	3	0.086
Max. herb height (cm)	1.54	1.508	2	0.287
No. of herb species	0.454	0.544	3	0.888

Source: Researcher (2015)

5.4 DISCUSSION

5.4.1 Habitat use

The average highest form of giraffe utilisation in this habitat was browsing (51.4%) followed by walking and browsing (26.8%) and walking (21.7%). The results are similar to Shorrocks and Croft (2009) who found that reticulated giraffes in Laikipia district of Kenya, spent more time foraging than they did on vigilance ($t56 = 5.94$, $P< 0.001$) or travelling ($t56 = 3.44$, $P <0.05$). The finding at GCS is also similar to a giraffe research conducted by Blomqvist and Reberg (2007) at Mokolodi Nature Reserve in Botswana who concluded that the giraffe in that park spent most of their time browsing (36 %), followed by walking (20 %) and standing-ruminating (16 %). They further mention that females spent more time actively eating and watching them, whereas males spent more time standing-ruminating. At the time of this study, the GCS had 7 female giraffes and 3 male which translated to high frequency of browsing.

The three transects were not utilized equally. Transect 1 was highly utilised for walking and browsing (55.1%) followed by walking (30.6%) and browsing (14.3%). Transect 2 had browsing (66.7%), walking and browsing (15.8%) and walking (17.5%) while transect 3 had browsing (81.3%), walking and browsing (3.1%) and walking (15.6%). This is comparable to Owino *et al* (2011) who conducted a research on patterns of variation of herbivore assemblages at Nairobi National Park. They acknowledged that patterns of variation of giraffes were partly attributed to their ecology whereby their distribution is correlated to browse quality and availability. In the same view, Pellew (1984b) explained that while chance and inherent aggregation may lead to uneven occupancy by giraffe, special habitat requirements are likely to be the major cause of this. The micro spatial dispersal of animals is influenced by the availability of food. Shorrocks and Croft (2009) also confirmed that the proportion of time spent travelling was significantly greater in open habitats than in areas of dense vegetation ($F2\ 47 = 3.49$, $P < 0.05$).

In this study area, transect 1 was mainly occupied by grass species but near to a water point which translated to less browsing. Transect 2 continuously passed through a relatively dense forest which provided a high opportunity for browsing hence less giraffe walking activity. Transect 3 sloped upwards through a thick forest to settle on a rocky bed with scanty vegetation characterised by shrubs. This also provided an opportunity for high browsing.

5.4.2 Effect on woody species

A high presence of giraffe activities in woody distance of >141cm in the GCS is understandable because according to Pellew (1984b), they are browsers and one key factor that would influence their utilisation is the availability and or distribution of food. This implies that giraffe activity had reduced the distribution of woody species in the study area. It is also explained by the high proportionate of *Solonum incanum* (18.5%) comparable to other herb species. The species was second after *Justicia spp* (35.0%). Estes *et al* (2006) studied the downward trends of ungulate populations in Ngorongoro crater during 1986- 2005. They explain that the spread of *Solonum incanum* in that habitat was due to over utilization of primary biomass by browsers and the ripple effect was reduction in browse availability.

In this sanctuary, the effect of giraffe walking and combination of walking and browsing on woody species diversity is unpredictable. This is because there is no linear increase or decrease of frequencies with the increase of diversity scale. However browsing depicts a linear increase with increasing diversity even though the difference between woody diversity scale of 2-3 and >3 is small (6%). This was influenced by availability of food options as explained by Pellew (1984b).

A total of 30 woody species were recorded in the study and their densities calculated. The absolute frequency and absolute density of individual species was corresponding which implies that the distribution of all the identified species was even. Mitchell (2007) explained that a high relative frequency indicates that the species occur near relatively many different sampling points, in other words, the species are well-distributed along transects. A high relative density indicates that the species appears in a relatively large number of quarters. If both are high, the distribution is relatively even and relatively common along transects.

Surprisingly, the three highly browsed species (*Rhus natalensis, Croton megalocarpus and Psidia puntulata*) had the highest densities. It is worth noting that there is an increase in percentage frequency of browsing with increasing diversity scale of woody species. The results are similar to Dharani *et al* (2007) who studied the browsing impact of large herbivores on *Acacia xanthophloea* in Lake Nakuru National Park, Kenya. The finding of this study showed that although heavy browsing reduced the height and canopy of trees, it did not kill any trees and seedling regeneration took place simultaneously. They further explain that the presence of large herbivores impacted some considerable browsing pressure but *Acacia xanthophloea* habitat would continue to remain in balance in the presence of recruitment of seedlings and saplings.

The analysis of giraffe concentration in three levels of canopy layer indicated that the highest giraffe concentration (58%) occurred in the canopy layer scale of 2-3 layers. The field observations recorded mainly 3-4 layers which are the ground cover, understory, main canopy and over story in limited areas. A typical forest has five to six canopy layers which include; the ground cover (herbs and ferns), shrub layer- 10m, lianas, understory- 20m, main canopy- 30m and over story- more than 30m (Blomqvist & Reberg 2007). While the giraffes in this sanctuary could have contributed in reduction of the shrub layer, the over story could have been affected by natural tree felling. During the study, there were log of old trees fallen on the ground.

The findings at Giraffe Center Sanctuary are similar to Blomqvist and Reberg (2007) whereby giraffes in Mokolodi Nature Reserve in Botswana browsed at 3-4m for males and 2-3m for females. Birkett (2002) also demonstrated that giraffe in Kenya would have the greatest impact on the 3–5 m size class of trees. The results are not comparable to the findings of Leuthold and Leuthold (1972) in Tsavo who explains that giraffes browse at

2m and below. The vegetation height in Tsavo National Park is not similar to the one at Giraffe Center Sanctuary due to difference in climatic conditions.

5.4.3 Browsing preference

The giraffes at the GCS browsed on 14 woody species (figure 5.2) out of the 30 species identified in table 5.3 and one grass species (*Megathyrus maximum*). The three highly preferred species were *Rhus natalensis, Croton Megalocarpus and Psidia puntulata.* The three least preferred species are *Dombeya burgessiae, Acacia xanthophlea and Dovyalis caffra.* Herbivores rarely eat all the food available to them. They feed selectively preferring certain high quality foods and avoiding others (Pellew 1984b). The selection of browsed species in this study is similar to Anyango and Were (2012) who studied the dietary preference of Rothschild giraffe introduced in Ruma National Park Kenya and found out that some of the preferred browse by giraffes in that park were *Rhus natalensis, Ocimum suave*, *Harrisonia abyssinica*, *Acacia Seyal*, *Grewia bicolor*, *Acacia abyssinica*. They explained that the higher the abundance of a species in a given vegetation community, the higher were the chances that it was eaten more frequently than others.

There are factors that influence the giraffes' preference for certain woody plant species. They include presence of aromatic substances, the abundance and size of leaves, the shape of the thorns, the physical accessibility of a tree and its growth form (Kingdon, 1979). In this case, the abundance of *Rhus natalensis*, *Croton Megalocarpus and Psidia puntulata* led to the species become highly preferred browse by the giraffe. In the GCS, giraffes browsed on *Megathyrus maximum* though at a small proportion. The proportion of grass in giraffe diet is usually low.

Most previous studies, for example, Blomqvist and Reberg (2007) and Pellew (1984b) depict that giraffes highly preferred to browse on acacia trees. The densities of the tree in their study sites were also high at levels incomparable with this case.

5.4.4 Effects on herbs and grasses

The sanctuary had 15 different types of plants with varied dominance. *Justicia spp* and *Solonum incanum* were the most dominant. 13 types of herb species had less than 10% frequency distribution. There was a decreasing giraffe activity with the increase of herb height and herb diversity respectively. The results imply that giraffe utilisation reduced the height and diversity of herbs.

The findings in this study indicated that no herb species was browsed by the giraffe. This is incomparable to Anyango *et al* (2012) discovered that the Rothschild giraffes at Ruma National Park browsed on *Solanum incanum* even though it was number 12 in their list of browse preference.

The study identified 6 species of grass. The most dominant was *Megathyrus maximum* and the least is *Sporobolus pyramidalis.* The findings depicted a similar trend as observed in the herb analysis. There was increased grass height and grass diversity with reduced giraffe utilization.

The trends in herbs and grass analysis are comparable to Pringle *et al* (2010) who studied the ecological importance of large herbivores in the Ewaso Ecosystem in Kenya and concluded that live above ground grass and herb biomass was greater in ungulate exclusion than control plots. By the sixth year of the experiment, grass density was 28% greater in cattle exclusion plots than in plots with cattle. This study however suggests the fact that responses to grass and herb community to giraffe utilization could be dependent on other environment factors for example topography, soils and other small mammals present in the sanctuary.

5.4.5 Effects on soils

An assumption would have been that giraffe presence would be a causal factor of soil erosion in this sanctuary. This is because giraffes are mega herbivores and can be able to open up landscapes thereby exposing soils to agents of erosion (Pellew 1984b). The findings depicted that giraffe presence has no negative effect on soils in this sanctuary because areas of soil erosions had minimal presence of giraffe (9%).

5.4.6 Socio-Economic benefits

The presence of giraffes led to income generation which indicated that the giraffe presence had a positive effect on the economic environment of this sanctuary. The funds were used to support community and school based conservation initiatives. This further indicates a positive effect of giraffes in this sanctuary to the biological and socio economic environment. Under support for community based conservation initiatives, the sanctuary management had supported various conservation work through several organisations including Africa Nazarene University, Mt. Kenya Trust, Nairobi National Park, Aberdare National Park, Wildlife Clubs of Kenya, CORDIO East Africa, Nairobi

Greenline, Watamu Turtle Watch, Karura Forest Environment Trust, Dolphin and Whale Conservation, Wildlife Direct, Giraffe Conservation Foundation, Kuruwitu Conservation and Welfare Association amongst others. This had resulted to conservation of Kenya's wildlife more so endangered species for example elephants, giraffes, black rhino, turtles, whales, wild dog and African honey bee. There was also a social benefit whereby communities were able to live in harmony with wildlife. For example, in the category of wildlife conservation, the support to fence Aberdare forest helped to scale down human-wildlife conflict and led to increased food security and reduced cattle rustling (Thenya *et al* 2011).

The support for community nature enterprises for example in Kuruwitu led to a positive social and economic benefit whereby local people embraced alternative sources of income away from natural marine resources.

The second largest funding was directed to environment education projects. Increased knowledge of conservation contributed a huge social benefit to the environment. The communities involved felt a sense of responsibility to promote conservation of biodiversity. For example in Watamu under the Watamu Turtle Watch, the local communities changed behaviour from killing the turtles to rescuing them. Finally, the school based conservation initiatives had also a socio economic benefit through increase of conservation knowledge amongst the youth and income generation. Most schools were able to either save or generate income hence an economic benefit.

5.4.7 Challenges faced at Giraffe Centre Sanctuary

The stray predators not only posed danger to the Rothschild population but also to customers at the sanctuary. Giraffe deaths and sickness frustrated the efforts of breeding the giraffes. Even though giraffes displayed the same symptoms, the management was unable to prevent subsequent deaths due to lack of adequate information on giraffe illnesses. The management also blamed the deaths on dependence on KWS vet services who delayed to correspond when on call. The changing weather which occurred during the study period caused drought. This affected the availability of giraffe browse during the dry spell leading to giraffe food supplementation. The management had to incur costs to provide lucern grass as a supplement to giraffe browse.

The maintenance of sanctuary fence line and ground was important for giraffe welfare. The least challenges experience at the sanctuary were tourist injuries and tress passers. Tress passers posed danger to the giraffe welfare through destruction of their browse. The management of these challenges also caused a financial strain to the sanctuary budget.

CHAPTER SIX
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter is divided into three sub sections**.** The first sub-section provides the summary of results. The second sub-section provides the conclusion from the findings while the last sub section outlines the recommendations for management, stakeholders and areas for further research.

6.2 Summary of findings

1) **The effects of Rothschild giraffe utilisation to the density, height and diversity of grass, herb, woody species and soil cover in the GCS**

The study assessed the effects of Rothschild giraffe utilisation to vegetation and soil cover in GCS. The vegetation parameters were woody species, herb species, grass species, and canopy layers. The types of habitat utilization were browsing, walking and both walking and browsing.

Averagely, giraffes used the sanctuary for browsing (51.4%), walking and browsing (26.8%) and walking (21.7%). They did not use all transects equally. Transect 1 was highly utilised for walking and browsing (55.1%) followed by walking (30.6%) and finally browsing (14.3%). Transect 2 and 3 were highly utilised for browsing at 66.7% and 81.3 % respectively. In transect 2, walking was 17.5% and walking and browsing was 15.8%. In transect 3, walking was 15.6 % and walking and browsing (3.1%).

The scales woody distance used were 0-70 cm, 71-141 cm and >141cm. There was greatest giraffe activity in the woody distances of >141cm. In this scale, walking was 54.5%, walking and browsing 54.1% and browsing 47.9%.

Giraffe browsing increased with the increase of number of woody species. There was no linear increase or decrease of giraffe walking and both walking and browsing with the increase of woody species diversity scale. The quantity of browsing increased with the increase of woody species diversity scale. It was 4.2% in 0-1, 45.1% in 2-3 and 50.7% in >3.

The results of this study identified 30 woody species and giraffes browsed on 15 species. The density of all the woody species varied and the three highly preferred species had the highest density as follows; *Rhus natalensis* (583 trees/ ha), *Psidia puntulata* (525 trees/ha) and *Croton dichogamus* (330 trees/ ha). There was one invasive woody species that is *Lantana camara* which had a density of 58 trees/ ha

The study identified 15 different types of herbaceous plants. *Justicia spp* (35.0%) and *Solonum incanum* (18.5%) were the most dominant. All the remaining 13 herb species had less than 10% frequency. There was a decreased giraffe activity with the increase of herb height and herb diversity.

The study identified 6 grass species which had *Megathyrus maximum* (42.3%) as the most frequent There was also *Themeda triandra* at (27.5%), *Cyperus rotundas* (15.3%), *Sporobolus pyramidalis* (6.9%), *Setaria plicatilis* (5.3%) and *Echinochloa Haploclada* (2.6%). Giraffes browsed on *Megathyrus maximum.* Comparable to herbs, there was decreased giraffe activity with the increase in height and diversity of grass.

The presence of giraffe dung was (76%) for the soil status of ‘ground covered with no evidence of soil erosion’, 15% for ‘bare ground but no evidence of soil erosion’ and 9% for ‘bare ground with evidence of soil erosion’. The presence of giraffe dung was highest (58%) in the canopy layer scale of 2-3 layers, 31% for 0-1 layers and 11% for >3 layers.

2) Socio-economic benefits of Rothschild giraffes

The presence of giraffe yielded economic benefits through generating income. In 2009, the income was Kshs 43.522 million, Kshs 50.917 million in 2010 and Kshs 58.945 million in 2011. The income received dropped in 2012 to Kshs 56.948 million and later increased to Kshs 67.353 million in 2013. Apart of this income was used to fund community and school based environmental projects.

The funded community projects include wildlife conservation projects (33.3%), environment education (22.2%) and project operation costs (19.0%). There was also funding for marine conservation (9.5%), forest management (4.8%), water conservation (3.2%), energy conservation (1.6%), waste management (1.6%) and environment research (1.6%). The mean number of supported school projects was; school greening and water harvesting (11), school greening (6), environment awareness (3), food security (2) and Energy (1), ICT (1), and waste management (1)

3) Challenges facing Giraffe Center Sanctuary

The results revealed several challenges. The most frequent was invasion by stray predators (17.2%). The predators were lions and leopards. Giraffe sickness, giraffe deaths, and drought had equal frequency of 13.8%. The giraffe sicknesses were mainly diet related. Giraffe deaths were caused by sickness or predation. Prolonged drought experienced during some years led to decrease in giraffe browse hence the need for food supplementation. There was also invasive species and maintenance of sanctuary fence line at equal frequency of 10.3%. The invasive species was *Lantana camara*. The maintenance of sanctuary fence line and floor was important to avoid predation and injuries of giraffes.

Giraffe injuries (6.9%) were experienced mainly around water holes or during rainy season when the sanctuary slopes were slippery. Food supplementation was a challenge with frequency of 6.9%. The least challenges experienced at the sanctuary were tourist injuries (3.4%) and tress passers (3.4%). Tourist injuries occurred when giraffes head butted customers while interacting with them. Tress passers were people who entered illegally to extract firewood or hunt on other mammals in the sanctuary.

6.3 Conclusion

1) The effects of Rothschild giraffe utilisation to the density, height and diversity of grass, herb, woody species and soil cover in the GCS

Giraffes mainly utilize this habitat for browsing. They do not browse on all the plant species in the sanctuary. Habitat utilization is influenced by abundance and distribution of food for example areas occupied by *Rhus natalensis, Croton megalocarpus* and *Psidia puntulata* are the most utilized. Giraffe utilization increases the density of browsed species but reduces the relative density of other woody species. All the woody species in the GCS are evenly distributed. Some areas have been over browsed and replaced by *Solonum incanum.* The availability and options for giraffe's palatable browse in this sanctuary is high.

Giraffe utilization has affected the growth and diversity of herb and grass species. The herb and grass diversity might be influenced by other factors for example soils, topography and other mammals present in the sanctuary.

Giraffe presence is able to cause soil erosion to a small extent (9%). Its presence also reduced the appearance of the shrub layer in this sanctuary. The canopy layers that exist in this sanctuary are the ground cover, understory, main canopy and over story. The over story has been reduced by natural tree felling at old age.

2) The socio-economic benefits of Rothschild giraffe

The presence of Rothschild giraffes in the sanctuary has contributed to income generation. This income has been used for furtherance of conservation work though support given to community and schools initiatives. Through this, there has been positive influence on conservation of other endangered wildlife in Kenya. The support has also contributed to positive co existence between communities and wildlife in some areas. The social and economic well being of supported communities has also improved through job creation and income generation from wildlife enterprises. Local people also feel a sense of responsibility for environment conservation through the EE programs supported by this organization. Wildlife areas are therefore able to appraise the social and economic well being of the local people.

3) The challenges facing Giraffe Center sanctuary

The Giraffe Center Sanctuary faces various challenges including stray predation, giraffe illnesses and deaths, drought and invasive species. The management is able to address most of these challenges even though they all had a cost implication and time consumption. The invasive species in the sanctuary are *Lantana camara* and *Solanum incanum.* The sanctuary puts in a lot of efforts to uproot *Lantana camara.*

6.4 Recommendations

Private ranches and sanctuaries have a role to play in conservation largely by maintaining natural areas of habitat and by providing resources to support reintroduction programs for threatened species. The Giraffe Center Sanctuary has benefitted conservation of the endangered Rothschild giraffe through the breeding and repatriation program. Despite the challenges experienced in this sanctuary, the Rothschild giraffe has significant positive effect in all aspects of environment. This implies that wise use and conservation of this species can be able to promote sustainable development. The study therefore recommends the following gaps to be filled.

1) Policy Recommendations

a) The efforts for the conservation of the endangered Rothschild giraffe should continue. The sanctuary management should continue maintaining the giraffe population within the carrying capacity of the habitat.

b) The sanctuary should consider early control of the *Solonum incanum* weed through replanting of palatable browse in the areas occupied by the weed.

c) The sanctuary should employ a resident veterinary doctor(s) for quick response of giraffe welfare issues

d) The sanctuary should be divided into paddocks to control giraffes from over utilisation of some areas.

e) The KWS and other stakeholders in giraffe conservation were able to develop a draft National Giraffe Conservation Strategy (2016-2020). The process should be hastened in order to allow its implementation. The government should support the implementation of the strategy as it offers a road map towards giraffe conservation in Kenya, including the Rothschild giraffe.

f) Strategic objective 5 of the NGCST proposes the approach for community involvement in giraffe conservation. There is need to focus on community awareness about the importance of Rothschild giraffe.

g) The government should enhance the capacity of Giraffe Center Sanctuary to manage the giraffe population through training on disease management, predator control and habitat management.

2) Recommendations for further research

a) There should be further research to determine the impact of Giraffe Center Sanctuary to conservation of other wildlife species.

b) There should be deep research into giraffe diseases and their control.

c) There is need for an evaluation of the carrying capacity of Giraffe Center Sanctuary.

REFERENCES

AFEW (n.d) *Interpretive Guide to the AFEW Nature Trail*. Nairobi

AFEW Giraffe News Issue No. 12. 2010 & 14. 2012, Lavinda Ltd. Nairobi.

Anyango D.C and Were P (2012). *Dietary preferences of the Rothschild Giraffes (Giraffa camelopardalis rothschildii) translocated to Ruma National Park, Kenya.* International Journal of Environmental Science, Management and Engineering Research Vol. 2 (1), pp. 1-23, Jan-Feb., 2013

Batzil, G.O. (1994). Special Feature: *Mammal- plant interactions*. Journal of Mammology 75:813-15

Birkett, A. (2002). *The impact of giraffe, rhino and elephant on the habitat of a black rhino sanctuary in Kenya*. Afr. J. Ecol. 40:276-282.

Blomqvist P and Reberg L (2007) *Feeding Behaviour of Giraffe (Giraffe carmelopardalis) in Mokolodi Nature Reserve, Botswana*, Minor Field Study 128, Committee of Tropical Ecology Uppsala University, Sweden.

Bond, W.J. and Loffell, D. (2001). *Introduction of giraffe changes acacia distribution in a South African savanna*. Afr. J. Ecol. 39:286-294.

Brenneman, R.A, Bagine, R.K., Brown, D.M., Ndetei, R. and Louis Jr, E.E. (2009). *Implications of closed ecosystem conservation management: the decline of Rothschild's giraffe (Giraffa camelopardalis rothschildi) in Lake Nakuru National Park, Kenya*. African Journal of Ecology 47(7): 711-719.

CBS (2001). *Population and Housing Census. Counting Our People for Development* Vol.1. Central Bureau of Statistics, Nairobi.

Chardonnet Ph., Clers des B, Fischer. J, Gerhold R, Jori F,and Lamarque F (2002). *The value of wildlife.* Rev. Sci. Tech. Int. Off. Epiz, 2002, 21(1), 15-51.

Dagg, A.I and Foster, J.B. (1976). *The Giraffe, its Biology, Behaviour and Ecology*. Van Nostrand Reinhold Publishers. U.S.A

Dharani N, Kinyamario J.I, Wagacha P.W and Rodrigues A.J. (2008). *Browsing impact of large herbivores on Acacia xanthophloea benth in Lake Nakuru National Park, Kenya.* Afr. J. Ecol. 47, 184- 191.

East, R. (1998). *African Antelope Data Base*, IUCN/ SSC Antelope Specialist Group Report, December 1998. Pp. 94-100

Estes R.D, Atwood A.J and Estes A.B (2006) *Downward trends in Ngorongoro Crater ungulate populations 1986–2005:* Conservation concerns and the need for ecological research. Available at http://www.rarespecies.org/crater.pdf. Viewed in July 2015

Fennessy, J. 2007. GiD: *development of the Giraffe Database and species status report*. *Giraffa* 1(2): 2-6.

GCF (2010) 'Rothschild Giraffes joins list of Species threatened by Extinction' *Bi-annual Newsletter of the International Giraffe Working Group (IGWG) Est. 2003* Volume 4, Issue 1, Pg 2.

Ginnet T. F and Demment, W. (1997). *Sex differences in Giraffe Foraging behavior at two Spatial Scales*. Oecologia 110: 291-300

GoK (2012), *The National Wildlife Conservation and Management Policy, 2012.* Ministry of Forestry and Wildlife.

Gok (2013). *The Wildlife Conservation and management Act (2013).* Republic of Kenya.

Gowda, J.H. (1996) *Spines of Acacia tortilis: what do they defend and how?* Oikos 77, 279-284

Herlocker, D.J. (1999): *Rangeland resources in Eastern Africa: Their ecology and development.* German Technical Cooperation, Nairobi

Jolly L (2003). *Giraffe Husbandry Manual*. Australia.

Kingdon, J. (1984). *East African mammals, An Atlas of Evolution* in Africa- Large Mammals. University of Chicago press. Pp. 308-337.

Krausman P.R (2007) *Some Basic Principles of Habitat Use* Plenum Press. New York.

Leopold, A. (1933). *Game Management*. Charles Scribner's Sons, New York.

Leuthold, B.M and Leuthold, W. (1972) *Food habits of Giraffe in Tsavo National Park, Kenya*. African Journal of Ecology, 10: 129- 141.

Luken, J.O. 1990. *Directing Ecological Succession*. New York: Chapman and Hall.

Milewski, A. V, Young T.P and Madden D. (1991), *Thorns as Induced Defences*: Experimental evidence. Oecologia 86: 70-75.

Ministry of Forestry and Wildlife, *Draft Wildlife Policy, 8th July 2011*. Republic of Kenya

Mitchell K (2007). *Quantitative analysis by the Point Center Quarter method*. Department of Mathematics and Computer Science Hobart and William Smith Colleges Geneva, NY 14456. Revised 2015.07.15

Muthee. L. W (1992). Ecological impacts of tourist use on habitats on the habitats and pressure point animal species. Wildlife Conservation International, Nairobi Kenya.

Mwaura, F. & H.M. Kaburu (2008): *Spatial variability in woody species richness along altitudinal gradient in a lowland dryland site, Lokapel Turkana, Kenya*. Biodiversity and Conservation 18(1): 19-32

Njagi 2009. *Born to be of Wild- Giraffes on the move.* AFEW Giraffe News, Issue No 11-2009, Pg7

Norton M. G (2000) *Shifts and reversals in conservation policy*: *wildlife losses in Kenya; an analysis of conservation policy*. Spring 2000, Volume 13, Number 1.

Owino. A.O, Kenana M.L, Webala P, Andanje S and Omondi P (2011), Patterns of Variation of Herbivore Assemblages at Nairobi National Park, Kenya 1990- 2008. *Journal of Environmental Protection*, 2011, 2, 855-866.

Oyake. L , Njenga B and Koech M (n.d). *City of Nairobi Environment Outlook*, Nairobi

Parker, D.M. (2004). *The feeding biology and potential impact of introduced giraffe (Giraffa camelopardalis) in the Eastern Cape Province, South Africa.* MSc thesis from Rhodes University.

Pellew, R.A (1984). *Giraffe and Okapi. In Hoofed Mammals*, D. Macdonald, (ed.) Torstar Books Inc. New York. U.S.A.

Pellew, R.A. (1984a). Food Consumption and Energy budgets of the Giraffe. *Journal of Application Ecology* 21: 41- 159.

Pellew, R.A. (1984b). The feeding ecology of a selective browser, the Giraffe (*Giraffa Camelopardalis Tippelskirchi*). *Journal of Zoology*, London. 202 pp 57- 81.

Pringle M. R, Palmer M.T, Goheen J.R McCauley D.J and Keesing F (2011). *Ecological importance of large herbivores in Ewaso Ecosystem*. Department of Ecology and Evolutionary Biology, Princeton, New Jersey 08544, USA.

Ramser T. (2007). Evaluating ecotourism in Laikipia, Kenya: *Assessing the Socio Economic Impacts and Conservation Attitudes*. University of Bern. German.

Republic of Kenya, *The Wildlife Conservation and Management Policy* 2012

Republic of Kenya, *Wildlife Management and Coordination Act* 2013.

Roe D, Williams N. L and Clayton B.D (1997). *Take Only Photographs, Leave Only Footprints*. Wildlife and Development Series, No. 10. International Institute for Environment and Development, London

Rothschild Giraffe Project (2009). *Conservation and Research in Africa*, viewed 14 September 2013, http://www.girafferesearch.com/#/research/4568189659.

Shorrocks B and Croft D (2009). *The behaviour of reticulated giraffe in the Laikipia district of Kenya.* Afr. J. of Ecol, 47, Early View, January 2009.

Sindiga I (1995). *Wildlife Based Tourism in Kenya: Land Use Conflicts and Government Compensation Policies over Protected areas*. The Journal of Tourism Studies Vol. 6, No. 2, Dec.'95

Skinner, J.D & Smithers, R.H. (1990). *The mammals of the Southern Africa Sub region*. University of Pretoria Press, Pretoria. Republic of South Africa. Pp 604-606

Soltau. S. K. (2003) *Conservation-related Resettlement in Central Africa*: Environmental and Social Risks, Development and Change34: 525-551.

Thenya T, Mungai D, Muthee A, Muchemi G, Mworia J. K, Oduor G and Kimani J (2011). *Environmental, Social and Economic Assessment of the fencing of the Aberdare Conservation Area*. Biotope Consultancy Services, Nairobi.

Udoto P (2012). *Wildlife as a lifeline to Kenya's Economy: Making memorable visitor experiences*. George Wright Forum Vol 29. No 1 Pg 51-58.

Umbertoh, 2007. *Saving the Rothschild Giraffe from Extinction.* AFEW Giraffe News, Issue No 9- 2007, pg 2

Weins, J.A. 1984. *Resource systems, populations, and communities*. p. 397-436 In: P.W. Price, C.N. Slobodchikoff and W.S. Gaud (eds.). A New Ecology: Novel Approaches to Interactive Systems. John Wiley and Sons. New York

Wildlife Direct (2007) *Emerging threats in the Giraffe Sanctuary* viewed 14 September 2013, http://giraffesanctuary.wildlifedirect.org/author/admin/page/2/

www.giraffecenter,org/index.php/who we are Visited September 2015 13.50 pm

www.giraffeconservation.org/download_booklet.php?id=1 Visited August 2015, 11.20 am

www.kws.org/NGCST/ visited October 2013, 1.35pm

www.kws.org/parks/ visited October 2013, 1.30pm

APPENDICES

APPENDIX 1: THE DISTANCE OF THE MEASURED WOODY SPECIES IN POINT CENTERED QUARTER METHOD

Sample points	**Quarter No.**	**Species**	**Distance (m)**
1	1	*Silver oak*	1.06
		Silver oak	1.06
	2	*Teclea simplicifolia*	2.81
		Croton dichogamus	1.06
		Croton megalocarpus	2.81
	3	*Dombeya goetzei*	2.81
		Strychnos heningsii	1.06
		Guinea fowl scratcher	2.81
	4	*Silver oak*	2.81
		Dombeya goetzei	1.06
		Dombeya burgessiae	2.81
2	1	*Teclea simplicifolia*	2.81
		Croton dichogamus	2.81
		Dombeya burgessiae	1.06
	2	*Silver oak*	2.81
		Ochna holstii	1.06
		Croton megalocarpus	1.06
	3	*Teclea simplicifolia*	2.81
		Croton megalocarpus	0.35
		Crotalaria agatiflora	2.81
	4	*Dombeya goetzei*	2.81
		Lantana camara	1.06
		Vangueria madagacanensis	2.81
3	1	*Elaeodendion buchananii*	1.06
		Croton dichogamus	1.06
		Clausina asinata	2.81
	2	*Strychnos heningsii*	1.06
		Clausina asinata	2.81
	3	*Ochna holstii*	2.81
		Clausina asinata	2.81
	4	*Teclea simplicifolia*	0.35
		Ochna holstii	1.06
		Clausina asinata	2.81
4	1	*Silver oak*	1.06
		Ocimum suave	2.81
		Psidia puntulata	1.06
	2	*Croton dichogamus*	1.06

		Rhus natalensis	1.06
	3	*Teclea simplicifolia*	1.06
		Croton dichogamus	1.06
		Clausina asinata	1.06
	4	*Croton dichogamus*	0.35
		Ochna holstii	2.81
		Hypoestes verticillaris	1.06
5	1	*Rhus natalensis*	0.35
		Psidia puntulata	0.35
		Acacia kirkii	2.81
	2	*Rhus natalensis*	1.06
		Rhus natalensis	1.06
		Rhus natalensis	1.06
	3	*Croton dichogamus*	1.06
		Rhus natalensis	1.06
		Psidia puntulata	1.06
	4	*Rhus natalensis*	2.81
		Psidia puntulata	0.35
6	1	*Ochna holstii*	2.81
		Psidia puntulata	0.35
	2	*Croton dichogamus*	2.81
		Rhus natalensis	1.06
		Psidia puntulata	2.81
	3	*Croton dichogamus*	1.06
		Ochna holstii	2.81
		Psidia puntulata	0.35
	4	*Psidia puntulata*	2.81
		Hypoestes verticillaris	2.81
7	1	*Psidia puntulata*	1.06
		Lantana spp	0.35
	2	*Ochna holstii*	1.06
		Clausina asinata	2.81
		Rhus natalensis	2.81
	3	*Lantana camara*	0.35
		Ocimum suave	2.81
		Psidia puntulata	0.35
	4	*Nerium Oleander*	0.35
		Clausina asinata	*1.06*
8	1	*Croton dichogamus*	*2.81*
		Rhus natalensis	*1.06*
		Euphorbia tirucali	*2.81*
	2	*Ochna holstii*	*1.06*
		Rhus natalensis	*2.81*
		Psidia puntulata	*1.06*
	3	*Croton dichogamus*	*1.06*
		Rhus natalensis	*0.35*

		Aloe rabiensis	*1.06*
	4	*Croton dichogamus*	*1.06*
		Rhus natalensis	*1.06*
		Hypoestes verticillaris	*2.81*
9	1	*Clausina asinata*	*0.35*
		Combretum molle	*1.06*
	2	*Clausina asinata*	*0.35*
		Ocimum suave	*0.35*
	3	*Teclea simplicifolia*	*0.35*
		Psidia puntulata	*2.81*
	4	*Silver oak*	*0.35*
		Grewia Similis	*1.06*
10	1	*Guinea fowl scratcher*	*0.35*
		Dovyalis caffra	*2.81*
	2	*Silver oak*	*1.06*
		Rhus natalensis	*1.06*
	3	*Grewia Similis*	*2.81*
		Clausina asinata	*2.81*
	4	*Silver oak*	*0.35*
		Psidia puntulata	*1.06*
11	1	*Acacia kirkii*	*2.81*
		Acacia xanthophlea	*0.35*
	2	*Grewia Similis*	*0.35*
		Hypoestes verticillaris	*0.35*
		Cactus pricly pear	*2.81*
	3	*Dombeya burgessiae*	*0.35*
		Rhus natalensis	*2.81*
		Teclea tricorcapa	*1.06*
	4	*Psidia puntulata*	*1.06*
		Euphorbia tirucali	*0.35*
12	1	*Dombeya burgessiae*	*2.81*
		Ocimum suave	*0.35*
		Rhus natalensis	*2.81*
	2	*Croton dichogamus*	0.35
		Clausina asinata	2.81
		Ocimum suave	1.06
	3	*Lantana camara*	1.06
		Rhus natalensis	2.81
		Combretum molle	1.06
	4	*Clausina asinata*	2.81
		Rhus natalensis	1.06
		Psidia puntulata	2.81
13	1	*Croton dichogamus*	0.35
		Guinea fowl scratcher	2.81

		Psidia puntulata	1.06
	2	*Teclea simplicifolia*	2.81
		Rhus natalensis	1.06
	3	*Grewia Similis*	2.81
		Clausina asinata	2.81
		Psidia puntulata	2.81
	4	*Rhus natalensis*	2.81
		Psidia puntulata	2.81
		Aloe rabiensis	2.81
14	1	*Elaeodendion buchananii*	2.81
		Rhus natalensis	0.35
		Rhus natalensis	1.06
	2	*Rhus natalensis*	2.81
		Rhus natalensis	2.81
		Psidia puntulata	0.35
	3	*Silver oak*	2.81
		Ochna holstii	2.81
		Psidia puntulata	2.81
	4	*Silver oak*	2.81
		Rhus natalensis	2.81
		Euphorbia candelabrum	2.81
15	1	*Psidia puntulata*	1.06
		Hypoestes verticillaris	1.06
	2	*Rhus natalensis*	2.81
		Hypoestes verticillaris	2.81
	3	*Psidia puntulata*	2.81
		Acacia xanthophlea	2.81
	4	*Rhus natalensis*	1.06
		Psidia puntulata	2.81
16	1	*Acacia xanthophlea*	1.06
	2	*Psidia puntulata*	1.06
	3	*No woody sps*	0
	4	*No woody sps*	0
17	1	*Hypoestes verticillaris*	0.35
	2	*Psidia puntulata*	1.06
	3	*Croton dichogamus*	2.81
	4	*Rhus natalensis*	2.81
18	1	*Clausina asinata*	0.35
	2	*Teclea tricorcapa*	1.06
	3	*Silver oak*	1.06
	4	*Clausina asinata*	0.35
19	1	*Silver oak*	2.81
	2	*Clausina asinata*	1.06

	3	*Silver oak*	1.06
	4	*Dombeya burgessiae*	2.81
20	1	*Teclea simplicifolia*	1.06
	2	*Psidia puntulata*	2.81
	3	*Psidia puntulata*	1.06
	4	*Rhus natalensis*	1.06
21	1	*Ochna holstii*	2.81
	2	*Croton dichogamus*	1.06
	3	*Croton dichogamus*	2.81
	4	*Rhus natalensis*	2.81
		Total	**301.75**

APPENDIX 2: SANCTUARY VEGETATION SPECIES IDENTIFIED BY THIS STUDY

Grasses	Herbs	Woody Species
G_1- *Megathyrus maximum*	He_1- *Justicia dicliptenoides*	Wo_1- *Brachylaena huillensis*
G_2- *Themeda triandra*	He_2- *Commelina benghalensis*	Wo_2- *Teclea simplicifolia*
G_3- *Echinochloa Haploclada*	He_3- *Draceana afromontana*	Wo_3- *Dombeya goetzei*
G_4- *Cyperus rotundus*	He_4- *Justicia Flava*	Wo_4- *Strychnos heningsii*
G_5- *Setaria Plicatilis*	He_5- *Vernonia spp*	Wo_5- *Elaeodendion buchananii*
G_6- *Sporobolus pyramidalis*	He_6- *Gloriosa Superba*	Wo_6- *Croton dichogamus*
	He_7- *Senecio syringifolia*	Wo_7- *Coffea eugenioidea*
	He_8- *Oldeniandia scolulorum*	Wo_8- *Ochna holstii*
	He_9- *Momordica Foetida*	Wo_9- *Dombeya burgessiae*
	He_{10}- *Pellaea longipilosa*	Wo_{10}- *Croton megalocarpus*
	He_{11}- *Plectranthus spp*	Wo_{11}- *Vitex Keniensis*
	He_{12}- *Conyza stricta*	Wo_{12}- *Lantana camara*
	He_{13}- *Hibiscus fuscus*	Wo_{13}- *Grewia Similis*
	He_{14}- *Asparangus spp*	Wo_{14}- *Nerium oleander*
	$He\ _{15}$- *Solonum incanum*	Wo_{15}- *Olea wilwetich*
		Wo_{16}- *Clausina asinata*
		Wo_{17}- *Ocinum suave*
		Wo_{18}- *Erythrococca bongesis*
		Wo_{19}-*Rhus natalensis*
		Wo_{20}- *Combretum molle*
		Wo_{21}- *Vangueria madagacanensis*
		Wo_{22}- *Aspilia mossambicensis*
		Wo_{23}- *Psidia puntulata*
		Wo_{24}- *Lantana spp*
		$Wo\ _{25}$- *Hypoestes verticillaris*
		Wo_{26}- *Crotalaria agatiflora*
		Wo_{27}- *Jasminum floribundum*
		Wo_{28}- *Olea Africana*
		$Wo\ _{29}$- *Aloe rabiensis*
		Wo_{30}- *Acacia kirkii*
		Wo_{31}- *Teclea tricorcapa*
		Wo_{32}- *Euphorbia tirucali*
		Wo_{33}- *Euphorbia candelabrum*
		Wo_{34}- *Dovyalis caffra*
		Wo_{35}- *Opuntia spp*
		Wo_{36}- *Makharmia lutea*
		Wo_{37}- *Rhus vulgaris*
		Wo_{38}- *Acacia brevispica*
		Wo_{39}- *Acacia xanthophlea*

APPENDIX 3: SANCTUARY SCORE GUIDELINES

PARAMETER	SCORE RATE	INDICATE AS
1. Presence of Dung		Yes/ No
2. Status of Dung	Wet (black in colour and is shiny with moisture	W
	Dry (black in colour but not shiny with moisture)	D
	Very Dry (cracked with whitish colour)-	VD
3. Signs of Giraffe feeding or walking	Hoof marks	H
	Browsing	Br
4. Nearest Grass Sp	0-40 cm	$G.D_1$
	41- 81 cm	$G.D_2$
	>81 cm	$G.D_3$
5. Number of Grass Sp	0-1	$G.N_1$
	2-3	$G.N_2$
	>3	$G.N_3$
6. Nearest Herb Sp	0-40 cm	$H.D_1$
	41-81 cm	$H.D_2$
	>81cm	$H.D_3$
7. No of Herb Sp	0-3	$H.N_1$
	4-7	$H.N_2$
	>7	$H.N_3$
8. Woody Cover		Yes/ No
9. Nearest Woody Species	0-70 cm	$W.D_1$
	71- 141 cm	$W.D_2$
	>141cm	$W.D_3$
10. No. of Woody sp.	0-1	$W.N_1$
	2-3	$W.N_2$
	>3	$W.N_3$
11. No of Canopy Layers	0-1 layers	C_1
	2-3 layers	C_2
	>3layers	C_3
12. Soil Assessment	Bare ground but no evidence of soil erosion	S_1
	Bare ground with evidence of soil erosion	S_2
	Ground covered with no evidence of soil erosion	S_3

KEY

1. sp- species
2. W- wet
3. D- dry
4. V.D - very dry
5. H- Hoof
6. T- Trail
7. Br- Browsed
8. G-Grass
9. He-Herb
10. Wo-Woody
11. G.D - Grass distance
12. G.N - Grass numbers
13. H.D- Herb distance
14. H.N- Herb number
15. W.D Woody distance
16. W.N - Woody number
17. C- canopy
18. S- Soil

N/B: All the data on vegetation species will be recorded according to cords as they appear in the field using guidelines G_1, G_2, G_3… for grass species, He_1, He2 and He3… for herb species and Wo_1, Wo_2, Wo_3… for woody species

APPENDIX 4: FIELD BIOLOGICAL DATA RECORD SHEET

GENERAL SITE INFORMATION	
Transect	

Transect details		Presence of Dung	Signs of giraffe feeding/ walking	Nearest grass species	No of Grass Sp.	Nearest Herb Sp	No of Herb Sp	Woody cover	Nearest Woody Sp	No of Woody Sp	No. of canopy layers	Status of Soil cover
Points	Quadr at											
1	1											
1	2											
1	3											
1	4											
2	1											
2	2											
2	3											
2	4											
3	1											
3	2											
3	3											
3	4											
4	1											
4	2											
4	3											
4	4											
5	1											
5	2											

5	3											
5	4											
6	1											
6	2											
6	3											
6	4											
7	1											
7	2											
7	3											
7	4											
8	1											
8	2											
8	3											
8	4											
9	1											
9	2											
9	3											
9	4											
10	1											
10	2											
10	3											
10	4											
11	1											
11	2											
11	3											
11	4											
12	1											
12	2											
12	3											
12	4											

APPENDIX 5: SOCIO-ECONOMIC IMPACT ASSESSMENT SHEET

		Popn of visiting tourists	popn of school children	Popn of giraffe translated	number of groups trained	No of schools funded on micro projects	Income earned from tourism (Ksh)	Funding for conservation projects (Ksh)	Number of conservation projects funded	Types of conservation projects funded	O.B records of incidences related to giraffe
2009	Jan										
	Feb										
	Mar										
	Apr										
	May										
	Jun										
	Jul										
	Aug										
	Sep										
	Oct										
	Nov										
	Dec										
2010	Jan										
	Feb										
	Mar										
	Apr										
	May										
	Jun										
	Jul										
	Aug										

	Sep										
	Oct										
	Nov										
	Dec										
2011	Jan										
	Feb										
	Mar										
	Apr										
	May										
	Jun										
	Jul										
	Aug										
	Sep										
	Oct										
	Nov										
	Dec										
2012	Jan										
	Feb										
	Mar										
	Apr										
	May										
	Jun										
	Jul										
	Aug										
	Sep										
	Oct										
	Nov										

	Dec										
2013	Jan										
	Feb										
	Mar										
	Apr										
	May										
	Jun										
	Jul										
	Aug										
	Sep										
	Oct										
	Nov										
	Dec										