HABITAT PREFERENCES OF THE THREATENED *BEISA ORYX* IN NAKUPRAT GOTU CONSERVANCY

Report compiled by: Josephat Murunga Mungoche

Emails: murungajosephat@gmail.com

j.mungoche@cgiar.org

murungajos@students.uonbi.ac.ke

CONTENTS

ACKNOWLEDGEMENT

I would like to thank Jana Robyest trust for availing extra funds to assist in completion of this work. I am indebted to the university of Nairobi team of technicians led by Mr. Musembi and the Nakuprat Gotu game wardens who assisted me in data collection and analysis.

1.0 CHAPTER ONE

1.1 INTRODUCTION AND LITERATURE REVIEW

Climate variations cause changes in biodiversity as well as the distribution of many plant species that affect the availability, accessibility and value of resources upon which wildlife depend on. These have consequences on conservation and management of flora and fauna and its habitats in protected areas (Gandiwa & Zisadza, 2010). It further constrains the pastoralists' access to quality grazing spots leading to their intrusion into conservancies and other protected areas.

Deterioration of vegetation is likely to lead to decline in wildlife and other herbivore populace dimensions (Ogutu, 2011). Land usage alteration is the main factor that modifies habitat and can determine the dispersal of species in an ecosystem (Musiega & Kazadi, 2004). To evade extinction of threatened species, it is vital to appreciate and manage their environments (Ortigosa, Leo & Gatto, 2000). Unfortunately, explaining the patterns of biodiversity at the species level is one of the most complex problems in environmental conservation. This is because biodiversity is the outcome of many contributing factors whose relative importance varies with spatial and temporal scale (Dale & Beyeler, 2001; Lovett, Midgley & Barnard, 2005). In Kenya, protected zones appear to be getting smaller to sustain worthwhile wildlife populations. Unending human settlements have progressively encroached on these lands, interfering with the migratory corridors and leaving only marginal areas for biodiversity conservation (King'oriah, 1995).

Wildlife distribution experience significant fluctuations as human encroachment into wildlife habitats increases. These vagaries necessitate greater commitment to management techniques for the protection of wildlife resources. Habitat analysis and population censuring have become important tools for wildlife managers. Habitat analysis provides a better understanding of wildlife needs within various habitat types, and censuring produces statistics that can be used to evaluate the status of wildlife populations. These techniques can be used to determine the relationship between wildlife populations and habitat, thus improving the management of wildlife resources. The availability of accurate data on wildlife resources is vital for conservation of biodiversity, ecosystem steadiness and enhance economic gains (Sinclair and Grimsdell, 1978). Additionally, it is needed for management and planning within the framework of sustainable development. Consistent monitoring reveals rationalized information about the status of species and their habitats which are vital for corrective measures in the case of major population variations and occasions of major catastrophes (Inglis, 1976). Inglis (1976) stated that species variations are common and are usually interconnected with the situations in the habitat.

This study therefore seeks to analyze the distribution of the *Beisa oryx* in the study area. Specifically, the study will assess the effects of habitat changes and human factors on distribution of the *Beisa oryx* with an aim of informing conservation stakeholders on the changing habitat quality of the species in this era of climate variability and land use changes.

1.1.2 Overview of habitat and anthropogenic disturbance

Africa is well known for having a rich and diverse wildlife. Land use in Africa has changed over recent years. Parker & Bernard (2005) stated that large proportions of agricultural land

are being converted to wildlife ranching. This form of ranching aims to promote conservation of African wildlife allied to the more lucrative tourism trade where ecotourism is very important for the Kenyan economy and ultimately for African conservation. A significant proportion of Kenya's income from foreign exchanges comes from the tourism industry (Weaver, 1999), with most of the tourists' sole purpose is to witness and experience the Kenyan wildlife (Norton-Griffiths & Southey, 1995; Akama, 1996). Naturally land is also changing with the encroachment and formation of new habitats. This requires regular monitoring of habitat use to determine whether the changing environment causes detrimental effects on species in Africa and the rest of the world.

There is a critical need for the development of conservation strategies for wild equids based on scientific data and methodologies (Moehlman 2002). The ever increasing human and livestock population pressure, habitat fragmentation, introduction of exotic species and other adverse human impacts have altered the seasonal migration and movement pattern of artiodactyls (East, 1996; Kingdon, 1997). As a result of these problems, artiodactyl populations have been declining in many of their natural habitats (Caughley and Sinclair, 1994). *Beisa oryx* is one of the artiodactyls which is facing continued decline in their population (Jacobs and Schloeder, 1993, EWCO/CARE, 2001).

1.1.3 Behavioral aspects of beisa oryx

The *Beisa oryx* is grouped in the family Bovidae, subfamily Hippotraginae and genus Oryx. The word Oryx is from the Greek word 'Orux' meaning gazelle or antelope. The taxonomy of Oryx tribe is still argued. According to Ansell (1977) and Corbet (1978), the genus Oryx comprises Oryx dammah (Scimitar-homed Oryx), Oryx leucoryx (Arabian Oryx) and Oryx gazella (Gemsbok, Beisa and fringe-eared Oryx). The genus Oryx is a name for several horse-like antelopes, found in deserts and arid scrub lands of Africa and Arabia. Their home range varies from 200 to 300km2 for females and from 150 to 300km2 for males (Frield, 1975; Kingdon, 1997). Sexes may be equal in number but usually the number of females is greater. Females give births in about nine-month interval and their gestation period is eight and half months (Walther, 1978). Calves lie up for 2-6 weeks. They join other young groups to form peer groups and may stay up to one year. Females could breed within 18-24 months and males within five years. Captive Beisa Oryx is known to live for about 22 years (Kingdon, 1997). Their herds have a definite hierarchy, with a cow leading the heard and 'alpha bull' found at the rear (Kingdon, 1997). Large herds are nearly always mixed and often do not include juveniles, but small herds under 20 may consist of females only, females with a male and females with calves (Estes, 1991). There is only slight sexual dimorphism in them. The penile sheath and scrotum are remarkably inconspicuous except for dominant males in breeding condition (Estes, 1991; Kingdon, 1997).

They are active by early morning and late afternoon hours and in moonlight. Water requirement could be satisfied with its food, which includes grasses and leaves of shrubs, by feeding during the period of maximum relative humidity between midnight and dawn (Taylor, 1969; King et al. 1975). Thus, Beisa Oryx is a good example of artiodactyls, which has successfully adapted to overcome harsh conditions of intense heat, little or no water and dispersed food (East, 1984;

Columbia encyclopedia, 2001). Seasonal movements in water-dependent large communities show a wet season dispersal and dry season concentration which can be related to the seasonality of rainfall and water availability, but those similar patterns do not prevail in the water-independent species (Durant et al., 1986). It suggested that seasonal migration of herbivores in grassland ecosystems of Eastern Africa is correlated to the availability of green vegetation and hence in the proportion of important nutrients. Different species of animals make seasonal movements between habitats. In areas where food resources change with seasons, populations of mammals are known to move from one type of habitat to another depending up on the season (Began et al., 1986). The availability of food resources affects the population dynamics and distribution of an animal species (Caughly and Sinclair, 1994). Knowledge of the relationship of an animal with its habitat is essential in understanding the ecological requirements of the species (Caughly, 1977). In addition, knowledge in the feeding habitats of an animal are essential for making and designing strategies for management. *Beisa oryx* are social, living in organized herds (Estes, 1991). They feed on grasses and scrub and go without water for long periods (Columbia Encyclopedia, 2001). They do not seek shade in the middle of the day and appear to withstand an ambient temperature of 45°C for at least 8 hours (Taylor, 1969). They congregate in areas where rainfall has brought a flush of new vegetation (Delany and Happlod, 1979). *Beisa oryx* makes obligatory moves after the evening feeding peak before settling to rest (Estes, 1991)

1.1.4 Habitat use concept

Habitat use is an important aspect in ecology and conservation. Paul Krausman (1999) defines habitat use as "the way an animal uses the physical and biological resources in a habitat". The term 'habitat' has many definitions and has many uses. Richard Hutto (1985) provides a suitable definition for term 'habitat' which can be related to this study. He defines a habitat as a "spatially contiguous vegetation type that appears more or less homogeneous throughout and is physio gnomically distinctive from other such types". In simple terms, a habitat is a distinct area where vegetation doesn't vary and provides a place for organisms to live and grow.

Different species will utilize habitats in a variety of ways (Aebischer et al, 1993). Species will use habitats in order to survive, grow and reproduce. They will do this by using the resources available at a certain habitat (Aarts et al, 2008). Examples of different variations of resources can be food, water and cover (Leopold, 1933). Most species would transition to different habitats with lower resources if faced with great interspecific and intraspecific competition (Block & Brennan, 1993; Krausman, 1999). Animals can use habitats as a survival strategy which avoids predation from carnivores (Turner, 1997). However, habitats are also important drivers for prey selection made by predators. This is due to the different features that habitats possess (Hayward & Kerley, 2005). Animals can change which habitats are used based upon seasons. Thus, a species may use a certain habitat during the summer period but will move onto a different habitat in the winter as a result of the changing resource availability (Morrison et al, 1985). Habitat use can also be influenced by the past experiences an individual has had in a habitat. New habitats can also be discovered from exploration behaviours by individuals (Hutto, 1985).

Acquiring the knowledge on how wild animals utilize a habitat can improve ways to manage and conserve populations of flora and fauna (Levin, 1992; Ellis & Bernard, 2005). During the modern era, habitat use can provide information and understanding of the effects of the changing environments. These effects can be caused by anthropogenic and invasive species encroachment (Hannah et al, 1995; Pimentel et al, 2005). Also, global warming can result in a shift of habitats (Parmesan & Yohe, 2003). The effectiveness of introducing new species to an area can be determined by the knowledge of the target species' habitat use. This understanding can provide guidelines on the habitats which are suitable for the introduction of new species and other management policies.

1.1.5 Effects of habitat change on ungulates

Kenya is endowed with an enormous diversity of ecosystems and wildlife species. It is renowned for its diverse assemblage of large mammals like elephant (Loxodonta Africana), black rhino (Diceros bicornis), leopard (Panthera pardus), buffalo (Syncerus cafer) and lion (Panthera leo) numerous species of ungulates. This rich wildlife together with other attractions has for decades made the country an important tourist destination and hub for the lucrative tourist industry. The rich biodiversity is partly attributed to diversity in landscape, ecosystems, habitats and convergence of at least seven bio-geographic units (IUCN, 1990; Young, 1996; Medley & Hughes, 1996). Overall, the interactions between relief, geology, climate and soils have a profound influence on the types of habitats, ecosystems and biota life forms within the country (IUCN 1990; Young 1996; Medley & Hughes, 1996). Thus, most landscapes are characterized by peculiar climatic factors, wildlife life forms and vegetation associations which give rise to distinguishable geographical regions in the country (Grove, 1978; Leifer, 1977; Ojany & Ogendo 1973).

Habitat type often modifies the group size of ungulates increasing their population size with increase of habitat openness (Jarman, 1974; Hirth, 1977). One of the explanations for this is that, in an open area, individuals in a bigger group have a greater chance of detecting predators. At the same time, they have a higher probability of escaping from predation (Hirth, 1977). In closed habitats, on the other hand, a smaller group has a lower probability being victimized by predators (Jarman, 1974; hirth, 1977). Group size may also be influenced by food conditions. For instance, Hanley (1982) explained that the increase of group size in elk and blacktailed deer was caused by a change of food selection pattern from a single plant to microhabitat patches that provided food of better quality than average. If foraging efficiency plays an important part in determining group size, then group size should vary not only between habitats, but also between seasons. Thus, it is considered that both food conditions and avoiding victimization by predators contribute to determining group size of ungulates (Hanley, 1982). Ungulates rarely range randomly (Duncan, 1983). A few factors such as season, availability of food, breeding activity and population density affect home range estimates (Eberhardt et al., 1984).

1.1.6 Distribution of *Beisa oryx*

Initially, several Oryx species were found in all of Africa's dry regions. One species that occurred on the Arabian Peninsula was eliminated recently but has now been reinstated into the wild from confined stock. Well-adapted to the environments of their hot, arid habitats, oryxes can live up to 20 years. Kenya's Tana River splits the range of East Africa's two types of Oryx: The Beisa Oryx (*Oryx gazelle beisa*) and the fringe-eared Oryx (Oryx g. callotis). The fringe-eared Oryx ranges from Kenya to Central Tanzania. The beisa Oryx ranges from Ethiopia over Somalia into Northeastern Uganda and Kenya. The East African or "beisa" Oryx lives in eastern Africa, particularly in Ethiopia, Tanzania and Kenya. This brownish-gray antelope feeds on fruit, buds, foliage and grasses and generally reside in grassland and bushland environments. In terms of population, unlawful poaching activities are a serious threat to *Beisa oryx*. Under the IUCN red list, Beisa Oryx are categorized as "threatened (IUCN, 2008). East (1999), correcting for undercounting bias, gives estimated total populations of about 50,000 *Beisa Oryx* and 17,000 Fringe-eared Oryx (East 1999). Population trends are probably gradually downward over most of the species' current range, with exceptions in areas such as Sibiloi and Laikipia (*Beisa Oryx*) and Kajiado, Tarangire and Mkomazi (Fringe-eared). Beisa Oryx occurs widely in the semi-arid and arid bushland and grasslands of North-East Africa. The condition of grazing and state of the soil influence seasonal movements (Wacher and Kingdon in press 2008). They occur up to altitudes of 1,700 m in Ethiopia (Yalden *et al.* 1996). Both sub-species eat a wide range of grass species and growth stages, taking more browse during the dry season (Wacher and Kingdon in press). Drinks regularly when water available, but can get by on water-storing melons, roots, bulbs, and tubers, for which it digs assiduously.

Accurate information is required on the status of ecosystems and distributions of the species to attain success in conserving ecosystems as well as specific species. In the absence of more recent data, the *Beisa oryx* is categorized as 'Threatened' in the IUCN Red List (Woodfine and Parker, 2011), and here the present study is aimed at assessing the present distribution and threats faced by *Beisa oryx* in Nakuprat Gotu conservancy.

1.1.7 Effects of anthropogenic disturbance on ungulates

In the last century, increased human population has created a high demand for land as well as exerting an incredible amount of pressure and threat to wildlife and other biodiversity types in Kenya (Mwale, 2000). For instance, in high potential areas of Western Kenya, Nyanza, Central and parts of the Rift Valley Provinces where agriculture is the predominant land-use, most biodiversity types have nearly been exterminated including substantial alteration and loss of wildlife habitats (Kameri, 2002). Human encroachment on critical biodiversity depository sites in search of agricultural land has since the 1970's and 1980's shifted to low potential rangelands which coincidentally are the prime wildlife ecosystems (Sindiga 1995; Mwale 2000). This has created a myriad of problems like competition for water resources, human wildlife conflicts, habitat fragmentation and blocking of wildlife migratory routes and dispersal areas and negative perception towards conservation (Sindiga, 1995; Norton Griffiths, 1997; Ottichillo, 2000). Similarly, mountain Ecosystems like Aberdare National Park, Mt. Kenya National Park, Mt. Elgon, the Mau Escarpment among others have in the past few decades seen substantial human influx for subsistence farming opportunities, collection of both animal and

plant resources. The Forest Department and more recently Kenya Wildlife Service have been faced with a new challenge of regulating and containing this encroachment as a means of minimizing habitat degradation, loss and subsequent biodiversity destruction.

In Nakuprat Gotu conservancy, encroachment of livestock herders into the conservancy is a threat to the remaining *Beisa oryx* (NRT, 2015). Direct competition for habitat resources such as salt licks, grazing lands and watering points pose a great danger for this species.

1.1.8 Wildlife conservation in Kenya

Institutions that have been in-charge of wildlife conservation and management of protected areas have taken little proactive approach to regularly evaluate status and threats of these areas. Various research works (Nyeki, 1993; Sindiga, 1995; Mwangi, 1995; Western, 1997; Smith, 1999; Ottichilo, 2000), have outlined some of the critical threats to protected areas that need to be seriously addressed. Attempts have been made to address and mitigate these threats but with mixed success. Consequently, the Kenya Wildlife Service and the government are; re-examining wildlife conservation approaches, policies and objectives. They are urgently undertaking a comprehensive or holistic assessment on threats undermining biodiversity conservation initiatives within and outside protected areas as well as their genesis.

1.2 Problem statement

Habitat destruction and habitat fragmentation are the two biggest threats to most wildlife currently. These have always been a problem and continue to get worse as the populations of wildlife need enough space for survival. The combined impacts of habitat loss, habitat fragmentation, habitat degradation, threaten the remaining Oryx numbers and their distribution (Namaga et al., 2016). Competition for resources with humans and their livestock is the main driver. Habitat loss and degradation is caused by increasing human demand for agricultural land and accessing water points that are in the protected areas. (Obari, 2014). Wildlife conservancies are important in the gene flow and existence of the wildlife species. Human population growth bordering these protected areas is high and has become a serious threat to the management of wild animals all over Africa (Msoffe et al., 2011). Local communities around the protected areas conduct activities such as agriculture practices, cutting of wood forest and setting bushfires, all of which are destructive to the vegetation cover. Illegal wildlife hunting for subsistence and commercial use is uncontrolled. The hunting activity is often conducted by poachers from outside protected areas (Pittglio et al., 2012

According to IUCN Red List, poaching (for meat and hides) and encroachment by settlement and livestock remain the major threats to the Oryx beisa species, especially since most of the population remains outside protected areas. Many studies have been concerned with conservation of other threatened wildlife species. However, there's no study that has assessed and documented habitat status and suitability for Oryx in the study area.

In Nakuprat Gotu conservancy, forest cover has reduced over the years except around Akunoit. Community members use trees for firewood, charcoal burning and house construction (NRT 2015)

1.3 Justification

Wildlife-based tourism is the backbone of many economies in African countries that still harbor high diversity of wildlife species. Wildlife-based tourism is Kenya's second largest economic sector after agriculture, contributing over 12% to the country's Gross Domestic Product (Akama and Kieti, 2003). Sustainable tourism is dependent on maintenance of high wildlife diversity in Kenya's protected areas, but its sustainability is threatened by the risk of extinction of many wildlife species in the country.

Wild animal species plays a critical role in attracting tourists both locally and internationally. Residents of Nakuprat Gotu derive their livelihood from entertaining tourists who come seasonally to watch and interact with the wildlife, the Isiolo Big five (Grevy Zebra, Oryx, Somali Ostrich, Lion, reticulated giraffe). East African Oryx is amongst the species that has been dominating Kenyan tourist sites hence promoting tourism in the country. However, according to IUCN, 2008 evaluation report, it is listed as a threatened species as its population is drastically declining in their natural habitats. Despite being native in most of the east African countries, it has been reported to be extinct in Sudan, Uganda and Eritrea (African antelope database 1998). This raises concern for conservation of this highly potential species to prevent further extinction in the remaining countries: Djibouti, Ethiopia, Kenya, Somalia, South Sudan, and Tanzania.

The *Beisa oryx* is listed as Threatened because numbers have been estimated at 67,000 and population trends are declining apart from in a few protected areas. It has already declined heavily around the margins of its range. Threats from hunting and overgrazing are continuing and it is predicted that the overall level of decline will reach at least 25% over the last 3 generations (21-24 years), thus approaching the threshold for Vulnerable under criterion A2(IUCN,2008). Encroachment of pastoralists into conservancies in search for water and quality pasture has been reported in most rangelands of Kenya. This has been attributed by prolonged drought periods caused by changes in weather patterns. There's a need to study how changes in vegetation patterns affect the population distributions, habitat status and the preferred habitats for *Oryx Beisa* in Nakuprat Gotu conservancy.

1.4 Broad objective

The main objective of this study was to establish the distribution and understand threats faced by *Beisa oryx* to maximize in-situ conservation.

1.5 Specific objectives

The specific objectives were:

1. Determine the distribution of *Beisa oryx* in various habitats within *Nakuprat* Gotu conservancy

2. To establish habitats preferred by *Beisa oryx* habitats in the study area

3. Determine the suitability of current habitat for *Beisa oryx* in the study area.

2.0 CHAPTER TWO

2.1.1 Study area

This study was conducted at Nakuprat Gotu conservancy which borders Shaba National park in Isiolo County. The Nakuprat-Gotu Community Conservancy was registered as a community-based organization (CBO) in 2010 but changed its status in 2014 to a not-for-profit company, Nakuprat-Gotu Conservancy Limited covering 39,300 hectares (NRT, 2015). The main occupants of the conservancy are the semi-nomadic Borana and Turkana communities whose main livelihood is derived from livestock resources. The conservancy act as a buffer for Sera community conservancy, and Shaba, Samburu and Buffalo Springs National Reserves, as it is the last protected area before Meru North district. Parts of it border the Ewaso Nyiro River, Kenya's largest water course, which provide a vital and constant water supply for communities and wildlife. Key wildlife species are lions and elephants and *Beisa oryx*. Its Eastern flank supports vast plains, home to one of the largest herds of *Beisa oryx* remaining in the region.

2.1.2 Climate

Temperatures range from 30ºC during hottest months to 20ºC between July and September. Annual rainfalls range between 100mm to 300mm on average usually divided into two seasons, short rains in October/ November and long rains between February and May.

2.1.3 Ecosystem and Wildlife

Nakuprat-Gotu acts as a buffer for Sera community conservancy, and Shaba, Samburu and Buffalo Springs National Reserves, as it is the last protected area before Meru North district. Parts of it border the Ewaso Nyiro River, Kenya's third largest water course, which provides a vital and constant water supply for communities and wildlife. Wildlife species found in the conservancy include: Elephants, Giraffes, *Beisa oryx*, Lions and a variety of bird species like the Sand grouse. Its eastern flank supports vast plains, home to one of the largest herds of *Beisa oryx* remaining in the region. The continuing support of the community and the focus on security by the scouts are vital if this species is to be protected.

2.1.4 Study design

Field data collection was collected during dry and wet seasons. The study area was first demarcated into census zones. Line transect counting method was used to collect data on *Beisa*

oryx (Norton-Griffiths,1978; Buckland et al., 1993; Sutherland, 1996; Wilson et al., 1996; Fanuel Kebede, 2013). The longest side of the census zone will be used as a baseline to lie sampling transects along.

Nine parallel sampling transects were systematically placed perpendicular to the baseline with a minimum distance of 1 km apart in an east-west orientation. Nearly 3 km distance were skipped at both ends of the baseline transects to avoid edge effects (Sutherland, 1996; Wilson et al., 1996).

Each transect was cover the three major habitat types (grassland, tree scattered grassland and bushland) found in the census zone. To avoid the effect of double counting of same individuals on the results due to proximity of adjacent transects, a transect width of 0.3-0.5 km will be used in the study.

The length of transect line was decided based on the total area of Nakuprat Gotu conservancy. Based on Sutherland (1996) for counting medium-/large-sized animals in each habitat, surveys of *Beisa oryx* population will be undertaken using four-wheel vehicle while driving slowly at an average speed of 20 km per hour. The exception was that some portions of transects may be inaccessible by vehicle during wet season, in which case, survey was done on foot for recording animals. Whenever a herd or individual of *Beisa oryx* was encountered, date and time of observation, kilometer traveled, estimated perpendicular distance from the sight of observation to the animal, total number of individuals in the group, sex and age categories and habitat type (grassland, tree scattered grassland and bushland) where they are observed were recorded on standard census datasheet that will be prepared for this study.

Age and sex composition of each herd was put into four broad categories, following Lewis and Wilson (1979) as adult male and female, sub-adult male and female, calves and unidentified sex. To categorize individual animals into these categories, the methods of Lewis and Wilson (1979) were followed. Relative body size, horn size, pelage, external genitalia and shape, fur color, the presence of scrotum in males or udder in females and other physical features were used as a clue to determine the sex and age of the individuals (Lewis and Wilson, 1979; Kingdon, 1997). Each transect was surveyed twice in each season (wet and dry seasons), totaling four surveys in the course of the study period.

Observations were made early in the morning (06:30 h−10:30 h) and late in the afternoon (03:30 h−06:30 h) with the help of experienced University of Nairobi taxonomist. On the average, 3-4 transects were covered on a single day. Care was taken to minimize the risk of double counting by noticing the movement of animals between the effective counting widths of adjacent transects. The start and end of geographical coordinates of each transects were saved in GPS unit to ensure same transects won't be repeated during each counting session. Pairs of binoculars was used for counting the animals and for proper sex and age identification, while camera, was used to take pictures of unusual features encountered in the study area.

2.2 Data collection methods

2.2.1 Distribution of Beisa Oryx in Nakuprat Gotu conservancy

The various habitats within Nakuprat Gotu were stratified and thereafter line transects were laid in each stratum to quantify the populations of *Beisa oryx*. Population means were tabulated to present the ground truthing data on Oryx's preferred habitats within the conservancy. In each of its home ranges, direct count method was used along transects. Fine details regarding age and sex were examined by use of binoculars and cameras.

2.2.2 Suitability of current habitat for Oryx in the study area.

Vegetation sampling was done at each area where the *Beisa oryx* has been spotted along transect. This was facilitated by laying 1m×1m quadrats along transect. Each species of grass, forb, shrub and trees were recorded on the vegetation data sheet. GPS was used to record specific sites for each area sampled. The leaves were clipped by use of shears for laboratory analysis to establish their nutritive values.

Historical range of data set was used to infer the suitability sites for *Beisa oryx*. Normalized difference vegetation index (NDVI) was used to assess whether the vegetation being observed contains live green vegetation or not.

Soil samples along transect were collected up to 30cm depth for chemical analysis.

2.3 Data analysis

2.3.1 Distribution of *Beisa oryx* in Nakuprat Gotu conservancy

The average number of animals observed along each transect in each habitat was calculated and used for analysis. The density estimate of the species was computed using jolly's method (Norton-Griffiths, 1978) for unequal sized sample unit using the formula.

$DTi = n/WTi \times 1/WTi$
Where DTi: Population density (D) along transect Ti
n: numbers of sighting
Ti: Transect
LTi: length of Transect i
WTi: width of Transect i

The density of animals observed per transects were used to calculate mean population density. Population size of *Beisa oryx* was estimated by multiplying mean population density (DTi) with total extent of the census zone using the following formula (Burnhan *et al.,* 1980).
$N = (\Sigma DTi/n) \times A,$

Where N= Population size estimates
D = Mean population density (individual per km^2)
n = number of transects
A = Total extent of the census zone (km^2).
Differences in herd size of overall herd and each herd type in the three-habitat types were determined using one-way ANOVA.

Demographic characteristic of *Beisa oryx* was analyzed by calculating the ratio of age and sex type. Ratios were calculated by dividing number of individuals of animals of each respective pair (e.g. adult male vs adult female) of age and sex categories. Moreover, ratios were determined between male vs female, adult vs sub adult, adult vs calf and sub-adult vs calf.

The habitat selection of *Beisa oryx*, was determined by comparing the observed abundance values in each habitat type with theoretically expected even distribution in each habitat type (Yosef Mamo *et al.*, 2015). The significance was tested using Chi-square analysis in IBM SPSS. In addition, mean differences in population abundance of overall and each age/ sex categories of the species among habitats and between seasons will be compared using Tukey's multiple mean test.

The data on effects of seasonal variations on the habitat quality for Beisa Oryx was analyzed by using the Pearson correlation method.

2.3.2 Effects of anthropogenic factors on Oryx habitat

Data based on questionnaire survey will be analyzed using SPSS and Chi square test was used to test the decrease or increase of wildlife based on respondent's perception. Also, was used to test the relationship between wildlife increase and respondents time spent in the study area.

Pearson correlation was used to analyze relationship between wildlife numbers and livestock, as well as wildlife numbers and human activities. A justification of employing Pearson correlation analysis is that wildlife, settlements, and livestock are numerical values.

2.3.3 The suitability of current habitat for Oryx

The preferred plant species for Beisa oryx were identified at the areas where Beisa oryx were spotted. The frequencies and densities of these vegetation were thereafter established.

3.0 CHAPTER THREE

3.1 Results

3.1.1 Population Estimate, Herd Size and Trends of Beisa oryx

A total of 732 and 92 individuals were recorded during wet and dry seasons, respectively. The population was more abundant during the wet season than during the dry season. The mean population size (SE), was 61 (4.85) and 7.67 (0.97) individuals during wet and dry seasons, respectively. There was a significant difference in the number of animals observed during the wet and the dry seasons ($\chi^2 = 1252.934$ df = 1 P <0.001). The present mean population estimate with standard error of Beisa oryx was 722 ± 119 in the study area. The wet and dry season estimation was 1,252 ± 104 and 191 ± 23 respectively (Table 1).

Table 1. Mean population estimate of Beisa oryx in Nakuprat Reserve in the present survey.

Year	Species	Mean population estimate (SE)	Season	
			Wet	Dry
2018	Beisa oryx	722 ± 119	1,252 ± 104	191 ± 23

A total of 101 herds of Beisa oryx were observed, 67 herds during the wet season and 34 herds during the dry season in study area. The wet season total number of Beisa oryx herds observed was higher. The maximum herd size consisted of 30 and 4 individuals during wet and dry seasons, respectively. The most frequently observed herd size was 7 animals during the wet season and 2 animals during the dry season.

Mean herd size with standard error was 9.73 (4.71) during wet season and 2.48 (1.29) during the dry season. The difference was statistically significant ($F_{1, 99} = 79.17$, $P < 0.001$). Large herd sizes of Beisa oryx were aggregated during the wet season, while during the dry season, they were distributed in a wider area forming smaller herds and solitary individuals. Results of one-way ANOVA showed that there was a significant difference in mean herd size of Beisa oryx among the three different vegetation types ($F = 7.67$, $df = 2$ $P < 0.001$). Tukey's multiple mean comparison showed that mean herd size of Beisa oryx in the grassland was 8.5 (SD = 4.61, N = 56) and the shrubby grassland habitat was 8.39 (SD = 5.95, N = 33) and these was significantly greater than the observations in the bush land habitat type (4.17, SD = 3.3, N = 12). The present population estimate of Beisa oryx in the reserve revealed that its population has declined by 22 % within the last five years.

3.1.2 Population Structure

The population structure and the proportion of various age and sex categories of Beisa oryx in study area are provided in Figures. 4 and 5. A total of 824 individuals were sighted during the present study period. Of these, adults comprised 703 (84.6% of the total), sub-adults 104 (14.2%) and calves 17 (1.2%) individuals. The sex ratios (male: female) of adults and sub adults were 1.0:1.8 and 1.0:1.9, respectively. Regardless of sex category, the age ratios of sub-adults to adults and calves to adults were 1.0:6.0 and 1.0:36.8, respectively. That of calves: sub-adults was 1.0:5.2 (Table, 2).

Table 2. Demographic ratios of (age and sex) composition of Beisa oryx population in study area during wet and dry seasons.

Categories	Ratios of demographic composition		
	Wet season	Dry season	Mean
Male: Female	1.0 : 1.8	1.0 : 1.7	1.0 : 1.75

Sub-adult: Adult	1.0 : 7.0	1.0: 5.1	1.0 : 6.0
Calf: Adult	1.0 : 36.8	0	1.0 : 36.8
Calf: Sub-adult	1.0 : 5.2	0	1.0 : 5.2

Adults accounted for 85.5% and 82.6% during the wet and dry seasons, respectively, while sub-adults and calves accounted for 12.15% and 16.3% during the wet and 2.32 % and 0% during the dry season, respectively (Fig. 4). The mean population size was 52.17 ± 4.04 for adults, 7.42 ± 0.8 for sub-adults and 1.42 ± 0.38 for calves during the wet season. During the dry season, the mean population size was 6.33 ± 0.67 for adults and 1.25 ± 0.38 for sub adults (Fig. 4). Calves were not recorded during the dry season. Analysis of age structure revealed that there was no significant difference in age distribution during the wet and dry seasons (χ^2 = 8.000, df = 5, P = 0.238).

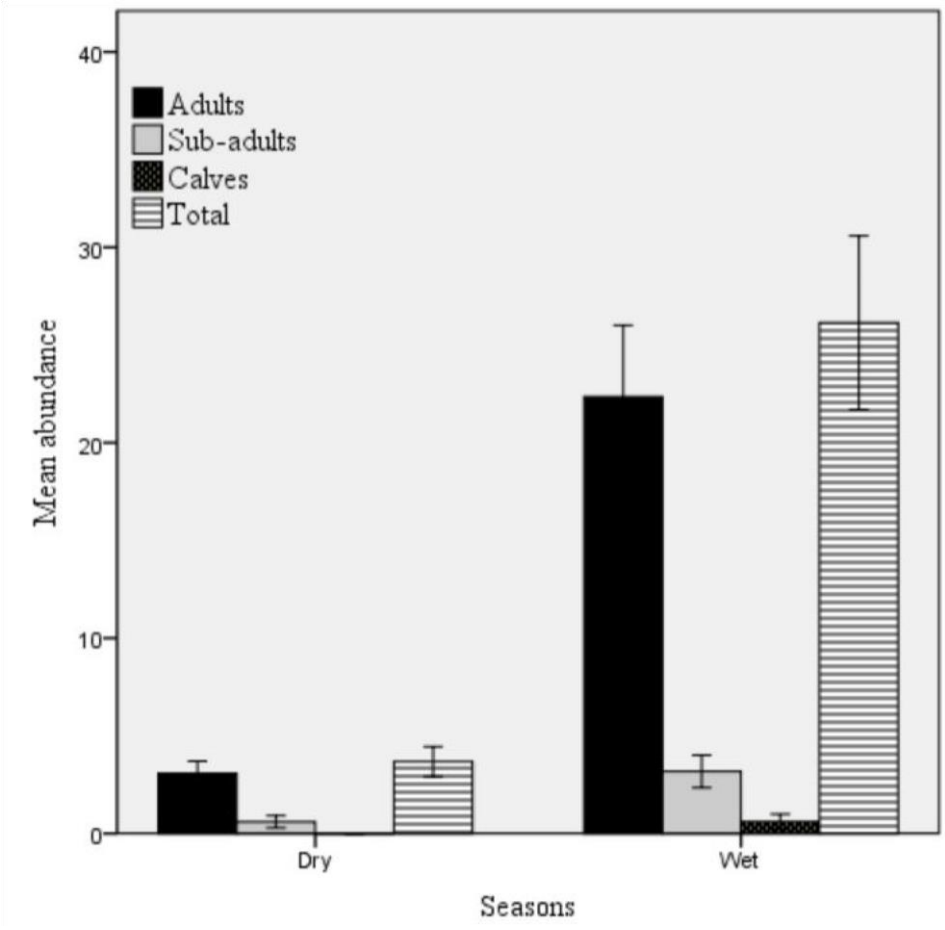

Figure 4. Age composition of Beisa oryx during wet and dry seasons.

Out of the total 824 individuals observed during the present study, 254 (30.8%) were males and 458 (55.6%) were females. The mean population size was 18.5 ± 1.64 and 33.58 ± 2.81 males and females during the wet seasons, respectively. The dry season mean population size was 2.67 ± 0.55 and 4.58 ± 0.41 males and females, respectively

(Fig. 5). Analysis of sex composition revealed that there was insignificant difference in sex composition during the wet and dry seasons ($\chi^2 = 63.75$, df = 3, P >0.05).

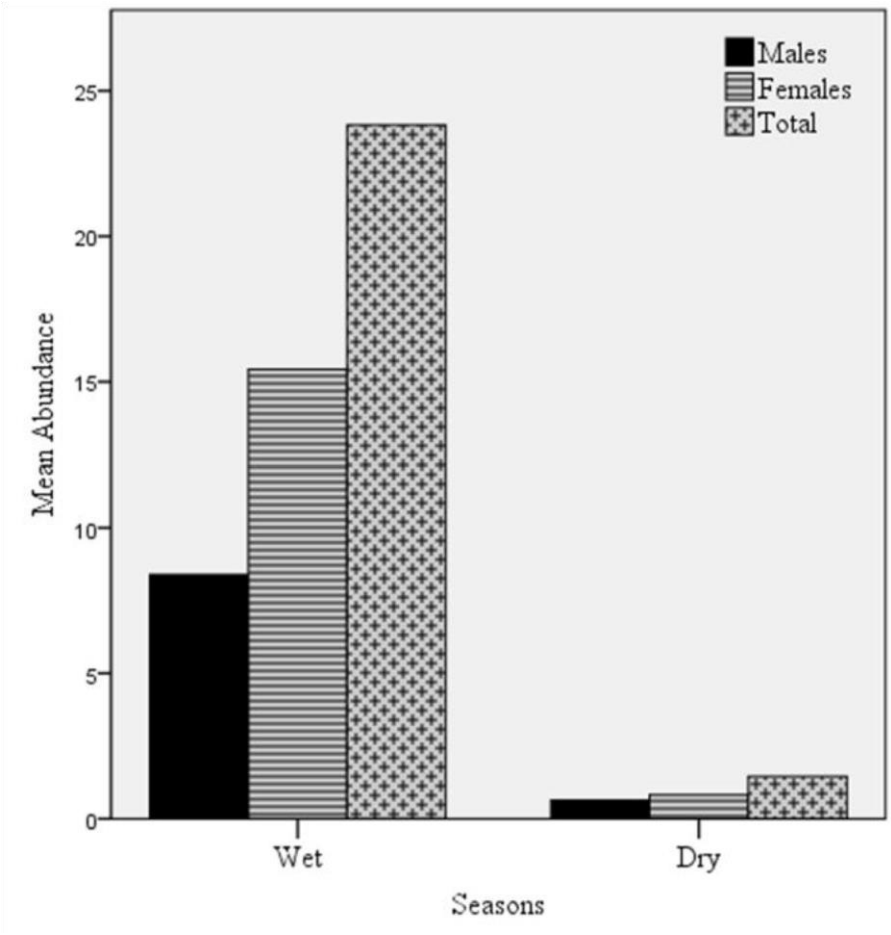

Figure 5. Sex composition of Beisa oryx during wet and dry seasons.

3.1.3 Distribution and Habitat Association of Beisa oryx

The mean population density was 2.66 individuals/km^2 and 0.1 individuals/km^2 in the grassland, 3.79 individuals/km^2 and 0.4 individuals/km^2 in the shrub grassland and 2.47 individuals/km^2 and 0.86 individuals/km^2 in the bush land habitats during the wet and dry seasons, respectively (Fig. 6). Results of Chi square test showed that there was a significant difference in the occurrence of Beisa oryx in each vegetation type during the wet season (September), Beisa oryx population was observed in shrub grassland and grassland habitats, whereas, during the dry season (December), the species was observed more in shrub grassland and bush land habitats. Results of Chi square test showed that there was a significant difference in their occurrence in various habitat types regardless of seasons ($\chi^2 = 50.37$, df = 2, P<0.05) (Table 3).

Table 3. Habitat association of Beisa Oryx in study area and its variation within and across season.

Treatment	Habitat/season	df	Chi square	P

Within habitat between seasons	Bush land	1	20.09	P<0.001
	Grassland	1	3463.28	P<0.001
	Shrubby grassland	1	571.70	P<0.001
Overall (between seasons)		2	50.37	P<0.05
Within season among habitats	Dry	5	86.9	P<0.01
	Wet	5	262.64	P<0.01

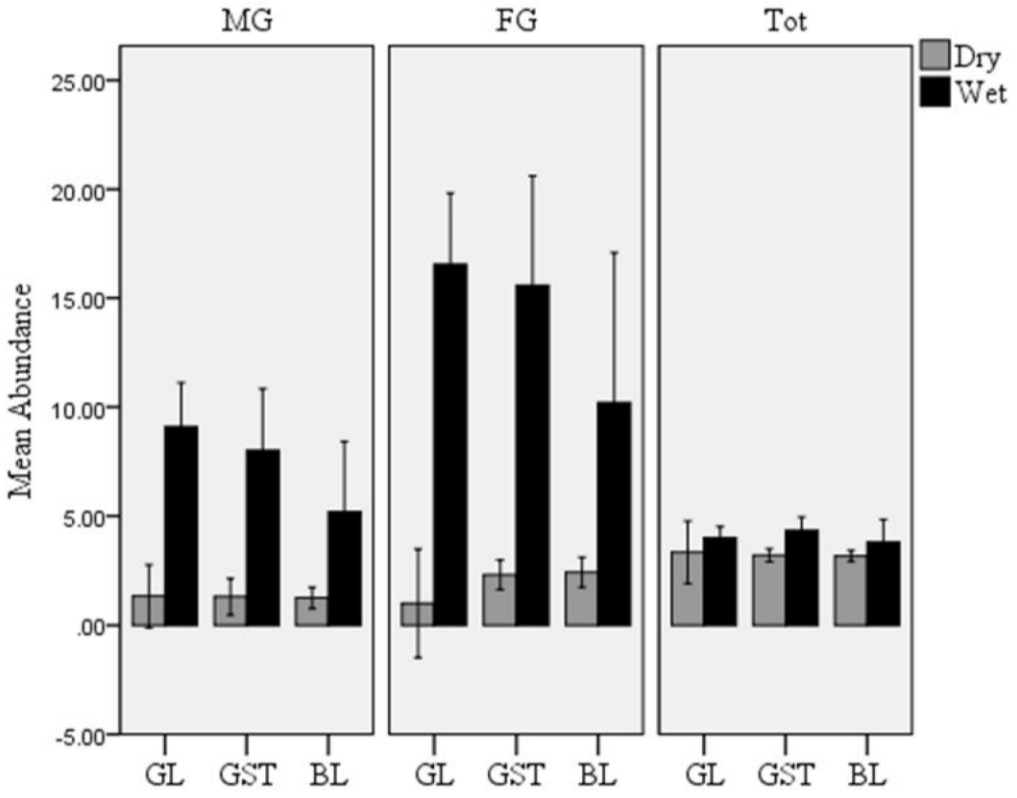

Figure 6. Sex composition of Beisa oryx in different habitat types during wet and dry seasons.

Where GL= Grassland GST= Grassland with scattered trees and BL= Bush land MG= Male herd FG= Females herd Tot= Total).

3.1.4 Estimate of Population Size and Density of Co-occurring Species

Soemmering's gazelle (*Gazella soemmeringi*) was observed in all transects both during wet and dry seasons. The present survey revealed that the mean population size was 77.75 (SE= 5.75) and 17.75 (SE= 2.2) individuals during the wet and dry seasons,

respectively. The average population size was 47.75 (SE= 3.975). The mean population estimates was 1,197 ± 291(SE) (Table 4).

Gerenuk (*Litocranius walleri*) was encountered in several transects during the present study. The mean population size with standard error was 8.5 (1.34) and 2.5 (0.48) during the dry and the wet season respectively. The average population size was 5.5 ± 0.91. The mean population estimates with standard error of the species in the study area was 126 ± 63 (Table 4).

Table 4. Mean population estimate of three major wild animals of in study area.

Year	Common name	Mean population estimate
2015	Beisa oryx	722 ± 119
	Soemmering's gazelle	1,197 ± 291
	Gerenuk	126 ± 63

Of all species encountered in the present survey Soemmering's gazelle had the highest density both during the wet (3.82/km^2) and dry (1.88/km^2) seasons. Beisa oryx had higher density than Gerenuk during the wet season (2.98/km^2 for Beisa oryx and 0.14/km^2 for Gerenuk). However, the dry season density of Gerenuk was higher than that of the Beisa oryx (0.47/km^{2}for Gerenuk and 0.45/km^2 for Beisa oryx).

3.1.5 Habitat Use Overlap of Beisa oryx with Other Co-occurring Herbivores

Wet season mean population sizes of Soemmering's gazelle and Gerenuk were significantly different from the dry season ($F_{1\ 22} = 50.36$ $P<0.05$ for Soemmering's gazelle and $F_{1\ 22} = 34.8$, $P<0.05$) (Fig.7).

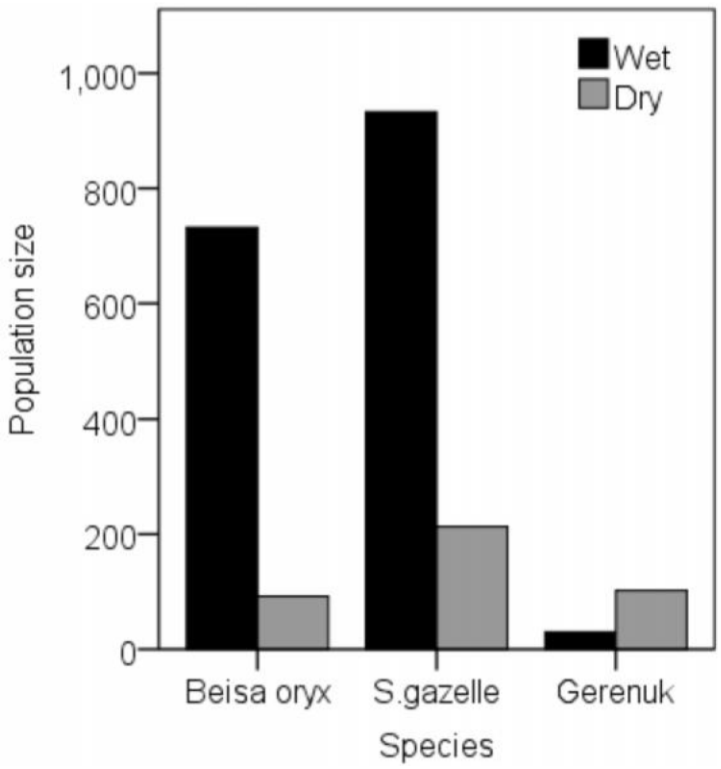

Figure 7. Population size of other co-occurring herbivores during wet and dry seasons.

Comparisons of mean population density of these animals in different habitats of study area between the two seasons showed significant differences (Fig 8). Chi-square test comparing the occurrence of Beisa oryx and the two co-occurring ungulates showed non-significant difference between seasons for each vegetation type ($\chi^2 = 1.86$, df = 5, P = 86.7 in open grassland, $\chi^2 = 0.99$, df = 5, P = 96.2 in shrubby grassland and $\chi^2 = 2.2$, df = 5, P = 82 in bush land) (Fig. 8).

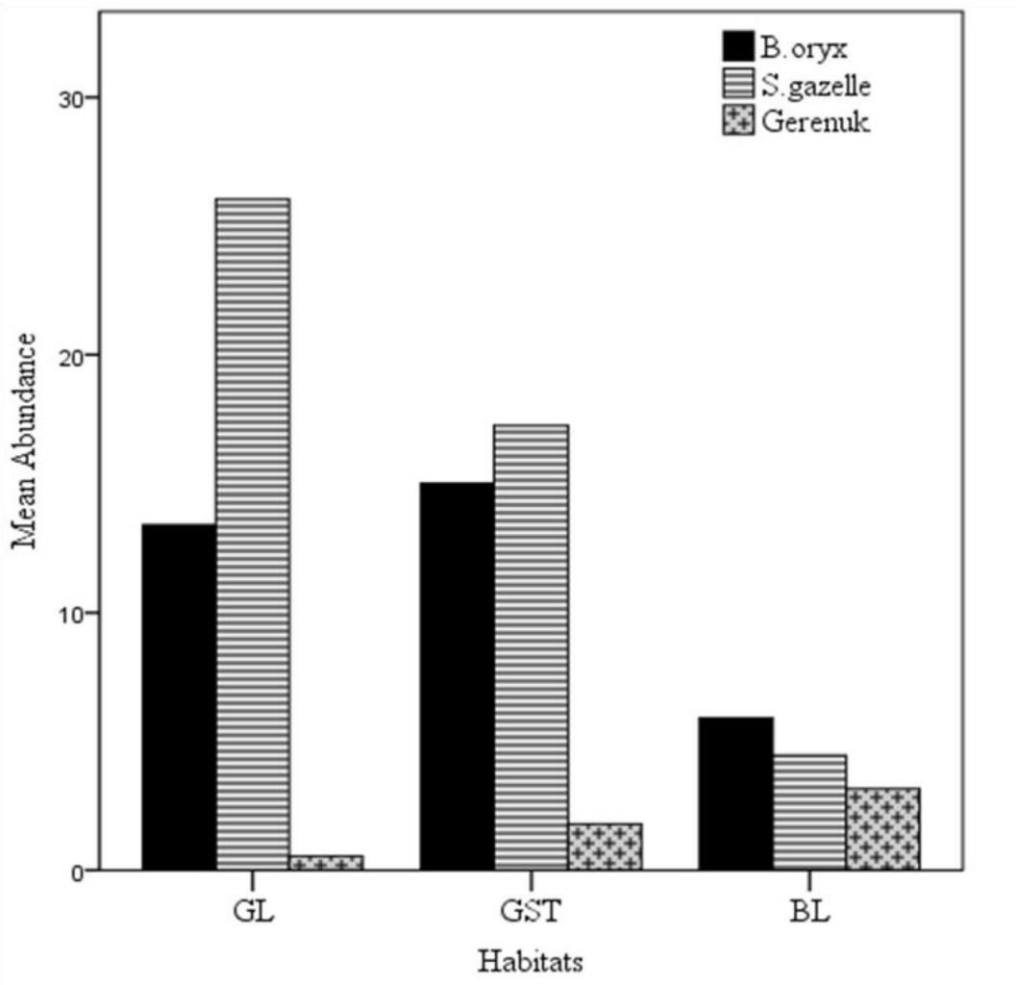

Figure 8. Habitat use of herbivores during the wet and dry seasons.

(Where GL= Grassland, GST = Grassland with scattered trees, BL= Bushland).

Regardless of habitat type, the overall co-occurrence of all the three ungulates between seasons was not significantly different. There was high habitat use overlap between Beisa oryx and Soemmering's gazelle (P = 0.934). Their association with Gerenuk was also more or less similar (P = 0.649 with Beisa oryx and P = 0.637 with Soemmering's gazelle)

(Table 5).

Table 5. Habitat use overlap among the three co-occurring wild ungulates of AWR.

Common name	P	df	Chi square
Beisa oryx vs Soemmering's gazelle	0.934096	6	1.836605
Beisa oryx vs Gerenuk	0.649895	6	4.19805
Soemmering's gazelle vs Gerenuk	0.637074	6	4.293127

DISCUSSION

3.1.6 Beisa Oryx Population Estimate and Trend

The present study revealed that the population status of Beisa oryx in study area is decreasing compared to its population in the past. As a result of the prevailing drought for two successive years in the area, the current population estimates was lower than the estimation carried out by previous workers (22% decline). Drought causes the animals to shift to less productive and more drought tolerant plant species (Grime *et al.,* 2008). This change, affects both the occurrence and behavior of species that feed on such vegetation, leading to population collapse in wild animals. Gandiwa and Zisadza (2010) have reported similar findings from Gonarezhou National Park, Zimbabwe, where 1,500 African elephants (*Loxodonta africana)* died after severe drought in 1991–1992.

It is unsurprising that the population size was found to be lower during dry season compared to the wet season, which accords well with the findings of Fanuel Kebede (2013) on ungulates in study area. More specifically, Cherie Enawgaw (2004) also reported that Beisa oryx population abundance vary between seasons in Awash National Park; higher during wet season than during the dry season. There are a number of reasons for such seasonal difference in ungulate populations. Rainfall is one of the important factors that determine the population dynamics of species, especially in African savannahs, due to changes in vegetation structure and composition in response to the limited rainfall (Ogutu *et al.,* 2008). Reproduction, survival and movements of wild ungulates are highly responsive to rainfall fluctuations, leading to population fluctuations between seasons. Furthermore, drought dramatically increases rates of breakdown in arid land and vegetation leading to further desertification, soil erosion and dust storms, posing negative impacts on wild animals such ecosystems (Omar and Roy, 2010). The prevailing drought for two successive years in and around the present study area had killed thousands of livestock and wild animals in the study area (Fig. 9). However, the effect on wild ungulates seems to be minimal compared to domestic animals. This is because domestic animals drink water on daily basis and they are incapable of adapting to drought compared to drought-tolerant wild animals, such as Beisa oryx and Soemmerring's gazelle. The population size of the species in the study area was higher during the wet season than the dry season. The variation observed was caused by the change in the resource requirements of the species in different habitat types. The availability of resource during the wet season probably made the Beisa oryx to form large herds and spend more time on feeding in the open grassland and shrubby grassland habitat and conversely spent less time in bush land habitat type.

Ungulates form large herds during the wet season and small herds during the dry season (Durant *et al.,* 1986). This was also observed from the results of the present study. Beisa oryx formed larger herds up to 30 individuals during wet season, while they disperse during the dry season. The largest herd observed had only four individuals during the dry season. Large herd size of Beisa oryx was aggregated during the wet season, while during the dry season, they were distributed in a wider area forming smaller herds and solitary individuals.

Figure 9. The skeleton of Beisa oryx in study area.

3.1.7 Population Structure

All unidentified individuals of Beisa oryx were adults; as sex identification was not possible as a result of the difficulty in spotting their genital organs. They were commonly observed ranging from large herds (composed of several males, females and sub-adults) to solitary individuals during the study period. Age and sex composition may be influenced by a variety of environmental factors. Unequal sex ratio can occur favoring either males or females in a population. In the present study, females have high proportion in the population. Estes (1974) explained that the possible reasons for an unequal sex ratio may be an increased predation pressure on males, due to greater boldness or the emigration of subordinate males to less favorable habitats. This reason might also be the cause for uneven sex ratio of Beisa oryx in study area. The large number of breeding females indicates that the species has high potential to increase its population, if better conservation measures are implemented. However, there was no calf observed during the dry season. This is certainly due to the drought condition in the area limiting the food resources.

3.1.8 Distribution and Habitat Association of Beisa oryx

Beisa oryx is distributed mainly in the open grassland habitat of the plains during the wet season. Its distribution was extended to the shrubby grassland and bush land habitats during the dry season. The present distribution pattern was in the open grassland habitat and shrubby grassland during the wet season and relatively similar pattern was observed during the dry season. A compassion of the seasonal changes in habitat association showed Beisa oryx has high preference to the grassland and shrub grassland habitat during the wet season while preferring the shrub grassland and bush

land habitat during the dry season. Ungulates form large population size during the wet season and decline throughout the dry season (Durant *et al.,* 1986). This was also observed from the results of the present study. Data on habitat association of the species revealed that there was a significant difference in the distribution of Beisa oryx among habitat types (open grassland, shrubby grassland and bush land) both during the wet and dry seasons. Beisa oryx was observed in open grassland and shrubby grassland habitat forming large herds. They also spent most of the wet season grazing together with less water requirement. However, during the dry season, the majority of the individuals disappear from the reserve. Only few solitary individuals and small herds were observed mainly in the bush land and shrubby grassland habitats of the reserve. Significant population of Beisa oryx moves to the area where critical resources are located outside the reserve. Thus, the seasonal local movement of the species depends on the availability of critical resources (water and pasture) condition of the area. The seasonal water sources persist only for a few months during and after rainy seasons. The permanent water sources are the Ewaso Nyiro located outside the reserve. During the dry season, a considerable number of the species was observed in the study area control hunting area adjacent to the reserve (Personal observation, 2016). This situation may expose the species to the pressure of hunting (Fig 10).

Figure 10. A road kill of Beisa oryx in the study area.

3.1.9 Habitat Use, Population Estimate and Density of Other Herbivores

Habitat use, population estimate and density of the three major wild animals were carried out since only three species were commonly observed along the transect lines. Thus, no habitat use, population estimate and density were done for rarely observed wild animals along transect lines. Monitoring trends in animal populations is a key aspect in the management of wildlife. Acevedo *et al.,* (2008) explained that monitoring schemes must generate reliable estimates of abundance to allow assessment of population trends. Ecological theory emphasizes the logic of spatially extensive movements across a heterogeneous environment so that wildlife can make best use of spatially separated key resources (Burnsilver *et al.,* 2003). Herbivores should be able to locate themselves in areas where they can maximize their energy gains (Bailey *et al.,* 1996) within the natural constraints imposed by abiotic factors such as slope and distance to water.

Apart from season, Beisa oryx and Soemmering gazelle occur in open grassland and shrubby grassland. There was high habitat use overlap between the two species. This observed habitat overlap might be attributable to the degree of similarities in their feeding ecology. However, Gerenuk is mainly browsers and spent more time in the bush land habitat. So, there was only low habitat overlap observed in the case of Gerenuk with Beisa oryx and Soemmering gazelle regardless of season.

The present population estimate and density of Beisa oryx and Soemmering gazelle was low compared to the earlier studies (Fanuel kebede, 2013). This shows that the population of wild herbivores in the reserve is declining from time to time. Drought has an important effect on herbivores in savannah species. Species living in the Mara Serengeti ecosystem have declined by 58% in the last 20 years due to drought related effects on vegetation (Ottichilo *et al.,* 2000). The 2009 drought in the Amboseli ecosystem has reduced the wildebeest (*Connochaetes taurinus*) and zebra (*Equus quagga*) populations by 70 – 95 % (KWS *et al.,* 2010).

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Large concentrations of wild mammals in Africa now occur only in national parks and other types of protected areas, which cover only about seven percent of the African landmass (Happold, 1995). The Beisa oryx population had wider distribution in East Africa, but with a reduced population. The present population estimate in the reserve revealed that its population has declined by 22% within the last five years. The expansion of invasive species and bush encroachment, unsystematic

Development activities, high level of displacement due to intensive livestock grazing and settlements are the major factors for the decline. More than 50% of the reserve has lost the potential to harbor large wild herbivores due to high modification by humans and encroachment of indigenous and exotic shrubs and herbs

Due to the devastating drought during for two successive years, the majority of the Beisa oryx population is forced to depart from the reserve during the dry season. They locally migrate separately to the north of the reserve around the plain area where critical resources (water and pasture) occur while very few individuals stay in the surrounding Ewaso Nyiro.

In order to maintain the Beisa oryx and other wild herbivores, urgent conservation strategy is required that can benefit both the wildlife and the communities adjoining the reserve.

4.2 Recommendations

The main recommendations are the following.

1. The population status of Beisa oryx and other wild ungulates have declined alarmingly in study area, mainly due to adverse human activities. Thus, there is an urgent need to take immediate measures against those threats to halt the depletion.

2. The problems of bush encroachment and invasive species *(Prosophis junifora)* are becoming a serious threat particularly for plain dwelling animals in the reserve. Thus, conservation efforts should focus on reducing the threats to ensure the longterm survival of key wild ungulates in the reserve.
3. Beisa oryx distribution depends on the availability of water and pasture. The species suffers from depredation, truck collision and hunting disturbance mainly as they move to Ewaso Nyiro in search of water during the dry season.
4. There is only less data on population and ecology of most of the wild ungulates in Ewaso Nyiro. Constant and long term investigations on the ecology and population assessment of key wild animals are essential to identify ecological problems and to maintain their habitats sustainably.

The Nakuprat is one of the major wildlife centers in Kenya with high tourism potential due to its spectacular landscape. Therefore, it is very essential to promote ecotourism in order to generate income for the local community at large.

5.0 References

A.W, G. (2000). Caprinae and Hippotragini(Bovidae,mammalia) in the upper Miocene. *Antelope,Deer and relatives(E.S Vrba and G.B Schaller,eds*, 65-83.

Asefu, A. (2016). interspecific association in ungulates of the Bale mountains National park Ethiopia. *Afr. J. Ecol. doi: 10.1111/aje.12290*.

Bailae, D. (1994). *Methods of Social Sciences Research.* London: The Free Press Collier 478pp.

Bibi, F., M. Bukhsianidze, A. W. Gentry, D. Geraads, D. S. Kostopoulos and E. Vrba . (2009). The fossil record and evolution of Bovidae: state of the field. *J.palaeantology 12*, 1-11.

Buckland, S.T., Anderson, D.R., Bernham, K.P and Laake, J.L. (1993). Distance sampling, establishing abundance of biological population.

Burnham, K.P., Anderson, D.R. and Laake, J. L. (n.d.). Estimation of density from line transect sampling of biological population.

conservancy, L. W. (2009). *"Newsletter No. 9" (PDF).* . Isiolo.

CR, F. (1975). Climate and the Food habits of Ungulates on Galana Ranch research. *East Afr.Wildl.J.13*, 203-220.

Dale and Beyeler. (2000). Challenges in the development and use of ecological indicators. 3-10.

database, A. A. (1998). antelope status report. *African antelope database*, 36.

Douglas E. Musiega, Kazadi Sanga-Ngoie, Kaoru Fukuyama. (2006). A framework for predicting and visualizing the East African wildebeest migration-route patterns in variable climatic conditions using GIS and RS. *Ecological research21,4*, 330.

E, B. (2007). *Survey Research. The Practice of Social Research.* . Belmont, CA:Thomson Wadsworth.305pp.

Ecology and Community Based Conservation of the Grevy's zebra (Equus grevyi) and the African wild ass(Equus africanus) in the Afar region,Ethiopia PHD dissertation. (2013).

Gandiwa E and Zisadza p. (2010). Wildlife management in Gonarezhou National Park,SouthEast Zimbabwe:climate change and implications for management. *Nat.Faun25*, 95-104.

Geraads, D., Blondel, C., Likius, A., Mackaye, H. T., Vignaud, P and Brunet, M. . (2008). new hippotragini(bovidae,mammalia) from the latr miocene of toros-menalla(chad). *J.Verteb paleon 28*, 231-242.

Geraads, D., Blondel, C., Likius, A., Mackaye, H. T., Vignaud, P and Brunet, M. . (2008). new hippotragini(bovidae,mammalia) from the miocene of toros-menalla(chad). *J.Verteb paleon28*, 231-242.

Groves, C. (2013). *Genus oryx: handbook of the mammals of the world: Hoofed mammals(D.E Wilson and R.A Mittermeier eds* (Vol. 2). Lynx Ediciens Barcelona.

Groves, C. P and Grubb, P. (2011). Ungulate taxonomy.

Grubb, P. (2000).). Morphoclinal Evolution in Ungulates. pp. 156–170 in Antelope, Deer, and relatives. *E.S Vrba and G.B Schaller, eds*.

Grubb, P. (2005). Order Artiodactyla in mammal species of the world: Ataxonomic and geographic Reference. *(D. E. Wilson and D. M. Reeder, eds.). 3rd ed.*, 637-722.

Harrison S, and Bruna E. (1999). Habitat fragmentation and large-scale conservation; what do we know for sure? *Ecography 22* , 225-232.

Iyengar, A., Diniz, F. M., Gilbert, T., Woodfine, T., Knowles, J. and Maclean, N. (2006). structure and evolution of the mitochondrial control region in oryx. *J.molecul.phylogenet evol.40*, 305-314.

J, K. (1997). The Kingdon Field Guide to African Mammals. London. *Academic Press*.

Kebede, F. (2013). Ecology and Community Based Conservation of the Grevy's zebra in the Afar region,Ethiopia PHD dissertation.

King, J. M., Kingaby, G. P., Colvin, J. G and Heath, B. R. . (1975). seasonal variation in water turnover by oryx and eland on the galana game ranch research project. *East Afr.wild.J13*, 287-296.

Lewis ,J,C and Wilson ,R.T. (1979). The ecology of Swayne's Hartebeest. *J.Biol.conserv.15*, 1-12.

Msoffe, F., Kshatriyaj, M., Neselee, M. and Said, M. (2011). *Novel forms of livestock and wildlife integration adjacent protected areas.* Arusha Tanzania.

Norton-Griffiths. (1978). *counting animalsA series of handbooks on techniques in african wildlife ecologyeds) african wildlife leadership foundation.* Nairobi. .

O, O. T. (2014). Population Ecology of Maasai Giraffe (Giraffa camelopardalis Tippelskirchi) In Relation To Climate Variability In Southern Kenya, PhD thesis, University of Nairobi. *Thesis*.

Ogutu J O, Owen Smith, N.piepho H-P and Said M Y. (2011). continuing wildlife population declines and range contraction in Mara region of kenya during 1977-2009. *Journal of zoology 285*, 99-109. Retrieved from . doi:10.1111/j.1469-7998.2011.00818.x

P, I. (1976). Wet season movement of individual heartbeest of the Serengati migratory herd. *East Afri. wild.J.9*, 158-169.

Pittiglio, C., A. K. Skidmore, H. van Gils, and. Prins. H.H.T. (2012). Identifying transit corridors for elephant using along time-series. *International journal of applied earth observation and geo-information 14*, 61-72.

Rosenzweig, M. (1996). Species Diversity in Space and Time.

Sinclair, A. a. (1978). population dynamics of large mammals. Nairobi: African wildlife foundation.

SSC, I. (2008). Antelope specialist group. *oryx Beisa, The IUCN Red List of Threatened species*. Retrieved 3 5, 2018, from .http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T15571A4828060.en.

Taylor, C. (1969). Hygroscopic food: a source of water for desert antelopes. . *Nature 219*, 181-182.

W.J, S. (1996). Ecological Census Techniques: A Handbook, Cambridge university london. London: cambridge university.

Yalden DW, Largen MJ,. (1996). Endemic mammals of Ethiopia. *Mammal review 22(3/4)*, 115-150.

.