ABUNDANCE AND DISTRIBUTION OF PUKU (*Kobus vardoni*) IN KILOMBERO GAME CONTROLLED AREA

BY

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ABSTRACT

Puku antelope (*Kobus vardoni*) is the most specialized and representative large mammal in the wetland of Kilombero Game Controlled Area (KGCA). The purpose of this study was to assess the abundance and distribution of puku in KGCA. Specific objectives were:- To assess the puku population density and population size in the KGCA; to assess the distribution of puku antelope in the KGCA and to identify human activities that influence the abundance and distribution of puku in the KGCA. The data on animal counts were collected in three blocks based on some identified aspects i.e. intact habitat block, moderately degraded habitat block and the highly degraded habitat block. Purposive sampling technique was used for socio-economic data collection in six villages adjacent to KGCA. The households were randomly selected for formal interview. The Statistical Package for Social Sciences (SPSS), Ms Excel programme and Statistical Analysis Software (SAS) were used to analyze qualitative and quantitative data. The results indicate that there is a great variation of puku population and density between blocks. The intact habitat block showed high density of puku (53.8 individuals/km^2), moderate degraded habitat and highly degraded habitat (18.2 individuals /km^2 and 5.1 individuals /km^2) respectively. This study also indicate that, there was a significant difference between blocks ($p<0.05$) from intact, moderately and highly degraded blocks. The male mean counts of puku were significantly different ($p<0.0005$) while other puku classes were significantly different ($p<0.0001$). It is concluded that the increases of anthropogenic activities are among the contributing factors which result into negative impact on puku population and density in KGCA. Therefore, it is recommended that there is a need to upgrade the status of KGCA to be a game reserve. Also, there should be land use plans for the villages surrounding KGCA and livestock carrying capacity should be controlled in each village.

DECLARATION

I, GERALD MARTINI KAUKI do hereby declare to the Senate of Sokoine University of Agriculture that, this dissertation is my own original work and has neither been submitted nor being concurrently submitted for degree award at any other Institution.

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10/11/2010
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The above declaration confirmed

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Date

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ABBREVIATIONS AND ACRONYMS

CV	-	Coefficient of variation
DGO	-	District Game Officer
DNRO	-	District Natural Resources Officer
DRC	-	Democratic Republic of Congo
FAO		Food and Agriculture Organization
GCAs	-	Game Controlled Areas
GPS	-	Global Position System
GRs	-	Game Reserves
IIED	-	International Institute for Environment and Development
IPCC	-	Inter-governmental Panel on Climate Change
IRA	-	Institute of Resource Assessment
IUCN	-	International Union for Conservation of Nature and Natural Resources
KGCA	-	Kilombero Game Controlled Area
KVTC	-	Kilombero Valley Teak Company
NCA	-	Ngorongoro Conservation Area
NGOs	-	Non-Governmental Organizations
NPs	-	National Parks
PAs	-	Protected Areas
SAS	-	Statistical Analysis Software
SD	-	Standard Deviation
SE	-	Standard Error
SPSS	-	Statistical Package for Social Sciences
SUA	-	Sokoine University of Agriculture

TAWIRI	-	Tanzania Wildlife Research Institute
TWCM	-	Tanzania Wildlife Conservation Monitoring
UDC	-	Ulanga District Council
UNDP	-	United Nations Development Programme
UNEP	-	United Nations Environmental Programme
URT	-	United Republic of Tanzania
VEOs	-	Village Executive Officers
VGSs	-	Village Game Scouts
WCAs	-	Wildlife Conservation Areas
WF	-	Wild Footprint
WWF	-	Worldwide Fund for Nature

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Puku (*Kobus vardoni*) is an antelope of medium size that has a scattered distribution across southern and central Africa. Geographically the puku population is found in northern Angola, northern Botswana, Malawi, northern-east Namibia, southern Tanzania, Democratic Republic of Congo (DRC), Zambia and Zimbabwe (East, 1998).

Puku have limited distribution in Africa, confined to the areas drained by tributaries of Zambezi River in Zambia and a few isolated pockets in Tanzania. According to East (1998) it is estimated that in Tanzania 75% of the total puku population is now restricted to the Kilombero valley which is an area rich in agricultural potential and natural resources. In other places of Africa, the species is found mainly in moist savanna and floodplains containing rivers or marshes (Stuart, 1997) and some might be found in adjacent areas of light woodland (Nowak, 1998). In the past, puku antelopes were widely distributed across savannah grasslands and floodplains, but at present they are only found as isolated populations in wetland ecosystems (East, 1998).

Worldwide, antelope populations are under increasing threat of extinction from unsustainable hunting (Thirgood *et al.*, 1994; Lushchekina *et al.*, 1999) and habitat change (East, 1998; Hilton-Taylor, 2000). Antelopes are important because they play a vital role in the ecological function of forest and savanna habitats (Maddock, 1979; McNaughton, 1979; East, 1998) and also provide protein, skins and tourist attraction (East, 1998). The relationship between the human exploitation of antelopes and any conservation measures

designed to protect species and habitats is particularly important in areas that do not receive high levels of wildlife protection.

The puku population is greatly reduced in some areas, notably Angola, Botswana and Democratic Republic of Congo (Goldspink *et al.*, 1998). Only about 150 individuals remain in Botswana, all concentrated in the Chobe National Park. Studies in Kasanka National Park in Zambia found that male puku were especially vulnerable to poaching (Goldspink *et al.*, 1998). There were large areas of unoccupied suitable habitats in Zambia and after five years of anti-poaching control in that area the population size of puku increased. This provides hope for the recruitment of the species in areas where its numbers have been depleted (Goldspink *et al.*, 1998).

Of the eight countries in Africa in which puku population are found only Tanzania contain a large especially in Kilombero valley (East, 1998). The puku antelopes in the Kilombero valley are a unique natural heritage and resource of great importance nationally and globally. Kilombero valley is the largest fresh water wetland in East Africa and the third RAMSAR site in Tanzania (East, 1998). Kilombero valley has the status of a Game Controlled Area (GCA), which only limits a few human activities.

The Kilombero valley consists of a seasonal flood plain, miombo woodland and fragments of Eastern-Arc ever-green mountain forest rich in biodiversity. The large part of the area is dominated by the Kibasila Swamp, and Kilombero River, which forms part of Africa's largest river basin joining the Great Ruaha, Rufiji and Luwegu rivers (East,1998).

1.2 Problem Statement and Justification

Human activities cause ecological impacts on natural ecosystems all over the world particularly in the third world countries. The accelerated decline of African wildlife species and populations is caused by increasing environmental disturbances, habitat deterioration, consumptive utilization and expansion of agriculture (Peter, 1996). In recent years, the expansion of human settlements, livestock grazing, agriculture and commercial forestry has increased the pressure on Tanzania's natural habitats (Kiss, 1996; East, 1998; Caro, 1999; Luoga, 2000). Pandey (1979) argues that the vulnerability of ecosystems is due to human interference through social and economic systems which include encroachment, overgrazing, illicit cutting of forest trees, fire, mining, poor fishing practices and quarrying. Surveys in the last two decades suggested that agricultural expansion, deforestation, and overgrazing had reduced the original wildlife habitats in Africa by over 65% (Kiss, 1990). These activities may contribute towards the distribution and abundance of puku in Kilombero Game Controlled Area (KGCA).

Puku antelope has a very specific habitat preference such as, floodplains or river margins, and they are very sensitive to habitat destruction due to human activities. It is the only wildlife species not represented in any other National Parks (NPs) or Game Reserves (GRs) in Tanzania (TWCM, 1998). The species is under threat due to the increased use and manipulation of natural resources. Many of seasonally flooded grasslands have historically been used for puku grazing during the dry season (Timberlake, 1998).

The Wildlife Policy of Tanzania (URT, 1998a) gives direction on conservation and advocates sustainable use of wildlife resources for the benefit of the present and future generations. However, unprecedented human activities coupled with poor law enforcement have continued to put pressure on the remaining antelope populations. In a

few parts of Africa, populations of some antelope species remain relatively understudied and this can be a barrier to effective conservation and management. The estimation of antelope population size has been essential for ecological theory and management (Norton-Griffiths, 1978). Conservation planning and practice rely heavily on available information generated at local scale for decision making (Cheryl *et al.*, 2004; Barnes, 1990). Tutin *et al.* (1995) pointed out that, survey data are essential for conservation and management of the protected areas. It is important to estimate numbers, but it is probably even more important to monitor trends in order to establish whether the populations are stable, declining or increasing over time.

This study therefore, provides information on puku abundance and distribution in Kilombero Game Controlled Area (KGCA) to enhance effective management and conservation of the species. Also the study contributes to scientific knowledge on the puku antelope, which may be used by other stakeholders including policy makers, wildlife managers, researchers, scholars and non-governmental organization (NGOs).

1.3 The Overall Objective

To assess the abundance and distribution of puku antelope in the Kilombero Game Controlled Area.

1.3.1 Specific objectives

i. To assess the puku population density and population size in the KGCA.

ii. To assess the distribution of puku antelope in the KGCA.

iii. To identify human activities that influences the abundance and distribution of puku in the KGCA.

1.3.2 Research questions

The following research questions were used to guide the study:

i. What is the population density and population size of puku antelope in the KGCA?

ii. What is the distribution pattern of the puku antelope in the KGCA?

iii. What is the preferred habitat for puku in the KGCA?

iv. What are the main human activities that influence the abundance and distribution of puku in the KGCA?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Global Conservation Efforts and Status of Wildlife Species

The International Union for Conservation of Nature and Natural Resources (IUCN) estimates that as of 2004, 23% of mammals, 57% of invertebrates, 70% of plants, and 41% of the total evaluated species are at risk of extinction around the globe (IUCN, 2005). In most areas of the world today, the destruction of habitat caused by factors such as habitat destruction, cattle ranching, agriculture, and the development of infrastructure constitute the greatest threat to biodiversity. In Africa, which is one of the few remaining areas in the world where vast expanses of forest remain intact, wildlife faces a much different challenge. On the other hand, despite committing more areas under legal protection, pressures on wildlife habitats are still growing. Wildlife species are increasingly being threatened, endangered, and becoming locally extinct. The 2006 IUCN Red List indicates that of 5 205 species evaluated in 1996, 25% of all mammals and 11% of all birds were threatened (IUCN, 2006). Recently, about 162 species of mammals and 181 of birds are critically endangered. Habitat loss due to human population growth and resulting activities is universally the greatest threat, impacting 86% of the threatened birds and mammals and 88% of the threatened amphibians (IUCN, 2006). These biodiversity are under threats due to human population pressure as well as global climatic change due to global warming.

2.2 Impact of Climatic Change on Forestry and Wildlife Conservation

Major problems facing the world today are global climate change and population growth. The link between the two problems being food quality and quantity for various species. Unfortunately climate change has badly affected food availability and many people find it

hard to meet their basic needs (Mwandosya *et al.*, 1998). Climate change impacts have direct consequences on the economy, ecosystems, water resources, weather events, health issues, desertification, sea level rise (IPCC, 2001). The wider global climate change trends are greatly reflected in Tanzania's climate. Because of her geographical location and the topographical characteristics.

Tanzania is among top African countries in terms of biodiversity of both flora and fauna species in its terrestrial and marine ecosystems. It has numerous vegetation cover distributed along the diverse landscapes. Its characteristic geographic location, i.e. located close to the equator and elevation ranging from sea level to Africa's highest point which is 5 985m above sea level. That situation makes Tanzania home to a number of endemic plants and animal species most of which are of world importance. Although Tanzania is among the richest countries in terms of biodiversity (UNEP, 1998; URT, 2003), her forests are under major continuing danger of deforestation from both anthropogenic activities and climate change. In 2002, it was estimated that deforestation rate in the country was about 91 276 hectares per year. Among the main anthropogenic activities responsible for deforestation include overgrazing, high demands for wood energy, wildfires, and over-exploitation of wood resources for commercial purposes and clearing for agriculture and settlement. The named activities have been contributing a significant amount of CO2 in the atmosphere while increasingly reducing carbon sinks (URT, 2003). Like in many other countries in Africa, the biodiversity of Tanzania is expected to change as different species try to adjust and cope with the impacts of climate change (Lovett *et al.*, 2005). Much more, climate change may trigger loss of some species; displacement and forced migration of ecosystems and potentially adjust seasons and migratory roots of birds and animals. Yet entire genetic structures, as affected by changes in breading rates, could be altered (Fick *at al.*, 2005). According to URT (2003) changes in forest types,

species composition and distribution will have major ecological implications in the country. Therefore more efforts are needed for the global biodiversity conservation.

2.3 Wildlife Conservation in Tanzania

Wildlife conservation in Africa is not new to the indigenous people because from time immemorial they have practised informal and traditional wildlife conservation. The formal and or conventional wildlife conservation in Tanzania dates back to the German rule. These rulers created Wildlife Conservation Areas (WCAs), which were known as Game Reserves or Hunting Reserves with the aim of regulating the exploitation of the wild animals. For example, in Tanganyika by 1911 the German rulers had set aside about 5% of the colony into 15 PAs to conserve wildlife but there were no WCAs designated as NPs (Baldus, 2000).

At the time of Tanzania's independence in 1961, there were only two NPs, namely, Serengeti and Lake Manyara. After independence, Tanzania increased the number of WCAs to the present status of 15 National Parks, 31 Game Reserves, 38 Game Controlled Area and the Ngorongoro Conservation Area (URT, 2002a). During that period, the conservation philosophy was based on ecological principles of making WCAs unique ecological entities. Conservationists emphasized on non-consumptive use of wildlife management and research activities were focused and biased on the ecology of animals. After political independence, Tanzania embraced and continued colonial policies and laws that supported conventional conservation approach. The conventional conservation approach also applied in partially protected areas where human activities were allowed.

The expansion of human settlements, illegal hunting and habitat destruction in the partially protected areas cause pressure on Africa's wildlife communities (East, 1998; Caro, 1999). In Game Controlled Areas, there is controlled annual off-take quota for certain species, but since agro-pastoralists activities are not regulated there is presence of human and livestock population that is thought to either indirectly (e.g. habitat changes through over-grazing) or directly (e.g. illegal hunting, food and water competition and spread of diseases as well) adversely affect wildlife populations. Conservationists argued that, the best hope of protecting wildlife species lies strictly in protected areas with heavy restrictions and enforcement on resource use (Oates, 1997; Terborgh *et al.*, 2002; Struhsaker *et al.*, 2005).

2.4 Overview of Puku Status in Tanzania

In the past puku have been existed widely in savanna grasslands and floodplain wetlands of southern and central Africa (Kingdon, 1982; East, 1998). Currently, the species have been eliminated from most of their former range and now have a scattered and isolated distribution in eight African countries. Large puku populations are now only found in Zambia and Tanzania, with the former having a fragmented population consisting of sub-populations comprising 500–8 500 animals (East, 1998). Until recently, Tanzania had three puku populations, but the smallest population on the eastern shores of Lake Nyasa became extinct before 1960s (Kingdon, 1982; Rodgers, 1984). Rodgers (1984) and East (1998) reported two other populations in Tanzania around Lake Rukwa area and the Kilombero valley. Small numbers of the latter population occasionally extend into the northwest of the adjacent Selous Game Reserve (East, 1998). The Lake Rukwa population was estimated at approximately 1 500 animals (East, 1998) and is threatened by the rise of the lake level, cultivation and illegal hunting (Rodgers, 1984). According to (TWCM, 1992) there are no puku censuses done in KGCA.

2.5 Wildlife Population Parameters

The wildlife populations have specific characteristics, including population size (total number of animals) or density (animals per unit area), fertility, birth, and recruitment rates; and age-specific mortality rates. Interactions between birth and death rates lead to changes in population size and density. In many cases, information about changes on birth and death or trends is easier to obtain than absolute estimates and may be a sufficient basis for management decisions. Roberson and Lindzey (1984) and Smith (1989) point out that the density estimates are used by wildlife management agencies for setting harvest quotas and other management prescriptions.

The distribution, abundance, and population trend of wildlife species are fundamental parameters for helping to determine the conservation status of wildlife species. An understanding of demographic trends of wildlife variables is essential for conservation and management (Siex and Struhsaker, 1999) and can provide important base-line data for long-term monitoring (Rosser, 1989; Goldspink *et al.*, 1998).

Information on species or animal abundance is important to wildlife managers to be able to understand the number of individual animals in a population of a certain species (Caughley and Gunn, 1993). According to the IUCN Red List the B criterion shows that, the species with small geographical distribution suggest that the species are declining. This criterion relies on knowledge of geographic range size, where a species with a range of less than 20 000 km^2 could qualify to be in one of the categories of threat depending on the size of animals. For example, density estimates of marine mammals in the Gulf of Maine between 1991 and 1997 were used to support fisheries management system in setting of fish quotas (Read and Brownstein, 2003). Furthermore, population density can be used as a guide to assess habitat management and conservation (Sisk *et al.*, 2000). It is evident that the conservation values of given protected areas (PAs) are well indicated by

the presence or even in low numbers of animals (Gaillard *et al.*, 1998). Unfortunately species abundance information at local scales is difficult or expensive to obtain (Gaston *et al.*, 2000).

Modern conservation practice is highly dependent on data on the abundance of species within an area, since it provides a basis for making practical conservation decisions. Abundance can, in theory, be predicted if the area occupied by individuals of species can be determined and all the underlying assumptions are met (Gaston and Blackburn, 2000).

2.6 Socio-economic Factors Affecting Wildlife

2.6.1 Human population

The human population around protected areas has expanded rapidly over the past 30 years, furthermore livestock populations have grown as well and the demand for land has risen (Caro *et al.*, 1999). The growth of human population increases the demand for natural resources. Since people are prohibited to use wildlife resource in the protected areas, they obtain them illegally. The growth of human population has, on the one hand inevitably caused the destruction of habitats leading to the reduction of wildlife (McNeely *et al.*, 1994). Ndziku (2001), for example, reported that the Maasai Mara National Reserve in Kenya has lost 50 to 80% of its wildlife species since 1970 due to the spread of commercial cultivation, which has converted critical areas such as migration routes and calving ground to mechanized agriculture.

Campbell and Hofer (1995) and Loibooki *et al.* (2002) showed that there was a positive correlation between illegal hunting in Serengeti National Park and human population growth around the park. Hackel (1999) identified three conservation problems associated with people settling or using new areas as a result of human population growth: (1)

disruption of ecological processes essential in maintaining long term biodiversity (for example dispersal and colonization might become more difficult as habitat is transformed to human use); (2) increased hunting for home consumption or market; and (3) increased pressure from local people to open protected lands for community use.

2.6.2 Low income and poverty

Poverty is defined as "a state of deprivation associated with lack of incomes and assets, physical weakness, isolation, vulnerability and powerlessness" (Chambers, 1987). It is considered as a rural phenomenon in Tanzania, where about 22% and 39% of its population live below the food poverty line and basic needs poverty line respectively (URT, 2002b). The proportions living below US$1 and US$2 per day are 19.9% and 59.7%, respectively, thus making 41.6% of the population live below the national poverty line (UNDP, 2003). Poverty is a primary source of degradation of natural resources in most developing countries although law prohibits certain practices and activities on natural resources. A need to survive may prompt violation of this law. Poor people are compelled to adopt the coping strategies, set priorities and make economic choices that are ecologically destructive. Illegal hunting in Serengeti National Park, for example, is linked to income poverty (Loibooki *et al.*, 2002). Inability to afford modern technologies and inputs required for more agricultural output leaves people with no option, but to open new farms in the wildlife sensitive areas such as protected areas, migratory corridors water catchments and dispersal areas.

2.6.3 Poaching

Poaching refers to illegal shooting, trapping or taking of game and or resource from protected areas. Accelerating rates of resource extraction generate much concern worldwide. The destructive processes such as habitat degradation, fragmentation, and

overexploitation, threaten natural resources and bring up the ideas on conservation of wild nature (Kiss 2004; Borgerhoff and Coppolillo, 2005). For example, illegal hunting for bushmeat continues to be an increasing problem in several areas of the Zambezi region (Timberlake, 1998). Poaching is a severe problem that affects the ungulates and in particular the kob (*Kobus kob*) population (Fischer and Linsenmair, 2001).

The negative impact of poaching cannot be overlooked in wildlife management, particularly because it can lead to the total extinction of a species, e.g. black rhino (*Diceros bicornis*) in Botswana (Othomile, 1997). Poaching takes place around the country and particularly across national boarders for economically rewarding species like elephants. Poaching can be carried out either for subsistence or for commercial purposes.

The consequence of ineffective management and lack of funds have caused uncontrolled poaching of animals such as hippopotamus (*Hippopotamus amphibius*) (Timberlake, 1998), elephant, and rhino (Adams and McShane, 1996). An estimated 200 000 animals are killed annually in Africa, resulting into large declines in the numbers of some species (Leader-Williams *et al.*, 1996). The number of black rhinos in the continent dropped from 65 000 in 1970 to 2 400 in 1995 due to an increase in demand for horns while that of the elephants was reduced from 1.3 million in 1979 to 625 000 in 1989 (Adams and McShane, 1996). Africa's lion (*Panthera leo*) population has also suffered from human impacts. Peek (1986) argues that overexploitation of wildlife due to illegal hunting is likely to bring hazards to wildlife species falling as victims, on the biological reproduction for their natural regeneration.

2.6.4 Bushmeat consumption threatening wildlife in Africa

Wildlife especially the large mammals contribute a substantial biomass of bushmeat sold in the markets, restaurants and consumed by households especially those in the vicinity of protected areas. Robinson and Bennet (2000) argue that the current rate of bushmeat consumption in west and central Africa is unsustainable. It is estimated that if the current trend in bushmeat consumption continues, the demand for bushmeat will increase by 2-4% per year. This level of consumption exceeds the annual growth rate of many wildlife species in west and central Africa, posing a particular threat to species with lower reproductive cycles like elephant (Eves and Ruggiero, 2002).

Furthermore, rural people consume more busmeat per capita than urban dwellers (Wilkie and Carpenter, 1999). For example fifty per cent of people in central Africa are already reported to be food insecure (FAO, 2001). Unless substantial efforts are made to increase domestic protein supply, both wildlife populations and the food security of millions of poor people will be severely compromised. For the rural communities the demand for bushmeat for subsistence is driven primarily by the nutritional need for animal protein in the absence of acceptable alternatives (Bernes, 2002), hence the greater per capita rural consumption. It is true that for the majority of remote rural bushmeat consumers in west and central Africa are due to few cheaper substitutes (Wilkie and Carpenter, 1999). For example, in three local markets in Cameroon the price of bushmeat was only 10 - 25% of available substitutes (Barnes and Lahm, 1997).

Also in Tanzania, bushmeat is becoming increasingly important for maintaining standards of living, as a source of protein and cash income (Barnet, 2000). Illegal bushmeat trade is therefore developing fast in urban areas and is beginning to drive demand (Milledge and Barnet, 2000). Hence, unless bushmeat hunting becomes managed within sustainable

limits, it will be an increasing threat to conservation of wildlife as human populations continue to grow.

In addition, harvesting of wildlife population is sustainable when the rate of extraction does not exceed the population's rate of increase. Therefore, it should be put into considerations to ensure that the population is not reduced by hunting to levels at which the species is vulnerable to local extinction or where ecosystem function is affected (Robinson and Redford, 1991; Bennett and Robinson, 2000).

2.6.5 Livestock and agriculture

Many partially protected areas have been established to protect not only unique and valuable natural features and conditions, but natural processes as well. Management is generally oriented toward limiting and managing human-induced changes in the partially protected areas. It is human-induced changes that we find most disturbing especially in partially protected areas. Such human-induced changes are overgrazing, agricultural expansion/encroachment, spread of diseases from domestic animals to wildlife, wildlife habitat destruction, water competition between domestic animals and wildlife.

The grazing lands support many species of wildlife as well as domestic livestock. As residents and consumers of vegetation on grazing lands, wildlife and their habitats must be properly managed if the land and associated resources are to be used wisely and efficiently.

The expansion of human and livestock populations into parts of the country that were previously solely occupied by wildlife has increased vulnerability of wildlife due to poaching and destruction of natural habitats. Recent studies on protected areas carried out in Central African forests highlight that even the protected areas are not free from human disturbances, and that wildlife in protected areas can easily be exploited beyond

sustainable levels (Noss, 1995). It is approximated that 160 000 migratory and resident animals are illegally hunted in the National Park and associated protected areas, yielding an approximate annual supply of 11 950 tonnes of bushmeat (Hofer *et al.*, 1996). An assessment of the protected areas in the Central African Republic (Blom, 2001) illustrates that human disturbance is the main threat to the effectiveness of wildlife conservation in many protected areas.

Some species of wildlife have become greatly reduced in number especially for species that are specialized to a particular habitat or limited in distribution are threatened with extinction. The disappearance of any species is an ecological, cultural, and in some cases, an economic loss. Productive wildlife populations in balance with available food, cover, and water resources fill a niche on grazing land ecosystems and can contribute to the overall environmental quality of the area. Alteration of the natural fire regime, hydrologic parameters of wetland sites and improper grazing practices have had a significant impact on some wildlife habitats in the protected areas. In Tanzania some areas like KGCA have been experiencing habitat loss because of the expansion of farm areas and increased large number of livestock as well as expansion of human population.

2.7 Human population expansion and natural resource conservation in Tanzania

Around 10 percent of the total land area of Tanzania is covered by National Parks and Game Reserves (Kurji, 1977; UNEP, 1993). Over years, new conservation areas have been created, hence, increasing the area demarcated as protected. The expansion of protected areas coupled with expanding human population and resource requirements have in a way stimulated much land use conflicts.

To a large extent, human population and its ecological impact is a major subject in wildlife and forest conservation. The underlying assumption here is that increases in human population increases the competition between man and wildlife for the limited resources (Kurji, 1977). Expansions of the ecological threshold of the human population often occur at the expense of the range for the wildlife, hence, decreasing the survival chances of the wildlife. Evidence from literature demonstrates significant impacts of human expansion into protected areas (Kurji, 1981, 1985; Meerteens *et al.*, 1995).

Rapid population growth around conservation areas of Tanzania has become of great local and national significance due to nation's commitment to promote both conservation and development. Examining the demographic settings around major conservation areas of Tanzania, Kurji (1976) proposed that human settlements should be given priority in any scheme of wildlife ecological study in order to enable the understanding of the dynamics of spatial development of settlements.

In the Ngorongoro Conservation Area (NCA), a rapid growth of pastoral population has been documented from 8 500 people in 1966 to over 18 000 in 1978 suggesting a growth rate of 6.5 percent (Kurji, 1981). This rapid population change posed a big challenge of ensuring long-term biodiversity, productivity and stability of the NCA. Human population increases has also been observed in the Maswa Game Reserve from 1.5 million in 1948 to over 3.3 millions people in 1978 (Kurji, 1985). The rapid population growth in this area was mainly influenced by large-scale migrations especially in the 1950s (Meertens *et al.*, 1995) and by a high internal population growth momentum due to high fertility (Kurji, 1985). Consequently, there have been settlement expansions into the Maswa Game Reserve.

Recent studies in Tabora Region illustrate that almost all Forest Reserves in the region are encroached (Shishira and Yanda, 1998). The encroachment is in the form of new settlements and clearing of forests for agriculture and livestock grazing. Due to uncontrolled harvesting of fuel wood especially for tobacco curing, deforestation of both the public lands and the forest reserves has proceeded at a rapid speed.

The changing population densities and growth rates around the major conservation areas in Tanzania signals the impact of human population and activities on the future conservation of those areas. Trends around the Serengeti-Maswa area demonstrate an increasing potential for conflict between the expanding human population on the one hand, and wildlife population and environmental conservation on the other (Meertens *et al.,* 1995). Increasing population densities pose a threat to land resources and necessitate an integrated land use management strategy.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Area

3.1.1 Location and climate

This study was carried out in Kilombero Game Controlled Area (KGCA) which is located between 036°10'E and 08°40'S in Ulanga and Kilombero districts in Morogoro region. KGCA is located between Udzungwa Mountains and Mahenge escarpment, which form part of the Eastern Arc Mountains. KGCA covers a total of 4 000 km^2 which is within Kilombero valley. The temperatures in the study area range between 22^0 to 41^0C and the mean annual rainfall ranges from 1 000 to 2 000 mm (WWF, 1992).

3.1.2 Vegetation

The study area is mainly composed of five vegetation types:- Wooded grassland, teak plantation, riverine forest, multi-layered evergreen forest and miombo woodland. The miombo woodland is a matrix of open woodland dominated by *Brachystegia spiciformis* trees combined with smaller dense areas of riverine vegetation. There is a sparse under storey of tall *Panicum maximum* grasses. The miombo mid-storey consists mostly of small trees e.g. *Dalbergia melanoxylon* (Lovett and Pócs, 1993). The lowland forest area had suffered the effects of timber extraction and has uneven canopy cover. The teak plantations established adjacent to the study area comprise very dense sapling undergrowth layer of various genera such as *Alchornea*, *Cassipourea*, *Dichapetalum*, *Harrisonia* and *Markhami*. Also, the multi-layered evergreen forest with high biological diversity is found within a smaller area.

3.1.3 Wildlife

The KGCA is rich in wildlife species and the most numerous species found in the area are puku (*Kobus vadoni*), bushbuck (*Tragelaphus scriptus*), hippopotamus (*Hippopotamus amphibius*), hartebeest (*Alcelaphus lichtensteinii*), warthog (*Phacochoerus aethiopicus*), elephant (*Loxodonta africana*), sable antelope (*Hippotragus niger*), lion (*Panthera leo*), impala (*Aepyceros melampus*), crocodile (*Crocodylus niloticus*), zebra (*Equus burchellii*), hyena (*Crocuta crocuta*) and eland (*Tragelaphus taurotragus*). Other species include vervet monkey (*Chlorocebus aethiops*), waterbuck (*Kobus ellipsiprymnus*), Buffalo (*Syncerus caffer*), Leopard (*Panthera pardus*) and Reedbuck (*Redunca arundmum*) among many others (Korning *et al.*, 1995).

3.2 Methods

3.2.1 Research design

Both socio-economic, animal distribution and abundance were conducted. A cross-sectional research design was adopted for socio-economic survey. This design allows a collection of data at one point in time from a sample selected to represent some larger population. The design was suitable for the purposes of description and determination of relationships between and among variables at the time of study (Babbie, 1990). One point in time means that the data are collected in as a short time as is feasible (Singleton *et al.*, 1993). This design was considered suitable for the study because of the limitation of time available for data collection. The activity was well accommodated using the line transect for animal counts.

3.2.2 Reconnaissance survey

Reconnaissance survey was conducted so as to get a general picture of the research area. The aim was to identify location of the research sites and sample size of interviewees

whereby familiarization with the research area was made by researcher and also the questionnaires were tested and modified accordingly. Pre-testing helped to check the validity and reliability of the questionnaire items (Kajembe and Luoga, 1996).

3.2.3 Sample and sampling procedures

Kothari (2001) defines a sample as a small group of respondents drawn from a population about which a researcher is interested in getting information so as to arrive to conclusions. The rationale for choosing the villages in the study area included the following:- The selected villages are adjacent to the KGCA and which are generally occupied by immigrants, particularly agro-pastoralists from other regions. Such people cause expansion of agricultural activities towards KGCA. Also, the selected villages are among the villages mostly involved in illegal bush meat selling in their local restaurants.

Purposive sampling technique was used in the selection of the six villages out of 32 villages adjacent to KGCA. The number of respondents for each village was obtained from official lists of village households. Random sampling method was used to select households. The sampling was conducted after obtaining a list of households from each village with assistance village executive officer. The list then acted as a sampling frame from which the households to be interviewed were selected randomly using random numbers from a scientific calculator. Random sampling avoids bias and gives a better representation of the intended population.

A sample size of 220 households was found sufficient to allow reliable analysis for the time allocated for the study. Boyd *et al.* (1981) and Kajembe and Luoga (1996), have shown that significant population representation is achieved when a random sample of at

least 5% is taken. The human population, number of households, number of sampled households and sample size of the study area are presented for each village in Table 1.

Table 1: Human population and households in the study villages

Villages	Population	Total Number of Households in the Village	Number of Sampled Households	Sample Size (%)
Igawa	5 448	720	36	5.0
Malinyi	5 945	602	36	6.0
Itete Minazini	4 057	609	36	5.9
Itete Njiwa	5 350	723	36	5.0
Lupiro	5 729	708	36	5.1
Igumbiro	6 871	842	40	4.7
Total	**33 400**	**4 204**	**220**	**5.2**

3.2.4 Block sampling for animal counts

Purposive sampling method was used to select three blocks i.e. intact habitat block with a total area of 48 km^2, moderately degraded block 65 km^2 and highly degraded habitat block with an area of 53 km^2 based on some known observational aspects as described by Stoddard *et al.* (1998). In case of this study; intact habitat block refers to the area found in the central part of the flood plain; moderately degraded habitat block which refers to the areas located near the villages with reduced agricultural activities and the highly degraded habitat block which refers to the areas with heavy cultivation, grazing and extensive teak plantations establishment. This sampling design is a good compromise between methodological and implementation constraints, and allowed reliable estimates of puku abundance at the scale of the study blocks (Stoddard *et al.*, 1998). All blocks had only one habitat type i.e. grassland.

3.3 Data collection

Data collection method refers to both the selection of sampled units and the way the data is collected from them (Seidman, 1991). The methodologies used were household heads

interview, direct observation and the line transect animal counts. Both primary and secondary data were collected.

3.3.1 Procedures for animal counts

A total of 18 systematic transects with a total length of 143.9 km spaced at an interval of three kilometres in all three blocks were traversed by a vehicle at a speed of 10 km/h to 20 km/h. Each block had six transects traversed once a month for three months. The starting point of each transect line within a block was placed systematically using a map of the study area. The baseline point of each transect remained the same in each block and the straight transect line was maintained as much as possible. Each transect line had an average of 8 km. The animals counted recoded using the line transect distance sampling method (Buckland *et al.*, 2001). According to Norton-Griffiths (1978), transects may be laid out randomly or in a regular pattern, lying perpendicular to the baseline.

The observer slowly drives following the established line transects searching for puku. For each puku seen, the observer measured the perpendicular distance (a) from the transect line to the point where the puku was first detected (Fig. 1). Alternatively, both sighting distance (b) from the observer to the puku when it was detected and the sighting angle (ø) between the transect line and the line of sight were measured by using range finder. The sighting distances and sighting angles were used to calculate perpendicular distances when the perpendicular distance was not measured. When observer moving along the transect is likely to see all puku located on or very near the line. However, the probability of detecting puku diminishes as distance from the transect increases.

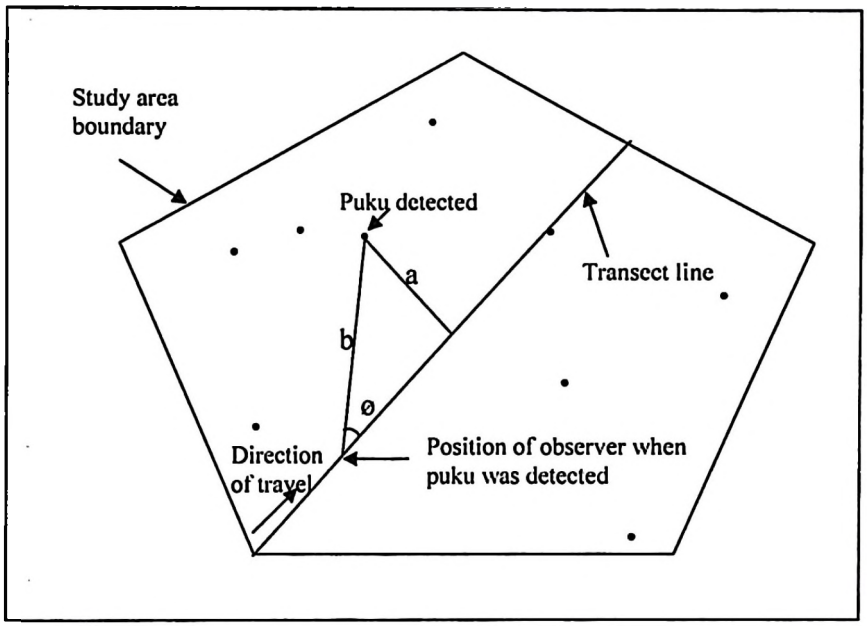

Figure 1: General representation of line-transect sampling of puku population

Sometimes groups of puku were considered as a single unit because individuals in pairs or herds are not statistically independent of each other (Alldredge and Ratti, 1986). Therefore, each sighting of a pair or herds of the puku were considered as a single observation. The centre of the group was approximately determined by each observer and used as the detection point for distance measurement. Global Position System (GPS) was used to show the position of animals and to calculate area of the blocks.

The distance travelled was measured by the vehicle odometer. The survey was conducted from October to December 2007 during the dry season; therefore all areas were passable by vehicle. Each transect was covered once in the morning (0800 to 1200) and once in the evening (1600 to 1800) each month because at midday most animals were not active. The transects were covered from opposite ends in order to minimize any bias arising from

variation in animal activity with time. The vegetation type was recorded when doing the animal census.

3.3.2 Assumptions of the line transects method

i. The probability of detecting animal decreases with increasing distance from the line of travel.
ii. Animals on the line are detected with certainty.
iii. Animals are detected at their initial location.
iv. Perpendicular distances (or sighting distances and angles) are measured without error.

3.3.3 Socio-economic data collection

The qualitative and quantitative data consisted of original information which was collected from communities in the course of the research. The researcher used structured questionnaires for interviews, focus group discussion, direct observation, and checklist to gather information from the village communities, tourist hunting companies and local government staff. Secondary data was obtained through a review of relevant documents. Several literatures were visited and relevant information related to the study was collected.

Questionnaires

Structured questionnaire (Appendix 2) was used to collect data on socio-economic activities. These tool unveiled information on socio-economic data such as education level, trend of puku, and community's opinions on the trend of puku, age and tribes. Other information included livestock keeping, land tenure and agricultural activities in the study area. In order to elicit more information, open ended and closed-ended questions were

used. Open ended questions help to get the respondent's views regarding the problem under study; while in the closed-ended interview, respondents were provided with alternative answers. This method of using questionnaire in data collection provide enough information on ethnic groups, age, sex, marital status, education level, size of household, land tenure, number of livestock kept, agricultural activities, types of animals in the area and size of land owned. According to Best and Khan (1993) questionnaires are used because they give desired factual information.

Focus group discussion

Focus group discussion aimed at validating information gathered through other research tools as well as clarifying controversial issues that rose during interview session (Koda, 2000). This technique has been found valuable in gaining insight into the dynamic relationship of altitudes, opinions, motivations concerns and problems related to the area of research. Focused group discussions were conducted using a checklist (Appendix 3). A focus group, involved gathering of several people (usually not more than 10 or 12) to discuss a particular issue for one or two hours. The focus group in this study involved village government leaders, prominent people in the village (preferably old people), members of the Village Natural Resources Committees (VNRCs) and youths. Each group was required to be represented by three members. Kothari (2001) asserts that focus groups are used when a researcher may want to interview several participants simultaneously

Key informants interview

In this study Key informants that were visited included the District Game Officer (DGO) of Ulanga District Council (UDC), tourist hunting company camp managers of Wildfoot prints and Miombo safaries, District Natural Resources Officer (DNRO) and retired

game officers. These people were interviewed to get their professional view on the issue to be researched by using a checklist (Appendix 4).

Participant observation

Participant observation was used to collect qualitative data such as household activities and real situation in the field. The method enabled to connect together different information collected by other methods.

3.3.4 Secondary data collection

Published and unpublished information/data on puku management and conservation were collected from different sources such as local government offices, i.e. Ulanga District Council (UDC) and Kilombero District Council (KDC), Tanzania Wildlife Research Institute (TAWIRI), Sokoine University of Agriculture (SUA) library and various other materials from electronic sources using the internet.

3.4 Data Analysis

Primary data were summarized and coded before entered to the computer. The statistical Package for Social Sciences (SPSS version 12) and MS Excel programmes were used for data analysis. Descriptive statistical analysis for various measures of central tendency was used. These are useful parameters in describing the properties of a population as well as calculation of frequencies, percentages and means for comparison of various data. Bogdan and Buklen (1992) state that data analysis is an important step towards finding out solutions of the studied problem. Focus group discussions and key informant's data were used in clarification of information obtained from household survey.

3.4.1 Analysis of animal counts data

Ms Excel programme was used to summarize animal counts in order to get different classes i.e. male, female, juvenile and infants. The Statistical Analysis Software (SAS) was used for comparison of mean sizes of puku groups sighted between and within blocks. Population size and density of puku individuals were calculated based on the following formula.

$$N = nA/2\overline{X}L$$

Where:

N = Population size of individuals of a species in the whole survey area

n = Number of animals sighted

A = Total area of the survey area in km^2

$\overline{X}$ = Mean perpendicular distance in meters

L = Total length of the transects in kilometers

The Arc View GIS software was used to produce a polygon area by using GPS coordinates taken during animal counts. These coordinates were used to compute the area of the study blocks. The area of each block was computed in order to enable the researcher to compute puku population size and density in the study area. The data of animal counts were subjected to one way analysis of variance general model (GLM) procedure in Statistical Analysis Systems (SAS) in order to compare the mean counts of male, female, juvenile and infants of puku groups sighted in different puku habitat blocks.

3.4.2 Socio-economic data

Data obtained from household survey were analyzed and presented using frequency tables, column charts and pie charts. The Statistical Package for Social Sciences (SPSS

version 12) computer program was used in the analysis of questionnaire data. With this program, frequencies, percentages and other statistical measures were computed and then used in the analysis. Descriptive statistics were summarized and tabulation was employed to report all quantitative information. Frequencies and percentage were calculated to facilitate the drawing up of inferences related to socio-economic findings. The findings were therefore, interpreted, presented and discussed in the context based on research tasks and questions.

3.5 Limitation of the Study

Majority of the respondents in the study area were afraid to provide information concerning issues related to poaching, number of livestock and areas where agricultural activities are conducted. This posed a big problem during the data collection exercise. Therefore, collection of the required data/information involved much explanation because the respondents were aware on bush meat selling in the local black market in their villages. However, to overcome the problem, the researcher assured the respondents that the data collected would be for academic use and would be treated with high level of confidentiality.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Puku Population Size and Density

During the study a total of 1 313 puku comprising of 164 groups were recorded in 18 transects (Table 2). The group sizes ranged from one to 25 individuals. The population sex ratio for adult males and females were biased towards females (1:4). Males were most commonly found as lone individuals or in larger groups of males. Most males occurred in single sex groups (bachelor herds), although one or two solitary males could be found on a particular area. Females by contrast were rarely found in small groups and were more commonly observed in mixed aggregations of two to 15 animals. Also juveniles and infants were commonly found in groups of adults. The results from previous aerial surveys in the Kilombero Valley (Rodgers, 1984) and the ground based counts in this study showed that, puku are usually found in small groups, ranging from two to twelve individuals. This is consistent with the results from other puku populations in Zambia whereby modal group size was three individuals (Goldspink *et al.*, 1998).

Table 2: Puku individuals observed in the surveyed blocks

Surveyed blocks/area	Males	Females	Juveniles	Infants	Total	Percent	Adult Sex ratio
Intact habitat block	120	583	91	55	849	64.7	1:5
Moderately degraded habitat block	77	252	18	9	356	27.1	1:3
Highly degraded habitat block	26	77	5	0	108	8.2	1:3
Total	**223**	**912**	**114**	**64**	**1 313**	**100.0**	**1:4**

4.1.1 Puku counts in the intact habitat block

Out of the 1 313 puku observed in the surveyed blocks, the intact habitat block (Table 2) showed higher number of puku individuals 849 (64.7%) compared to the other blocks. The population size of puku in the intact habitat block was estimated to be 2 584 individuals and the puku population density was 53.8 individuals /km^2. Therefore, among the three blocks surveyed the intact block ranked the highest in population size and density with overall mean of 11.8 ± 0.7 individuals /km^2 (Table 3).

Table 3: Estimated population size and density of puku in the blocks

Habitat Blocks	Block area km^2	Puku observed (n)	Population size (N)	Density km^2	Mean (n)	Standard error (n)
Intact habitat block	48	849	2 584	53.8	11.8	0.7
Moderately degraded	65	356	1 185	18.2	7.3	0.5
Highly degraded habitat	53	108	262	5.1	2.5	0.2

The reason for the high number of puku in the intact habitat block is probably due to high protection against illegal hunting for bush meat conducted by Wild Footprints (WF) tourist hunting company at Itete Njiwa where WF built their permanent camp (Plate 1). WF is the central government agency, which conducts tourist hunting in the study area. Tourist hunting as the wildlife policy of Tanzania points out, is economically viable and it enables sustainable use of wildlife that is consistent with the policy. The wildlife policy of Tanzania 1998 emphasizes sustainable hunting that can contribute significantly to the national economy. Also the Wildlife Policy of Tanzania asserts that "the policy will continue to give wildlife economic value to rural communities to enhance rural development without prejudice to the environment, and in such a way that the benefits compensate for the opportunity cost of this form of land use" (URT, 1998).

Plate 1: Wild Footprint tourist hunting camp at Itete Njiwa village in Kilombero Game Controlled Area

This study revealed that the tourist hunting activities and anti-poaching patrols conducted by WF in the intact habitat block protect wildlife against poachers in order for the company to be sure that, there is a sustainable availability of wildlife species for tourist hunters in each hunting season. Therefore this is done to benefit the company.

Another reason for high puku population density in the area might be due to few agricultural and livestock activities as well as low number of poaching activities. These activities are few because tourist hunters prohibit farmers and agro-pastoralists to carry out their activities such as cultivation and grazing in the central part of the game controlled area. Also in this area there are frequent patrols on wildlife carried out by tourist hunters for the whole year round as compared with the moderately degraded block where patrols are done only during the hunting season which starts in July to December each year. In the highly degraded habitat block, there has never been any patrol activity by tourists' hunters since 1992. This is when the WF abandoned its tourist camp after

increasing human induced activities which caused wild animals including puku to shift to the other areas where they find conducive environment.

4.1.2 Puku counts in the moderately degraded habitat block

In this block, a total of 356 (27.1%) puku individuals were observed. The population size of puku was estimated to be 1 185 individuals and its population density was 18.2 individuals /km^2. This was ranked the second in population size and density with a mean of 7.3 ± 0.5 (Table 3) as compared to the other blocks. The main factors for the few number of puku population in this block could be due to moderate poaching mainly for bush meat which is common in the local black market in the study area. The second factor is expansion of settlement into the game controlled area by the villagers mainly for agricultural activities and searching for pastures for their livestock.

Currently, in this block there is one private company, which deals with tourist hunting. The company is called Miombo Safaris popularly known by the local community as "*Wawindishaji*" or "*Watalii.*" The study revealed that the presence of Miombo Safaris company during the hunting season facilitates patrol activities and hence reduced the number of poachers. During non hunting season however the number of poachers increases as a result, the number of puku decreases while others migrate toward Itete (intact block) where, to some extent, they get protection throughout the year.

4.1.3 Puku counts in the highly degraded habitat block

Unlike other habitat blocks, in this block a small number of puku individuals was found as compared with other blocks such as intact habitat block and moderately degraded habitat block. Only 108 (8.2%) individuals observed with a mean of 2.5 ± 0.2 (Table 3). The population size of puku in the highly degraded block was estimated to be 270 individuals

and its population density was 5.1 individuals /km^2. This suggests that the area is highly disturbed due to poaching, over-grazing of domestic herbivores (Plate 2), agricultural activities, the expansion of human settlements and commercial teak plantation.

Plate 2: Group of cattle grazing in Kilombero Game Conrolled area at Igawa village

Licensed trophy hunting has probably a negligible impact on puku because of very low off-take (Table 4), but illegal hunting poses a serious threat near human settlements during the wet season and in the floodplain during the dry season Goldspink *et al.* (1998) report that, most puku occurred in a relatively small number in the isolated floodplains which are suspected to be decreasing as a consequence of continuing poaching pressure from outside the Kisanka National Park in Zambia.

Table 4: Tourist hunting quotas in Ulanga District for 5 years

Species	Number of animals hunted by tourist hunters for 5 years (2003 - 2007)					Total number of animals hunted
	2003	2004	2005	2006	2007	
Buffalo	106	116	24	87	68	401
Hartebeest	22	60	26	43	27	178
Zebra	12	28	0	14	21	75
Warthog	11	22	9	24	22	88
Eland	2	8	3	6	4	23
Sable	3	5	0	8	8	24
Hyena	1	5	0	8	3	17
Reebuck	8	24	12	25	15	84
Impala	3	19	19	6	5	52
Bushbuck	2	19	5	5	4	35
Hipopotamus	4	8	0	10	5	27
Lion	7	7	0	2	2	18
Leopard	3	5	0	4	3	15
Duiker	1	2	3	0	0	6
Puku	6	6	0	6	6	24
Crocodile	3	1	0	3	2	9
Bush pig	2	5	4	2	2	15
Baboon	1	0	0	3	4	8
Waterbuck	2	10	0	12	8	32

Source: Ulanga District Council annually reports

Generally, the findings of this study indicate that the main reason for having a small number of puku in this block was poor conservation and management of wildlife resources including puku due to increasing number of livestock, human population growth, expansion of farmland, teak plantation development and poaching instances by villagers as well as outsiders from the neighboring districts and other regions of the country. As it is already known that Tanzania faces a number of constraints which affect its current wildlife conservation efforts and being one of the poorest countries in the world, it is faced with rampant poverty, which leads to fewer resources allocation for conservation activities and high financial constraints associated with budgetary limitations. As such, the country is unable to fully fund wildlife conservation activities, research and other activities in this area and hence making it dependent on donor support. Furthermore, Tanzania is faced with high level of indiscriminate poaching both for

subsistence and commercial purposes, institutional structure, legislation and policy related problems (Cumming *et al.*, 1990; URT, 1998; Malisa *et al.*, 2000; Vogel, 2001).

According to the focus group discussion, the researcher noted that, the extension of human settlements, farms and wildlife poaching affected hunting activities previously undertaken by WF company in the highly degraded habitat block. This has made the company to abandon their activities because of the decreasing number of animals due to various human activities. After the WF company abandoned their activities the area remained without security from poachers and other human activities. Unfortunately, the District Council through the District Game Officer is not able to manage wildlife resources in the area due to limited funds. Even though there some initiatives of conservation of wildlife such as encouraging communities adjacent to the wildlife protected areas to establish wildlife management areas still there is a challenge of limited funds from local and central government lead to accelerating poaching and other related activities which cause uneven distribution and threats to wildlife management and conservation.

4.1.4 Comparison of mean sizes of puku groups sighted between blocks and within blocks

This study indicate that there was a significant difference between blocks ($p<0.05$) from intact, moderately and highly degraded habitat blocks. The male mean counts of puku were significantly different ($p<0.0005$) other puku classes (female, juvenile and infants) were significantly different ($p<0.0001$) (Table 5).

Table 5: Comparison of mean sizes of male, female, juvenile and infants of puku groups sighted between blocks

Blocks	Male Mean	Female Mean	Juvenile Mean	Infants Mean
Intact habitat block	2 (0.20)a	8 (0.51)a	1 (0.20)a	1 (0.17)a
Moderate degraded block	2 (0.18)a	5 (0.37)b	0 (0.10)b	0 (0.08)b
Highly degraded block	1 (0.16)b	2 (0.17)c	0 (0.05)b	0 (0.00)b
CV	105.8	59.3	173.0	260.5
P-value	0.0005	0.0001	0.0001	0.0001
RMSE	1.42	3.258	1.188	1.004

Note: The numbers in the parenthesis represent standard error; different letters a-c within the same column differ significantly ($p<0.05$); RMSE-root mean square, CV-Coefficient of variation %

This significant difference is probably due to the increasing grazing pressure by domestic animals, uncontrolled fire outbreak, human population pressure, establishment of teak plantation and expansion agricultural activities. According to East (1998) expansion of human settlements, agriculture, the degradation of rangelands and unsustainable hunting practices are among factors which are currently threatening the populations of antelopes in Africa. The conservation of these herbivores is critical, because in addition to their economic, nutritional and aesthetic value, they can directly or indirectly affect puku regeneration and this would affect biodiversity.

However, the selected puku habitat blocks exhibit differences in terms of classes i.e. male, female, juvenile and infants within habitat blocks. In each habitat block there was a significant difference in mean counts of puku classes ($p< 0.0001$) as shown on Table 6.

Table 6: Comparison of mean sizes of male, female, juvenile and infants of puku groups sighted within blocks

BLOCK	Puku age composition in the study blocks	Mean counts
Intact habitat	Male	1 (0.19)b
	Female	8 (0.50)a
	Juvenile	1 (0.19)b
	Infants	1 (0.16)b
	P-value	< 0.0001
	CV	86.982
	Root MSE	2.5641
Moderate degraded	Male	1(0.18)b
	Female	5 (0.37)a
	Juvenile	0 (0.09)c
	Infants	0 (0.08)c
	P-value	< 0.0001
	CV	88.832
	Root MSE	1.5502
Highly degraded	Male	0 (0.16)b
	Female	2 (0.17)a
	Juvenile	0 (0.04)c
	Infants	0 (0.00)c
	P-value	< 0.0001
	CV	126.3926
	Root MSE	0.7936

Note: The numbers in the parenthesis represent standard error; different letters a-c within the same column differ significantly ($p<0.05$); RMSE-root mean square, CV-Coefficient of variation %

The mean counts of puku classes (male, female, juvenile and infants) in the intact habitat block ranged from one to eight, zero to five and zero to two for intact, moderately degraded and highly degraded habitat block respectively (Table 6). The mean counts of the females observed in each block were higher compared to the rest of the groups (male, juvenile and infants). According to the tourist hunters, this study reveals that male puku are the most hunted animal illegally because they are big in body size and attract poachers compared to the females.

4.1.5 Trends of puku since 1975 in KGCA

Generally, the trend of puku in KGCA is decreasing due to the increased human population and socio-economic activities. The result in Fig. 2 indicates that 75.9% of the respondents reported a decrease of puku population, 11.8% of the respondents were not

aware of the puku trend; while 9.1% claimed that puku population is increasing and the remaining 3.2% claimed that the population of puku as constant.

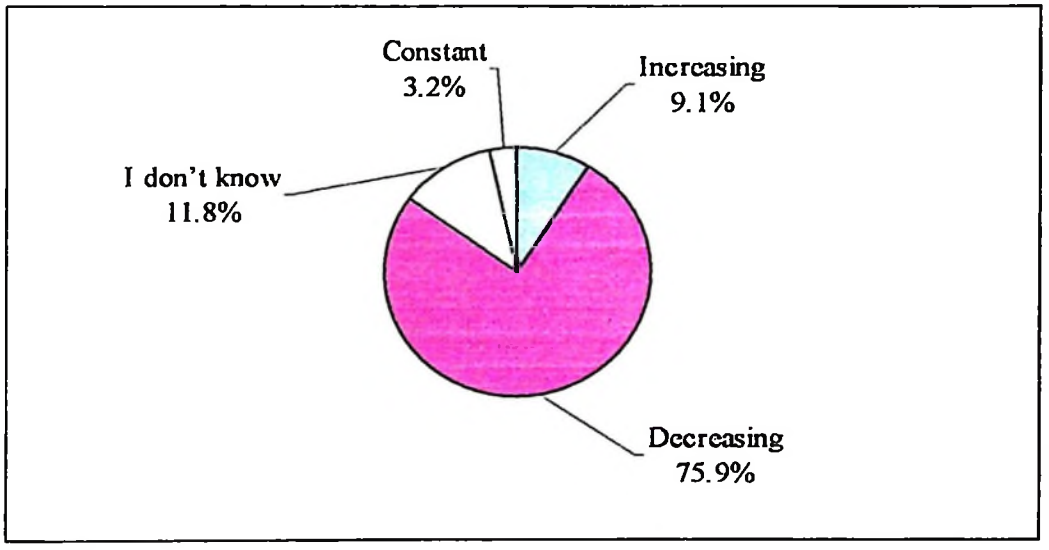

Figure 2: Respondents' opinions on the trend of puku from 1975-2007

From the findings, it was revealed that, the main reasons for decreasing in the population of puku were poaching and agro-pastoralists (54.5%), followed by farming (25.5%). Other activities contributing to the decreasing number of puku include farming, livestock and poachers (6.6%) while some respondents claimed that puku migrated to the intact block (9.7%) and others did not know (3.7%) (Fig. 3). Caro *et al.* (1998) suggest that poaching activity in Tanzania was high in areas used by legal hunters, but not patrolled by guards. Therefore poachers move into the same areas after the end of the hunting season. This implies that increasing socio-economic activities including poaching are the main causes of puku decreasing to some areas in KGCA between 1975-2007.

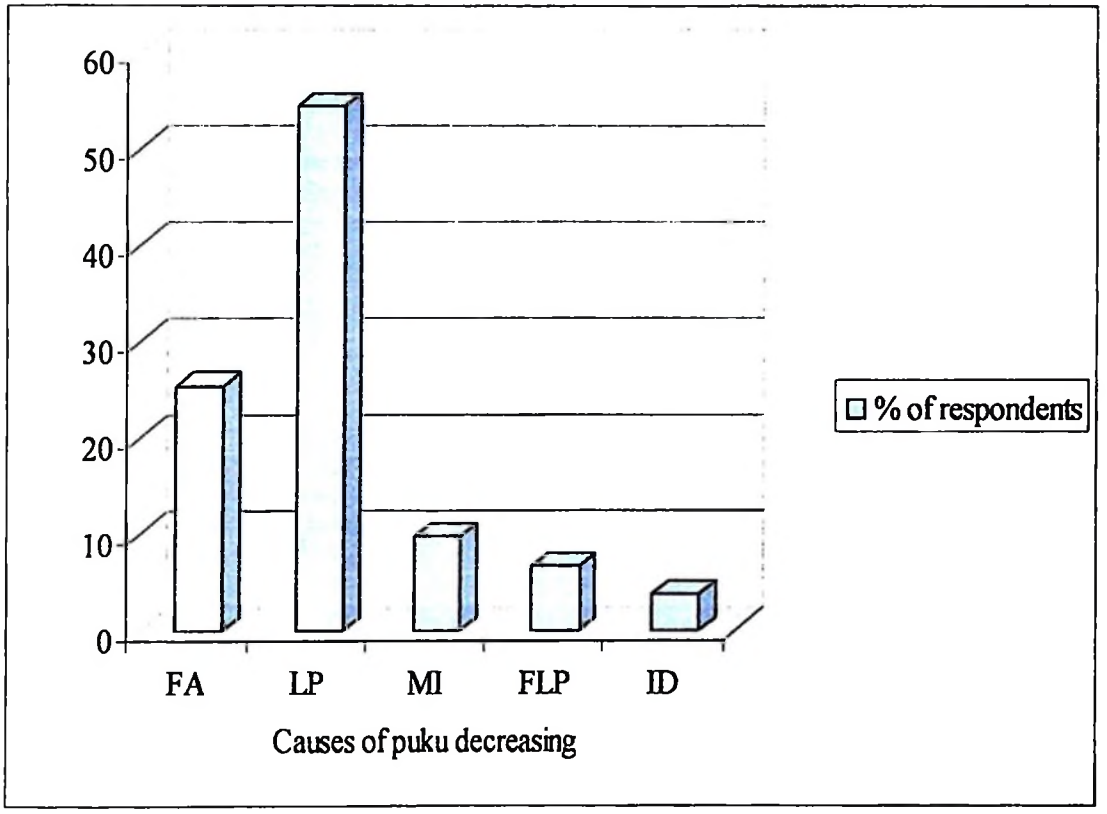

Figure 3: Reasons for decreasing of puku in KGCA

KEY: FA = Farming activities; LP= Livestock keepers and poachers; MI= Migrated to the intact block; FLP= Farming, livestock and poachers, ID= I don't know

The sustainability and distribution of wildlife populations in the partially protected areas such as KGCA is threatened by several factors including commercial poaching for trophies, poaching for bushmeat and other wildlife products for household consumption, and habitat destruction as a result of changed land use. Caro *et al.* (1998) argue that the hunting quotas should be reduced for some species with restricted geographical ranges, which include puku.

4.2 Factors Contributing to Distribution of Puku

Understanding the ecological parameters that influence animal dispersal can provide insight of the areas which are important for that animal population (Foley, 2002). Fryxell and Sinclair (1988) stated that a characteristic of the African savannah ecosystem is the

spatial and temporal variation in resource availability that forces savanna wildlife to shift to the areas where food and water can be obtained. In this study, it was found out that the overall puku density was not evenly distributed to all the three blocks (Fig. 4).

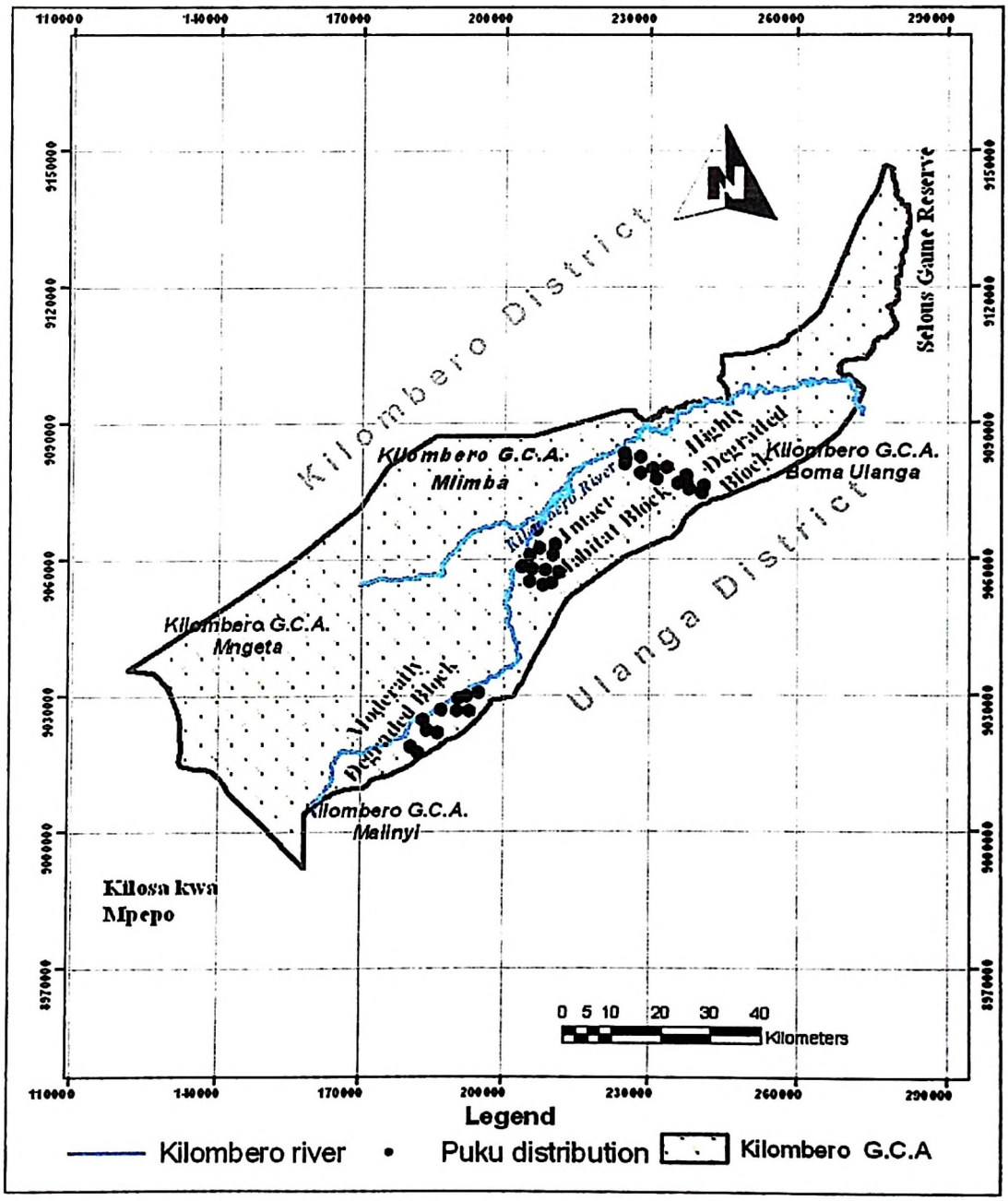

Figure 4: Map of KGCA indicating puku distribution in the study blocks

The reason for such differences can be due to various factors including habitat loss and degradation, competition for water between livestock and wildlife, occurrence of wild fire, establishment of teak commercial plantations and poaching.

4.2.1 Habitat loss and degradation

Any given species is considered to have a preferred area or territory in the habitat. Many activities associated with human habitation of an area cause loss of the habitat of this area and the decrease in the carrying capacity of the land for that species. The wildlife habitat degradation in KGCA results from expansion of agricultural activities and increased number of livestock as observed during the field survey. Furthermore, during focus group discussions it was confirmed that the expansion of agricultural activities, increased number of livestock and human settlements in KGCA over thirty years since 1975 caused wildlife habitat loss and degradation. In addition, the focus group discussion participants reported that in the previous years puku were evenly distributed all over the KGCA but now puku are found in the area with an uneven distribution. This happened because of an increase in poaching activities, human population increase and their socio-economic activities which extended in the wildlife partially protected areas (PAs). This observation concur with the finding by Songorwa (2004), who identified two major problems facing the wildlife conservation in Tanzania, namely encroachment into wildlife areas, resulting from human population increase. The situation is also aggravated by immigration. Songorwa (2004), show that there was an encroachment in Maswa and Kijereshi Game Reserves due to human population increase in communities surrounding these PAs. The population increase led to land pressures, ascribed by competition for natural resources, including land that is needed by both wild animals and people for their survival. WWF (1992) argue that the local human population increased markedly in the beginning of

1970s and as a result the demand for land has grown and the density of livestock has increased in wildlife areas.

4.2.2 Wild fire

The high and growing human population adjacent to the KGCA leads to intense pressure in the KGCA with anthropogenic fire being one of the main threats to this ecosystem. The local farmers adjacent to the KGCA practice traditional subsistence farming and use fire as a management tool. Furthermore, fire is used for hunting, honey collection and charcoal burning. Some of these fires cause significant ecological and socio-economic impacts and if fire enters dense dry tall grasses and high forest then it can cause considerable damage to the wildlife. During the key informants' discussion, the respondents claimed that wildfires are among the threats to the wildlife habitat particularly the young puku in KGCA. The major sources of fires reported by key informants and focus group discussions were clearing land for agriculture, hunting of small animals, clearing pathways for poaching, scaring wild animals done by fishermen as they pass across the KGCA and agro-pastoralists who set uncontrolled fire in order to get fresh grasses for their livestock (Plate 3). According to Sarre and Goldammer (1996), wild fires are world-wide problems and uncontrolled or misused fire wreaks havoc on society and the environment, destroying property and natural capital, depleting nutrient pools, polluting water supplies, reducing biodiversity, increasing emission of greenhouse gases, disrupting communities, decimating livestock and even killing wildlife. Furthermore, fire contributes in changing the landscape structure and species composition including grasslands, savannah, closed forests and woodlands (Christensen, 1985; Goldammer, 1990; Tyler, 1995).

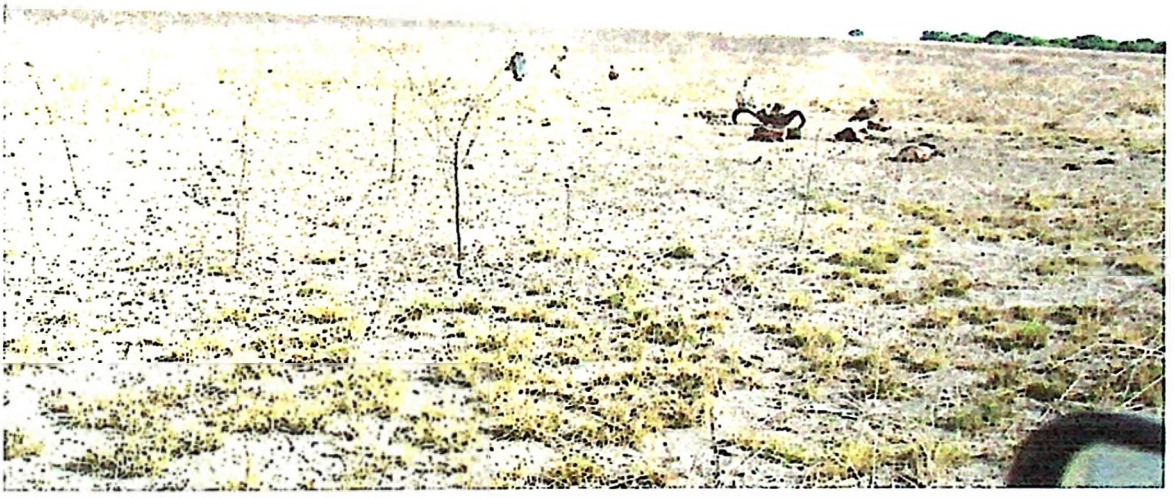

Plate 3: Burned area inside Kilombero Game Controlled Area

4.2.3 Livestock keeping in the study area

The majority of the respondents (65.5%) (Table 7) in the study area were not livestock keepers. Only 34.5% of the respondents were agro-pastoralists and almost all of them were migrants from Shinyanga region who came to the area searching for livestock pasture and suitable land for agriculture. It was observed that the majority of the respondents (87.0%) had no area for their livestock and still 89.6% of the respondents claimed that the area for grazing is not enough. For the livestock keepers interviewed 92.8% reported to be grazing their livestock inside KGCA (Table 7). The way in which livestock grazing activities practiced in KGCA could cause spread of diseases from domestic animals to wildlife in long run but also from wild herbivores to domestic livestock.

During focus group discussion and the key informants' discussions it was reported that the outbreak of conjunctivitis type of infection in puku occurred in 1999 was related to

cattle and this could possibly be due to increased number of cattle in KGCA. However, the increasing number of cattle in the KGCA also increases the potential of wildlife-human contact and consequently the possibility of poaching.

Table 7: Percentage response on livestock keepers in the study villages

Aspects	Percent
(a) Livestock keepers	n = 220
Yes	34.5
No	65.5
(b) Animals kept	n = 220
Cattle	1.8
Goats	2.3
Cattle and goat	5.9
Cattle, goat and sheep	22.3
Non livestock keepers	65.9
Cattle and sheep	1.8
(c) Land owned for livestock grazing	n = 77
Yes	13.0
No	87.0
(d) Grazing area	n = 77
Yes	10.4
No	89.6
(e) Grazing area by livestock keepers	n = 69
Kilombero Game Controlled area (KGCA)	92.8
Village land	4.3
KGCA and village land	2.9

This study showed that livestock keepers kept large herds of animals. For example, in Table 8 the mean number of cattle is about 230 which is thought to exceeded the carrying capacity of the area. The current findings are supported by Ngowe (2003) who reported that expansion of agriculture close to wildlife areas, increasing livestock numbers, poaching and lack of community participation in the wildlife management are among the potential threats to wildlife conservation.

Table 8: Livestock keepers interviewed and the type of livestock kept

Livestock kept	Minimum	Maximum	Mean	S.E.
Cattle	3	550	229.9	11.6
Goats	5	150	44.8	3.2
Sheep	3	200	43.0	4.1

4.2.4 Livestock and wildlife competition for water

The term competition is generally used to refer to any interaction where there is a negative outcome for one or more species. Competition occurs when a number of individuals use common resources that are in a short supply or when they seek a resource that may not be in a short supply, but cause harm to one another as they use the resource. During this study, the researcher observed some water points which were previously used by wild animals throughout the year. But due to an increase of human activities especially the increased number of livestock, the expansion of agricultural activities and climatic factors due to global warming cause some water points to become completely dry during dry seasons. In addition to that, some parts of this country both farmers and pastoralists have adapted to some local ways of predicting short to long term climatic changes such as drought. For example once the drought is locally predicted, pastoralist distribute their livestock and/or shifting herd to safer places to reduce risk. Northern societies namely Barabaig and Masaai have particularly been involved in transhumance. For example, Morogoro region has observed huge influx of pastoralists with large herd of livestock from various regions (Roessig *et al.,* 2004). According to focus group discussion, apart from poaching activities, an increase of the number of livestock and expansion of agricultural activities have also contributed much to the disappearing and/or distribution of puku in some areas in KGCA. In the conservation areas, most of the wildlife species concentrate around water points (Owen-Smith, 1996). The impact of water points on

wildlife in game controlled areas is high because these areas receive little attention due to the fact that human activities are allowed in this type of wildlife protected area.

In the partially protected areas, probably livestock compete with wildlife for both water and forage around water points and herders may intentionally or unintentionally scare away wildlife (Plate 4). Competition for grazing lands and water resources between livestock and wildlife could be a possible reason for uneven distribution of puku in KGCA. Prins (1992), for example, argues that livestock husbandry could wipe out wildlife as a result of competition for resources. According to Andrew and Lange (1986), who also report that kangaroos avoided areas close to water points which are intensively used by sheep.

Plate 4: Water points used by livestock and wildlife in Kilombero Game Controlled Area

However, gradients of utilization pressure develop around water points, with the greatest impact near the water point and decreasing pressure as distance away from the water point

increases (Brits *et al.*, 2002). As a result, grazing species that are unable to meet water requirements solely from forage, concentrate around permanent water supplies during dry seasons. In the dry and open savannah, wildlife tends to aggregate and reduce their home range, in response to poaching or to the threat from human hostility (Poole, 1996).

4.2.5 Land tenure and agricultural activities in the study area

Land tenure is a system whereby an individual or institution can acquire and maintain rights over a given piece of land. Land tenure system in Tanzania is governed by the Land Act (URT, 1999) in which the land is divided into three categories: village lands, general lands, and reserved lands. The KGCA falls within the reserved land where some human activities such as cultivation, agro pastoralists farming and settlement are allowed. The village lands are owned under customary land tenure and the one owned by Kilombero Valley Teak Company (KVTC) is under statutory land tenure.

Based on customary land tenure system, the majority (65.9%) of the respondents acquired and own land that had been cleared from KGCA for agriculture, indicating the shrinkage of KGCA, while 16.3% of the respondents inherited it (Table 9). Only few households (8.2%) were given land by the village government. Others (9.6%) acquired land through renting, buying and some acquired the land both in KGCA and inheritance. Although this study showed that the majority occupied land from KGCA, still the demand for land is high since the majority of the respondents (64.6%) said they could get more through clearing land from KGCA and 23.6% from village government. Others said they could rent and purchase, i.e. 10.2% and 1.6% respectively.

Table 9: Percentage response on land demand for agriculture in the study villages

Land acquisition	Percent
(a) Owned land for agriculture	n = 220
Yes	94.5
No	5.5
(b) Means of acquiring land	n =208
Bought	2.4
Rented	4.3
Inherited	16.3
Allocated by village government (VG)	8.2
KGCA	65.9
Inherited and KGCA	2.9
(c) Possibility of acquiring more land	n =209
Yes	60.8
No	39.2
(d) Acquiring of more land	n =127
From KGCA	64.6
Through VG	23.6
Rent from others	10.2
Purchase	1.6

Despite the fact that agriculture is the mainstay of Tanzania's economy and that approximately 55.0% of the total land area is suitable for farming, only 6.0% is under cultivation (UNEP, 1998). Most of the land in the rural areas of Tanzania has no title deeds and therefore land tenure insecurity is common among the communities who thus tend to misuse the land since it is not assigned to them permanently.

In the recent past, increasing subsistence demands of land for agricultural activities, livestock keeping and establishment of teak plantation within the KGCA have led to destruction of wildlife habitats and blocking of wildlife migration routes along the Kilombero corridor. The community adjacent to the KGCA practices activities that block the wildlife migratory routes which is an instinctive movement that takes place daily due to water and pasture needs or annually due to climatic changes. These activities have led some of wildlife species like puku to be unevenly distributed in KGCA while others move

from one area to another to secure area with no human disturbances or areas with high protection against human activities particularly poaching.

According to the key informants discussions it was reported that expansion of agricultural activities in KGCA is a widespread problem as well as illegal over-exploitation of puku (Catherine, J.L. personal communication, 2007). The Kilombero corridor which provides link between Selous Game Reserve and KGCA in Ulanga District has been blocked due to conversion of natural forest, mainly sub-humid miombo woodlands to monoculture of teak (*Tectona grandis*) plantation. This corridor had been blocked by KVTC through installation of electric fences surrounding their teak plantations to avoid large mammals like elephants which damage the young growing teaks. By doing so, this causes wild animals including puku along the corridor spread around human settlements (Makota, J.F. personal communication, 2007). This study further revealed that, insecurity of land tenure over land occupied by household especially immigrants has significantly increased the temptation of expanding unplanned farms towards KGCA. Usually, insecure pieces of land which are occupied without title deeds or certificate of occupancy are not normally respected by the occupier. This situation might have been the cause of poor land use practices like shifting cultivation and expansion of agriculture farms unnecessarily as observed during the field survey in the study area.

This observation concurs with Kikula's (1997) findings that security of land tenure had a direct link with sustainable farming practices which, in turn, enable sustainable wildlife management and conservation. Land use and related rights play a key role in determining the use and sustainable management of land resources since they specify accessibility of using resources. Kikula (1997) reported further that people are willing to invest their scarce resources if they are sure that they will reap benefits. Insecurity of tenure is one of

the stumbling block hindering loan accessibility of the rural poor from financing institutions. The title deed over the land could help the rural poor to borrow and raise financial ability to purchase farm inputs and improve agricultural productivity. This would have enabled them to enhance resource use instead of shifting from one piece of land to another looking for the fertile soil in the protected area.

4.2.6 Teak plantation establishment

Establishment of teak plantations by Kilombero Valley Teak Company (KVTC) along the wildlife corridors and installation of electric fences around the teak plantations lead to sparse and uneven distribution of wildlife particularly puku in KGCA (Emanuel, B. personal communication, 2007). It was revealed that during the rain season puku move from the lower floodplain to the high altitude areas but unfortunately these high altitude areas are the ones where teak plantations were established. The situation of changing natural habitats allows poachers to kill puku very easily due to the fact that puku fail to hide themselves because their natural habitat changed through the establishment of teak plantations. The teaks have been planted in a matrix design consisting of many small plantation fragments. However, IIED (1992) report that the absolute percentage loss of woodland which is replaced by teak plantation in Kilombero valley is not considered a major threat to wildlife but the location of the plantations may interfere with the seasonal movements of large mammals. In this case, the establishment of teak plantations has direct implications for wildlife species distribution and their survival.

4.2.7 Poaching

The illegal hunting of puku particularly in the highly degraded and moderately degraded blocks is high due to inadequate wildlife protection against poachers. According to the key informants discussions the trend of poaching will result into puku extinction in the

study area. The puku extinction might occur due to excessive killing of puku illegally. Excessive wildlife killing occurs whenever hunting is at a rate greater than the reproductive capacity of the population being exploited.

Harvesting of game meat is one of the foremost issues confronting the management of the protected areas and the communities adjacent to the protected areas. During the discussion group it was revealed that the majority of the community in the study area use bush meat as a source of protein and income for their daily lives.

Also through the focus group discussion, it was revealed that agro-pastoralists used their domestic dogs to kill puku as a source of meat for them and their dogs. Moreover, poachers used modern weapons such as guns, local weapons such as clubs and torch in the night to kill puku for bushmeat for the local black market in the villages. Poachers are pretend to be fishermen passing across the game controlled area in the morning while in fact they are illegal hunters who carry weapons such as short guns for killing puku and other wildlife species. This has resulted into increased demand for bushmeat in the study villages. These findings could be compared to the ones in the studies done by Arcese *et al.* (1995) and Baldus (2001) who report that poaching is widespread, uncontrolled, and mostly at unsustainable levels. Poaching for trade, meat, skins, feathers, and trophy, is a threat to the survival of many wildlife species. In view of the increasing trend of favouring bush meat as a delicacy, it is likely that after several years, puku will disappear in KGCA.

According to Haule *et al.* (2002) wildlife and forests provide important services to local people in KGCA and the most important benefit is the access to cheap meat. For example, the responses from primary school pupils in Kilombero valley on most recent bush meat meal showed that buffalo ranked the highest followed by puku and hippopotamus (Table 10).

Table 10: Responses from pupils in Kilombero valley on species of their latest meal of meat

Categories of animals species	Number of respondents (N= 96)	% of respondents
Wild animals		
Buffalo	38	39.6
Puku	19	19.8
Elephant	3	3.1
Bush pig	5	5.2
Bushbuck	1	1.0
Hippo	8	8.3
Warthog	1	1.0
Total	75	78.0
Domestic animals		
Cattle	16	16.7
Goat	1	1.0
Chicken	4	4.2
Total	21	21.9

Source: Haule *et al.* (2002)

According to the tourist hunters in the study area, it was reported that the local illegal hunting of puku is mainly undertaken in the wet season as puku move from flooded grassland up into the higher areas. Furthermore, this migration brings puku into contact with human settlements whereby illegal hunting takes place using a variety of methods but rifles and snare traps seem to be the most common.

Also the tourist hunters reported that poachers from neighbouring districts kill several elephants, from which they took ivory and numerous wildlife products including puku for meat. The number of puku killed in recent years is increasing (Emanuel, B. personal communication, 2007). It is suspected that TAZARA railway is an important conduit for illegal wildlife products.

4.3 Socio-economic Attributes on Puku Conservation

4.3.1 Sex

Household respondents in the study area comprised of 84.5% males and 15.5% females (Table 11). During interviews most of the males were more willing to respond to questions than females. Females were afraid and feel shy to talk anything in relation to puku decreasing in number because they were worried of getting into trouble with their husbands who are involved in puku illegal hunting. This reflects that males are the ones who compromise the wildlife conservation efforts in the study area as opposed to females. That implies the majority of the households in the study area were male headed and are the decision makers on natural resource use. This is a typical characteristic of most traditional African societies. The group discussion participants admitted that the majority of males deal with puku illegal hunting during night time. Also, males are involved in illegal selling of bush meat especially puku meat by using local transport means, e.g. bicycles. Furthermore, the group discussion participants reported puku as being the most hunted wild animal due to its non aggressive behaviour compared to other aggressive large mammals like buffalo.

Table 11: Respondents responses by sex

Sex of respondents	Number of respondents	% of respondents
Male	186	84.5
Female	34	15.5
Total	**220**	**100.0**

4.3.2 Average household size

The average household size among the interviewed households was 8.7 persons. That figure is deviating positively from the district average household size of 5.3 persons (URT, 2002b). This exceeding the natural average for households in the district mainly due to immigrants from other regions to get free natural resources especially land for

cultivation and livestock keeping. This means that instead of decreasing, the average household size is increasing thus threatening sustainable conservation and management of the puku antelope due to the fact that the demand for natural resources use within the game controlled area is increasing.

A household is an important variable in determining sustainability of natural resources in an ecosystem (Kajembe, 1994; Mung'ong'o, 1995 cited in Nduwamungu, 2002). According to IRA (2002) there is a strong relationship between household size and environment degradation. Large households tend to over-exploit their resources in order to meet their needs (Kajembe, 1994; Njana, 1998; Bakengesa, 2001; IRA, 2002). From personal observation most of the married households in the study area comprise a large number of family members especially agro-pastoralists. This means that as the average household size increases the demand for more resources increases, leading to threats on the conservation and management of the wildlife resources in KGCA.

4.3.3 Education level

Education is perceived as among the factors that influence individual's perception of a particular development intervention for decision making. It also imparts the desire of an individual to learn more, to attend training and seek information regarding interventions (Luhasi, 1998). Fig. 5 shows that the majority of the respondents (66.8%) had primary school education whereas 20.0% had no formal education and very few (3.2% and 1.4%) respondents attained secondary education and college respectively. This shows that 20% of the respondents in the study area were illiterate.

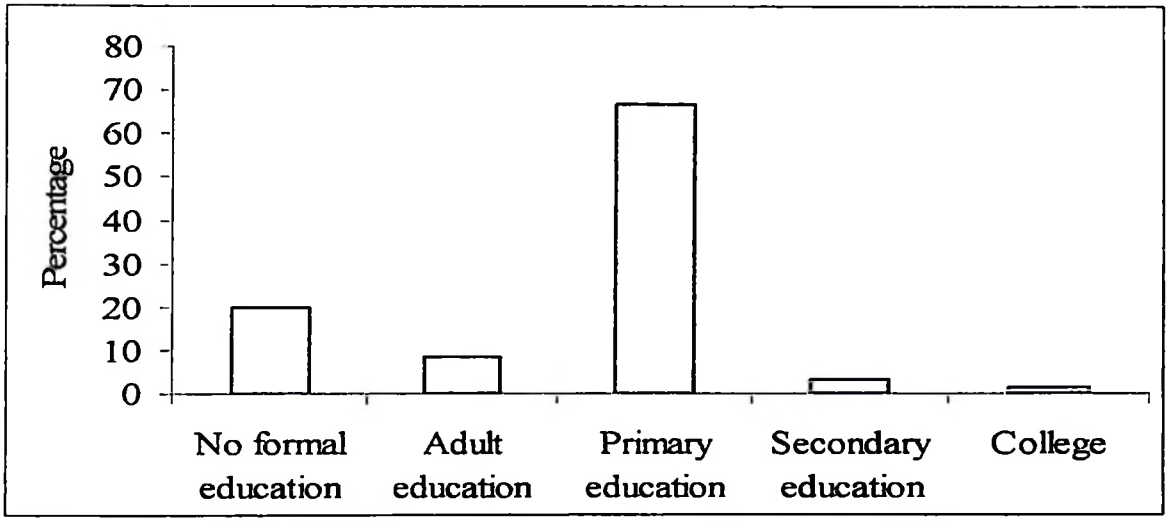

Figure 5: Education level of the respondents in the study villages in KGCA

The increase in the level of education of the community or household reduces the possibility of causing environmental degradation in the PAs. People who are exposed to the knowledge on wise use of resources including wildlife will tend to practice more environmentally friendly, agricultural land use and wildlife conservation and management than otherwise. Furthermore, illegal hunting of puku in the study area by local communities is driven by economic or income related factors. Therefore, education in the rural areas tends to improve the economic power of the society thus reducing dependence on puku meat which is obtained illegally. Increase in education level increases the level of awareness and creates positive attitudes and values which stimulate people to manage natural resources sustainably.

Kajembe and Luoga (1996) argue that education tend to create awareness, positive attitudes, values and motivation. Education also tends to stimulate self-confidence and self-reliance. Thus, development and implementation of wildlife conservation interventions could be impossible without education. Educated rural households are more productive and likely to use off farm income earning opportunities than non educated. The disadvantage of low education on resources use was reported in Zambia by Ngalande

(2002) who revealed that local people with low education could not recognize the impact of cultivation in the forest by clearing the forests while educated people were capable to see the relationship between cultivation and forest clearing. This implies that education level has a crucial impact on the rural household in the conservation and management of wildlife resources particularly puku in KGCA and thus reducing pressure on the wildlife resources and encourage better management and conservation as well as reducing pressure on the other easily accessible natural resources. Moreover more emphasis should be on sustainable income and protein alternatives for the poor communities adjacent to the protected areas by allocating community's cropping quotas.

4.3.4 Migration pattern

In recent years a large number of illegal immigrants migrated to KGCA. These immigrants cause detrimental effect to the puku habitat and puku distribution as well. This has been caused by expansion of agriculture activities, uncontrolled fire outbreak, poaching and herds of livestock. This study has revealed that in KGCA there is a high migration of people from other areas such as Shinyanga, Ruvuma, and Mbeya regions. Wasukuma (33.2%) were reported to be the largest ethnic group in the area followed by Wapogoro (16.4%), Wandamba (12.7%), Wangindo (11.2%) and other tribes such as Wangoni, Waluguru, Wandewe, Wajaluo, Wabena, Wachagga, Wayao, Wanyiramba, Wanyakyusa, Wahehe and Wamasai constitute 24.5%. Only the Wapogoro, Wandamba and Wangindo were native to the area and this indicates that nearly 58.6% of the interviewed respondents are migrants (Fig. 6). The recent influxes of agro-pastoralists in KGCA are mainly coming from Shinyanga region. These immigrants migrated into the area looking for fertile land for agriculture and livestock keeping. This situation probably increased the human population in the area and which may, in turn have led to shortages of land and exploitation of wildlife resource particularly puku. Furthermore, the

immigrants were reported to be killing puku in order to get bushmeat and parts of animal that are not edible are used for feeding their dogs.

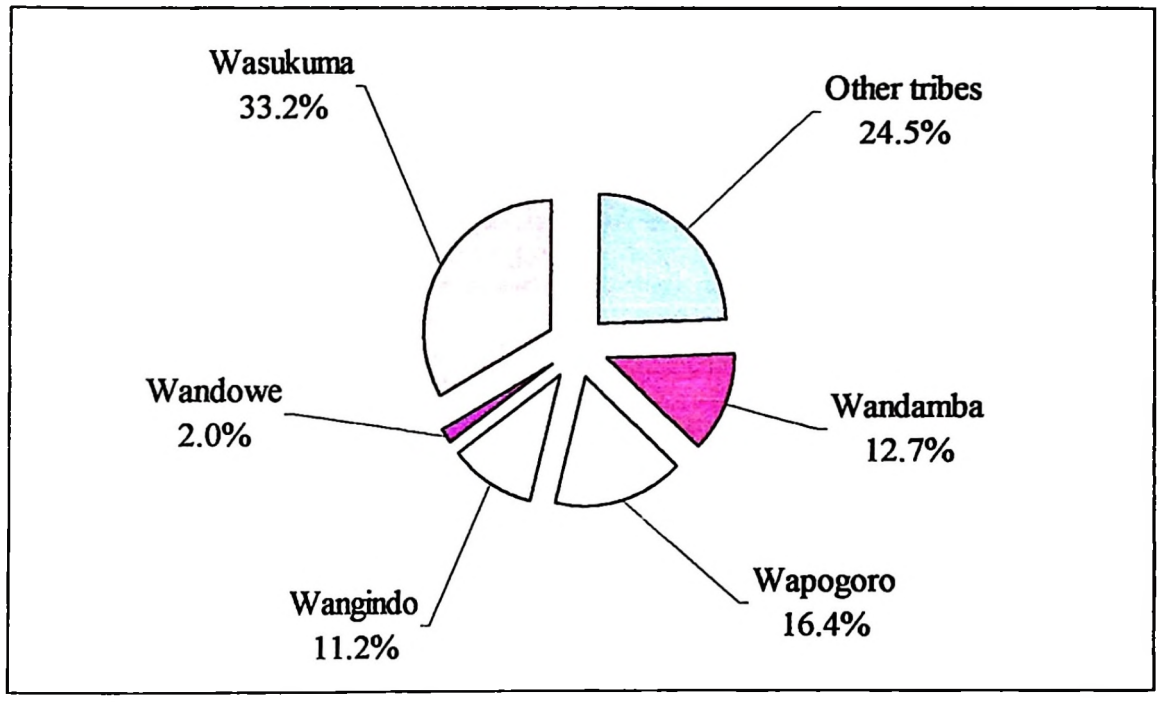

Figure 6: Respondents by tribes in the study villages

The high rate of migration was confirmed by the high rate of respondents (43.7%) who reported not to have been born in the villages they are residing now. This migration indicates how human population density in KGCA is influenced by the presence of natural resources found in the study area and the climate that favours agricultural practices. This observation concur with the findings by Mbonile *et al.* (2003) who cited movement of people from their former residence in search for land for cultivation and habitation as being the major reason for immigration. The same findings were reported by Noe (2003) that Maasai population increased by 9.5% due to immigration which caused pressure on the demand of more land for settlement and agriculture in the area between Kimanjaro and Amboseli National Park wildlife corridor and this finally led to land use changes in the area and conflict with conservation authorities.

4.3.5. Income sources

The finding shows that agriculture is the main source of income for the most respondents interviewed. The majority of the respondents (60.5%) depend on agriculture as the main source of income, 26.4% were agro-pastoralists and only 1.8% were employed and were also involved in petty business (Table 12). The increased demand for agricultural land and grazing land for livestock in KGCA is a growing problem. This study revealed that the form of livestock keeping practiced in KGCA is nomadic pastoralists. According to the respondents most of the socio-economic activities particularly agriculture and livestock keeping is conducted inside KCGA (70.0%) (Fig.7). These practices are not for sustainable management and conservation of partially protected areas due to the increasing human activities which are threatening wildlife in such areas.

Table 12: Main activities in the study area as sources of income by respondents

Main activities	Number of respondents	% of respondents
Agriculture	133	60.5
Livestock keepers	6	2.7
Business	13	5.9
Agriculture and livestock keepers	58	26.4
Formal employment	6	2.7
Employment and petty business	4	1.8
Total	**220**	**100.0**

Generally, GCAs are areas where human activities are allowed, provided they are operated in accordance with the Wildlife Conservation Act No. 12 of 1974 and in a manner that does not endanger the life of the wild animals and their habitats. In the GCA, wildlife corridors (dispersal areas) and wild animals' migratory routes, usually people are allowed to reside, practise agriculture and other human socio-economic activities (URT, 1974). The legislation governing GCAs, wildlife corridors and migratory routes, however, is too weak to protect and make wildlife conservation

compete with other forms of land use, especially in the rural communities (Songorwa, 2004). Always local communities see the protected area in terms of economic (opportunity cost) but conservationist consider that in terms of environmental conservation. Therefore, this situation normally brings the conflict of interest in the protected areas.

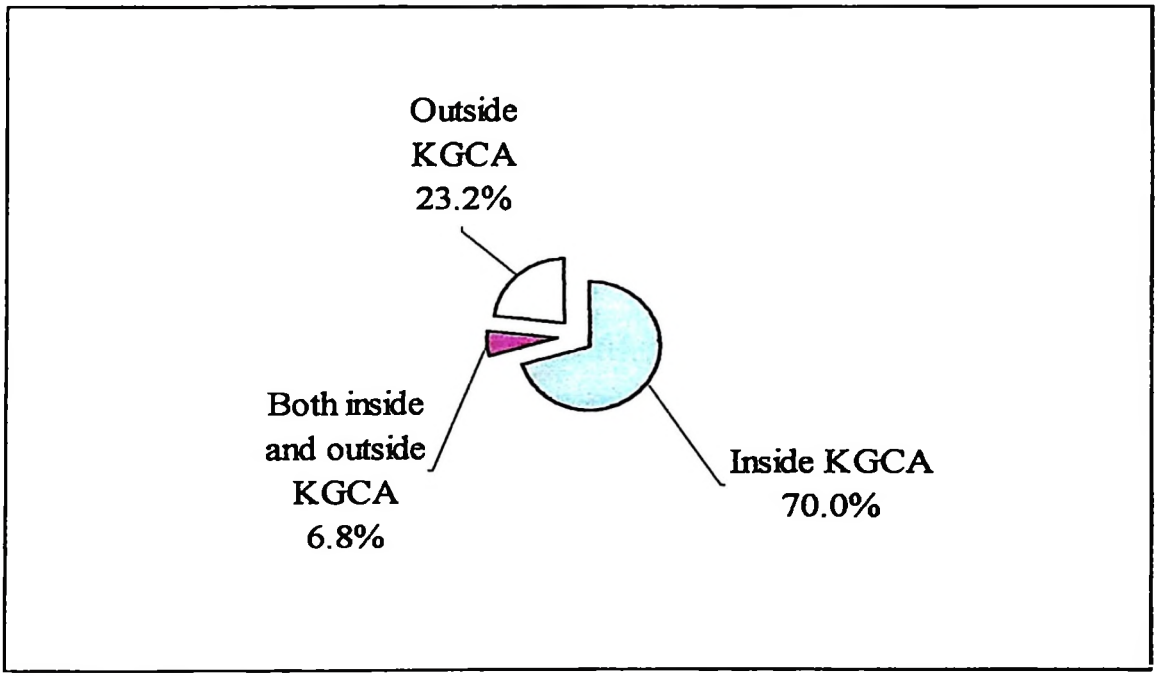

Figure 7: Respondents responses on the areas where the main socio-economic activities are carried out in the study area

4.3.6 Large mammals known in KGCA by the respondents

Puku is among wildlife species found in KGCA. Other wildlife species found in KGCA according to the respondents and direct observation were hartebeest, warthog, bushbuck, elephant, zebra and Reedbuck (Table 13).

Table 13: Large mammals known in KGCA according to the respondents

S/No	Common name	% responses
1	Warthog	7.5
2	Puku	15.9
3	Elephant	11.5
4	Zebra	9.2
5	Buffalo	13.5
6	Hippopotamus	7.4
7	Bush pig	6.4
8	Lion	3.8
9	Leopard	1.0
10	Bushbuck	5.0
11	Reedbuck	4.1
12	Hartebeest	5.8
13	Vervet monkey	1.5
14	Eland	2.2
15	Crocodile	1.0
16	Hyena	1.3
17	Sable	2.9
Total		**100.0**

It was revealed that, the most popular type of large mammal known by several respondents (15.9%) in the study area was puku because of supplying bush meat and also it is easy to be caught by the community adjacent to the KGCA, followed by buffalo and elephant, 13.5% and 11.5% respectively (Table 13). The respondents mentioned leopard as well as crocodile in some areas along Kilombero river as very rare, 1.0% and 1.0% respectively, because leopards are sensitive animal and usually solitary while crocodiles have limited habitat, unless one follow them in the river. Generally, the responses from the interviewees reflect the extent in which the local communities obtain bush meat through illegal hunting.

4.3.7 Culture on bushmeat eating

During this study the majority of the respondents admitted that their culture allowed them to eat bush meat of some wild animals. This can be explained by the results in Table 14

which show 90.9% of the respondents belong to the culture that allows them to eat bush meat and only 9.1% belong to the culture that did not allow them to eat bush meat.

Table 14: Respondents' culture on eating wild meat

Responses	Number of respondents	% of respondents
Yes	200	90.9
No	20	9.1
Total	**220**	**100.0**

The study revealed that communities in the study villages are predominantly dependent on bush meat of some wild animals such as puku, buffalo, hartebeest, bushbuck, sable antelope, hippopotamus and reedbuck; also bush pig and warthog for non-Muslims. From the researcher's physical observation there was no butcher for selling domestic meat in the study villages, except some people selling bushmeat to local restaurants during the night time. The researcher interviewed participants during focus group discussion to know which animals provide more meat for local use in the study villages. The majority of the participants indicated puku meat as being more available in the villages on grounds that puku is easy to kill using clubs or dogs as opposed to other aggressive animals such as buffalo. Currently the department of natural resources in Ulanga district mostly depends on village game scouts (VGS) for anti-poaching patrols.

Although in the study villages there are village game scouts the bush meat is still sold around the villages. The current study shows that 75.5% of the respondents claimed not to have seen village game scouts (VGS) in the village. while only 24.5% reported to have seen VGS (Table 15). About 77.8% of the respondents reported that the main activity performed by VGS is to conduct patrols on wildlife protected areas in order to control poaching and about 13% reported that VGS protects wildlife against crops damages.

Others respondents (1.9%) claimed that, VGS performed both patrols on wildlife protected areas in order to control poaching and protect crops against wildlife damage. Lastly 7.4% of the respondents were not aware about the activities performed by VGS.

Generally, this study revealed that poaching cannot be stopped by depending on VGS only for patrols on wildlife against poachers. Some poachers comes from outside the district especially the neighboring district which is Kilombero while others are among the local communities from the study villages. The situation shows that the bushmeat is the only most important means of protein source due to the fact that domestic meat is inadequate for the local communities adjacent to the KGCA. Furthermore the VGS with their families are part of the local communities that depend on bushmeat as a source of protein and cash income. Therefore, because these VGS are not paid and they have no alternatives source of protein and cash income. Alternatively it easy for them to become or colluding with poachers.

Table 15: Responses on village game scout activities

Game scouts situation	Percent
(a) Responses on presence of village game scout (VGS)	n =220
Yes	24.5
No	75.5
(b) Responses on activities performed by VGS	n =54
Patrol on wildlife issues	77.8
Protect wildlife against crop damage	13.0
Patrol on wildlife issues and protect wildlife against crop damage	1.9
I don't know	7.4
(c) Level of VGS in curbing poaching	n = 54
Effective	44.4
Not effective	55.6
(d) Reasons for VGS failure in curbing poaching	n = 29
Inadequate patrol equipment	65.5
Working without being paid	31.1
Few number of VGS in the study area	3.4 .

In curbing poaching, 44.4% of the respondents said that patrols were effective while 55.6% of the respondents said that patrols were not effective. The reasons given were, inadequate patrol equipment (65.5%), lack of payments (31.1%) and 3.4% of respondents reported of there being limited number of VGS in the study villages (Table 15). The study revealed that most of the villages surrounding KGCA had no VGS and where there are VGS they happen not to be effective in curbing poaching. Ineffectiveness of VGS probably contributes toward increased number of poachers that use traditional traps as well as morden technologies for illegal hunting of wildlife species in the study villages.

Furthermore in Tanzania, traditional hunting is essentially carried out by tribes who rely heavily on bushmeat rather than on other types of food like honey, fruits and roots. Traditionally, bush meat has provided a secure source of protein for rural people of Africa, as well as being a complementary source of income (Hofer *at al.*, 1996). However, increased exploitation of bush meat species and its commercialization is now endangering many wildlife populations worldwide. Bennet and Robinson (2000) reported that bush meat is not limited to Africa, wildlife populations in Asia and Latin America are equally threatened. In addition, trade in bush meat, growing human populations, greater access to remote areas, and more efficient hunting technologies are often cited as major threats to wildlife conservation.

4.3.8 Benefits derived from the presence of puku in KGCA

The wildlife resources of KGCA are potentially of great benefit to local communities in terms of revenue and food. Currently the benefits are not supportive to the communities adjacent to the KGCA. In this situation there is no structure to allow local people to legally harvest wildlife and consequently illegal and unregulated poaching is widespread.

The study findings indicated that about 52.7% of the respondents obtained bush meat as being their prime and reliable source of meat. About 31.4% of the respondents knew about the government revenues accrued from tourist hunters and 1.8% cited meat and increase in government revenues as being the benefits (Table 16). The majority of the respondents considered bush meat as a source of income being the only benefit and were not aware about government revenue contribution through hunting quota.

Table 16: Benefits derived from the presence of puku in KGCA

Benefits	Number of respondents	% respondents
Meat	116	52.7
Meat and government revenue	4	1.8
No benefits	31	14.1
Government revenue	69	31.4
Total	**220**	**100.0**

This implies that poaching for puku cannot stop since the majority of the local communities around the game controlled area consider the only direct benefit gained is through bushmeat but they have no knowledge of the funds disbursed to the villages adjacent to the KGCA by the central government. Only few local communities knew about the contribution made by the central government, indicating that there is inadequate awareness creation for wildlife conservation among the communities and therefore communities around game controlled areas were unwilling to conserve wildlife around them.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMMENDATIONS

5.1 Conclusion

The findings from the present study showed that the moderately and highly degraded habitat block have few number of puku as compared to the intact habitat block. The main reason for having few number of puku in the moderately and highly degraded habitat blocks is poor conservation and management of wildlife resources including puku due to increasing number of livestock, expansion of farmland, unplanned fire regimes, establishment teak plantations, extension of human settlements, forest clearing and poaching instances by villagers as well as outsiders from the neighboring districts and other regions of the country. Furthermore, there is inadequate protection of wildlife in KGCA by both local and central government due to inadequate funds disbursement for conservation and management of wildlife in the partially protected areas.

In this study it is concluded that puku is unevenly spread in all the surveyed habitat blocks. Clearing and felling of miombo woodlands which were used to serve as a refuge for puku during wet seasons are replaced by teak commercial plantations surrounded by installed electric fence. This has had a significant effect for puku and other wild animals distribution especially when the central part of the KGCA floodplain is flooded. These cause disturbances to the wildlife on their migratory routes (wildlife corridors) which enable wild animals to migrate towards Selous Game Reserve and KGCA.

Increased human activities in KGCA include migration of agro-pastoralists with their large herds of livestock, expansion of agricultural land in area formerly occupied by wild animals, illegal wild animal hunting by local people are the main threats to the wildlife conservation and management in the study area. People's trespassing in the KGCA

looking for bush meat and specific wild animal species like puku are among the contributing factors impacting on puku population and density in KGCA.

Most of the communities adjacent to KGCA who are thought to be involved in the conservation of wildlife are not aware of the value of conserving puku although according to Wildlife Policy of Tanzania (1998), the vision of wildlife sector for the next 20 years recognizes that wildlife is a natural resource of a great biological, economical, environmental and nutritional importance that must be conserved.

5.2 Recommendations

(i) There is a need to survey the whole KGCA in order to identify areas suitable for puku conservation. Also, there is a need to upgrade the status of KGCA to be a game reserve where human activities will be reduced.

(ii) The government should support land use planning in villages bordering the KGCA in order to reduce human pressure on natural resources. For instance, the government should use its resources to build capacity of communities bordering KGCA to prepare strategic land use plans, survey villages and natural resources available in order to provide communities ownership of such resources like land for cultivation and grazing.

(iii) Community sensitization on wildlife conservation in the villages bordering KGCA is important in order to ensure wildlife protection and management in general by controlling livestock carrying capacity for each village. The local communities residing adjacent to the KGCA should be encouraged to be fully

participate in the conservation and management of wildlife resources by given hunting quotas.

(iv) There is a need to emphasize frequent monitoring programmes to detect puku population trends and their interrelationship with human activities in KGCA. Baseline data on puku densities and monitoring programmes may provide the opportunity to better understand the extent and intensity of human pressure exerted on wildlife resources found in KGCA.

(v) The tourist hunters should be encouraged to involve VGS whenever planning for patrols so as to make VGS feel part and parcel of the wildlife conservation and management team as opposed to the current situation whereby wildlife conservation is a responsibility of tourist hunters.

(vi) The central and local government should allocate funds for wildlife conservation which will be used for anti poaching patrols, training of VGS and incentives for VGS. This should go together with a study to find out appropriate incentive structures for sustainable wildlife resources management in KGCA.

(vii) Village game scouts work under very hard and high risk conditions. Since VGS abandon some of their activities and go for anti-poaching patrols, they need to be given some incentives. It is recommended that for the Ministry of Natural Resources and Tourism in collaboration with the Ministry of Home affairs should allow VGS to own guns which will enable them to fight against poachers.

(viii) More researches are needed for sustainable wildlife conservation particularly in KGCA. The researches should be based on the following:- The general participation of local people in wildlife conservation and management; the application and use of GIS for wildlife resource mapping and management in order to determine specific area for wildlife species; the number of livestock and the carrying capacity of the area as well as their interaction with wildlife; puku feeding habits and their reproduction.

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APPENDICES

Appendix 1: Field Animal Count Form

1. Date ..... 6. Time of a day .....
2. Name of enumerator .....7. Transect length (m) .....
3. Form No. .....8. Village .....
4 Block No .....9. Ward .....
5 Transect No .....10. Division .....

Number of animals (n)	Perpendicular distance (m)	GPS Coordinates	Vegetation type	Signs of human activities	Remarks

Appendix 2: Questionnaire for Household Data

1.0 General Information

1.1 Date.....1.2 Name of division.....

1.3 Name of ward.....1.4 Name of the village.....

1.5 Age.....

1.6 Sex.....

1.7 Tribe.....

1.8 Place of birth.....

1.9 Household size.....

1.10 Marital status :(i) Single .....(ii) Married .....(iii) Divorced .....

(iv) Widowed.....

1.9 Level of education

i. No formal education [ ]

ii. Adult education [ ]

iii. Primary education [ ]

iv. Secondary education [ ]

v. Others (specify).....

2.0 Research Information

2.1 What are the activities do you conduct to earn your living in this village?

(i).....

(ii).....

(iii).....

2.2 Where do you carry these activities mentioned above?.

(i).....

(ii).....

(iii).....

2.3 Does your culture allow you to eat wild meat? Yes [ ] No [ ]

2.4 Which types of wild animals present in your area?

S/no	Types of animals	Animal's values on the study area

2.5 For how long have you lived in this village? .....

2.6 What are the mostly area where puku prefer to stay? .....

2.7 What are the advantages of puku being in your area?

(i).....

(ii).....

(iii).....

2.8 What can you say about the puku population over 30 years ago? (*Circle the appropriate answers*)

(i) Increasing (ii) decreasing (iii) constant (iv) I don't know

If it is decreasing explain why.....

2.9 What are the socio-economic activities do you think are the mostly affect distribution of puku in KGCA?

(i).....

(ii).....

(iii).....

2.10 Do you know any cases of fire outbreak in the KGCA?

Yes [ ] No [ ]

2.11 If yes what are the reasons for fire outbreak in the KGCA?

(i).....

(ii).....

(iii).....

2.12 Do you think the occurrence of fire affect puku habitat?

Yes [ ] No [ ]

If Yes, Why? .....

2.13 Do you keep livestock in your area? Yes [ ] No [ ]

If yes what are the types of animals? (*Circle the appropriate answers*)

(i) Cattle, how many? .....

(ii) Goat, how many? .....

(iii) Sheep, how many? .....

2.14 Where do you graze your livestock?

(i) Communal grazing lands

(ii) KGCA

(iii) Village land

(iv) Others (Specify)

Is the grazing area enough? Yes.....No.....

2.15 Do you own land for agriculture?

Yes [ ] No [ ]

2.16 If the answer (Qn 2.15) is yes what size is it? ..... (in acres)

(i) 0 to 5 acres [ ]

(ii) 6–10 acres [ ]

(iii) 11–15 acres [ ]

(iii) More than 15 [ ]

(iv) more than 20 acres [ ]

2.17 How/where did you acquire the land you own?

(i) Bought [ ]

(ii) Rented [ ]

(iii) Inherited [ ]

(iv) Allocated by village government on village land [ ]

(v) KGCA [ ]

(vi) Others specify

2.18 Is the land owned enough for agriculture?

Yes [ ] No [ ]

2.19 Is it possible to get more land?

Yes [ ] No [ ]

2.20 If the answer (Q2.19) is yes where/how? .....

2.21 Do you have the village game scout (VGS)? Yes [ ] No [ ]

(i) If yes, what are their activities?.....

(ii) Are they effective in curbing poaching in the village? (*Circle the appropriate answers*)

(i) Effective (ii) Not effective

If not effective, why? .....

2.22 What are the strategies do you propose for minimizing poaching in this area?

(i).....

(ii).....

(iii).....

2.23 What do you think should be done for sustainable conservation and management of puku in Kilombero Game Controlled Area.

(i).....

(ii).....

(iii).....

Appendix 3: Checklist for Focus Group Discussion

1 Which types of wild animals are present in your area?

2 Probing questions on benefits of puku being in the study area.

3 Probing questions on human activities, puku distribution and the trend of puku over twenty years ago in KGCA.

4 Perception of local communities on conservation and management of puku in KGCA.

5 Does the expansion of commercial forest plantations (teak plantation) affect puku distribution?

6 How about the land utilization twenty years a go compared to the present time in KGCA?

7 What strategies do you think can minimize poaching in KGCA?

8 What do you think should be done to promote sustainable management and conservation of puku in Kilombero Game Controlled Area?

Appendix 4: Checklist for Key Informants

The key informants were local government officers, tourist hunters and retired wildlife officers

1. Trend of puku over twenty years ago.
2. Role of local community institutions, tourist hunters companies and the local and central government on puku conservation and management.
3 Threats of puku in the area and strategies for sustainable conservation of puku.
4 The use of law and bylaws to address the conservation of puku?
5 The situation of poaching particularly for puku in the KGCA
6 What is your general view about the puku population over 20 years ago?
7 Do you think establishment of teak plantations affect abundance and distribution of puku in KGCA?