ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

DIVERSITY, ABUNDANCE, DISTRIBUTION AND HABITAT ASSOCIATION OF LARGE MAMMALS IN THE CHEBERA CHURCHURA NATIONAL PARK, ETHIOPIA

THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE DEGREE OF MASTER OF SCIENCE IN BIOLOGY (ECOLOGICAL AND SYSTEMATIC ZOOLOGY)

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Diversity, Abundance, Distribution and Habitat Association of large Mammals in Chebera Churchura National Park, Ethiopia.

By
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A Thesis Presented to the School of Graduate Studies of the Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Biology

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DEDICATION

This work is dedicated to my parents , to Ato Timer Jeza and W/ro Tsehaynesh Andegbe.

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LIST OF ABBREVATIONS AND ACRONOMY

a.s.l.	above sea level
CCNP	Chebera Churchura National Park
CDC	Conservation and Development Center
ENMSA	Ethiopian National Metrological Service Authority
EWCO	Ethiopian Wildlife Conservation Organization
FAO	Food and Agriculture Organization
IBA	Important Bird Areas
IBC	Institute of Biodiversity and Conservation
IUCN	International Union for Conservation of Nature and Natural Resources
MNP	Mago National Park
NNP	Nechisar National Park
ONP	Omo National Park
SNNPRS	Southern Nation Nationality and People's Regional States

ABSTRACT

This study attempted to investigate diversity, abundance, distribution and habitat association of mammalian fauna of Chebera Churchura National Park (CCNP). Representative samples of each vegetation types were surveyed using the transect method. Four habitat types were identified (riverine forest, montane forest, woodland and grassland with scattered trees). A total of 37 mammalian species were recorded. The park harbours a number of larger mammals such as the African elephant, African Buffaloe, and Hippopotamus but are now under various levels of threat in many parts of their former range in Ethiopia. The 37 species of mammals were observed in different combination and vegetation types. The majority of the species are, however, localized with low levels of abundance. The highest mammalian diversity was recorded in the Riverine forest habitat. The park is comparable to the very well known protected wildlife areas of the country in terms of its mammalian faunal diversity. A few species that were rare or absent in the Riverine forest habitat were recorded in abundance in the other three habitat types (montane forest, grassland with scattered trees and Woodland habitats). The distribution of different species of mammals suggests that the entire Chebera Churchura National Park is critical for efficient mammalian fauna conservation. The species that were recorded in low levels of abundance are probably declining and ecological investigations need to be conducted in order to understand the factors that influence their decline.

Key words: *Mammals, diversity, relative abundance, contact frequencies, Chebera Churchura National Park.*

1. INTRODUCTION AND LITERATURE RIVIEW

1.1. Introduction

Ethiopia has diverse wildlife resource. This is reflected by altitudinal range and the diversity of climate, vegetation and landscape. It is one of the few countries in the world that possesses unique and characteristic fauna with a high level of endemism (Yalden *et al.*, 1984; Hillman, 1993a; 1993b; Shibru Tedla, 1995; Tilahun *et al.*, 1996; Jacobs and Schloeder, 2001). Although, the highland regions of Ethiopia have fewer species diversity than many lowland regions, they have higher number of endemic mammalian and avian species. The eastern lowland has a number of Somali Massi Biome bird and antelope species. Few Sudan-Biome bird and antelope species are known to occur in the western and south western parts of the country (Tilahun *et al.*, 1996).

So far 288 mammalian species are recorded from Ethiopia of which 31(11%) are endemic (Yalden, 2000). A total of 861 bird species are also known to occur in Ethiopia, of which 16 are endemics and 13 are near endemics (Tilahun *et al.*, 1996). In addition, 6000-7000 plant species have been identified out of which 1400 (12%) are endemic (Hedberg and Edwards, 1989).

Over the years, the natural ecosystem in Ethiopia has been altered because of human and natural factors. Much of the highland and some parts of the lowlands have been converted into agricultural and pastoral land and the vegetation has been used for fuel wood, construction and other purposes. As a result, wildlife resources of the country are now largely restricted within a few Protected Areas. Only about 22,829 square kilometer of the total area of the country is currently left aside for wildlife conservation (Hillman, 1993a; 1993b). The Protected Areas include nine National Parks, three Sanctuaries, eight Game Reserves and eighteen Controlled Hunting Areas (Jacobs and Schloeder, 1993; Hillman, 1993a; 1993b; Stephens, *et al.*, 2000). Currently, these Protected Areas have different levels of conservation status. Many of them are directly managed by the National Regional States and only two National Parks (Awash and Yangudi Rasa), two Sanctuaries (Babile and Sinkile) are directly managed by the Ethiopian Wildlife Conservation Department, Ministry of Agriculture and Natural Resources.

The Southern Nations Nationalities and People's Regional State (SNNPRS) is one of the few National Regional States of Ethiopia that have diverse biological resources and endemic mammalian and avian fauna. The diversity of the biological resource of the SNNPRS is a reflection of its unique geological history and diverse physical and climatic conditions.

The Region is located in the southern quadrant of the country (4^0 27'- $8^0$30'N and $34^0$55'-$39^0$11'E) (Figs. 1 and 2). It is a region with wide geographic variation, high rugged mountains; deep gorges, river valleys and rolling plains associated with the Great Rift Valley and its lakes. The mountain ranges of the region run northeast to the southwest dividing the Omo watershed from that of Rift Valley lakes (Tilahun *et al.*, 1996). The altitude in the region varies from 360 m a.s.l. at Lake Rudolf, which border with Kenya, to over 4200 m a.s.l. at the Guge Mountain, in the Gamo Gofa Zone. The region has an area of 113,359 km^2, that is bounded by Oromia Region in the north and east, Kenya in the South, Gambela Region in the northwest. There are thirteen administrative zones and eight special Woredas in the region with a human population of more than 13 million (SNNPRS Regional Statistics and Population Office, 1994; 2001).

The SNNPRS also has diverse climate, vegetation, soil, drainage pattern and it is rich in wildlife resources. The wildlife resource of the region is commonly known to be restricted in Wildlife Protected Areas (Fig. 2) which includes five National Parks, two Game Reserves, eight Controlled Hunting Areas (Almaz Bayero pers. com.) and ten Important Bird Areas (Tilahun *et al.*, 1996). Although these wildlife areas (especially Game Reserve and Controlled Hunting Areas) are known as Wildlife Protected Areas, the status of their wildlife resource as well as its national and global significance in terms of vegetation, animal life and other unique natural ecosystem compositions are not yet well explored or investigated.

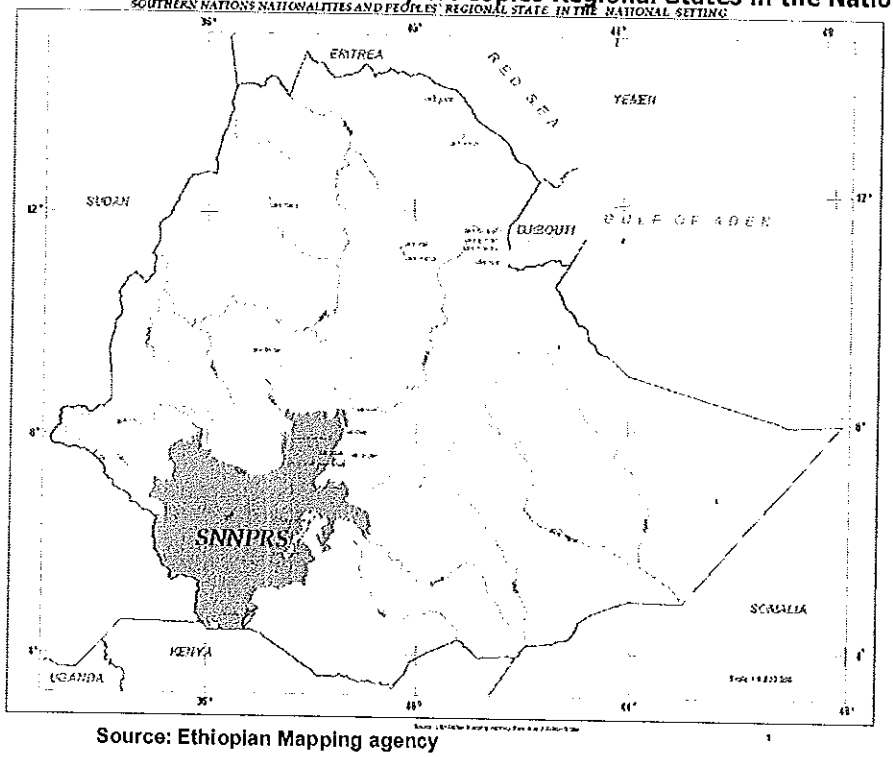
Chebera Churchura National Park (CCNP), one of the recently declared wildlife protected areas of the Region, is the subject of the present study. It is one of the wildlife areas of Ethiopia that has attracted the interest of the Region and the Federal Government but with limited biological information.

CCNP is reported to harbor a few important species of wild mammals and bird species (SRNAB file). However, due to lack of systematic ecological studies, the diversity, distribution and relative abundance of the mammalian fauna of the area is very little known.

Information from local community elders, regional experts and results of the few preliminary surveys made in CCNP indicate the presence of magnificent large mammals (African Elephant, African Buffalo, Giraffe, Hartebeest, Lion, and Leopard), and varieties of birds and other forms of life. CCNP provides unique ecosystem with diverse wildlife species that should be developed for its various benefits such as ecological service, biological resource use, other non-consumptive utilization and for the maintenance of genetic diversity.

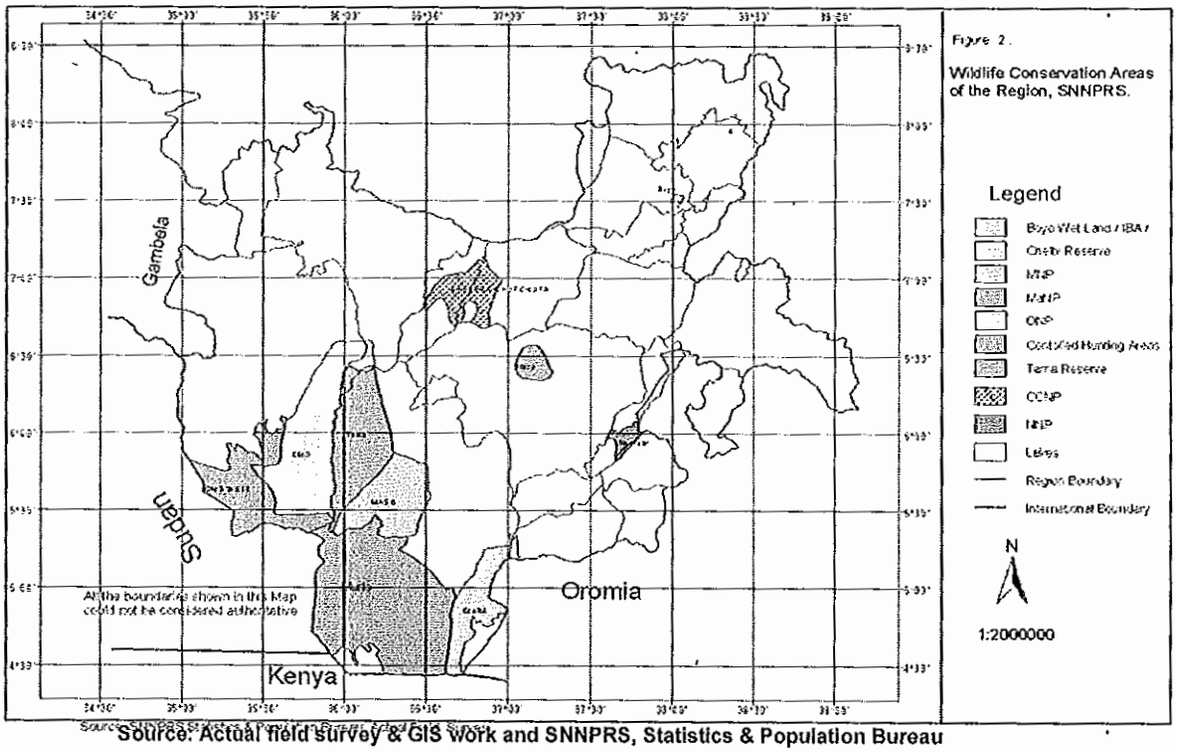
Identifying the diversity, distribution, relative abundance and habitat association of the mammalian fauna is vital to demonstrate the importance of CCNP, and for the preparation of a management plan for the park. This study, therefore aims to accomplish this aspects.

Figure 1. Southern Nations Nationality & Peoples Regional States in the National Setting.



Source: Ethioplan Mapping agency

Fig 2. Wildlife conservation areas of Southern Region (SNNPRS).



Source: Actual field survey & GIS work and SNNPRS, Statistics & Population Bureau

1.2. Literature review

Accelerating rates of biodiversity loss and the signing of international agreements, such as the convention on biological diversity and agenda 21, have called for the world biodiversity to be inventoried and monitored (Stork and Samways, 1995). The convention requires each signatory nation to provide and identify biodiversity components that are important for conservation and sustainable use. Biodiversity inventorying and monitoring provide fundamental and essential biological information used by many basic scientific disciplines (e.g. systematic, population biology, behavior, ecology and other comparative fields of biology) and applied science. Thus, it helps biological conservation to have a scientific basis from which we can gain knowledge about species, habitat and ecosystem. The more we know about species, habitats and ecosystem and about how these entities function, the more likely we are able to be successful at conserving biodiversity. Spellerberg and Steven, (1995) suggested that, before adequate conservation measures can be undertaken, it is necessary to conduct an accurate survey on identification, distribution and abundance of the species harboured in an area.

Among biodiversity, which is a general term, wildlife is one of its main components, including wild animals, plants and microorganisms with their associated natural habitats or ecosystems. Some authorities define wildlife to imply all biodiversity that are living outside the direct control of man, which include those plants and animals that are not cultivated or domesticated.

The need to conserve wildlife emanated after examining the current loss of biodiversity, the impact of humans in relation to these loses and in attempting to assess the value of diversity (Spellerberg, and Steven, 1995).

Hellwell (1991) suggested that wildlife management or conservation is the application of ecological knowledge to populations of vertebrate animals and their plant and animal associate in a manner that strike a balance between the needs of the wildlife, and the needs of people. In doing so, wildlife managers must apply both skills (art) and knowledge (science). Professional wildlife biologists face numerous issues that require research and management skills. Questions

are addressed by reviewing scientific literature, finding answers with field and/or laboratory work and implementing and evaluating remedies.

Out of the 900 genera of placental mammals in the world, 20% occur in East Africa (Kingdom, 1971). Simpson (1945, in Kingdon, 1971) classified 26 orders of placental mammals, ten of which have become extinct. Out of the remaining 14 orders of placental mammals, 12 are represented in East Africa in 47 families with over 360 species.

Mammalogists commonly group mammals as small or large based on body weight or size. The extant land placental mammals range from the six ton elephant to mice, shrews and bats weighting a few grams (Wirminghaus and Perrin, 1993; Nowak, 1991). The body size of mammals, generally, correlates with territory, amount of food intake and reproductive potential. Large mammals in general require larger territory, consume large quantity of food per individual and have relatively lower reproductive potential as compared to the smaller mammals. Happoled & Happoled (1991), grouped mammals based on their body weight and size and in relation to the general response to human influences. Thus, according to Happoled & Happoled large sized mammals (elephant, rhino, ungulates, carnivores and most primates) have low reproductive rates and compete directly with humans for resources. Most medium sized mammals have variable size, moderate reproductive rate and limited competition with humans for resources. Smaller mammals (rodents, shrews and bats) have high metabolic and reproductive rates, and are difficult to hunt compared to large mammals. They show positive response (population increment) to most human influences, unlike large mammals.

The economic and ecological importances of larger mammals are far-reaching. Mammals are clearly the most important terrestrial animals that have visible effect on the environment. The activity of wild mammals often drastically alters the character of the vegetation, the availability of water, patterns of erosion and the diversity and nature of the vertebrate and invertebrate fauna. The great impact of mammals on their environment is largely a result of endothermy that requires more energy (Vaughan, *et al.*, 2000). This impact results from a variety of activities, including feeding, patterns of migration or daily movement, the quest for water and shelters or refuges. Some mammals affect their community so strongly that they can be viewed as keystone species,

for example Aardvark (*Orycteropus affer*) has a greater role in the richness of most savanna ecosystem. It has strong claws on its forelimb with which it can excavate the earth for shelter. There are a number of mammalian species (also birds) that commonly use aardvark hole for their shelter and breeding.

Through millions of years of plant-herbivores interactions, many plants have adapted to mammals by taking advantage of them as agent of seed disperser (Fleming and Sosa, 1994). There is evidence that diversity of mammals (including bats, primates, rodents, ungulates and some carnivores) improves the reproductive success of plants. This ability of mammals is largely due to their mobility, the effect of their digestive tracts on seeds, and to caching behavior (Kingdom, 1971). The Cretaceous ecological evolution that resulted in the domination of terrestrial flora by Angiosperm (flowering plants) was perhaps facilitated by the diversification of birds and mammals (Regal, 1977).

Some mammals cause damage to agricultural crops, pasture, and forest nursery. Others are involved in disease transmission or hosts of diseases. Genetic and biological researchers use mammals (rodents and primates) as their principal laboratory animals. Mammals are important among animals in involving energy flow in the complex patterns of energy transfer (food web) within a biotic community. In the food chain, the second trophic level is occupied by herbivores (rodents, rabbits and ungulates). Small carnivores such as weasels, occupy the third trophic level and large carnivores are in third or fourth level (Vaughan, *et al.,* 2000). Many mammals (mainly herbivores) serve as human food sources in different countries. Owing to these conditions, larger mammals are one of the most commonly studied groups of vertebrates.

Although some mammals are easily seen, many species are highly secretive often hidden from view (Suterland, 1996; Norton-Griffiths, 1978; Ruette, *et al.*, 2003). Many wildlife observations are based on indirect evidence such as the density of dung, foot prints, or feeding signs. A few have even been observed without the study species being seen at all. Those species that are both secretive and occur at low densities are extremely difficult to census. In the aim of such species, indirect methods are often used. These techniques usually give distribution and an index of relative abundance rather than a measure of density (Wilson, *et al.*, 1996; Suterland, 1996). Many

conspicuous large mammals can be counted in their habitats. Dividing the area into blocks and counting the number of individual, total count of large mammals is made and this requires accurate maps. Different observers can count the grids or sections simultaneously. Conspicuous mammals can also be counted by strip and lines transect methods. This entails traveling along a line, recording individuals on each side. Thus, the above direct methods can also be made from the air. Counting animals from a low flying aircraft in the census zone particularly is important for large conspicuous mammals. Generally, both direct and indirect methods provide diversity, distribution and relative abundance of medium sized and larger mammal community in the study area.

The geographical distribution of mammals is world-wide. They occupy all continents, from far beyond the Arctic Circle in the north to the southern most parts of continents and large islands in the south covering most habitats of the earth (Walker, 1975). Some orders and families,.that are absent in one continent occur in the other. Family *Leporidae, Mustllidae, Canedae* and *Felidae* are native to all continents except Antarctica and Australia. Aardvark occurs only in Africa. Insectivores are absent from Australia and South America (Prasad and Kashyap, 1995). Since the distribution and abundance of animal population is the result of their past colonization history and ongoing interactions with their respective environment, the reason for restricted or wider distribution of any given species needs to be viewed accordingly.

The distribution and abundance of large mammals are determined by abiotic and biotic factors of the environment. The influences of physical features of an area (topography) on the fauna are often indirect, as the all-important climatic and ecological environment and superimposed upon it. Environmental influence has molded the distribution patterns of mammals within the area and on the continent as a whole (Kingdon, 1971). Vegetation provides food, shelter and cover to mammals. The structure and composition of vegetation, therefore, determine the distribution, abundance, and diversity of mammalian community residing in it. A reciprocal relationship is also reported to exist between mammalian community type and plant structure dynamics.

In general, the more diverse the habitat, the higher is the mammalian fauna. The better the habitat, the better is immigration, survival, abundance, recruitment, length of breeding season and

body weight (Rogers and Gorman, 1995). The physical environment is a tremendously complex functional unit within which animals live, feed, reproduce and die. The role of an organism in a community depends on the interactions of organisms with other members of the community and with the physical environment (Vaughan, *et al.*, 2000).

Climate has direct influence on the distribution and abundance of mammals, essentially, in those areas where seasonal contrasts are prominent. In such areas during the dry season, bush fire scorch large area, and large area appears devoid of green growth that directly or indirectly sustains all mammals (Inglis, 1976). To counterbalance these climatic effect, most mammals change food habits (moving to new pasture), herds assemble or disperse and in many species, breeding rhythms are clearly associated to the seasons. Climate determines vegetation, which in turn affects the distribution and abundance of larger mammals. Natural vegetation has a correlation with the duration of moist or arid periods that can be expected in the course of the year.

The day–night fluctuations in temperature have direct effects on many mammals. During the dry season, many large mammals such as elephant, zebra and buffalo drink regularly, while others like eland, topi, and reedbuck seek shade during the hottest part of the day. Many fossorial mammals and hyrax seek protection of burrows and rock shelters. On the other hand, gazelles and oryx are well adapted to withstand considerable heat without drink, and consequently can remain in the open plains in the dry season when other animals are more restricted (Bergström and Skarpe, 1999). The competition between mammals for the available food and moisture during the dry season ensures that these differing responses have considerable influence upon both local and overall distribution (Balakrishnan and Easa, 1986). The competition for a single resource may be avoided by a nocturnal diurnal specialization.

A large number of mammal species have annual breeding seasons and often bear their young at the end of the dry season or at the beginning of the rains. However, the seasonal rhythms vary from species to species. Patterns also can vary within species for quite different reasons (Vaughan, *et al.*, 2000).

Environmental, climatic, nutritional and social factors that determine breeding patterns are often interdependent and may be difficult to separate. The weather is also an important factor in disease transmission. The incidence of some diseases (rinderpest, anthrax) increases with wetness of the habitat and the lowered resistance of animals after a long dry season may assist outbreaks of disease at the beginning of the rains (Leykun Abune, 1991). Several species appear to be less active during the dry season. The aardvark, *Orycteropus,* and hedgehog may store up fat for the lean periods of the dry season (Kingdon, 1971). Catastrophic droughts or floods affect mammals. Fires take an annual toll of many species which is a major limitation on surface living rodents in the savanna ecosystem (East, 1984).

Diversity and its distribution is the product of a long history of evolution and diversification in a complex and changing geographical and ecological setting (Hawksworth, 1995). Patterns of biodiversity are the product of evolutionary diversification interacting with local ecological processes, which are influenced by the intrinsic characteristics of organisms, and how the landscape and seascape are structured. A trend of increasing mammal diversity is seen with decreasing latitude on land (Fisher 1960; Stevens 1989), i.e. more mammal species or higher taxa live in the tropics than in areas at higher latitudes (Vaughan *et al.,* 2000). No one seriously suggests that latitude per se drives animal diversity gradients but several factors that might influence diversity at various scales co-vary with latitude.

Altitude wise distribution of animals including mammals is reported to follow different patterns in different parts of the world. In the case of groups of terrestrial organisms, diversity has been found to decrease with increasing altitude (Stevens, 1992). For terrestrial environment, although these are general, trends are observed for increasing species diversity towards the tropics (latitudinal gradient) in many larger taxa. Also along elevational gradients, there are numerous exceptions among groups, which keep us against generalization (Meyers, 1992; Baskin, 1994). Thus, decreased number of species and individual and numerical dominance of a single species with increase in altitude is not a phenomenon observed under any circumstances. Yalden (1986) reported increase in species number with increasing altitude, Houksworth *et al.,* (1995) indicated that the local knowledge of an area will always be necessary. Habitat complexity is given more emphasis than altitude increment in determining distribution and abundance of mammal species.

Pearson and Kalp (1978) stressed the influence of local environmental conditions on the diversity-altitude and latitude relationship. Other potential important factors affecting the diversity, distribution and abundance of mammals include temperature, total precipitation, seasonal variation and ecosystem energy flux.

So far, many researchers have dealt with the East African (mainly in Kenya, Uganda, Tanzania and Malawi) mammalian ecology. Some workers have also conducted biological work on mammalian fauna of Ethiopia, which was mainly focused in the Rift Valley system and in the known wildlife protected areas of the country (Morris 1967a, 1967b, Blower 1967, 1968, Bolton 1969, 1970, Dandle and Provosts 1972, Corbort and Yalden 1972, Bolton 1973, Kingdon 1974, Duckworth *et al,* 1992 and Hillman 1993a; 1993b). Despite the availability of diverse ecosystem in the different regions of the country, the ecology of most wildlife is very little known.

Among the known wildlife area of the country, CCNP is one of the conservation areas where the diversity, distribution and abundance of mammals are very little known. The present study, therefore, attempts to address this problem.

1.3. Objectives

General Objectives

The general objectives of this study are to:

- Conduct biological survey and determine the diversity, distribution, relative abundance and habitat association of mammalian fauna in CCNP,

- Contribute to the sustainable development of biological resources of Ethiopia through conservation, management and sustainable utilization.

Specific objectives

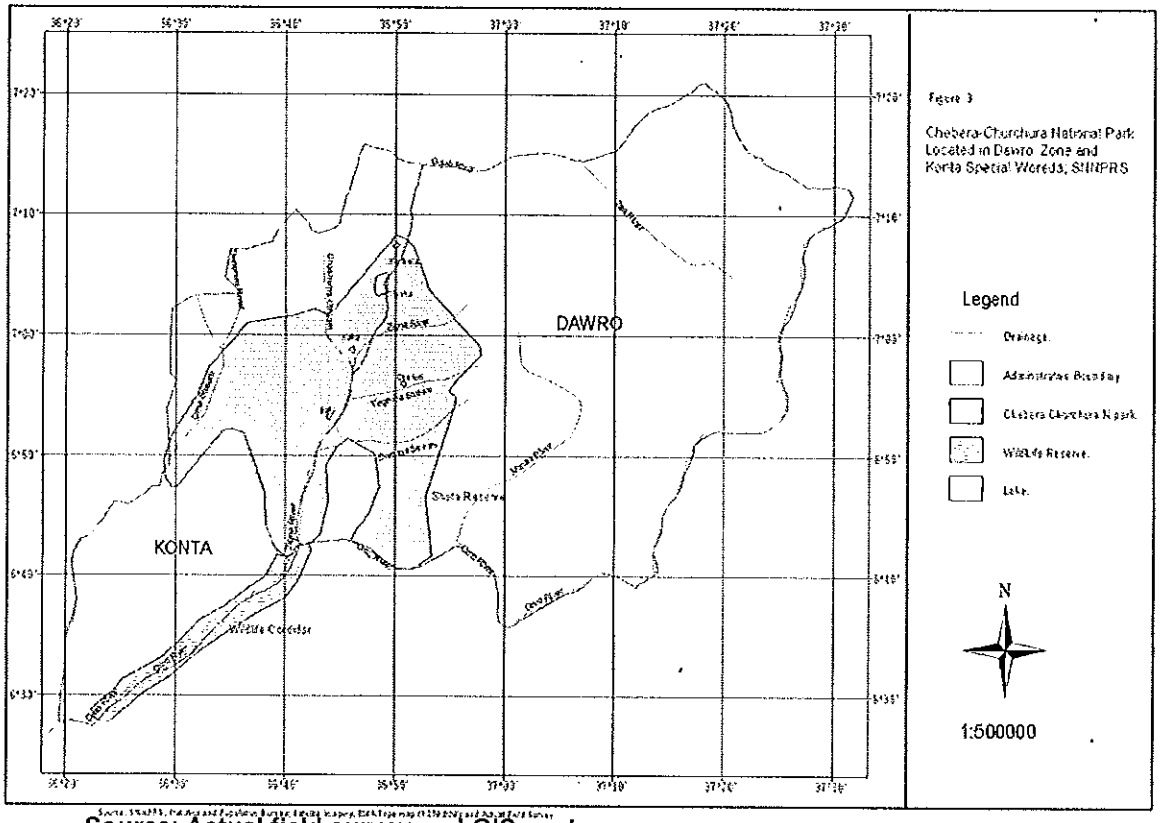
- To determine the diversity of larger mammalian species and their habitat association
- To determine the relative abundance of the major mammalian fauna
- To determine the distribution of the major mammalian fauna
- To provide reliable biological and physical information of the study area and suggest possible conservation strategy.

2. DESCRIPTION OF THE STUDY AREA

2.1. Location

Chebra Churchura National Park is located about 330 km and 460 km south west of Awassa and Addis Ababa, respectively. It covers an estimated area of 1215 km^2 and lies within the central Omo Gibe basin. The reserve extends from 6^0 39' N to 7^0 09'N and from $36^0$32' E to $37^0$00'E. It is found within the western side of the central Omo Gibe basin, where the Omo River forms its southern boundary. The southeastern and eastern boundaries are Esera and Tocha Woreda, respectively. Both Woredas are in the Dawero administrative zone. To the, west, northwest, and north and with a small area in the northeast, the area is bounded by the Konta Special Woreda of the SNNPRS (Fig. 3).

Figure 3. Chebera Churchura National Park located between Dawro zone and Konta special Woreda, SNNPRS.



Source: Actual field survey and GIS work

2.2. Topography

The prominent topographic features of the CCNP are characterized by unique and highly heterogeneous and hilly terrain. Large proportion of the study area is highly undulating and rolling interspersed with different valley floors, purely drained bottomland and punctuated by different hills. The general pattern of topographic features of the study area, therefore, is one of the rolling to steep hills as interfluves between relatively narrow flat to undulating bottom land which acts as collecting sites for run-off water from the nearby uplands. Few flat lands and highly undulating to rolling plains with incised river and perennial streams, valley and gorges, generally characterize the region.

Agriculture is largely confined in the upland areas with forest increasingly restricted to the steepest and most in-accessible slopes surrounding the reserve. Shifting cultivation is common in the south and southwestern lowland on the undulating and rolling plains by resident around the study area.

2.3. Climate

As there are no temperature and rainfall record for the study area, the data used for the description of the climate was collected from different stations located about 11 Km from the study area. Data were obtained from the Ethiopian National Metrological Service Agency (ENMSA) and Natural Resource and Agricultural Office of the SNNPRS.

2. 3.1. Rainfall

According to the 10 years rainfall summarized data. The rainfall in the area is uni-modal (having one long rain season) in which the northwestern, north and eastern highland areas of the study and the surrounding areas are characterized as having a continuous or a more even distribution of rainfall between March and September with a peak in July (with an average total monthly rainfall of 379 mm). Sometimes the rains extend up to the first half of December in the north and

northwestern highland areas (Konta). The total amount of annual rainfall in the area varies between 2000 and 3500 mm. The highest rainfall was recorded in 2000 and 2003 with a total annual rainfall of 3178.8 and 3489.3 mm, respectively. The lowest rainfall was recorded in 1997 with total amount of 1857.2 mm. The mean annual total rainfall of the area is 2154 mm. However, the southern part of the study area has lower amount of annual rainfall (between 1000 mm and 1600 mm over the period). The pattern, however, is almost similar (Fig. 4).

In terms of soil moisture, the majority of the well-drained upland has ustic soil moisture (Woodroof and Associates, 1995) i.e. soil is moist for long periods.

2.3.2. Temperature

The study area can be divided into two major thermal zones, which broadly correspond to traditional temperature regions. This includes Kola thermal zone (with altitude varying between 800 and 1500 m a.s.l. and with temperature varying between 21and 27.5 ^{0}C). Weinadega thermal zone with altitude varying between 1500 and 2450 m and temperature varies between 11 and 16 ^{0}C.

The daily temperature range in the study area is widest during the dry season, and narrowest during the wet season. The dry season of the study area includes December, January and February and the hottest months of the area include January and February with mean maximum temperature varies between 27 and 29^{0}C, respectively. The absolute maximum temperature was 32.1^{o}C in February 1994. The cooler months are July and August with mean minimum temperature varying between 10 and 11.4 ^{o}C, respectively. The mean annual temperature of the area is 17 ^{0}C and the mean daily temperature of the warmest month is 25.4 ^{0}C. The mean daily temperature of the coldest month is 10.2 ^{0}C.

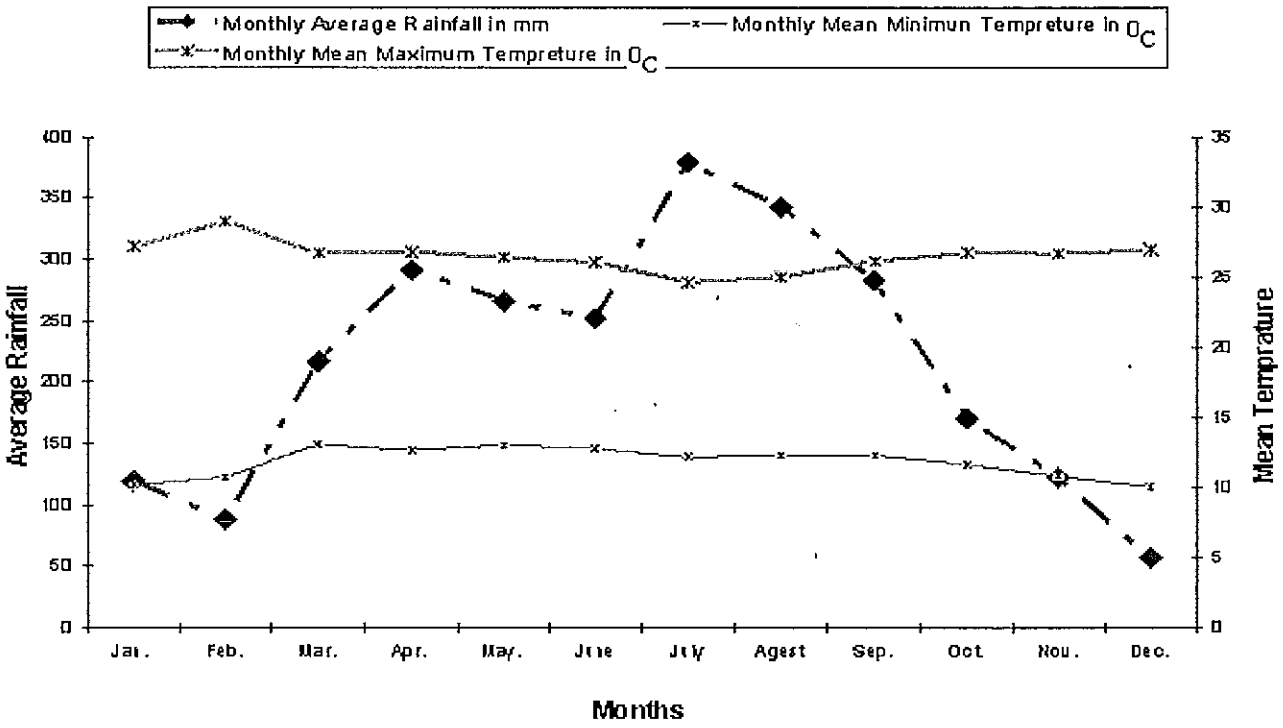


Figure 4. Average monthly rainfall and maximum and minimum temperature of the study area.

2. 4. Geology

Geologically the area is made up of Tertiary Jima volcanic as described by Woodroof and Associates (1995). Accordingly, these Jima volcanic rocks are divided into lower basalt and upper rhyolites with minor basalts. The CCNP is mainly characterized by the rhyolite Jima volcanic parent rocks which crop out in the north eastern parts forming the highlands whereas the lower basalt based on this Jima volcanic are exposed in all areas around the Omo gorge to the south of the study area. The age of these Jima volcanic rocks are reported to range from the Eocene to Oligocene.

2. 5. Soil

The soil type of the north and eastern upland areas of the study area is well drained, dark brown to dark reddish brown sandy clay loams to clay though most are usually clay loams. The soil

structures are weak tending to be massive with friable top soils over friable sub-soils. They are non calcareous. Shallow soils are more prevalent in the areas with steep slops in the southern parts and the Omo gorge. There are also imperfectly to poorly drained bottom soils. Thus, soils occur at receiving sites for run off surrounding hilly terrain. They are water logged for many months of the year (Damene Darota, 2003).

2. 6. Accessibility

There are two all weather tarmac roads that lead to CCNP. One of these roads is the main Addis Ababa - Jimma road through Woliso and Wolekite and then from Jimma to Ameya (Chebera).It covers a total distance of about 450 km. The other road is Addis Ababa -Arbaminch (or Wolaita) road ,which covers a distance of about 500 km. Recently, a total of about 60 km road has been constructed inside the park to open access for resettled people in the Delba settlement area located southwest of the reserve in the Konta Special Woreda. Within the study area, there are network of tracks, that are impossible to use during the rainy season and some of which are accessible through local guide.

2.7. Landuse and Land cover

2.7.1. Landuse and Settlement

The principal ethnic groups found around the reserve area are Dawro and Konta nationalities. The land use types practiced by these ethnic groups are variable and might be related to the differences in climatic conditions and resource types in the sites. The eastern highland areas are inhabited by the Dawro ethnic group. These people traditionally practice agricultural land use that combines inset, root crops, cereals cultivation and trees with livestock rearing simultaneously (a type of mixed agriculture). These people do not make extensive use of the lowlands except along the periphery. The land use practiced by the local people includes grazing, grass cutting (cut and carry system), wild honey gathering and traditional beekeeping. In addition, collection of spices and wild coffee from the forest are common activities of the local people of the area.

The Konta ethnic group occupies the north and northwestern highland areas. These people have similar pattern of landuse system as the Dawro people found in the eastern highland. However, people who are living close to the study area, on lower altitude of about 1400 m a.s.l. , practice a type of landuse for the production of cereals, teff and vegetables.

People of the Churchura peasant association inhabit the southern lowland. The total population is not more than 500. The Konta Koisha and Delba peasant associations occupy the southwestern lowland area, which adjoins the study area. They belong to the Konta ethnic group and with the total estimated population of 4000. Both the above indigenous Churchura and Konta Koisha ethnic groups live in more or less similar climatic condition and resource type. As a result, the landuse practice is predominantly traditional shifting cultivation and livestock rearing. Teff, maize, sorghum and fruits are the major food products of these areas.

2.7.2. Land cover

2.7.2.1 Vegetation types

The vegetation of the study area can be categorized into four major habitat types (Fig. 5) as follows:

1. Grassland with scattered trees
2. Woodland
3. Montane forest and,
4. Riverine forest

1. Grassland with Scattered trees

The savanna grassland with scattered trees is the most luxuriant habitat, which covers the largest part (62.5 %) of the study area and belongs to the Sudanian-Biome regional center of endemism. It is found north to south within the very undulating to rolling landscape, valley and gorges (Fig. 5). The dominant grass species vary locally; elephant grasses (*Pennisetum sp.)* are common

mixed with tussock grass. Most of the grass species belong to the genera *Andropogon, Imperata, Hyparrhenia and Themeda*. The tree species are predominantly deciduous and no more than 6 meter in height, but when they occur in large grooves they become evergreen species with greater height in some localities. Most of the tree species in these fires prone areas have thick and gnarled bark which is fire-resistant. The dominant tree species include broad-leaved *Combretum* species in association with *Terminalia albiza*. Fire commonly occurs once a year during the dry season in the different localities. This habitat provides both browse and grazing, supporting most of the wild animals in the reserve.

Lowland baobabs grow within this habitat in several places of lower lying areas, mostly in sloppy land. In general, the baobabs (*Oxythenantra abyssinica*), with its thick bark and sponge like, water-saturated wood, usually stand isolated covering up to 5 hectare.

The altitudinal distribution of the habitat is also very wide covering between 600 to1500 m a.s.l. At different altitude, the habitat shows variation in tree species composition. Perhaps this may be due to the variability in soil type and moisture. Generally, this habitat in the study area is mostly seen next to the dense forest and woodlands, either from the continuous mountainous forest (which flanks the east and west parts of the reserve) or from the riverine forest and or from the woodlands of the reserve.

2. Woodland

In the study area, there are different types of woodland habitats which include mixed woodland, dominated by mixed species. This habitat occurs in the northern upland area next to highland drainages and at the break between the highland and the lowland. The other type of woodland occurs in the southern parts of the park habitat, which is *Combretum* woodland dominated by *Combretum* and *Terminalia* species, occurring below 1100 m a.s.l. It is also common in low-lying valley areas. This type of woodland is a classic woodland habitat with an even distribution of trees, uniform canopy, almost no understory of bushes or shrubs, but typically with a well developed grass cover. They are commonly burnt every year.

Riparian woodland is found along many of the drainages in the lower or the southern part of the study area (i.e. along lower Zigina, Tikurwuha, Mensa and Oma Rivers) near to the Omo confluence. This vegetation type has a clear tree-grass formation without additional stories; typically dominated by tall Acacia trees (*Acacia polychanta*).

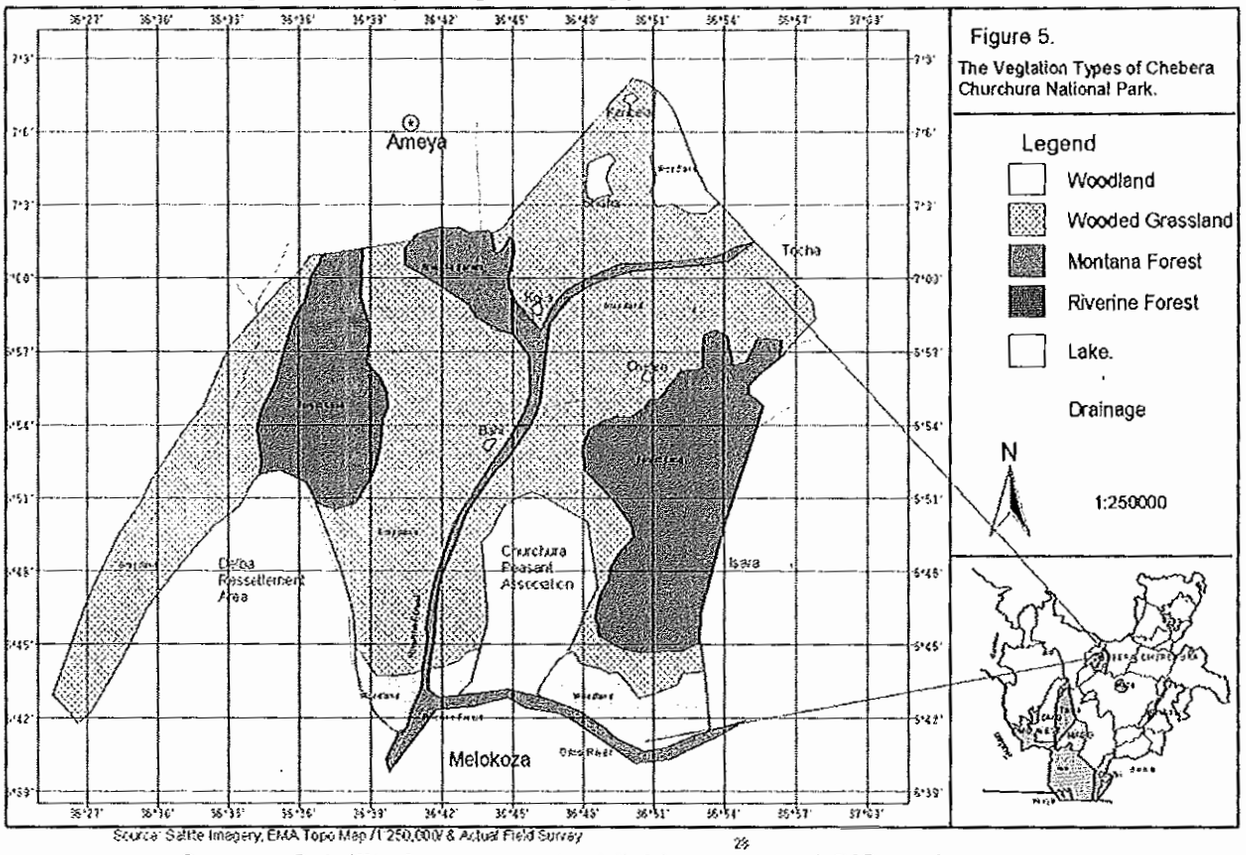
3. Montane forest

This habitat dominated by trees and characterized by the crown cover of 50%.The structure is multistoried (WBISPP, 2002). The floristic composition of the forest is commonly rich with climbers and saprophyte. Under natural condition, the distribution of trees through this forest area is relatively uniform. This type of forest occurs in the eastern and in patchy distribution in the northwestern highland of the reserve. Most of this area is dominated by Juniperus, Podocarpus and broad-leaved tree species (Fig. .5).

4. Riverine forest

This occurs along the different rivers inside the study area (Zigina, Tikurwuha, Mensa and Oma) and the different smaller perennial water courses. All of these water courses in almost all their path have trees except the southern part where they join with Omo River (or where it becomes Acacia tall trees Riparian woodland). The floristic composition of these forests varies with altitude and edaphic conditions, but is always richer than the general area and is distinct (Fig. 5).

Figure 5. Major vegetation types and water bodies of CCNP.



Source: Satellite imagery, actual field survey and GIS work

3. MATERIALS AND METHODS

3.1. Description of the vegetation types

The description of the major vegetation types of the park was made based on the framework of White (1983) Vegetation maps of Africa. This information was, however used with recent satellite imagery information for the description. All the available information about the vegetation and landuse of the area were further verified through ground survey during the present study.

Along each of the transects in the sampled blocks of the survey zone, vegetation survey was conducted while observers searched for mammals, and an attempt was made to integrate each observation to determine the distribution of habitats and the dominant plant species of each habitat types of the park. During this vegetation survey; 89 specimens of plants were collected following the guidelines of the Flora of Ethiopia (Hedberg and Edwards, 1989; Benget and Sven, 1974). These specimens were properly pressed for further verification and identification. The collected plant specimens were identified up to species level in the herbarium of Addis Ababa University. The result was used for the description of each of the major vegetation types of the park (see section **2.7.2.1**.)

3.2. Study area subdivisions

Reconnaissance survey was conducted prior to the filed work by vehicles and on foot in August 2003. This activity revealed that the study area was not homogenous in vegetation type coverage, human settlement, landscape or topography and rainfall distribution.

The study area was, therefore, stratified into four main study units or census zones of various size using aerial photography (scale 1:30,000), satellite imagery in formation and EMA topography maps (scale 1:50,000 and 1:250,000). The boundary of each study units was traced and followed based on the main vegetation type of the study area. These include census zone 1. Savanna

grassland with scattered trees (GLT), census zone 2. Montane forest (MF), census zone 3. Woodland (WL) and census zone 4. Riverine forest (RF) habitats (Fig .5). The areas of the study blocks/units/census zones are displayed in Table 1 below. Each of this census zone or units was then subdivided into grids on the map for sampling (Fig. 6.).

Table. 1 Estimated area and proportion of census zones.

Census zones /habitat	Area (km^2)	Proportion	Number of grids	Area of each Block (grid) (km^2)
Grassland with scattered trees (GLT)	725	0.60	29	25
Montana forest (MF)	350	0.29	13	25
Woodland (WL)	100	0.08	4	25
Riverine forest (RF)	40	0.03	-	-
Total	1215	1.00		

3.3. Sampling design

A modification of the unequally sized sample unit ratio methods (Frankyates, 1971; Norton Griffiths, 1975; Balakrishnan and Ndhlovu, 1991) was adopted for sampling. Out of the possible quadrats (sample units) formed in each census zone a number of representative sample quadrats (blocks) were randomly selected and marked for sampling using random numbers. The sampling units selected from each census zone represent 20-25% of each of the census zone. Randomly selected transects were then established in each census zone.

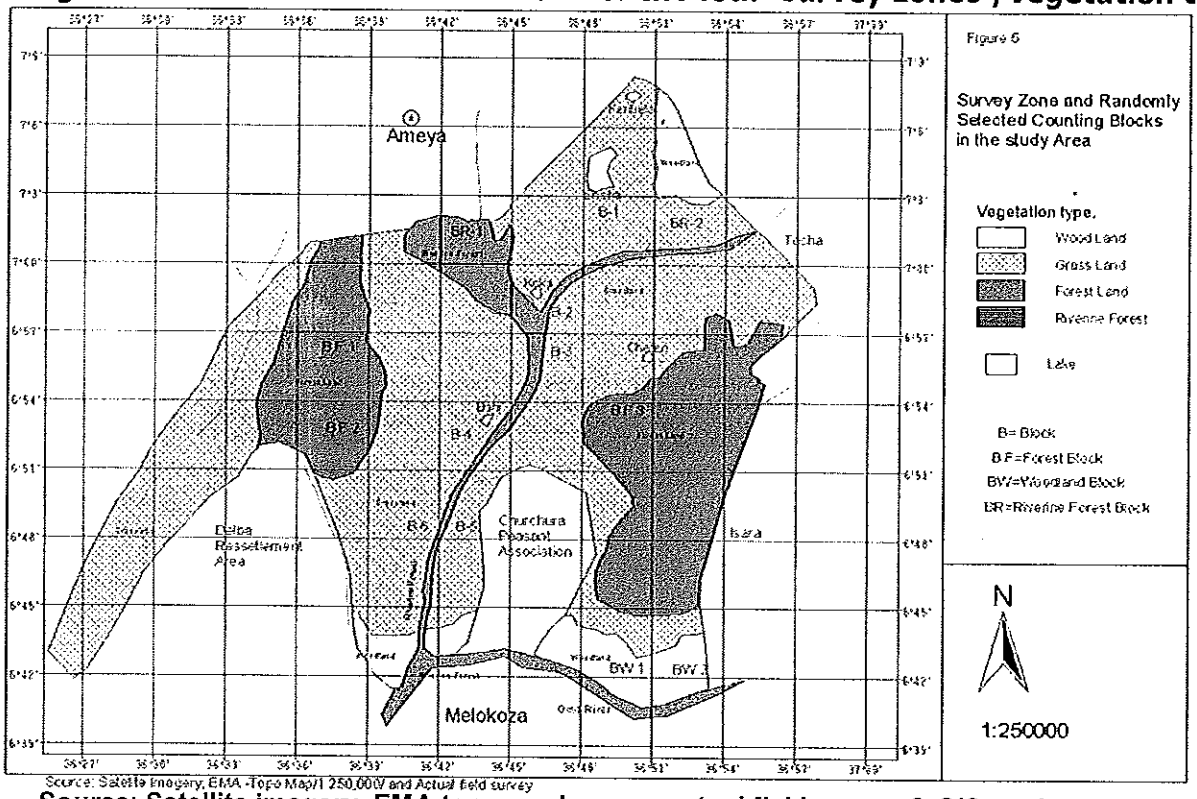
The number of transects in each census zone varied depending on visibility. Thus, survey was conducted using subsidiary tracks guided by GPS (Global Positioning System) and compass in each randomly selected block along selected transects. The transect width varied between 100 m and 600 m and this was determined based on the type of vegetation cover of each of the census zone. The length of transects also varied from 4.5 to 5 km (Table 2.). There was also a minimum of 0.1 to 0.6 km distance between any two consecutive transects. The proportional area of each

sampling block in the survey zones, the number and total length of transects and the areas sampled are given in Table 2 below.

Table 2. Number and sizes of the randomly selected quadrats (blocks) in each census zone.

Census zones	Number of Sampled blocks (proportion)	Total area Sampled Block (km^2)	Potential Transect (N)	Number and Proportion of Transects (n)	Length and width of Transects (km x km)
Wooded grassland	6 (20%)	150	48	12 (25%)	5 X 0.6
Montane forest	3 (21%)	75	75	15 (20%)	5 X 0.1
Woodland	1 (25%)	25	17	4 (23.5%)	5 X 0.3
Riverine forest	8(20%)	8	18	9 (44.4%)	4.5 X 0.1

Figure 6. Observation blocks in each of the four survey zones /vegetation type



Source: Satellite imagery, EMA-topography map, actual field survey & GIS work.

3.4. Duration of the Study

Faunal field survey in the CCNP was conducted form August 2004 to March 2005 so as to cover both wet and dry seasons in the study area.

The diversity, distribution, relative abundance and habitat association of the major larger mammalian species of the park were studied along the transects established in the randomly selected blocks of each vegetation type for two months each during the wet (August and September) and dry (December and February) seasons. A total of 4 months of field work, comprising wet and dry season was conducted for filed data collection. The two periods represent beginning and end (peak) of the wet and dry seasons experienced in the area and this was considered to give representative samples of the whole year. The major vegetation types and dominant plant species of the park were described. The views of local people towards the wildlife of the reserve were also assessed. Records of climatic data from various sources were collected and summarized for the study area.

3.5. Assessment of diversity and abundance

Identification and recording of larger mammalian species and their numbers were made through direct observation with naked eyes or aided with binoculars. Field guidebooks were used for identification. The survey was conducted on foot along the established transects left and right side in both wet and dry seasons.

Survey of the mammalian species was done simultaneoúsly in all sampled blocks of the survey zone early in the morning during 06: 00 - 11: 00 h and late in the afternoon form 16: 00 - 22: 00 h when most diurnal and nocturnal larger mammals were more active in the study area.

Nocturnal larger mammals were identified and recorded using flashlight at night time. Animals were detected by their reflective eyes or occasionally from vocalization. Frequent brief stops were made to listen and setting the flashlight to maximum diameter to allow detection of eye

shines over as wide an area as possible. Those animals illuminated with the flashlight during the night survey were identified and recorded. The slow walking pace (about 4-3 km/h) allowed careful searching in each survey zones at all night and daylight survey during the filed work. Field identification of both diurnal and nocturnal mammalian species was based on visible morphological characters of each of the mammalian species such as body size and coloration, proportion and structure of various organs (tails, ears, faces, tusks and horns). To have clear pictures of each mammalian species, observer noises were minimized to zero level and to avoid being smelled by the animals movement was followed against the direction of winds.

Time of start, stop and change of habitat were recorded, when animals were watched for more than 2 minutes, the watching periods was subtracted from searching time, allowing precise quantification of effort in each census zones. Besides, in each study transects the following details were taken for each encounter, species, group size, sex and age structure, time, location points (UTM), reaction to observer and any other interesting behavior of the observed animals.

Indirect evidence was also used because of the low direct detectability of most larger mammals of the park in their natural habitat. This was done by walking on foot along transects, while observer was looking for mammals, he also carefully searched for tracks, dropping and other signs of mammals. Only those observations positively identified were included. The result was used to determine the distribution and habitat uses of mammals in the different major vegetation types of CCNP.

Photographic pictures of some mammals and their indirect evidence (foot prints, droppings) were taken for further confirmation. Documentary film, which shows the present status of the different habitats and the associated wild animals, was also made during this study period.

Standardized arrays of random sampling decrease detection of the number of animals and incidence of rare species (Kunin and Gaston, 1993). Consequently, in addition to the standardized arrays of transects (blocks), the inventory also included non-standardized arrays of blocks in non-random locations. This exploration of habitats was used to find out the presence or absence and the distribution patterns of particularly rare mammals of the park.

3.6. Assessment of distribution and habitat association

All the activities described above, which were carried out in the field were also used to determine the distribution and habitat association of the different mammalian species in the park. The methods of Larson *et al.* (1978) and Norton Griffiths (1978) were used to describe the dry and wet season distribution and habitat uses of mammalian species recorded in the park.

The location point (UTM) of each mammal (group or individual) at each vegetation types was identified and recorded using hand held GPS in the field. The result was used to produce the distribution map of the mammals recorded by vegetation type. In addition to taking each group or individual sighting scores with respect to habitat types and comparing their frequencies to the relative availability of vegetation types, it was also possible to detect the habitat association and distribution of the mammals of the park.

Both the wet and dry season data collection were assisted by four experts assigned from the nearby natural resources and agriculture development offices and five well trained rangers from the SNNPRS National Parks (Omo, Mago and Nechisar). Eight local men were also involved as field guides and assistant data collectors.

3.7. Data analyses

Records of mammalian species from all observers in each season were analyzed together by major vegetation types and thus adjusted to describe the biological attributes of the mammalian community of the study area. Thus, such measures as the number of species, relative abundance of individuals and diversity (a combination of the richness and evenness) were taken into account during data analyses. Diversity measures take into account both the number of species and how evenly distributed individuals in those species are across the whole community (Vaughan, *et al.*, 2000).

The diversity indices of Shannon Wiener information theory were computed, and the result used to determine the composition and complexity of the different communities of the four major habitats in the study area

Mammalian species recorded in both seasons were also used to show the frequency of occurrence or habitat uses (Duckworth *et al.*, 1992) based on their contact frequencies during the study period. The time spent searching in a given habitat was divided by the total number of individuals seen to give contact frequencies as hour per animals for each species. For animals living in group, a group was considered as consisting single individual only.

A Chi-square test was performed on thirteen species, recorded in sufficient numbers for both dry and wet seasons mammal data collection. The test has also applied to calculate the contact frequencies of mammals detected in each survey zone. Expected numbers were calculated from the total groups found across all test categories (vegetation types), divided in proportion to the amount of time (total hour of work) in each category (vegetation type). The association of each species with the vegetation types was explored by calculating the deviation from the expected frequencies, assuming proportional abundance between habitats based on the required total hour work across each habitat types.

Causal records of mammals including animals seen on non-random basis have not been considered in the calculation of contact frequencies, but they have been incorporated to indicate their distribution and for comment on the species account.

To see the difference in abundance of mammals between habitats and seasons, species were also grouped based on their trophic preference (Table 3.). The result of each of these mammalian groups was treated together to calculate the mean abundance of the group of species by their respective vegetation types and with seasons.

Table 3. Categories of mammals based on feeding habits

Categories	Examples of mammals belonging to the different categories
Bulk Feeders	Buffalos, Elephants, hippo
Small Gleaners	Bush buck, Duiker
Grazers & Browsers	Waterbuck, Greater kudu
Rooters	Giant forest hog, Bush pig, Warthog
Flesh eaters	Lion, Leopard, Hyena, Jackal, Civet, Mongoose, etc.
Fruit and leaf eaters	Baboon, Monkey
Termite Specialists	Pangolin, Aardvark
Others(smaller group)	Squirrel, Porcupine

A GIS analysis was performed to show the distribution of the various mammal species on the map, based on the data of each of the mammalian species recorded in the different habitat types. The location point of each mammal species were taken from the direct observation and also from identifiable signs (dropping, track, dung) in the park. The location points (data) were recorded by GPS for each mammal species during the field work. These data were used to produce separate distribution maps for a group of mammalian species in the park.

3.8. Assessment of the views of the local People

In order to understand the views of the local people in relation to the wildlife resource of CCNP, field surveys were undertaken on the people living surrounding the park area. The method used for assessing about the views of the local people based on questionnaires prepared for the study (Appendix 3.). In line with the guidelines of local and regional higher officials, school communities, development agents, local field guides, respected elderly people, members of the community including herd boys took part in the various discussions held during the study periods. The discussions were made directly using questionnaires and meeting and informal interview at any opportunities during the study periods.

4. RESULT

4.1. Diversity

A total of 37 larger mammalian species belonging to eight feeding groups were identified and recorded in the CCNP during the present investigation. Out of these, 32 species were recorded within the randomly selected sampling blocks of the four major vegetation types and the remaining five species were recorded out side the sample blocks in the survey zones of the park (Table 4). There was no difference in the total number of mammalian species recorded during the dry and wet season survey for the whole park.

The mammalian species recorded belong to eight orders, sixteen family and twenty-eight genera. The order Carnivora was represented by the highest number of species (fifteen species) followed by Artiodactyla (ten species), Primates (five species) and Rodentia (3 species). The order Proboscidea, Hayracoidea, Pholidota and Tublidentata were represented by one species each during both the wet and dry season survey (Table 4).

Among Carnivora, the Family Felidae was represented by the largest number of species (five) followed by Viverridae (four), Canidae (three), Mustelidae (two), and Hyaenidae (one). In the Order Artiodactyla, the family Bovidae was represented by six species. This was followed by Suidae (three) and Hippopotamidae (one). Among the two families of primates, Ceropithecidae had the highest number of species (four), followed by the only other family, Lorisidae, which was represented by only one species. In the order Rodentia, the family Sciurinidae consisted of two species and Hystricidae one species (Table 4).

Table 4. Large mammals recorded in the CCNP during dry and wet season and taxonomic categories (Animals with symbol * =observed outside sampled blocks and are not considered in calculation).

No.	Taxonomic groups and feeding Categories				No. observed by season	
	Order	Family	Species	Feeding Groups	Dry	Wet
1	Artiodactyla	Suidae	*Phacochoerus africanus*		89	86
			Hylochoerus meinertzhageni		50	43
			Potamochoerus larvatus	Rooters	41	26
		Hippopotamidae	*Hippopotamus amphibius*		128	118
		Bovidae	*Syncerus caffer*	Bulk Feeder	188	182
			Sylvicapra oreotragus		47	36
			Tragelapus scriptuss	Gleaners	41	43
			Tragelapus strepsiceros		55	63
			Kobus ellipsipprymus	Grazers and	10	15
			*Alcelapus buselaphus**	Browsers	-	36*
2	Carnivora	Canidae	*Canis mesomelas*		8	5
			Canis aureus		6	14
			*Lycon pictus**		-	8
		Felidae	Panhara paradus		5	7
			Panhara leo		3	6
			Caracal caracal		2	6
			Leptailurus serval		5	11
			Felis silverstris		5	14
		Hyaenidae	*Crocuta crocuta*		11	12
		Mustelidae	*Ictonyx striatus**		dead	-
			Mellovora capensis		9	14
		Viverridae	*Ichneumia albicauda*		2	6
			Galerella flavescens		6	5
			Genetta genetta		7	12
			Civettictis civetta	Flesh eaters	10	10
3	Proboscidea	Elephantidae	*Loxodanta Africana*	Bulk Feeder	191	189
4	Hayracoidea	Procavidae	*Procavia capensis**	Others		13
5	Primates	Lorsidae	*Galgo senegalensis**			7
		Ceropithecidae	*Papio cynocephalus*		260	284
			Cercopithecus aethiops		48	45
			Cercopithecus neglectus		26	19
			Colobus gureza	Fruit and Leaf eaters	109	91
6	Rodentia	Sciurinidae	*Helosciurus gambianus*		30	27
			Xerus erytropus		14	16
		Hystricidae	*Hystrix cristat*	Others	11	15
7	Tublidentata	Orycteropodidae	*Orycteropus afer*		5	7
8	Pholidota	Manidae	*Manis temmincki*	Termite eaters	2	6
total	8	28	*37*	*8*	1415	1433

4.2. Abundance

The total number of mammals belonging to the different species recorded during the wet season survey was 1433 while the number was 1415 in the dry season. There was no marked difference in the total number (abundance) of mammals recorded during the dry and wet seasons.

The relative abundance of the different mammalian species varied from 0.35 to 19.82% in the wet season and from 0.07 to 18.37 % in the dry season. Three species (Savanna baboon, African elephant and African buffaloes) are relatively the most abundant in both seasons (Table 5 and Figs.7 & 8). The three species contributed between 12.7 and 19.8% and 13.3 and 18.4% of the total sample of the wet and dry season survey, respectively. Whereas, each of the remaining mammalian species contributed between 0.35 and 8.23% in the wet season and 0.07 and 9.15% during the dry season survey.

In the savanna grassland, relative abundance of the different species varied between 0-22.02% in the wet season and 0 - 29.84 % in the dry season. The montane forest habitat, the relative abundance was between 0 - 15.92% in the wet season and between 0 - 17.9% in the dry season. For the woodland habitat it was between 0 - 20.38% in the wet season and 0 - 28.7 % in the dry season. The riverine forest habitat presented the most varied species relative abundance, which is between 0 - 26.2 % in the wet season and between 0 - 39.2 % during the dry season. Generally, majority of the species recorded in the different habitat types and in the two seasons exhibited low abundance (Table 6).

Table 5. Ranked, number (No) and relative abundance (RA) of the different species of mammals during wet and dry season.

	Wet season			Dry season		
Rank	Common name	No	RA	Common name	No	RA
1	Savanna baboon	284	19.82	Savanna baboon	260	18.37
2	African elephant	189	13.18	African elephant	191	13.6
3	African buffalos	182	12.7	African buffalo	188	13.39
4	Hippopotamus	118	8.23	Hippopotamus	128	9.15
5	Colobus monkey	91	6.34	Colobus monkey	109	7.8
6	Warthog	86	6	Warthog	89	6.39
7	Water buck	63	4.4	Waterbuck	55	3.89
8	Vervet monkey	45	3.14	Giant forest hog	50	3.63
9	Giant forest hog	43	3	Vervet monkey	48	3.39
10	Bush buck	43	3	Greater kudu	47	3.32
11	Greater kudu	36	2.51	Bush pig	41	2.2
12	Tree squirrel	27	1.87	Bush buck	38	2.69
13	Bush Pig	26	1.81	Tree squirrel	30	2.22
14	Debraza monkey	19	1.33	Debraza monkey	26	1.84
15	Ground squirrel	16	1.11	Ground squirrel	14	0.99
16	Porcupine	15	1.05	Spotted hyena	11	0.78
17	Duiker	15	1.05	Duiker	10	0.71
18	Common jackal	14	0.98	African civet	10	0.71
19	Wild cat	14	0.98	Ratel	9	0.64
20	Ratel	14	0.98	Porcupine	9	0.64
21	Spotted hyena	12	0.84	Black backed jackal	8	0.57
22	Genet cat	12	0.84	Genet cat	7	0.49
23	Serval cat	11	0.77	Black slender mongoose	6	0.42
24	African civet	10	0.77	Common jackal	6	0.42
25	Aardvark	7	0.48	Serval cat	5	0.35
26	Leopard	7	0.48	Leopard	5	0.35
27	Lion	6	0.41	Wild cat	5	0.35
28	Caracal	6	0.41	Lion	3	0.21
29	White tailed mongoose	6	0.41	Caracal	2	0.14
30	Pangolin	6	0.41	White tailed mongoose	2	0.14
31	Black slender mongoose	5	0.35	Pangolin	2	0.14
32	Black backed jackal	5	0.35	Aardvark	1	0.07
	Total	1433	100		1415	100

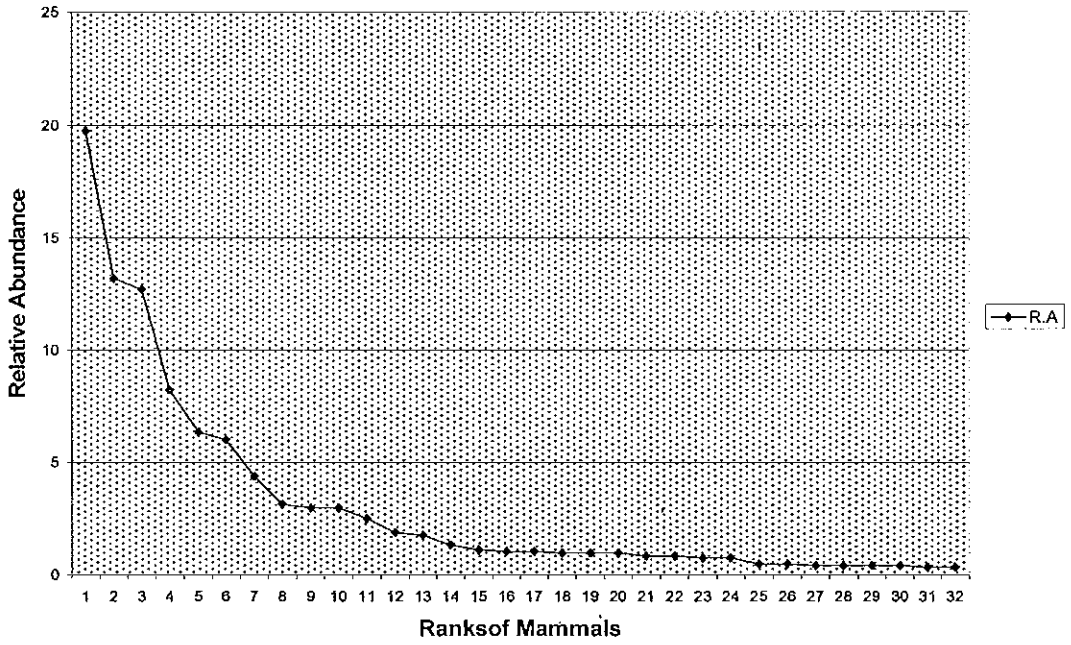


Figure 7. Wet season relative rank abundance of mammals species (1-32 as given in Table 5).

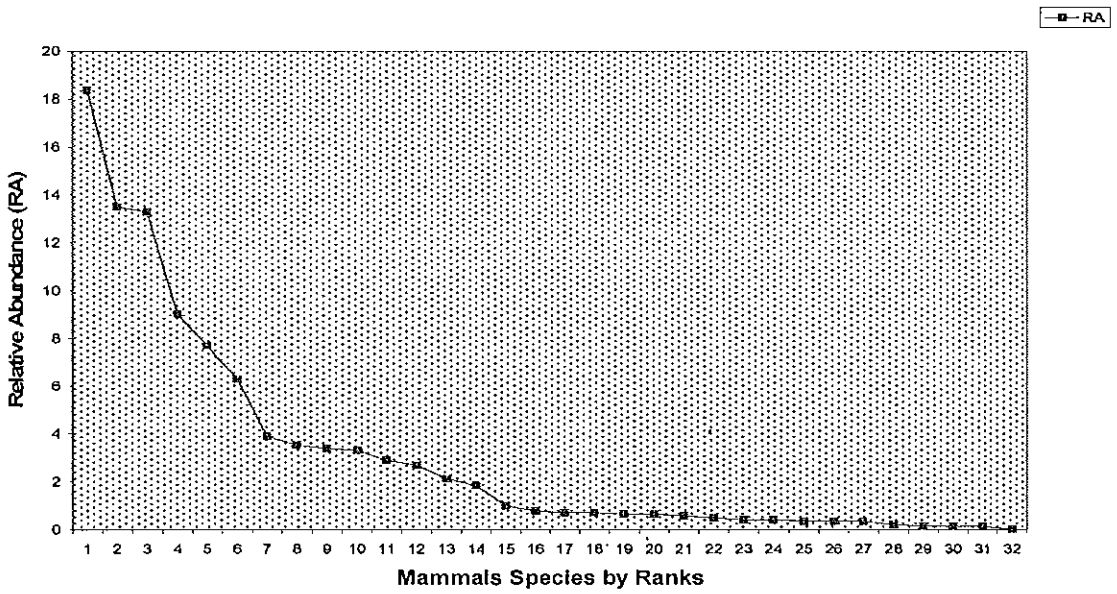


Figure 8. Dry season relative rank abundance of mammals species (1-32 as given in Table 5).

Table 6. Wet and dry season relative abundance (% out of total) of mammalian species in the different vegetation type (GLT=Grassland with scattered trees, MF= Montane Forest, WL=Woodland, RF=Riverine Forest).

Common name	Relative abundance in the four major vegetation types							
	GLT		MF		WL		RF	
	wet	dry	wet	dry	wet	Dry	wet	dry
Savanna baboon	22.02	23.08	15.92	17.9	20.38	28.7	18.98	12.32
Hippopotamus	17.94	29.84	0	00	0	00	2.14	00
African buffalo	18.92	19.11	11.76	15.09	7.01	8.33	5.61	7.8
Elephant	14.84	00	00	00	00	00	26.2	39.22
Warthog	6.36	8.39	6.23	6.39	8.92	7.41	4.01	4.11
Water buck	5.87	6.99	0	00	7.64	6.48	4.01	3.7
Bushbuck	3.1	3.03	3.11	3.32	5.73	6.48	1.6	1.03
Greater kudu	1.79	5.36	00	00	15.92	22.22	00	00
Wild cat	1.31	00	0.69	0.77	1.27	0.93	0.53	0.2
Common jackal	1.31	0.93	0	00	3.82	1.85	0	00
Serval cat	1.31	0.93	0	00	1.91	0.93	0	00
Ground squirrel	1.31	1.17	0	00	5.1	8.33	0	00
Genet cat	0.98	00	0.69	0.77	1.28	0.93	0.54	0.62
Spotted hyena	0.65	0.7	0.69	0.02	2.55	1.85	0.53	0.41
Lion	0.33	00	0.69	0.51	0.64	00	0.27	0.2
Pangolin	0.33	00	0.35	00	1.27	0.93	0.27	0.2
Aardvark	0.33	00	0.69	00	1.27	00	0.27	0.21
Leopard	0.33	0.47	1.04	0.51	0.64	00	0.27	0.21
Ratel	0.16	00	2.08	1.53	3.19	0.93	0.54	0.41
Colobus monkey	0	00	16.96	15.1	0	00	11.23	10.27
Vervet monkey	0	00	10.03	7.16	0	00	4.28	4.11
Giant Forest Hog	0	00	9.34	7.42	0	00	4.28	4.31
Debraza monkey	0	00	4.5	4.35	0	00	1.61	1.85
Tree squirrel	0	00	4.5	4.09	0	00	3.74	2.87
Duiker	0	00	1.73	2.05	2.55	00	1.61	0.41
Black backed jackal	0	00	0.69	1.53	0	00	0.8	0.41
African civet	0	00	1.73	2.05	00	00	1.34	0.41
Slender mongoose	0	00	1.04	1.53	0	00	0.53	00
White tailed mongoose	00	00	00	00	3.82	1.85	00	00
Porcupine	0.16	00	2.08	1.28	1.27	1.85	1.61	0.41
Caracal	00	00	0.69	0.26	1.27	00	0.53	0.2
Bush Pig	0.65	00	2.77	5.37	2.55	00	2.67	4.11
Total	613	429	289	291	157	108	374	487

The number of mammal species recorded in the different vegetation types and seasons was different. In the savanna grassland with scattered tree habitat, 613 and 429 mammals were recorded during the wet and dry seasons, respectively. This was followed by riverine forest (374 and 487), montane forest (289 and 291) and woodland (108 and 157) (Table 10).

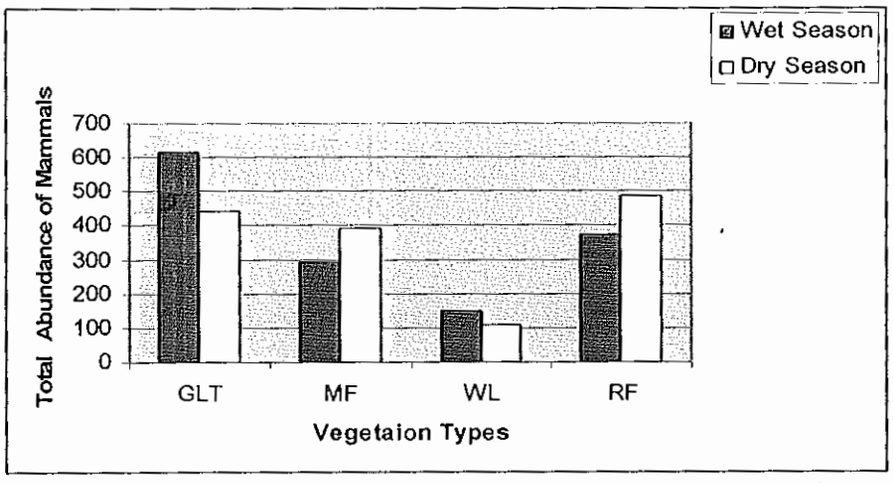


Figure 9. Seasonal pattern of abundance of mammals in each vegetation type.

The mean abundance of the different feeding groups of mammals in the different habitat types were significantly different (Tables 8 & 9 and Figs 11 & 12). The highest mean abundance (mean 51.3 ± 14.7) was found in the grassland habitat with scattered trees during the wet season survey. During the dry season, however, the riverine forest showed the highest (54.63± 6.3) mean abundance.

Number of large mammals based on feeding groups for both seasons is given in Table 7. Bulk feeders had the highest number of individuals during the dry (507) and wet (489) seasons (Table 7). This was followed by the fruit and leaf eaters (433 and 439), Rooters (180 and 155), flesh eaters (74 and 122), small gleaners (88 and 79),), grazer and browsers (65 and 78), and termite specialists (7 and 13) during dry and wet seasons, respectively.

Table 7. Number of larger mammals (feeding groups) recorded during dry and wet seasons.

Feeding groups	dry	wet
Bulk Feeders	507	489
Rooters	180	155
Gleaners	88	79
Grazers and browsers	65	78
Flesh eaters	74	122
Termite eaters	7	13
Fruit and Leaf eaters	443	439

Table 8. Mean abundance (+ SE) of different feeding categories of mammals recorded during the wet season in different vegetation types.

Categories	Abundance of mammals in different vegetation types			
	G L T	M F	W L	R F
Bulk feeders	27.1 ± 9,3	2.3 ± 0.74	2.8 ± 1.3	13.2 ± 1
Gleaners	1.6 ± 0.5	1.1 ± 0.46	2.25 ± 0.61	1.6 ± 0.27
Grazers & browsers	3.9 ± 0.4	0	9.25 ± 1.33	1.8 ± 0.34
Rooters	3.25 ± 0.53	3.7 ± 0.4	3.5 ± 1.8	5 ± 0.44
Termite specialists	0.44 ± 0.33	0.13 ± 0.17	1.25 ± 0.7	0.22 ± 0.22
Fruits and leaf eaters	11.25 ± 9.7	9.1 ± 4.8	8 ± 22.3	14.9 ± 5.8
Flesh eaters	3.25 ± 0.38	2.1 ± 0.23	7.8 ± 1.1	2.2 ± 0.3
Others	0.7 ± . 36	1.3 ± 2.3	2.75 ± 1.3	2.2 ± 0.45
All mammals (mean)	51.3 ± 14.7	19.7 ± 5.1	37.8 ± 20,8	41.1 ± 5.6

Table 9. Mean abundance (+ SE) of different feeding categories of mammals recorded during the dry season in different vegetation types.

Species group	Abundance of mammals in different vegetation types			
	GLT	MF	WL	RF
Bulk feeders	17.5 ± 6	3.9± 0.85	2.3 ± 1.8	25.4 ± 23
Small gleaners	1.1± 0.5	1.4 ± 0.25	1.8 ± 0.7	0.8 ± 0.3
Rooters	3 ± 0.41	5 ± 0.8	2 ±1.1	6.8 ± 0.7
Grazer & browsers	4.4 ± 0.7	0	7.8 ± 1.8	2± 0.4
Termite specialists	0	0	0.25±0.7	0.2 ± 02
Fruits and leaf eaters	8.3 ± 14.8	11.6 ± 4.6	7.8±12.5	15.4 ± 4.6
Flesh eaters	1.1± 0.5	2.7± 0.4	2.5 ± 08	1.7± 0.4
Others group	0.4 ± 0.3	1.4 ± 0.3	2.8 ± 1.3	1.8 ± 0.34
All mammals (mean)	35.8 ± 8.4	26 ± 14.2	27 ± 1.3	54 ± 6.3

4.3. Distribution and Habitat Association

The results of faunal composition in different vegetation type indicated the existence of great difference in species composition and richness between the different habitats of the park (Table 10). The riverine forest habitat has the highest number of species (25). This is followed by montane forest with (23), woodland with (21) and Grassland with scattered trees habitat with (20) species. The number of mammals recorded in different vegetation type differed with season except in the forest habitats (Montane and Riverine) (Fig. 10).

The number of species in the different vegetation types at different seasons was more or less similar in the montane and riverine forests. However; there is higher difference in the woodland and grassland with scattered trees habitat (Fig. 10).

Differences in species evenness, richness and diversity between seasons on the stratified vegetation types were higher in the park (Table 10). Application of Shannon-Wiener information

theory revealed that diversity index and evenness of 2.18 and 0.74 for grassland with scattered trees habitats, 2.53 and 0.81 for montane forest, 2.49 and 0.83 for woodland habitat and 2.18 and 0.67 for riverine forest habitats during the wet season, respectively. While, the diversity index and evenness value of the dry season mammal community were 1.88 and 0.76 for grassland with scattered trees habitat, 2.61 and 0.83 for woodland, 2.17 and 0.78 for montane forest and 2.45 and 0.76 for riverine forest habitats, respectively.

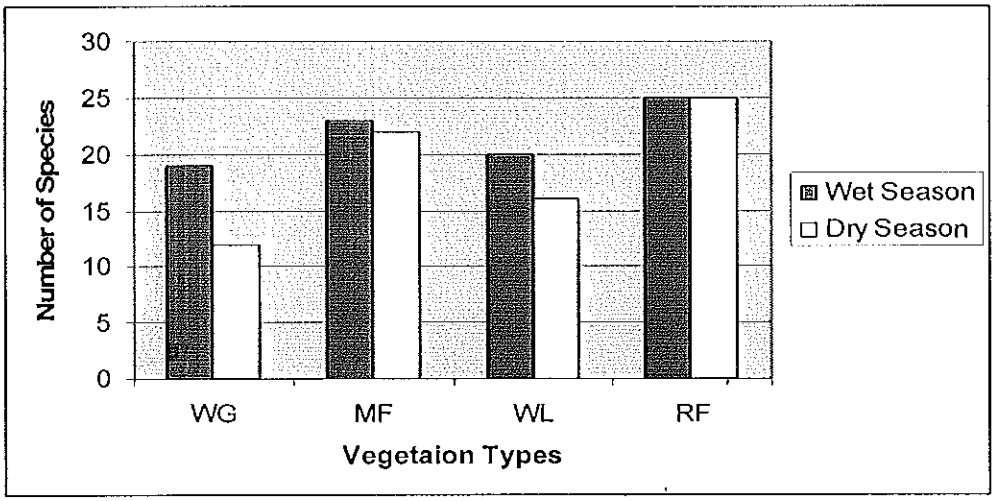


Figure 10. The number of species recorded by vegetation types and season.

Table 10. Mammal species, diversity and abundance in the different vegetation types.

	Diversity & abundance in different Vegetation types				
	Season	*GLT*	*MF*	*WL*	*RF*
Species Number	Wet	19	23	20	25
	Dry	12	22	16	25
Mean species per transects	Wet	4.8±1.2	2±1.5	6.5±2.9	17.1±1.5
	Dry	2.6±0.85	2.6±0.3	4.8±4.1	18±0.94
Shannon Evenness	Wet	0.74	0.81	0.83	0.67
	Dry	0.76	0.83	0.78	0.76
Shannon index	Wet	2.176	2.529	2.492	2.179
	Dry	1.883	2.612	2.165	2.447
Mean mammals Per transects	Wet	51.3±10.4	19.7±6.9	37.8±24.6	41.1+8.8
	Dry	36.7±12.6	26±6.9	27±17.1	54.1+4.5
Total (mammals observed)	Wet	613	289	157	374
	Dry	429	291	108	487

The distribution and habitat association (contact frequencies) of thirteen out of the 37 species of mammals given in Tables 11 & 12.

Table 11. Distribution and contact frequencies of the major mammal species in different season

Species Common name	Habitat type, Total hour of work, and contact frequency				χ^2	Probability value
	GLT	MF	WL	RF		
	96	90	18	54		
Hippopotamus	13.7	0	0	13.5	9.25	P<0.05
Buffalo	6.9	15	6	13.5	3.77	P>0.1
Elephants	13.7	0	0	9	8.8	P<0.05
Warthog	6.4	18	4.5	10.8	6.12	P>0.05
Waterbuck	6.9	0	9	9	13.7	P<0.05
Bushbuck	12	12.9	2.57	9	13.8	P<0.05
Colobus monkey	0	9	0	7.7	11.25	P<0.05
Vervet Monkey	0	12.9	0	9	11.25	P<0.05
Giant forest hog	0	12.9	0	9.00	11.25	P<0.05
Tree squirrel	0	6.9	0	3.2	33.53	P<0.001
Duiker	0	12.9	3.6	6.75	16.1	P<0.05
Porcupine	0	15	0	9		-
African Civet	0	18	6	9	12	P<0.05
Over all	1.3	1.14	0.6	0.7	24..83	P<0.001

Table 12. Distribution and contact frequencies of major mammals by vegetation type and season.

Species Name	Habitat type, Total hour of work, and contact frequency					Probability value
	GLT 96	MF 90	WL 18	RF 54	χ^2	
Hippopotamus	16	0	0	0	12	(<0.01)
African buffalos	6	7.5	6	5.4	0.46	(>0.1)
Warthog	10.7	15	9	10.8	1.63	(>0.1)
Bush buck	8.7	8.2	3	10.8	8.7	(<0.05)
Water buck	13.7	0	9	10.8	8.1	(<0.05)
Colobus monkey	0	7.5	0	6	19.82	(<0.001)
Giant forest Hog	0	12.9	0	10.8	8.58	(<0.05)
Vervet monkey	0	15	0	9	9	(<0.05)
Tree squirrel	0	5	0	3.9	25.46	(<0.001)
Duiker	0	15	9	27	13.3	(<0.01)
Porcupine	0	18	9	27	5.3	(<0.1)
African civet	0	12.9	0	27	9.3	
African Elephant	0	0	0	6	31.5	(<0.001)
Over all	1.9	0.92	0.72	1.2	24.78	(<0.001)

4.3.1. Species account

Hippopotamus *Hippopotamus amphibious:*-this animals were more frequently encountered within the savanna grassland habitat (DF, 3, $\chi^2 = 12$; $P < 0.01$) for the dry season and (DF= 3, $\chi^2 = 9.25$; $P < 0.05$) for the wet season around the five smaller lakes in both seasons (Figure 14). A total of 118 and 128 individuals of hippos within 7 and 6 herds were counted during wet and dry season survey, respectively. The animals were also common outside the sampled blocks in Omo River in both seasons. However; it also visited rivers (Zigna, Shoshuma) and lower swampy floors during the wet season within the sampled blocks inside the park.

African buffalos *Syncerus caffer:*-this animals were common and frequently seen in all major habitat types throughout the park (Figs. 11 & 14.). The animals showed no significant difference

in preference between the four major vegetation types of the park (DF, 3,, $\chi^2 = 0.46$; $P > 0.1$) for the dry season and (DF, 3, $\chi^2 = 3.77$; $P > 0.1$) for the wet season.

These animals also used the luxuriant tall grass for cover during the wet season. During the dry season, most of them passed the day time inside or closed to different rivers, streams and lakes area where there were food, water and cover. In the late afternoon a number of herds ventured out to the grassland with scattered tree habitat, which was mostly burnt and stayed there up to the early morning and returned back to forest habitat. A total of 182 and 188 individuals were recorded in wet and dry season survey, respectively. Out of these, 14 were newly born calves recorded during the beginning of the wet season.

African Elephant *Loxodanta africana*:-this species was best counted in the northwestern part of the park inside Meka forest and the nearby wooded grassland habitat in both season closed to the Chebera village (Figs. 12 & 14). During the wet season survey three groups (herds) were seen in the northwestern part of the park around Boka area. No signs of any of this species were detected in the southern parts of the park. There was significant difference in the preference of this animal between habitat types (DF, 3, $\chi^2 = 8.8$; $P<0.05$) for the wet season and extremely significant difference (DF, 3, $\chi^2 = 31.5$; $P<0.001$) for the dry season. A total of 189 and 191 African elephants were directly counted during the wet and dry seasons survey, respectively. Eight newly born calves were recorded among the herds during the wet season survey

The animals commonly prefer the riverine forest, particularly the large Meka forest during both seasons, located northwest of the park whereas during the dry season some of the herds locally migrate to northeast of the park, the Boka area.

Figure 11. Photo of African Buffalo *Syncerus caffer* herd in CCNP.

A

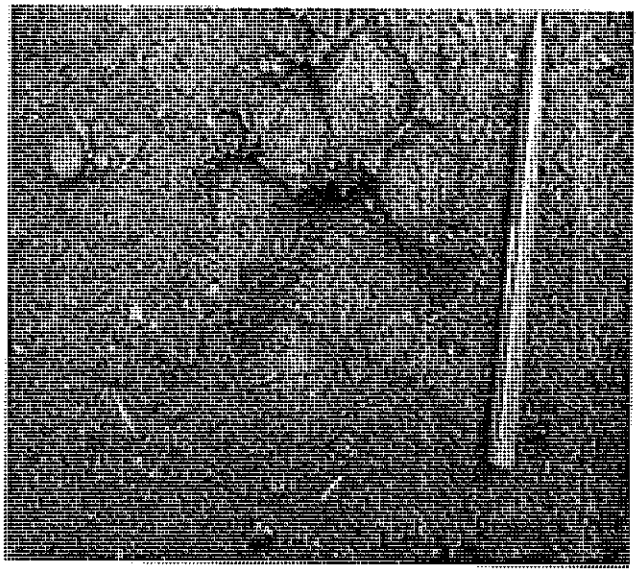
B

Figure 12. Photos (A & B) of African Elephant *Loxodanta africana* taken from Meka forest north west of the park..

A B

C

D



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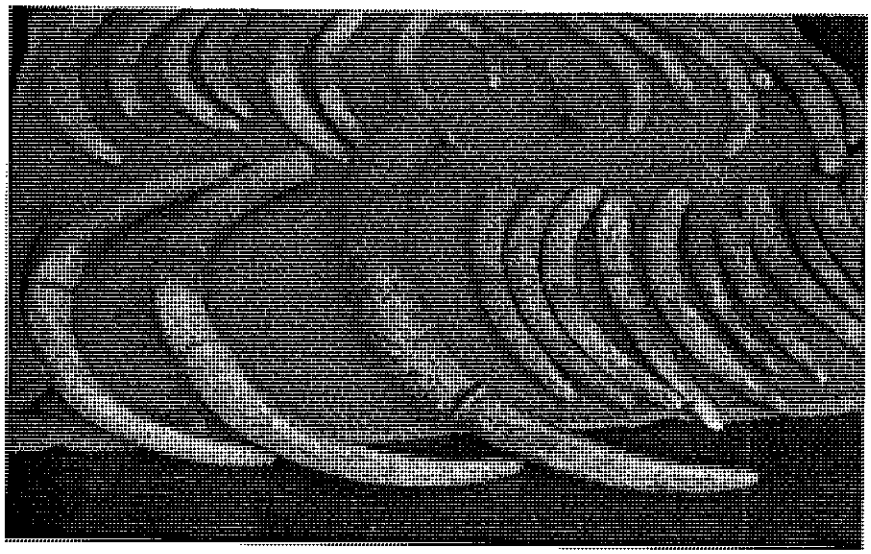

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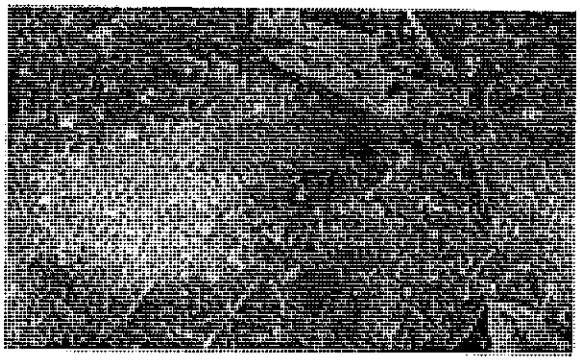


G

Figure13. Photos showing indirect evidences of mammals (A = Incisor of warthog, B= Waterbuck dropping, C= Elephant dung, D= dropping of bush pig, E= Foot print of spotted hyaena, F=Ivories, G=Fresh dead tree squirrel, respectively).

Warthog *Phachoerus aethiopicus* :- this species was common during the day in all habitats in both seasons in the park. There was no over all significant difference in the preference between habitats (DF, 3, χ^2 = 1.63; P>0.1) for the dry season and (DF, 3, χ^2 = 6.12; P>0.05) for the wet season. Three up to fourteen and three up to nine groups, often with piglets, were recorded daily in all habitats during the wet and dry seasons survey, respectively. Mostly they were common in the savanna-wooded grassland and woodland habitats near the riverine forest habitat and they rarely ventured far to the grassland habitat. Single animals were seen during night also, when lit; they stopped activity and lowered the head, seem checking the situation around and if there is no problem to them. They resumed feeding on grasses.

Defassa Waterbuck; Kobus *ellipsiprymnus*:-This species was common and encountered in all habitats except the montane forest habitat, along most of transects during the present surveys (Fig. 14). Considering the whole park, the habitat association showed significant difference (DF, 3, χ^2 = 8.1; P<0.05) for the dry season and (DF, 3 , χ^2 = 13.7P<0.05) for the wet season. No significant difference was observed among the three habitat types (DF=2, χ^2 = 0.65,P>0.1) during wet season and (DF=2, , χ^2 = 0.37.P>0.1) during dry season. However; waterbucks were more frequent and venture out to the upland grassy habitat closer to any of the water points during both seasons. All observations of waterbuck were during the day in both wet and dry seasons. Usually two up to five groups were recorded feeding the newly grown shoots on the burnt grassland during the dry season. They were commonly seen feeding on shorter grasses along the slopes of the hills during the wet season.

Bushbuck *Tragelaphus scriptus*:- this species was common and frequently observed in all habitats. However, in the grassland habitat, they commonly restrict themselves to the margins and do not venture far away from forests and bushy area (Fig. 14). In the montane and riverine forest habitat, Bushbucks were frequently seen during the day and usually in the woodland and grassland margins during the night. Six up to eight bushbucks were recorded in ones and twos during both seasons in the four major habitats of the park. However; there was a higher significant difference in the contact frequencies hour of bushbucks across the four major habitat

types of the park in which it is less in the riverine and woodland habitat (DF, 3, , χ^2 = 13.8; P< 0.05) for the wet season and (DF, 3, , χ^2 =8.7 P<0.05) for the dry season.

Vervet monkey Cercopithecus *aethiops*:- this species was solely common and frequent in the montane and riverine forest habitat (Fig. 16). Groups of six up to seven were recorded in both habitats during dry and wet seasons. Comparison of the habitat preference of this species revealed that there is no significant differences between the two habitats (montane and riverine forest) (DF 1, χ^2 =0.33 P<0.05) during wet season and (DF 1 χ^2 = 0.8 P<0.05) in the dry season. Many young were present in the group during both seasons. Troops of this species and Colobus Monkey were seen foraging on the same trees kept separate in the Zigina Riverine forest.

Abyssinian Colobus Monkey (Guereza) *Colobus guereza*:-This species was also common and frequent in the two forest habitat (montane and riverine forest) (Fig. 16) and was detected by their loud early morning call. Groups were audible inside montane forest and more in the riverine forest habitat. They seemed markedly shyer than the vervet monkey, highly disturbed and jumped from tree to tree when they see humans from a distance. There is no significant difference in their frequencies of occurrence between the two habitats, (DF 1, χ^2 =0. 26 P<0.05) during the wet season and (DF 1, χ^2 = 0.21 P<0.05) in the dry season. Most of the troops consisted of a number of young in both seasons, which were carried most of the time.

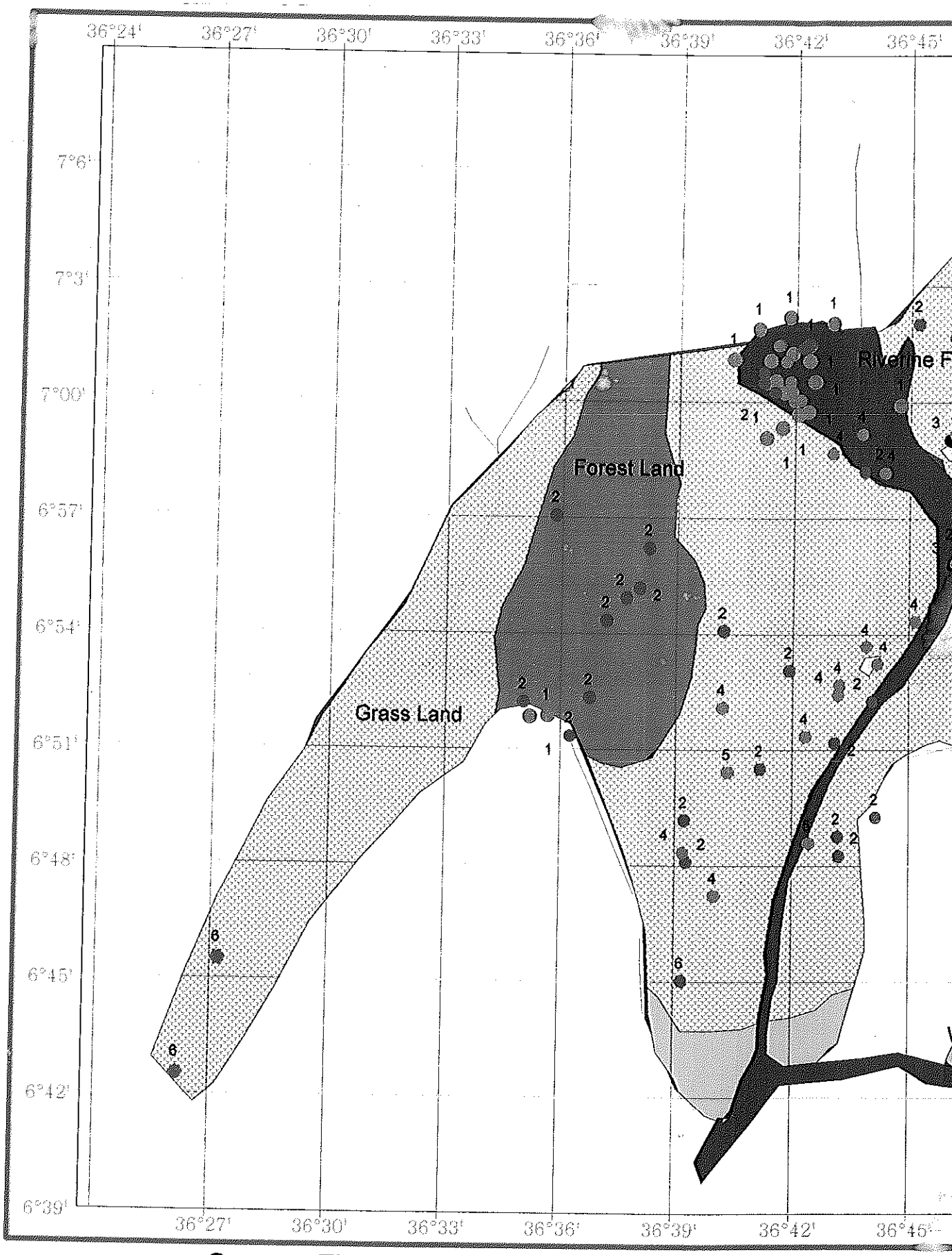
Duiker *Sylvicapra grimmia* :- this species were directly recorded in all habitats except in the grassland with scattered trees. However, indirect evidences indicated that a number of them use along the margin of grassland by night. Thus, a number of duiker footprints and carcasses were observed in all the habitat types during both seasons. The rather lower over all contact frequencies of duiker in the woodland habitat approached statistical significance (the three habitat tested against each other DF=2, χ^2 = 6; P<0.1). Most of the duikers observed were single and a few were in groups of two. These were detected during night.

African civet *Civetictis civetta:* - this species was very common in the montane and riverine forest habitats as numerous signs were observed in the area during both seasons and probably less in the Woodland habitat (Fig. 18). These, three habitats were tested based on night observations against each other and showed no significant difference in the habitat preference of the animals (DF=2, χ^2 =1.27 P<0.05) during the wet season and (DF= 2, χ^2 = 2.13 P<0.1) in the dry season.

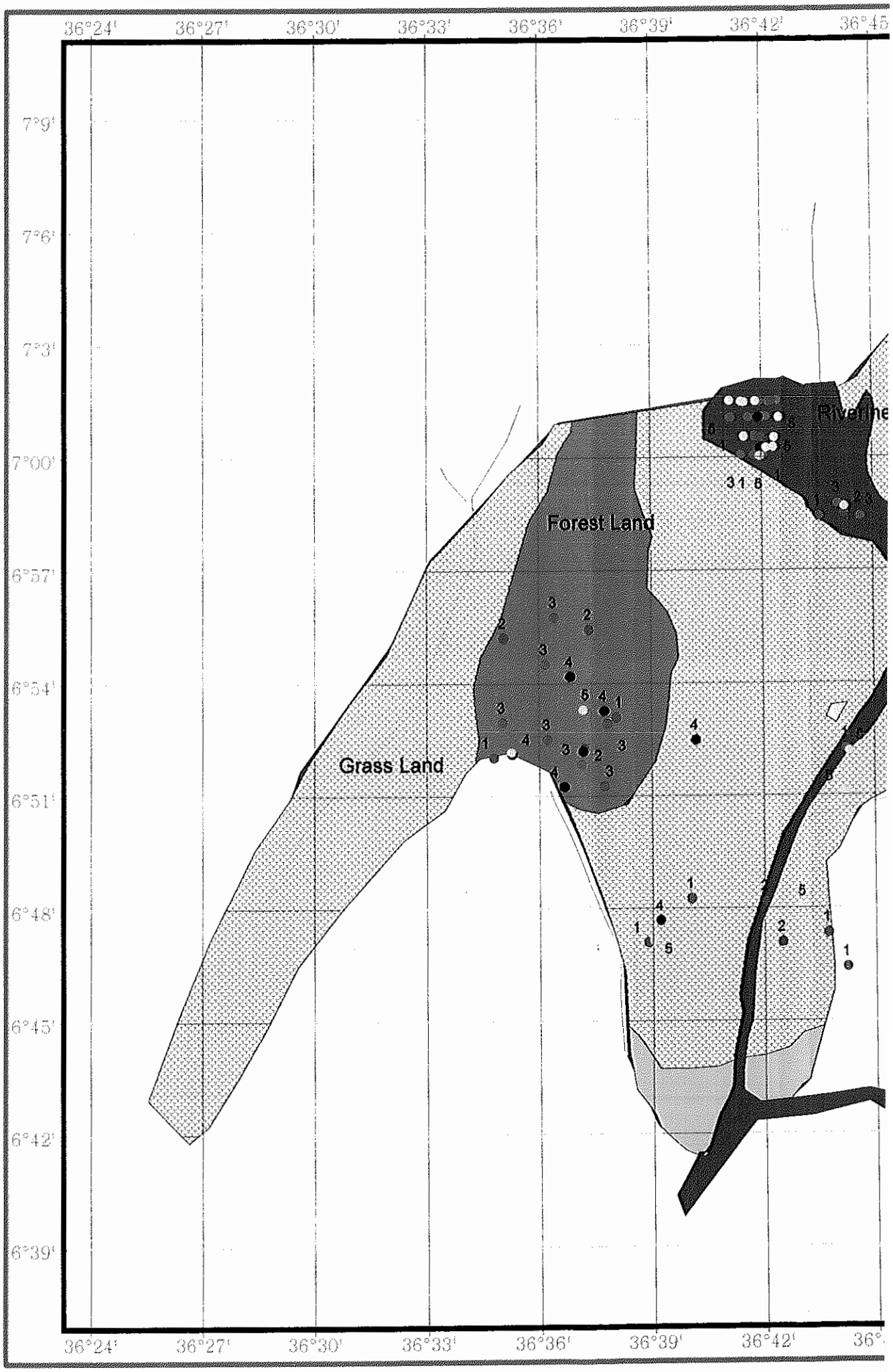
Gambian sun squirrel *Helosciurus gambianus*: this species was found and abundant in both riverine and montane forest habitat (Fig. & 17) and unrecorded in the rest of the park habitats. Photo of fresh dead tree squirrel was taken (Fig. 13 G) from the ground in the Meka riverine forest. On average, up to sixteen individuals were recorded in each of the two forest habitat. No significant difference was recorded between the two habitats (DF=2, χ^2 = 5.2, P>0.05) during wet season and (DF 2, χ^2 == 0.5, P<0.1) during the dry season.

Crested Porcupine *Hystrix cristat*:- this species inhabited all habitats equally based on the indirect evidence (a number of dropping and spines) observed in the park. A total of seventeen animals were observed directly.

Species like Giraffe and Rhinoceros were used to occur in the area, but was not confirmed during the present study. Non-random exploration of the various habitats of the park, recorded five more species in the park. These includes; Lelwel Hartebeest (found in the southwestern parts of the park (Figure.14.), Hunting dogs, one pack having eight individuals was observed inside the park around Bahi Lake in the grassland with scattered trees habitat (Fig. 18), Bush baby (recorded in the forest and woodland habitats), rock hyrax recorded on two outcrops of northern and southwestern parts of the park (Fig. 17.) and one dead striped polecat (Zorilla) was observed in the woodland habitat during the present survey.



Source: Field Survey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Forest Land
Grass Land
Riverine


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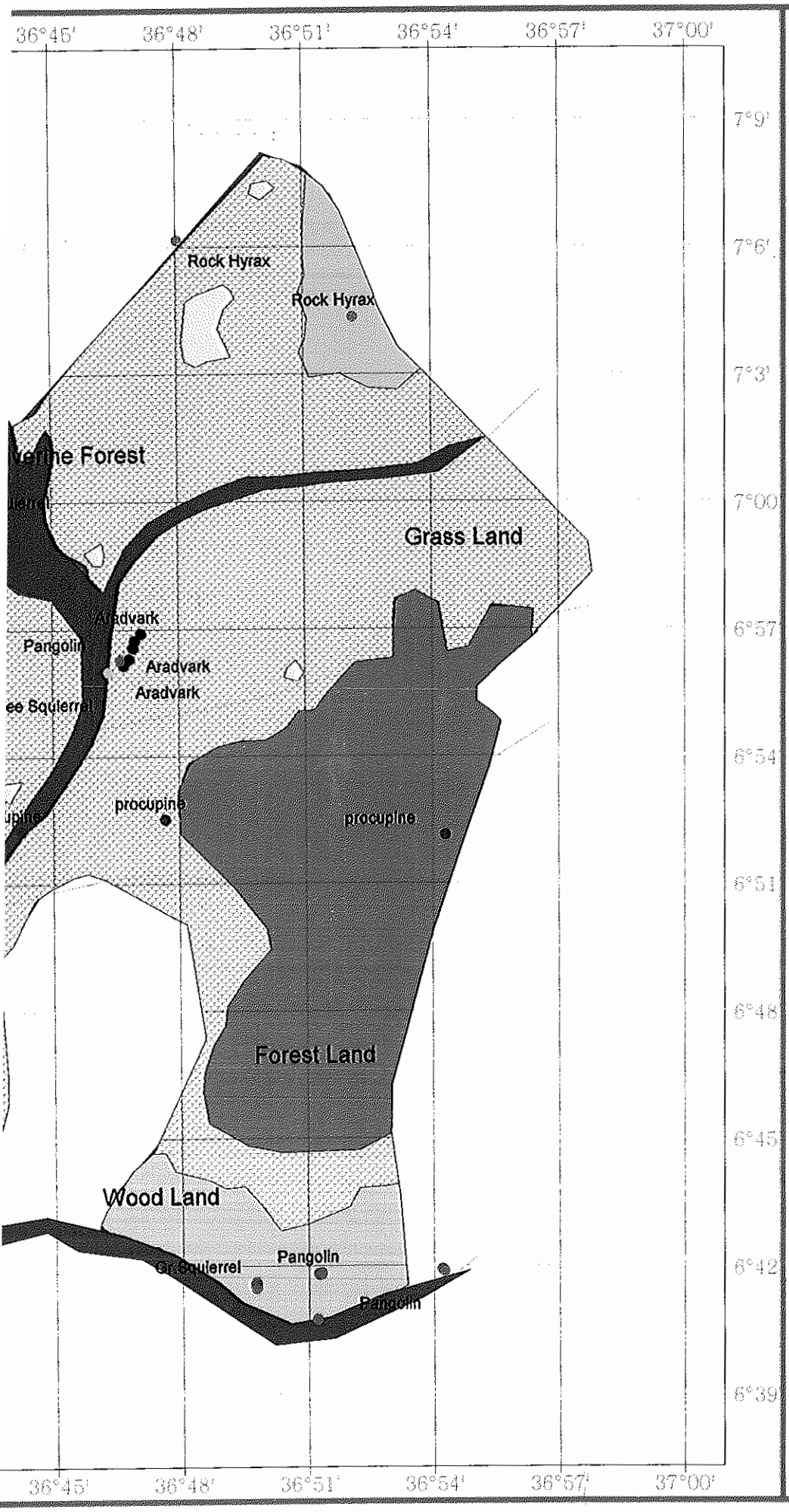

Figure 9

The Distribution of Termite Specialists and Other Smaller Mammals in the Park

Legend

- Aradvark
- Gr.Squierrel
- Pangolin
- Rock Hyrax
- Tree Squierrel
- procupine

N

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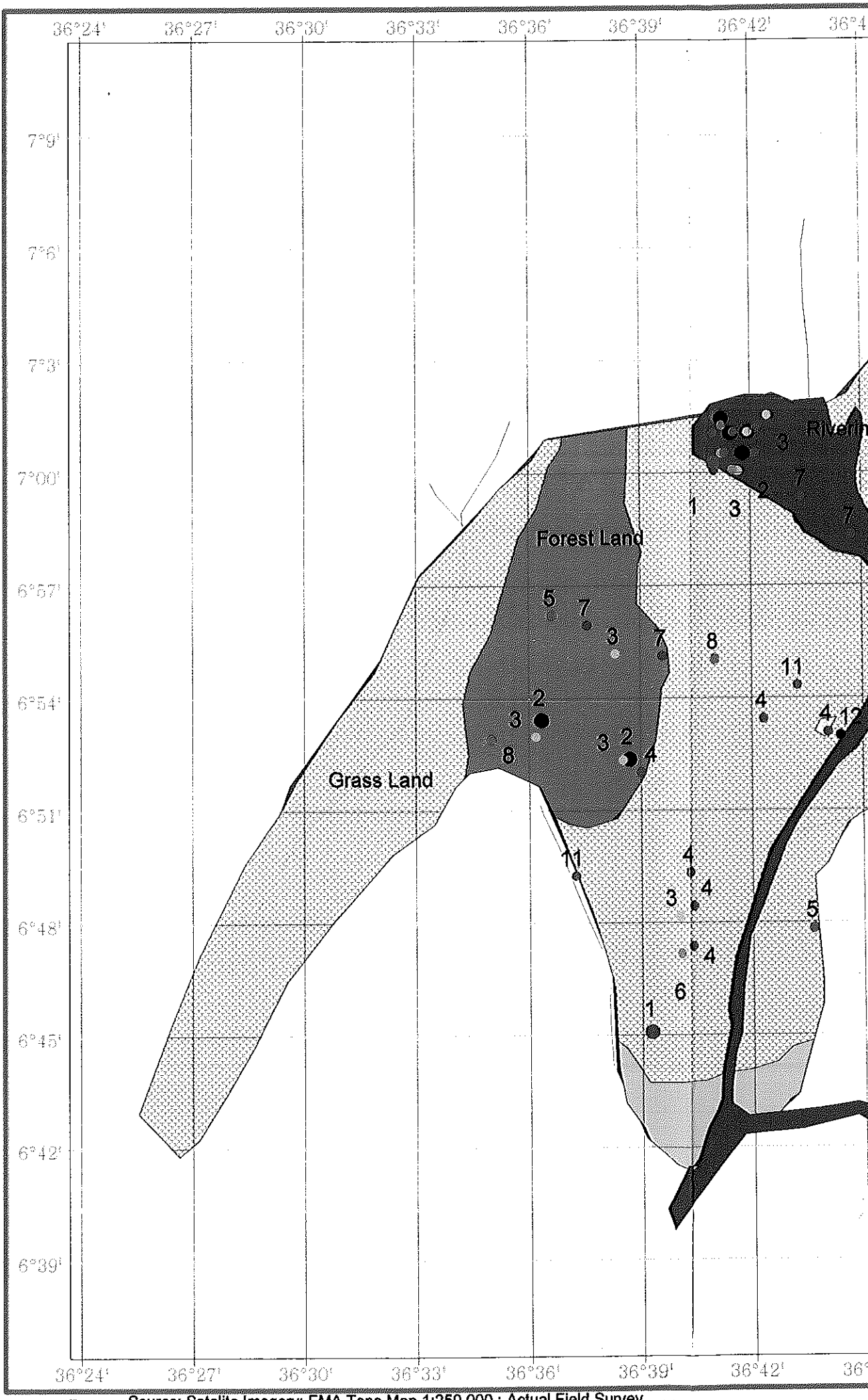

Source: Satelite Imagery; EMA Topo Map 1:250,000 ; Actual Field Survey

4.4. Assessment of public opinion

Discussion with the local people and district officials made it clear the views of local community toward the park and particularly to conservation of larger mammals in the area. According to the local people and observation in the study area, the following four major and most pronounced threats of the park were identified during the study period.

1. Poaching

The local people living surrounding the park illegally hunt most mammals for food and for their hides and skins. Previously, illegal hunting particularly of African elephant was common. The local hunters kill large number of elephant for ivory. A number of ivory was confiscated by the local polices. Figure 13. F shows the ivories from the Konta special Woreda police officer. Most of them are from sub adult and younger elephant.

During the field work the team had counted 53 carcasses of larger mammals were observed during the study period (Table 13). Most of these (49 %) were killed by the surrounding local people (Fig 19)

At present, a number of poachers are known to occur in the southern part of the park around Churchura peasant association area.

Table13. Number of dead animals found during the study period

Species common name	Number	Causes of death
African buffalo	7	2 old age & 5 poaching
Ratel	4	2 unknown & 2 killed by man
Bush buck	7	Predation by carnivore, 3 Poaching & 2 fire
Waterbuck	5	Poaching
Warthog	7	Predation by carnivore & 4 Poaching
Bush pig	5	2 Predation by leopard, 3 poaching
Hippopotamus	3	Poaching & one old age
Zorilla /striped polecat/	1	Unknown
Caracal	2	Unknown
Ducker	6	Fire
Tree squirrel	4	Predation
Baboon	2	Killed by man
Total	53	

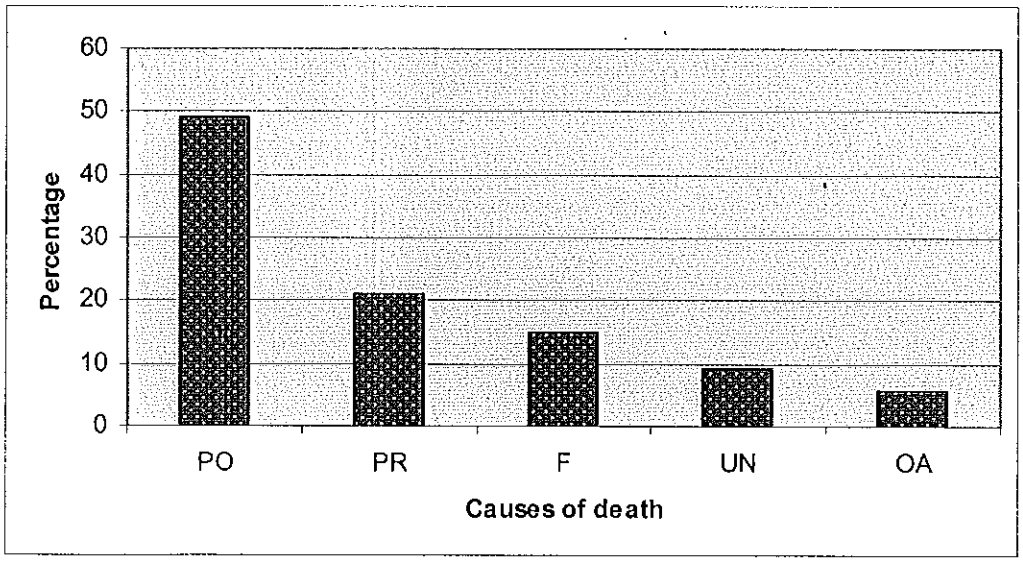

Figure 19. Percentage of causes of deaths (based on carcasses counted) during the study period. (PO=Poaching, PR=Predation, F=Fire, UK=Un known, OA=Old age)

2. Wildfire

Fire is one of the main threats to the wildlife of the park. During the dry season, the Savanna Grassland and Woodland habitats were indiscriminately burnt off. The southern and central parts of the reserve are burnt early, beginning from mid-November whereas the northern part is burnt from February up to March. Fires are initiated by the local people surrounding the park in order to promote the growth of more open land for cultivation, to clear away the old dead material in order to ensure a better growth of young grass and to open foot tracks (internal roads). In the dry season, an uneven pattern of fire initiated by the honey gatherers and hunters creates a mosaic of different stages of growth. Areas burnt early carry a flush of young grass and leaf growth, but on areas burnt at a later stage, drier grounds were observed. Regeneration may not begin again, until the rains. The dispersal of ungulates (Buffalo, warthog, Waterbuck, etc,) usually tends to follow the pattern of burning.

3. Grazing

Locals regularly bring cattle to the park mainly for gazing and drinking water. Mineral water sites are located in several places inside the park. The people believe that the water has medicinal properties and considered it as appetizer to get high milk production.

4. Cultivation

The present study reveals that there are some scattered resident populations within the park located in the Shashogueg forest, Churchura, Serri and Shewakela peasant associations. There are also human settlements around the park. They use some parts of the park for shifting cultivation. Besides, the regional government considered the surrounding area for settlement program. There are some 2000 non-indigenous people that have settled around the park, on the southwestern boundary in the Delba and Koisha Konta peasant association area

5. DISCUSSION

5.1. Diversity and abundance

The topography, climate and diverse vegetation types of the CCNP have provided habitats for a diverse species of mammals. The 37 large and medium sized mammals were recorded in the park for the first time demonstrate the importance of the study area as an area to be protected for the conservation of important mammalian fauna of Ethiopia.

A comparison of the diversity of large mammalian species in CCNP with other very well known wildlife protected areas in the country shows that Nechisar National Park has the same number of mammalian species (37), while Mago and Omo have 38 and 40 mammalian species, respectively (Graham, *et al.,* 1996).In addition, there can also be other unexploited mammals since this study is for a shorter duration

The present study also revealed that the CCNP supports good population of one of the globally highly threatened mammalian species, the African elephant. These are evidences for the critical role that CCNP plays as a natural ecosystem in conservation of Ethiopia's terrestrial fauna particularly larger mammals.

The number of species recorded in different habitat types varied with seasons. This is related to local migration of some of the species between habitats based on the availability of food, cover and other factors such as fire in the park. That is why, differences in species evenness and diversity between seasonal habitat types on the stratified vegetation types were higher in the park (Table 10).

The reason for the abundance of mammals higher in the grassland with scattered trees habitat during the wet season probably was related to the availability of food and water for most of the mammalian species. This site also has minimal security problems as compared to other habitats. All the bulk feeders including the African elephant were recorded in this habitat during the wet

season. During the dry season, most individuals (large mammals population) migrate locally to the riverine forest area.

The park is probably one of the richest wildlife protected areas next to ONP in the country in terms of population (abundance) of larger mammals particularly, the African buffalo. This species harboured in all habitat types with a herd of seven up to thirty. The availability of large savanna grasses, water and the relatively low poaching as compared to other wildlife protected areas in the region could be reasons for the high abundance and widespread distribution of animals in the park. During the wet season filed work most of the internal roads were closed and it was difficult to move from one point to the other as the tall grasses had covered the entire land. Tracks of mammals particularly, of bulk feeders (hippo's, elephant and buffaloes) were very important, which made possible and easy access for the survey in the entire park. There are a number of hippo tracks (about five kilo meters in length), dropping and grazed areas in the grassland habitat around the five lakes and along the main river basins in the study area. However; they were perhaps less numerous around the Montane forest habitat particularly during the wet season. During the wet season when there was more abundant luxuriant grass or food most population of buffalo herds evenly distributed and seen day and night over the entire central wooded grassland habitats of the park.

The African elephant counted in present survey, more or less, seems a permanent resident in the park. Some of the herd split and move to the north eastern portion of the park (Boka area) during the dry season. The rest occur in the northwest (Chebera Meka forest area) of the park in both seasons mainly due to the availability of forage and water. It is also the safest area in terms of security (poaching). The long migratory routes of this animal require specific study; however Indirect evidences and information from the local community revealed that a number of herds migrate to the area following River Omo and Oma Cheta Valley every two or three years from Omo National Park.

Despite the reported high level of regional mammalian diversity, the majority of the species were recorded in low abundance. In view of the human activities resulting in the natural habitat modification (kingdom, 1972) and the fact that most larger mammals are sensitive to natural

habitat disturbance (Happold & Happold, 1991), it is probable that these species declined in number. Further survey on the mammalian ecology to investigate critical environmental factors that influence the diversity patterns is necessary for the implementation of appropriate conservation strategies to safeguard this healthy mammalian biodiversity.

5.2. Distribution and Habitat Association

Distribution and habitat association of mammals is determined mainly in terms of their water and food requirements in the park. Water and pasture condition or combinations of them are the major factors determining the distribution of wildlife populations in the natural habitats (Western, 1975; Grimsdell, 1978; Balakrishnan and Essa, 1986). The distribution of mammals revealed that the fauna is not uniform across the four prime habitat types. The frequency of species encountered in the sampling blocks showed that only two species (African buffaloes and warthogs) were common or widespread in the different major vegetation types of the park (Tables 11 & 12). They were sufficiently recorded in each vegetation types of the sampling blocks. This is consistent with the findings of Dora and Balakrishnan (1991) in the Upper Lupande Game management area, Zambia.

A few of the mammalian species recorded in the study area showed no significant difference in composition and abundance between the different vegetation types and seasons (Tables 5, 6 & 10). Almost 41% of the large mammals (savanna baboon, African buffalo, warthog, bush Pig, porcupine, wild Cat, genet cat, spotted hyena, lion, aardvark, leopard, ratel, and pangolin), were found in all the 4 habitat types in varying frequencies. These are mammalian species that have relatively wide habitat range. On the other hand, a few species of mammal (colobus monkey, vervet monkey, giant forest hog, debraza monkey, tree squirrel, black backed jackal, and black slender mongoose) were recorded only in the montane and riverine forest habitats and most of them were recorded at very high frequencies. These are mammalian species that are adapted to such habitats and the present record is in line with previous observations (Duckworth, *et al.*, 1992; Kirubel Tesfaye, 1985). Kingdom (1971) also stated consistent distribution and habitat association for most of these mammalian species.

The distribution of mammals in the different habitat types might indicate habitat selection of the different species of mammals based on their ecological preferences and evolutionary adaptation. The diversity results show that the greatest mammal diversity was concentrated within the riverine forest, with the least diversity being registered at grassland with scattered tree habitat. The montane forests have an intermediate number of species in both seasons. The faunal composition of the different habitats may be an indication of the feeding habits of the mammalian species. The riverine forest habitat is rich in the species richness and evenness; this is probably related to the habitat complexity and stability as compared to other habitat types. Foliage diversity of the forest increases species diversity. Besides, most part of the riverine forest habitat was located within the center of the park and so the human impact is also minimal. Whereas the habitat complexity and stability of the woodland and grassland with scattered tree habitat were lower mainly as a result of the low floral diversity. Besides, these two habitats are highly threatened by fire. They were constantly burnt every year in the dry season. Fire affects particularly calves of medium sized mammals. During the dry season survey, the field team had observed two burnt bushbuck calves and six duikers (Table 13).

Bulk feeders showed high preference to wooded grassland habitat in the wet season and to the riverine forest habitat in the dry season. The gleaner and rooter groups showed similar preferences for all habitats during the wet season. However, the rooter group showed more preference to the riverine forest habitat during the dry season. The primate group, apart from savanna baboons showed a high preference for riverine and montane forest habitats and this is related to the animals arboreal habits and feeding preferences since both occur in the forest trees. The large grazer and browser groups displayed a strong association with woodland and grassland habitat in both seasons. This is in line with the observation of Duckworth, *et al.* (1992) in Nechisar National Park, and Hinde, *et al.* (2001) on large mammals in Kilombero Valley, Tanzania. Environmental influence has molded the distribution patterns of mammals within the area and on the continent as a whole (Kingdon, 1971). Vegetation provides food, shelter and cover to mammals. The structure and composition of vegetation, therefore, determine the distribution, abundance, and diversity of mammalian community residing in it.

Among the bulk feeders, the African buffaloes showed preference to all major habitat types. However, the number and herd size was higher in the grassland habitat during the wet season. Kingdon (1982a) stated that animals harbour in all habitats, where water and grass are not a limiting factor. The African elephant and hippos are restricted in the wooded grassland and riverine forest habitats in the wet season and near the riverine forest habitat during the dry season. The dense vegetation of the highland area is unlikely to have been a physical barrier to these species so their low reliance in the montane forest habitat may have been related to permanent water and food availability (particularly for hippos) and security problem (poaching) in the area. There were old fallen trees by the African elephant in the montane forest habitat detected during the present survey. High poaching incidence in the area made these animals to keep their distances from the montane forest habitat area.

The fifteen carnivore species recorded during the current survey, may reasonably indicate CCNP is rich in the diversity of wildlife. Kingdon (1977) stated that abundance of predator species in an area is one of a good sign of ecological richness and diversity. In addition bat eared fox (*Otocyon megaloties)* (considered as pest by the local people) and Cheetah *(Acinonyx jubatus)* might reasonably occur, judging from the information of the local informants.

5.3. Assessment of the views of local people

Along with the main objectives of this survey, effort has also been directed towards assessing threats of human origin, which may cause management problems to the wildlife of the park and to suggest and discuss ways of alleviating them.

As compared to most of the wildlife protected area in the country, the park has a greater pristine nature with minimum human impact. At present, the majority of the habitat types are not as such threatened by the surrounding people and the mammals remain healthy. Wildlife conservation and management outside and inside the wildlife protected areas needs to understand the attitudes of local communities towards conservation. This could be one of the main tools, which enables one to resolve the conflict which commonly exists between conservationists and the local people

around the protected areas. It also provides immediate and long-term benefits to the management of the area.

Formal and informal interviews and discussions with the local people have revealed that the local community strongly supports conservation initiatives. At present, the awareness level of the local people towards wildlife conservation is promising, as they are clearly informed about the significance of wildlife resources and the actual benefits they may gain by conserving the wildlife resource of the area. The reserve was declared largely by the recommendation of the local people occurring in the Konta special Woreda and Dawro zone. The question to raise the area into the status of a national park arose mainly because of the decline of wildlife particularly larger mammal species due to the negative activity imposed by the local people in the vicinity.

Poaching have the most significant impact for the disappearance and population decline of larger mammals, particularly, the African elephants. Illegal hunting is one of the top most serious threats to the park. However; according to most of the local people and district higher officials, trends of illegal hunting, in general has been highly reduced recently compared to the previous years. This is related to the routine control and imposing strict punishment on the offenders by the local government. At present, the majority of the local people around the park give great attention to the wild animals of the park. The people themselves protect the animals from illegal hunters. Particularly, hunting of the African elephant is highly controlled. No animals of this species were killed during the present study period.

At present, the effects of livestock grazing are not as such visible on the wildlife of CCNP. However, the effect will be dangerous in the future as the number of cattle increase proportionally in relation to the growing number of people in the area. These factors may result in the Competition for the same resources among wild animals. This will result in the loss of quality grasses, trampling, erosion and transmission of diseases (Leykun Abune, 1991). Many of the similar habitats of the Region's conservation areas (Nechisar, Mago and Omo National Park) are known alter large parts of the former natural vegetation as a result of livestock degradation.

Repeated and uncontrolled fires may affect the tall perennial grasses, beneficial organisms and loss of soil fertility in the future, unless immediate control measures are taken by the concerned body. Besides, a number of small mammals can be highly threatened through burning each year.

The other major vegetation types of the park, montane and the riverine forest are less impacted by the fire. This may be related to the evergreen and moist nature of the habitats all over the year. In contrast, a significant portion of the savanna grassland with scattered trees and woodland habitats was burnt under fire during the dry season.

The communities living surrounding CCNP area have been notable for their extensive cooperation for wildlife conservation activities. However, shifting cultivation and livestock tending still occur within and parts of the park boundaries by the local residents.

It is believed that shifting cultivation under traditional management system has a positive impact on the natural biodiversity. This traditional agricultural practice has been characterized by the use of a wide variety of crop species within the same system. The mosaic of shifting cultivation sites, pastures, graves and secondary forest in different stages of vegetational succession has enhanced landscape heterogeneity and had been responsible for the abundance of wildlife (Caughley and Sinclair, 1994).

These cultivations were established prior to the designation of the boundaries of the park. These activities would represent a potential source of conflict between the national park authority and the local people surrounding it in the future. Preparation of a management plan to mitigate potential landuse conflict is, therefore, a high priority management action that should be considered.

The non-indigenous (resettled) people landuse system is a recent phenomenon. The people were provided with farmland by settlement program of the region adjoining the southwest of the park boundary. At present, several pieces of savanna wooded grassland are being cleared for crop production in this area. Here also great care should be taken to safeguard the wildlife as the landuse systems of the non-indigenous people are different from the native one.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The present ecological survey revealed that the park supports an impressive variety of larger mammalian species; comparable with very well known wildlife protected areas in the country. Among these varieties of mammalian fauna, some species which originally had wide ranges are now under greater conservational problems everywhere from habitat loss, deforestation, settlement, poaching, and lack of conservation attention, at present appear to have healthy population in CCNP. Some of these mammals include the African elephant, hippopotamus, African buffalo, lion, and leopard. Particularly, the site appears the most suitable habitat for the African elephant as compared to other wildlife protected area in the country.

Specific conclusion might not be possible on the trends of mammalian diversity, abundance and distribution in the study area because regular systematic ecological inventory was not conducted before the present study in the area.

CCNP could be a very ideal place for national and international tourists as many of the larger animal populations are easy to see in the different habitats of the park. Besides, the topography or landscapes, the evergreen forest and lakes are breathtaking and it is wise to push it for tourism development.

According to the various discussions held with the local communities and district officials poaching, cultivation, uncontrolled fire and livestock grazing are the major prevailing threats, which must be controlled to make sure the wildlife diversity in the park.

At present most of the local community members strongly support conservation initiatives as they are aware about the significance of wildlife resources and the actual benefits they may gain by conserving the wildlife resources of the area.

6.2. Recommendations

- The adverse human activities poaching, cultivation, uncontrolled fire and livestock grazing would have a greater impact on the diversity, abundance and distribution of mammals in particular and the natural ecosystem of the park as a whole. It is, therefore, wise to take immediate measures to counter the problems and make sure the future of wildlife in the park.

- Much attention is required from the Federal and Regional Governments to begin functional conservational activities in CCNP, by integrating local peoples around the park. It is, important to design the management plan of the park based on the present study results.

- Proper wildlife management activities should be conducted in the park, with well-equipped and trained management staff. People around the park should be involved in the developmental and conservation activity so that they can benefit from the resources.

- It is important to promote income-generating alternatives for the local communities. Bee keeping, wildlife based tourism development (trained local guides, scout employment, sovereign and handicraft shops, etc.). These will help the people get benefit from the resource in a sustainable manner.

- There is an urgent need to have up-to-date regional wildlife policy, and the relevant legislation and conservation of the Park habitat and wildlife management must incorporate law enforcement and awareness raising programs.

- CCNP is the best refuges for large populations of larger mammals particularly bulk feeders (African elephants, African buffaloes, and hippos) and other mammals in Ethiopia. Besides, at present, the area is accessible for tourists. It is, therefore, very important to develop and conserve this pristine natural habitat with the collaboration of all stakeholders to safeguard the diverse habitats and prestigious wildlife resources.

- In addition to the above measures, specific and detailed research on the different resources of the park is essential for the long term management plan of the animal and plant life of the park. Based on the present study, the following studies should be carried out on priority basis:

1 Population status, habitat requirement and movement patterns of the African elephant in and the nearby wildlife area (Omo National Park and Tama reserve).

2 Population status, habitat requirement and distribution pattern of the African buffaloes.

3 Diversity, abundance, distribution and habitat association of avifauna.

4 Floristic compositions and distribution of plant species in the different ecological habitats of the park. Collection of plant specimens should be conducted during the rainy season, when many more plant species are in flowering stage.

5 Species identification of animals (other than larger mammals such as birds, smaller mammals, insects, reptiles and amphibians) should be carried out in the future, which could yield biological information on the relative importance of the different habitat types of the park.

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APPENDICES

Appendix 1. Species of mammals recorded in the CCNP during the study period.(Asterisk = * indicates mammals recorded outside the sample block in the study area and Asterisk = ** mammals from local resident)

Common name	*Scientific name*
Bush baby*	*Gelato senegalensis*
Savanna baboon	*Papio cynocephalus*
Vervet Monkey	Cercopithecus *aethiops*
DeBraza's Monkey	Cercopithecus *neglectus*
Gureza	*Colobus gureza*
Gambian sun squirrel	*Helosciurus gambianus*
Warthog	*Phacochoerus africanus*
Giant forest hog	*Hylochoerus meinertzhageni*
Hippopotamus	*Hippoptamus amphibius*
African Buffalo	*Syncerus caffer*
Greater kudu	*Tragelapus strepsiceros*
Bushbuck	*Tragelapus scriptuss*
Bush pig	*Potamochoerus larvatus*
Waterbuck	*Kobus ellipsipprymus*
Common Duiker	*Sylvicapra oreotragus*
Savanna Elephant	*Loxodanta africana*
Blacked backed Jackal	*Canis mesomelas*
Golden Jackal	*Canis aureus*
Honey Badger (Ratel)	*Mellovora capensis*
African Civet	*Civettictis civetta*
Genet cat	*Genetta spp*
White tailed mongoose	*Ichneumia albicauda*
Black slender mongoose	*Galerella flavescens*

Spotted Hyena	*Crocuta crocuta*
Leopard	*Panthera paradus*
Lion	*Panthera leo*
African wild cat	*Felis silvestris*
Serval Cat	*Leptailurus serval*
Caracal	*Caracal caracal*
Aardvark	*Orycteropus afer*
Pangolin	*Manis temmincki*
Ground squirrels	*Xerus erythropus*
Porcupine	*Hystrix cristata*
Lelwel Hartebeest*	*Alcelaphus buselophus lelwel*
Hunting dog*	*Lycaon pictus*
Striped polecat*	*Ictonyx striatus*
Rock hyrax*	*Procavia capensis*
Blue/Sykes monkey*	Ceropithecus *mitis*
Cheetah**	*Acinonyx jubatus*
Black Rinoceros**	*Diceros bicornis*
Giraffe**	*Giraffa camelopardalis*
Bat eared fox**	*Otocyon megaloties*

Appendix 2. Plant specimens collected and identified during the study period.

Local name	Family name	Scientific Name
Gragambusa (k))	Asteraceae	*Vernonia filigera Oliv. & Hiern*
Gunfela (K), Qeqeba (O)	Amaranhaceae	*Cyathula uncinulata (Schrad.) Schinz*
Gemobalo (K)	Rubiaceae	*Gardenia ternifolia Schumach. & Thonn.*
Zuzaya (K)	Euphorbiaceae	*Bridelia micrantha (Hochst.) Baill*
Tsemo (K)	Euphorbiaceae	*Ricinus communis L.*
Dega (K)	Myrsinaceae	*Maesa lanceolata Forssk.*
Murala (K),Liqanluqe (O)	Apiaceae	*Steganotaenia araliacea Hochst ex A. Rich.*
Sebicha (K)	Simaroubaceae	*Harrisonia abyssinica Oliv.*
Kafylalu (K)	Sapindaceae	*Paullinia pinnata L.*
	Tiliaceae	*Triumfetta pilosa Roth.*
Chimawula (K),Hedessa(O)	Rutaceae	*Teclea nobilis Del.*
Gariw	Euphorbiaceae	*Bridelia micrantha (Hochst.) Baill*
Indindo(A) tamboloni(O)	Asteraceae	*Laggera pterodonta (DC) Sch. Bip*
Wratura (K)	Ranunculaceae	*Clematis simensis Fresen.*
Dindiqi gora	Capparidaceae	*Capparis erythrocarpus Isert.*
Kisho (K)	Asteraceae	*Aspilia mossambicensis (Oliv.) Wild*
Kisho (K)	Asteraceae	*Aspilia mossambicensis (Oliv.) Wild*
Beka	Rubiaceae	*Psydrax schimperiana (A. Rich) Bridson*
Chele (K)	Sapindaceae	*Lepisanthes senegalensis (Poir) Leenh*
Gopanto (K)	Rhamnaceae	*Gouania longispicata Engl.*
Tunja (K)	Piperaceae	*Piper capense L.f.*
	Loganiaceae	*Nuxia congesta R. Br. ex Fresen.*
Dega (K)	Myrsinaceae	*Maesa lanceolata Forssk.*
Lade (K)	Apocynaceae	*Carissa spinarum L.*
Hinchecha (K)	Phytolaccaceae	*Phytolacca dodecandra L Herit*
Kalsha (K),	Araliaceae	*Polyscias fulva (Hiern) Harms*

Marqa (K)	Oleaceae	*Chionanthus mildbraedii (Gilg & Schellenb.)*
Desha aleko (K)	Fabaceae	*Senna petersiana (Bolle) Lock*
yechere shuho (K)	Fabaceae	*Senna septemtrionalis (Viv.) Irwin & Barneby*
Sissa (K)	Fabaceae	*Entada abyssinica Steud. ex A. Rich.*
Anka (K),	Euphorbiaceae	*Croton macrostachyus Del.*
Sansa (K)	Euphorbiaceae	*Acalypha ornata A. Rich.*
Loshe gomere (K)	Tiliaceae	*Grewia ferruginea Hochst ex A. Rich.*
Gomere (K)	Tiliaceae	*Grewia mollis Juss.*
Amobe (K), Debeqa (O)	Combretaceae	*Terminalia laxiflora Engl. & Diels*
Ocha (K)	Myrtaceae	*Syzygium guineense DC.*
Ilansa (K)	Fabaceae	*Indigofera garckeana Vatke*
Dengarisa tsera (K)	Fabaceae	*Indigofera spicata Forssk.*
Aramoba (K)	Fabaceae	*Albizia malacophylla (Steud. Ex A. Rich.)*
Zamo (K), Chekote (O)	Fabaceae	*Albizia grandebracteata Taub.*
Michmele (K), Dimaro (O)	Verbenaceae	*Lantana trifolia L.*
Michmele (K)	Verbenaceae	*Lantana trifolia L.*
Gulo (K), Berberasa (O)	Lamiaceae	*Ocimum urticifolium Roth.*
Asso (K), Fiiti (O)	Lamiaceae	*Leonotis ocymifolia (Burm.f.) Iwarsson*
Dolge (K)	Marantaceae	*Marantochloa leucantha (K. Schum.) Milne-.*
Bequr buto (Kefigna)	Acanthaceae	*Brillantasia grotanellii Richi-Sermoli*
Aha (K), Qoseru (O)	Acanthaceae	*Acanthus polystachius Delile*
Qale (K)	Poaceae	*Hyparrhenia anthistirioides (Hochst. ex A. R)*
Zala (K)	Poaceae	*Panicum maximum Jacq.*
Tsersa (K)	Cyperaceae	*Cyperus cyperoides (L.) Kuntze*
Gelesho Akash (K)	Zingiberaceae	*Aframomum alboviolaceum (Ridl.) K. Schum.*
Betsesa (K)	Dennistaedtiaceae	*Pteridium aquilinum (L.) Kuhn*
Itri wanja (K)	Boraginaceae	*Ehretia cymosa Thonn.*
Moqosa (K)	Boraginaceae	*Cordia africana Lam.*
Buloo (K)	Solanaceae	*Solanum incanum L.*
Betsata (K), Matenna (O)	Pteridaceae	*Pteris confusa*

Cheew (K)	Rutaceae	*Vepris dainellii (Pichi-Serm.) Kokwaro*
Gerchecha	Fabaceae	*Albizia schimperiana Oliv.*
Bertoo (K)	Fabaceae	*Erythrina brucei Schweinf.*
Gerwa	Asteraceae	*Vernonia amygdalina Del.*
Kora	Fabaceae	*Tamarindus indica L.*
Kora	Fabaceae	*Tamarindus indica L.*
Tsema	Anacardiaceae	*Rhus ruspolii Engl.*
Shimel	Poaceae	Oxythenantra abyssinica

Appendix 3. Questionnaires

1. Background information

2. District ----------3. Village---------4. Name of the household---------

3. Sex---- Age----------Marital status --------6. Ethnic group------- Religion-------

4. How long have you been in the area? ---------- Occupation--------

5. Source of income: 1. Herding----------2. Farming----------3. & others, specify-------

6. If farming, type of crops ---------- ---------- ----------Size of farm land--------

7. Do you have livestock? If yes, type and number: Cattle/Sheep/Goat//Others--------

8. What was the trend in livestock numbers for the last 10-20 years? Increasing/ Decreasing/Stable. If decreasing, please specify reasons for the decline?

9. Do you have grazing land? If yes; communal/private

10. What is the impact of the Park on the livestock?

11. Is there any benefit obtained from the Park? Yes/ No. If Yes, in what form? Employment/Fuel wood collection/ grazing /benefit from tourist income/ others----------16. Do you practice hunting? Yes/No. If Yes, which animal? Why? For what purpose?

12. What about at present? Any conflict with the CCNP? Yes/No, If yes, please specify the reason.

13. What do you think about the future of Park-people interaction? ----------

14. Do you know these animals (show picture of mammals) in your language? -----

15. Where can each be found? Wet season---------Dry season----------

16. Do you know the reason for their movement? ----------

17. Have wild animals ever raided your crops? Yes/ No. If yes, which animal & which season?

18. What control measures been taken? ----------

19. Is there any change in the diversity and distribution of mammal species compared to 5-10 years back? If yes, please specify their previous distribution and causes for change.

20. Do you think that wild animals should be conserved? If yes, why? ----------

21. What are the best mechanisms for managing wildlife? ----------

Appendix 4. Wildlife census sheet

Place: ---------- Date: ---------- Transect number: -----

Starting time: ----------Stop time: ----------Total time--------

Starting km: ----------Stopping km: ---------Total distance-----

Observers: 1----------2----------3----------

Time 24h	Distance (km)	species	Sighting distance (m)	Total seen	Ma	Fa	Sa	Jv	Cf	Un	H.T	Ac.	Com.

(Ma = Male - adult, Fa = Female - adult, Sa = Sub- adult, Jv= Juvenile, Cf = Calf, Un= Un known, H.T= Habitat Type, Ac=Activiry, com.=comment)