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**SCHOOL OF GRADUATE STUDIES**  
**DEPARTMENT OF ZOOLOGICAL SCIENCES**



**POPULATION STATUS, DEMOGRAPHY AND TIME BUDGET OF THE  
AFRICAN BUFFALO (*SYNCERUS CAFFER* SPARRMAN, 1779) AND  
ANTHROPOGENIC IMPACTS IN CHEBERA CHURCHURA  
NATIONAL PARK, ETHIOPIA**

**BY**

**ABERHAM MEGAZE**

**ADVISORS**

**PROFESSOR M. BALAKRISHNAN**

**DR. GURJA BELAY**

**MAY, 2016**

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This is to certify that the thesis prepared by Aberham Megaze, entitled: Population status, demography and time budget of the African buffalo (*Syncerus caffer* Sparrman, 1779) and anthropogenic impacts in Chebera Churchura National Park, Ethiopia and submitted in fulfillment of the requirements for the Degree of Doctor of Philosophy in Zoology (Ecological and Systematic Zoology) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the Examining Committee:

External Examiner -----Signature-----Date-----

Internal Examiner -----Signature -----Date-----

Advisor-----Signature-----Date-----

Advisor-----Signature-----Date-----

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Chair of Department or Graduate Program Coordinator

Population status, demography and time budget of the African buffalo (*Syncerus caffer* Sparrman, 1779) and anthropogenic impacts in Chebera Churchura National Park, Ethiopia

### **Aberham Megaze**

**ABSTRACT:** An investigation on the population status, structure and habitat association of the African buffalo (*Syncerus caffer* Sparrman, 1779) and anthropogenic threats in Chebera Churchura National Park (CCNP), Ethiopia was carried out during 2012–2015. The study area was stratified into four habitat types, viz., grasslands, woodlands, montane forests and riverine habitat. Sample counts were carried out in an area of 1,215 km<sup>2</sup>. The estimated buffalo population was 5,193 individuals, with the population density of 4.27/ km<sup>2</sup>. The population estimates for wet and dry seasons were 5,788 and 4,599 heads, respectively. Males comprised 42.56%, while females 46.68% of the population (M: F=1.00: 1.10). Age structure was dominated by adults, which constituted 52.49% of the total population. Subadults comprised 24.30%, young 12.44% and unidentified sex of the population was 10.75%, with a significant difference between young and adults. Larger herds of up to 30 individuals were observed during the wet season and smaller herds of a minimum of four individuals were seen during the dry season. The mean herd size during the wet and dry seasons was 29.59 and 16.95, respectively. Buffaloes were observed more in the riverine vegetation types during the dry season. Relative abundance of food sources, green vegetation cover and availability of water were the major factors governing their distribution in the present study area. Buffalo spent a greater proportion of the time in feeding and resting activities. Feeding and resting were the predominant activities (87.14% of the diurnal active period), with 48.95% time spent feeding during the dry season, and 44.91% during the wet season. Daytime grazing and resting periods during the wet season were estimated to be 5.39 h and 4.98 h, respectively. Morning and the late afternoon activity peaks were more pronounced during the dry season than the wet season. The main threat of the African buffalo in the study area was poaching, wildfire, livestock grazing, illegal farming and expanding human settlements. Questionnaires survey, group discussions and direct field observations indicated that, firewood collection, setting fire, hunting, livestock grazing and farming were having great impacts on biodiversity conservation in CCNP. Crop damage, livestock loss, human injures and illegal resource access were the major problems encountered in CCNP resulting in conflicts between local people and Park officials, and also human and wildlife. To mitigate these problems, the local people have adopted intensified vigilance, use of guard animals, fencing, use of repellents and killing problematic wild animals. Even though most of the respondents of the questionnaire survey had positive attitude towards conservation areas and wildlife, they were not satisfied by the benefit from the Park. Proper conservation measures incorporating all stakeholders have to be implemented to solve the problems and safeguard the wildlife in the Park.

**Key words:** Activity patterns, habitat association, natural resource use, human–wildlife conflict.

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## **DEDICATION**

This work is dedicated to my family, who helped me from the beginning to the end of this research work!

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## **ACRONYM AND ABBREVIATIONS**

<b>CCNP</b>	Chebera Churchura National Park
<b>ENMSA</b>	Ethiopian National Metrological Service Authority
<b>EWCO</b>	Ethiopian Wildlife Conservation Organization
<b>HWC</b>	Human–Wildlife Conflict
<b>IUCN</b>	International Union for Conservation of Nature and Natural Resources
<b>IBA</b>	Important Bird Area
<b>SNNPRS</b>	Southern Nations Nationality and People’s Regional State
<b>WHO</b>	World Health Organization

# **1. INTRODUCTION AND LITERATURE REVIEW**

## **1.1. Background and Justification**

Mammals are the most highly evolved class of the Kingdom Animalia (Kingdon, 1997). Among mammals, the Order Artiodactyla comprises even-toed ungulates, which is the most diverse group of large herbivores in the world. They satisfy their nutritional requirements by seasonally shifting between habitats and selecting a variety of plant food sources (Jarman and Mmaari, 1972). Their conservation and management require regular survey to provide the trends in population size and distribution patterns (Elkan and Tchamba, 1995). Africa is unique among the continents in having maintained an extraordinarily diverse and prolific megafauna spanning the Pleistocene–Holocene epochs of Quaternary period. Only little is known about the historical dynamics of this community and even less about the reasons for its unique persistence to modern times (Heller *et al.*, 2012). A total of 5416 species of mammals are recorded globally. Over 1150 species of mammals are currently listed from Africa, but more mammalian species await discovery (Kingdon, 1997) and their new description are coming up these days as a result of advanced molecular taxonomy (Afework Bekele and Yalden, 2013). Of these, at least five species have become extinct in the last 300 years due to anthropogenic pressure, and many other species are of critical conservation concern. As much as 84 out of a total of 175 species of large herbivores are today classified as vulnerable, endangered or critically endangered. Pressure on large herbivore populations is diverse and particularly heavy in many of the African countries (Gallina and Mandujano, 2009).

The family Bovidae of the Order Artiodactyla consists of diverse groups of mammals. They live in habitats ranging from tropical rainforest to deserts. The radiation of bovids in Africa has been particularly pronounced during the past seven million years, and they are now the dominant herbivores in most of the African countries (Kutilek, 1979). Compared to other regions, Africa has the largest number of endemic families and genera of large animals. This high degree of endemism is one of the reasons for the African fauna to be so interesting and spectacular (Delany and Happed, 1979). But, African wildlife experienced a reduction in population size and geographical distribution over the last millennium, particularly since the 19th century as a result of human demographic expansion, wildlife overexploitation, habitat degradation and cattle-borne diseases. In many areas, ungulate populations are now largely confined within a network of

loosely connected protected areas, which cover about seven percent of the African land area (Delany and Happold, 1979; Smitz *et al.*, 2014).

Ethiopia has diverse wildlife resources (Afework Bekele and Yalden, 2013). This is reflected by altitudinal ranges and the diversity of climate, vegetation and landscape. Altitudinal variations along with other physical factors have contributed for a diverse set of ecosystems ranging from humid forest and extensive wetland to the desert of the Afar depression. Elevations in Ethiopia range from 116 m below sea level in the Afar depression, to a number of peaks of mountain 4,000 m, of which the highest is Ras Dashen, rising at 4,620 m, asl, in the Simien Mountains. Most of the country comprises of highland plateaus and mountain ranges that are dissected by numerous streams and rivers. The variety of ecosystems and diverse topography of Ethiopia provide a wide spectrum of habitat types and ecological niches of a variety of fauna and flora (Hillman, 1986; 1993). Ethiopia has 70% of all afro-tropical lands above 2,000 m and 80% of all lands above 3,000 m (Yalden, 1983). These areas are isolated to the north-western and south-eastern of the Great Rift Valley by mountain blocks that favors the country to have large number of endemic species compared to the rest of Africa (Yalden, 1983). The altitudinal variations in Ethiopia have resulted in a wide range of climates (temperature, rainfall and humidity), which affect the faunal and floral distribution as well as their diversity. The Great Rift Valley, the Omo River Valley and the western lowlands of Ethiopia contain several unique and large game animals. The flora and fauna of Ethiopia are very heterogeneous with high endemic elements. It is one of the few countries in the world that possesses unique and characteristic fauna with a high level of endemism and hence the Ethiopian high lands have been listed as one of the biological hotspots (Yalden, 1983; WCMC, 1992; Hillman, 1993; Shibru Tedla, 1995).

The variations in climate, topography and vegetation have contributed to the presence of a large number of endemic species in Ethiopia. This in turn reflects a diversity of habitats, created by different combinations of elevation, rainfall, geology, soil surface and ground water. More than 320 mammalian species are recorded from Ethiopia of which 31 are endemic (Hillman, 1993; Yalden *et al.*, 1996; Afework Bekele and Yalden, 2013). The endemic mammals include larger mammals such as *Tragelaphus buxtoni*, *Capra walie*, *Equus asinus somalensis*, *Alcelaphus*

*buselaphus swaynei*, *Tragelaphus scriptus meneliki*, *Canis simensis* and *Theropithecus gelada gelada*, two bats, nine insectivores and 15 rodent species (Melaku Tefera, 2011).

However, due to the human impact, the overall habitats of wildlife of Ethiopia and its biological diversity are decreasing from time to time due to the rapid growth of human and livestock populations, and consequent degradation, destruction and fragmentation of natural habitats (Hillman, 1993; Yalden *et al.*, 1996; Afework Bekele and Yalden, 2013). As the general level of economy depends upon agricultural productivity, which is very low throughout Ethiopia, increase in food production depends on increasing the area under cultivation and grazing. This expansion is usually at the expense of wildlife habitats, leading to the loss of both flora and fauna and also results in severe competitions for natural resources between wild animals, livestock and the local communities. Such human-related activities have resulted in human–wildlife conflicts (Yalden and Largen, 1992). Such ever-increasing conflicts between the biological resources and human land-use pattern changes have been threatening the survival of wildlife (Yalden *et al.*, 1986; Yoseph Getnet, 1995). As a result, wildlife resources of the country are now largely restricted within a few protected areas.

Establishment of more protected areas is one of the conservation efforts aimed at protecting wildlife. Ethiopian Wildlife Conservation Authority (EWCA) has established more National Parks and protected areas to protect diverse habitat types and wildlife in these areas. At present, Ethiopia possesses 49 protected areas under different categories, covering 73,279 km<sup>2</sup> (6.5% of the total land mass) (Afework Bekele and Yalden, 2013). In Ethiopia, there are 14 National Parks, 3 Sanctuaries, 7 Wildlife Reserves, and 24 Controlled Hunting Areas. Many of them are managed by the EWCA and some of them are managed by National Regional States (EWCA, 2010; Afework Bekele and Yalden, 2013). Other protected areas in Ethiopia have different levels of conservation status.

The Southern Nations Nationalities and Peoples Regional State of Ethiopia (SNNPRS) is one of the National Regional States, which have diverse biological resources and endemic mammalian and avian fauna. The diversity of the biological resources of SNNPRS is a reflection of its unique geological history and physical and climatic conditions. It is located in the southern

quadrant of the country (4°27'–8°30'N and 34°55'–39°11'E). It is a region with wide geographic variations, high rugged mountains, deep gorges, river valley 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 of the region ranges from 360 m asl at Lake Rudolf, which border Kenya, to over 4200 m asl at the Guge Mountains, in the Gamo Gofa Zone. The region has an area of 105,887.18km<sup>2</sup>, which is bounded by Oromia Region in the north and east, Kenya in the south, and Gambela Region in the northwest. Human population of the region is >15,042,500 (SNNPRS, Population and Statistics Bureau, 2007).

The SNNPRS also has diverse climate, vegetation, soil and drainage patterns. It is rich in wildlife resources (Abaturov *et al.*, 1995). The wildlife resources of the region is known to be restricted in Wildlife Protected Areas, which includes five National Parks, two Game Reserves, eight Controlled Hunting Areas (EWCA, 2010) and ten Important Bird Areas (IBA) (Tilahun *et al.*, 1996; Ash and Atkins, 2009). However, the status of the wildlife resources as well as national and global significance of the protected areas in terms of vegetation, animal life and unique natural ecosystem compositions is not well explored. The present study area, Chebera Churchura National Park (CCNP), is one of the recently declared wildlife protected areas of the region. Information from local community, elders, regional experts researchers and results of the preliminary survey carried out in CCNP indicates the presence of large mammals, such as the African elephant (*Loxodonta africana*), African buffalo (*Syncerus caffer*), lion (*Panthero leo*), hippopotamus (*Hippopotamus amphibious*), warthog (*Phacochoerus africanus*), leopard (*Panthero pardus*), and a variety of birds, reptiles, amphibians, fish and other animals and plants in the complex ecosystem.

The African buffalo, which is the focus of the present study, is the largest member of the Family Bovidae inhabiting the sub-saharan Africa. In the past, they inhabited most of Africa south of Sahara from the east to the west coast. Today, the range of their distribution is reduced and fragmented (Sinclair, 1977; Haltenorth and Diller, 1980). At the end of the 19th century, the African buffalo population was affected by rinderpest epidemics. During the 20<sup>th</sup> century, their population and range of distribution have further depleted as a result of habitat fragmentation and

disease (Lessard *et al.*, 1990; Suttmoller *et al.*, 2000; de Vos *et al.*, 2001). Recent studies have revealed further depletion of the population of African buffalo in Kenya and southern Africa (vanHoft *et al.*, 2002; Winterbach, 1998). African buffalo ranges are extended over most of southern Africa, Angola, central and East Africa to the southern borders of Sudan, Kenya, Tanzania, Uganda and Ethiopia (Sinclair, 1977). According to IUCN (2000), they occur in 38 African countries.

Wildlife assessments conducted in Ethiopia have revealed that the African buffalo is found in Omo, Mago, Gambella (EWCA, 2010), Altish (Grima Mengsha, 2005) and Chebera Churchura (Abraham Megaze, *et al.*, 2012) National Parks. The eastern part of Ethiopia is relatively dry and not favourable for buffaloes (EWCO, 2010). However, due to lack of research and information on buffaloes, the population size is not properly known. Therefore, comprehensive detailed studies are needed to determine the distribution and status of African buffaloes in Ethiopia.

Many of the African conservation areas are experiencing decline in their size and diversity of ungulate populations due to various factors (Fynn and Bonyongo, 2010). Further, details of distribution and status of many of the taxa are uncertain, and only little is known of the ecology of several species. The absence of adequate survey data to monitor wildlife population and distribution prevents timely management and conservation decisions that could ultimately save many of the wildlife in the African continent. Chebera Churchura National Park of Ethiopia is one of the conservation areas where the diversity, distribution and abundance of mammals are little known as is the case in many other parts of Ethiopia. The available information suggests that CCNP has the potential to be developed as a biodiversity conservation, cultural, educational and research center, if properly studied, managed and maintained.

## **1.2. Literature review**

A vast amount of literature on the African buffalo (*Syncerus caffer* Sparrman, 1779) is available. Its ecology has been widely studied especially in East Africa (Sinclair, 1977; Prins, 1996). Diet and feeding strategies of the African buffalo were investigated by Field (1975), Grimsdell and Field (1976), Sinclair and Gwynne (1972) and Corne'lis *et al.* (2011). Information on the diet and spacing patterns were studied by Leuthold (1972), Ryan and Jordaan (2005), Ryan *et al.*

(2006), Venter and Watson (2008), Winnie *et al.* (2008), Tshabalala *et al.* (2009), Ryan *et al.* (2012) and Bennitt *et al.* (2014). Patterns of movements in relation to water availability were analyzed by Western (1975) and Bar-David *et al.* (2009). Population structure, herd size, and density were discussed by Sinclair (1974; 1977) and Eltringham (1980). In West and Central Africa, ecology of this species, particularly habitat use, diet, and coexistence with other ungulates was studied by DeBie (1991). In Southern Africa, a complete account of the ecology of this species was given by Skinner and Smithers (1990), Mills and Hes (1997) and Jolles (2007). In Zimbabwe, feeding habits of the buffaloes were investigated at Lake Kariba by Taylor (1989). General information on the ecology and distribution were assessed by Estes (1991), Kingdon (1997), Stuart and Stuart (1997) and Bennitt (2008). The genetic diversity of the African buffalo was studied by VanHooft *et al.* (2000) and Smitz *et al.* (2014).

### **1.2.1. Taxonomy**

The African buffalo was formally described from a specimen shot near Port Elizabeth, South Africa in 1779 by the Swedish naturalist, Sparrma (Skinner and Smithers, 1990; Cornélis *et al.*, 2014). The scientific name *Syncerus caffer* Sparrman 1779 is derived from the Greek word “Sun” meaning together and “Keras” meaning the horn of an animal. It is a reference to the fused boss of the horns in the adult male Cape buffalo. “Caffer” or Cape of “Caffraria” means Kaffraria, the country of Kaffirs (Africa) (Sinclair, 1977).

The African buffalo is a member of the Family Bovidae and tribe Bovini. Other bovidae in the same tribe are cattle, yaks, bison and the Asian buffalo, to which the African buffalo is most similar genetically. The African buffalo is not the ancestor of domestic cattle and is only distantly related to other larger bovines (Smitz *et al.*, 2013). The ancestral bovid was probably small forest dwellers, perhaps resembling the present time forest dwelling duikers. The expansion of grasslands of Eurasia and Africa in the Miocene and Pliocene set the stage for the movement of bovidae into open grasslands or savanna habitats (Sinclair, 1977).

The African buffalo is the most recent and advanced ruminant and evolved during the last seven million years. The nearest known relative of their lineage is the extinct *Ugandax gautieri*, first found in Uganda. *Syncerus* is an African endemic genus, and probably originated in the area

between Lake Victoria and the horn of Africa, spreading southward and westward (Gentry, 1967 as cited in Sinclair, 1977). Smitz *et al.* (2013) noted that the African buffalo most likely expanded and diverged in the late to middle Pleistocene from an ancestral population located around the current-day Central African Republic, adapting morphologically to colonize new habitats, and developing the variety of ecophenotypes observed today. It is indicated that there was a late middle to late Pleistocene population expansion of Cape buffaloes (Fig. 1). This also seems to be the period in which Cape buffalo evolved as a separate sub-species (Sinclair, 1977; Cornélis *et al.*, 2014). Additionally, there appears to have been a population expansion from eastern to southern Africa, which may be related to the vegetation changes (Van Hooft *et al.*, 2002). However, their phylogenetic origin is far from clear (Sinclair, 1977).

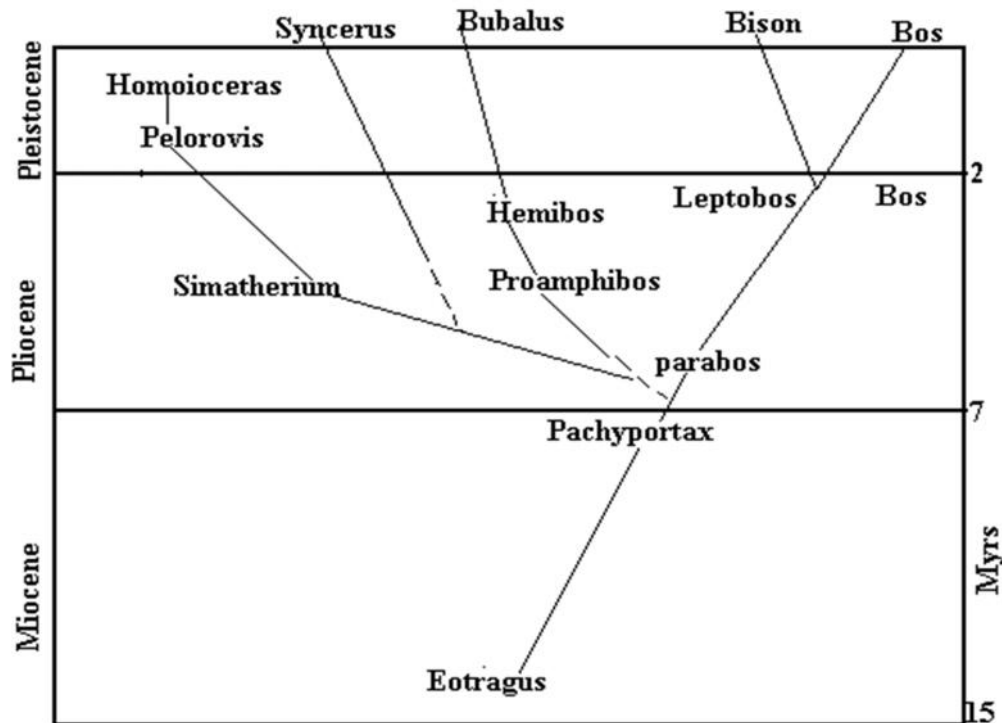


Figure 1. Phylogenetic relationships between *Syncerus* and other Bovini (Sinclair, 1977)

In 1779, several names were suggested for the African buffaloes, with many local variations thought to be different species, and with as many as 43 subspecies (du Toit, 2001). African buffaloes are grouped in to two definite subspecies (Skinner and Smithers, 1990; Prins 1996), ranging from lightly built reddish, and small-horned forest buffalo (*S. caffer nanus*) to the heavily built darker big-horned savanna buffalo (*S. c. caffer*) (Skinner and Smithers, 1990; Prins, 1996; Stuart and Stuart, 2000). Where the range of these subspecies overlap, various

intermediate forms between them are found and taxonomists have debated and regarded these intermediates either to be *S. c. aequinoctialis* (du Toit, 2001; 2005; Furstenburg, 2007) or *S. c. brachyceros* (Prins, 1996; du Toit, 2005). Smitz *et al.* (2013) also indicates that the African buffalo exhibits extreme morphological variability across its range, both in body size and weight, fur color and horn shape and size throughout its range of distribution, which have led to controversies about the validity and taxonomic status of the various recognized subspecies. As a result, the buffalo has previously been assigned to as many as 52 distinct subspecies. Although there are considerable morphological variations, the African buffalo is currently considered as a single species by various authorities (IUCN, 2013; Prins and Sinclair, 2013), with commonly recognized subdivision of four subspecies. They are: *S.c. brachyceros*–the West African savanna buffalo, *S. c. aequinoctialis* – the Central African savanna buffalo, the Forest buffalo *S. c. nanus*, which occurs along the west coast of Africa from Cameroun to the Ivory Coast, and the Southern savanna buffalo, *S. c. caffer* (Fig. 2, Plate 1). The southern savanna buffalo subspecies is by far the most numerous and widely distributed across the continent. The other subspecies (e.g. the “mountain buffalo” *S .c. mathews*, live in mountainous areas of East Africa) may be valid but intergrades occur amongst the recognized subspecies (Kingdon, 1997; ASG, 1998). In contrast, recent work of Smitz *et al.* (2013) conducted over the whole geographical range of the African buffalo, analyzing mitochondrial D-loop sequences, revealed the existence of two lineages in the species, matching with the *caffer* subspecies of East and South Africa, and the *nanus* subspecies of West and Central Africa. These lineages seem to have diverged between 132 and 286 thousand years ago. On the basis of the evolutionary history of both lineages, the authors suggest that the most prudent treatment of the African buffalo would be a subdivision into two subspecies, or management units, namely *S. c. caffer* (East-Southern Africa’s lineage), and *S. c. nanus* (West-Central Africa’s lineage).

Georgiadis *et al.* (1990) examined DNA samples taken from the African buffaloes from different countries and concluded that there were considerable differences in the genetic composition between the extremes of the range. However, there were no obvious disjunctions in the genetic samples, which might form the basis for assigning subspecies status to buffaloes from any particular locality.

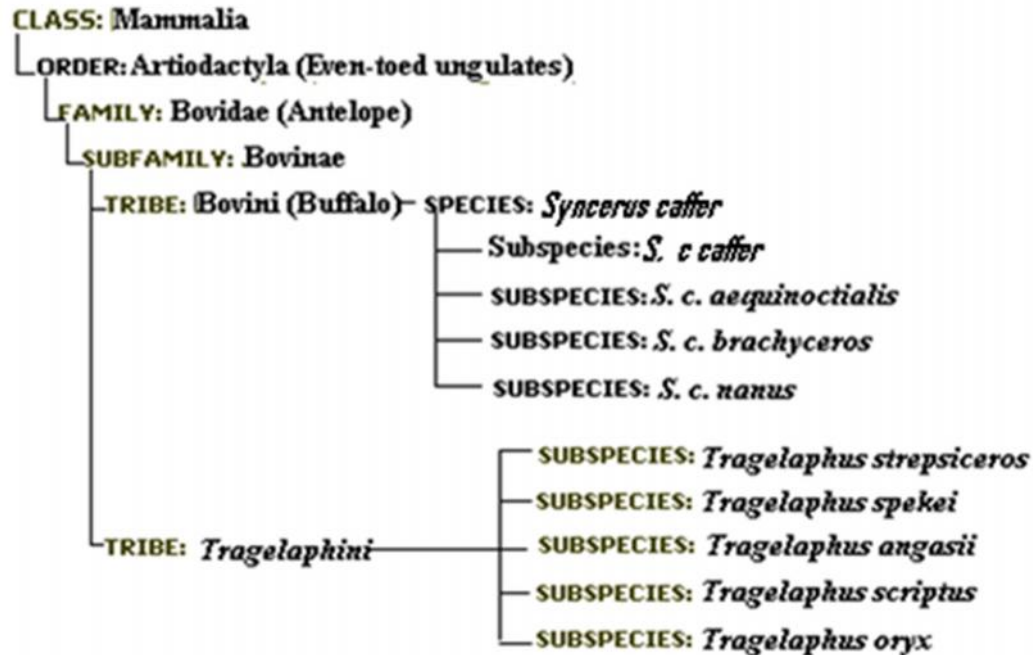


Figure 2. Taxonomic classification of the African buffaloes (Source: ASG, 1998)

### 1. 2. 2. Physical characteristics

The African buffalo is a strong, massive and heavily built Africa's only wild cattle species. It is a cow-like ruminant (Stuart and Stuart, 2000; Cornélis *et al.*, 2014). Together with the elephant, rhino, lion, and leopard, it is considered as one of the 'big five' group of terrestrial animals. The African buffalo is similar to the Asian water buffalo. However, the Asian water buffalo has a lighter built than the African Buffalo. Estes (1991) described the physical appearance of *S. caffer* as the bulkiest and most formidable African bovid. Male African buffaloes are considerably larger than females, and savanna races can be up to twice as heavy as *S. nanus*, the forest race (Nowak, 1999). In all races of the African buffaloes, the body is barrel-shaped and the chest is wide, their legs are stocky, the head is massive and the neck is short and thick. The front hooves are larger than the hind to support the heavy weight of the trunk and the head (Alden *et al.*, 1995). There is sexual dimorphism in body size, with adult female average weighting about 17% less than adult males. The body color also varies with sex and age classes (Buchholtz, 1990; Nowak, 1999; Prins and Sinclair, 2013). The mass ranges from 500 to 900 kg, the length from head to the back ranges from 2100 to 3000 mm; tail length ranges from 750 to 1100 mm, and the shoulder height ranges from 1000 mm to 1700 mm (Estes, 1991). They have large heads and limbs with a broad chest (Stuart and Stuart, 1997; Nowak, 1999). Forest buffaloes tend to measure

less than 120 cm in height and under 320 kg (Kingdon, 1997). Adult African buffaloes have a sparse covering of short hair, which tends to decrease with age (Buchholtz, 1990; Kingdon, 1997; Nowak, 1999). The body color is unpatterned, and ranges from red to black, depending on the sub-species (Alden *et al.*, 1995). Adult savanna buffaloes are extremely dark brown or black, males darker than females (Sinclair, 1977; Buchholtz, 1990; Nowak, 1999). Forest buffaloes are typically red to reddish brown with smaller horns and they are forest-dwelling (Melletti *et al.*, 2007a; Melletti *et al.*, 2007b). The horns of African buffalo are very peculiar. A characteristic feature of them is that the adult bull's horns have fused bases, forming a continuous bone shield referred to as the "boss". From the base, the horns diverge, then bend down and smoothly curve up inwards. The distance between the ends of the horns of large bulls is more than a meter. The world trophy record (horn span) comes from Lake Manyara (Tanzania): 165 cm (bull) and 150 cm (cow) (Prins and Sinclair, 2013). Apart from the horns, the most distinguishing character on the head is the larger droopy ear, which fringes with long hairs on edges (Fig. 3) (Alden *et al.*, 1995; Kingdon, 1997). In forest buffaloes, two long white or pale yellow hair tracts line inside the ear as tufts along the edges (Buchholtz, 1990).



Figure 3. An adult male savanna buffalo (Source: Myers *et al.*, 2012)

## **1. 2. 3. Distribution and habitat**

### **1.2.3.1. Distribution**

The African buffalo is one of the most successful African mammals in terms of geographical distribution, abundance and biomass. It inhabits a wide range of habitats across Africa; primarily savannas with high grass biomass and mosaics, preferring areas with easy access to grass, water, and dense cover, such as thickets, reeds and forest (Buchholtz, 1990; Estes, 1991; Kingdon, 1997; Nowak, 1999; Estes, 2012). Rainfall is the main biophysical factor limiting the distribution and abundance of African buffaloes in large geographical areas (Kingdon, 1997). It is found in the near-deserts of West Africa, the rain forests of the Congo Basin, the savannahs of eastern and southern Africa, and even at very high altitudes (Prins, 1996).

In the past, *S. caffer* inhabited most of Africa south of Sahara from east to the west coast. In the context of recent global changes, African buffalo populations have undergone a severe reduction in size and distribution since the nineteenth century, as a result of the combined effects of anthropogenic impacts such as land conversion, poaching, disease outbreaks and droughts. Consequently, African buffalo populations tend to be confined within a network of protected areas, exposing them to the risk of natural gene flow disruption. Population fragmentation is a major challenge for long-term conservation of this species as it can induce genetic erosion, inbreeding depression and reduce evolutionary potential. At present, around 75% of the savanna buffalo population is confined to a patchwork of protected areas and well-managed surrounding hunting zones, mostly loosely connected to one another (Winterbach, 1998; East 1999). An outbreak of foot and mouth disease coupled with rinderpest epidemic further reduced their distribution and caused local extinctions. The most severe population collapse occurred in 1896, with the mortality rate estimated at 90–95% across the African continent (Smithers, 1983; Winterbach, 1998; van Hooft *et al.*, 2000; van Hooft *et al.*, 2002; Ayebazibwe *et al.*, 2010).

African buffalo ranges extend over most of southern Africa, Angola, central and East Africa to the southern borders of Sudan, Kenya, Tanzania, Uganda and Ethiopia (Sinclair, 1977; East, 1999; IUCN SSC, 2008; Okello *et al.*, 2015). The southern limit of the distribution of the African buffalo lies in southern South Africa (Skinner and Smithers, 1990) and the northern limit is in northern Ethiopia. There is no palaeontological evidence of the presence of the African buffalo

in North Africa or in the Nile Valley to the north of Khartoum (Prins and Sinclair, 2013). In South Africa, it once occurred in some parts of the southwest arid zone from the Kalahari east through the present day Botswana to Orange River avoiding only the Kalahari, Karroo and Namibia desert. According to IUCN (2000), the buffaloes occur in 38 African countries. However, they are exterminated from large areas of South Africa where its range is now fragmented and confined to protected areas (Kingdon, 1997). Tanzania has the largest African buffalo population, with over 342, 000 individuals recorded (East, 1998). They are common in most of the country's major wildlife areas. In Mozambique, buffalo populations occurred throughout the country until the 1970s, but their population has decreased drastically during civil conflicts (1977–1992). Probably the largest buffalo herd in Africa may be in the Marromeu area in Mozambique, which was estimated as 756,000 animals in 1978. Between 1979 and 1993, these populations have declined by 79% (Dutton, 1993). In Zimbabwe, the population of African buffalo was estimated at 665,900 in 1984, but in 1989 there were only about 80,000 heads present because, of habitat destruction, poaching and diseases (Taylor, 1989). In the Hwange National Park of Zimbabwe, the African buffalo decreased from 17,000 in 1989 to 5,080 in 1995 (Dutton, 1993). In Angola, buffaloes have been wiped out by uncontrolled hunting and poaching throughout the country, including Kissama National Park, where East (1998) reported a declining population of the transitional forest buffaloes.

East (1998) estimated >627, 000 individuals of African buffaloes throughout Africa, but based on the most recent and available census data, the total estimated population is >513, 000 individuals (Prins and Sinclair, 2013). This figure is slightly lower than the last global estimate of East (1998). The buffalo population globally appears stable and even increasing in countries such as Mozambique and South Africa. The slight decrease in the overall number mainly results from an apparent decrease of the total estimate in Tanzania, the country hosting the largest population of the African buffaloes (Prins and Sinclair, 2013). The forest buffalo is declining across its geographic range. East (1999) estimated a total population of 60, 000 individuals with about 75% of the population in nominally protected areas. The future of this subspecies depends on well-managed protected areas and hunting zones with special attention to forest clearings and mosaics of forest and savannas, where critical food resources are abundant (Melletti *et al.*, 2008).

*Syncerus caffer nanus* is found in both dense lowland forests and savannas from Ivory Coast to Cameroon, and Central African Republic to Congo. *Syncerus caffer aequinoctialis* is distributed in the eastern Zaire to the west of Lake Tanganyika and Kivu in the Albert National Park, and further in to Lake Chad and eastwards to southern Sudan, Ethiopia and to the Upper Nile. *Syncerus caffer brachyceros* extends from the Ivory Coast through Nigeria to Lake Chad and Central African Republic, Congo and Northwest Zaire. *Syncerus caffer caffer* extends from South Africa and Angola, through Central and East Africa to Southern borders of Sudan (Fig. 4) (Stuart and Stuart, 1997; Chamberlan *et al.*, 1999; Melletti *et al.*, 2007a; Melletti *et al.*, 2008; Cornélis *et al.*, 2014; Okello *et al.*, 2015).

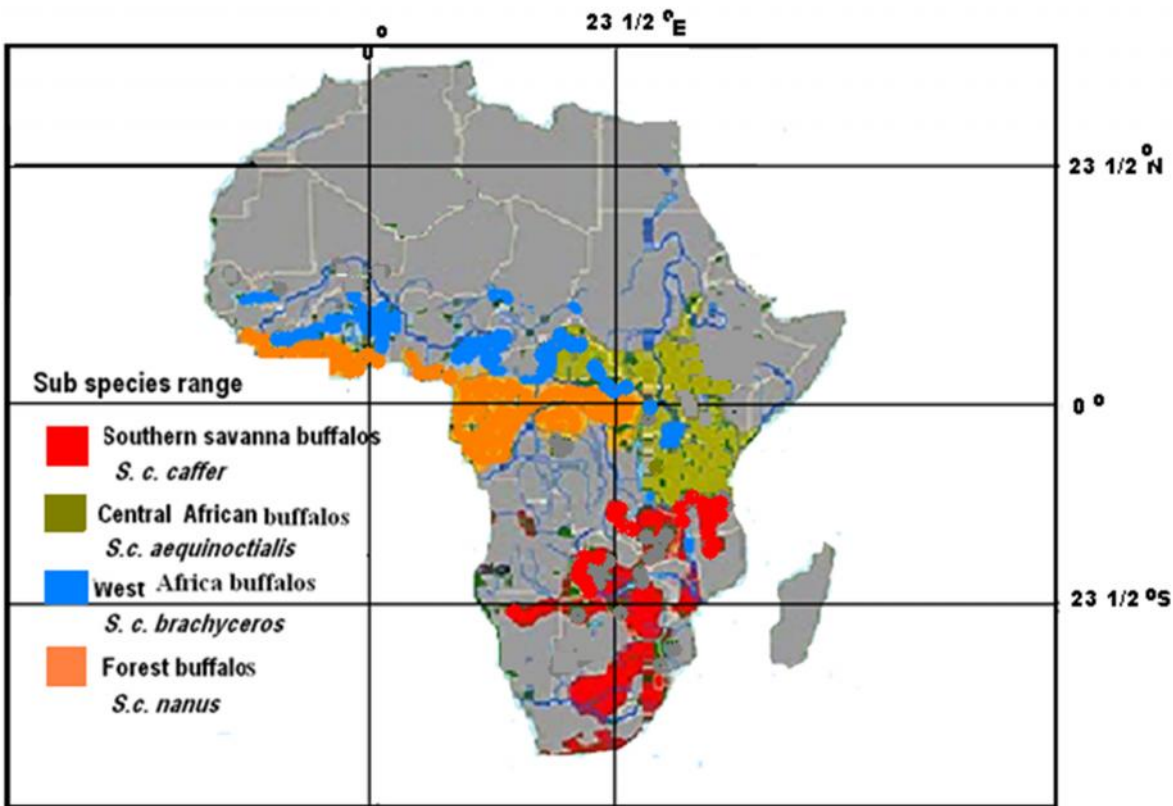


Figure 4. Distribution of African buffaloes in Sub-Saharan Africa (Source: IUCN SSC, 2008)

### 1.2.3.2. Habitat

Selection of suitable habitats by wild ungulates is shaped by the spatial and temporal heterogeneity of biotic and abiotic factors such as temperature and rainfall (Sinclair, 1977; Balakrishnan and Essa, 1986; Smit, 2011). In addition, critical resources often are segregated spatially (e.g., the best places for feeding, drinking, resting, or lowering the predation risk might

occur at great distances from each other). African buffaloes live in a wide range of habitats, from open grasslands to rainforests, including all intermediate vegetation types: scrublands, grassland, woodlands and deciduous forests. They appear not to be bounded by elevation constraints, and their altitudinal distribution ranges from coastal to the boundaries of forests on the highest mountains, except areas with annual rainfall less than 250 mm. African buffaloes persist in semi-arid environments, as long as surface water is available within 20–40 km, year-round (ASG, 1998; Naidoo *et al.*, 2012; Prins and Sinclair, 2013). The habitat requirements of the African buffaloes include abundant grass, shade and water (Skinner and Chimimba, 2005). Buffaloes must drink at least every two days, taking in about 45 liters daily, as they are unable to survive on the moisture content of their food alone (Prins 1996; Cornelis *et al.*, 2011; Prins and Sinclair, 2013). They are absent from areas without permanent drinking water and without permanent grass. However, buffaloes do not frequent wide, open areas of grasslands or floodplains, as they also require shade from trees during the day (Sinclair, 1977). Funston *et al.* (1994) noted that African buffaloes are able to live in mountain areas provided sufficient water supply is available. Savanna buffaloes may also ascend and descend steep slopes, up to about 50° and may be found at high elevations (Prins and Sinclair, 2013). They are known to regularly reach the alpine belt on Mount Kenya and are observed on Kilimanjaro, throughout the forest belt on the northern and western slopes, and buffalo tracks were observed up to 4200 m asl. A frozen carcass of African buffalo was located near a glacier of Mount Kenya, 4800 m above sea level (Ross, 1911 as cited in Sinclair, 1977).

The African buffaloes prefer areas close to rivers or lakes (Sinclair, 1977; Prins, 1996). They also prefer *Acacia* shrub and *Combretum*-dominated woodlands (Ryan *et al.*, 2006). They can not adapt well to dry conditions, where it is hard to find enough water and food when the grass is dry and short. They seek out shades where possible, but can stay out in the open without shade for extended periods of time (Kingdon, 1997). *Syncerus caffer nanus* is found in swamp jungle, primarily in the rain forests of western and central Africa and secondary growth forest and shows adaptation to forest life (Alden *et al.*, 1995; Kingdon 1997; Melletti *et al.*, 2007a). It is the only forest dwelling subspecies of the African buffalo; the other three subspecies inhabit mainly in savannah lands (Sinclair 1977; Mloszewski, 1983; Prins 1996).

## 1.2.4. Ecology and behavior

### 1.2.4.1. Feeding ecology

The ecological requirements of the African buffaloes are similar to those of the abundant grazing ruminants in the continent. African buffaloes feed mainly on grass. They are both morphologically and physiologically adapted for grazing (Prins, 1996), and capable of eating a range of herbs, shrubs and also browse on leaves of small twigs and young shoots (Buchholtz, 1990; Prins, 1996; Tshabalala *et al.*, 2009; Cornélis *et al.*, 2014; Watermeyer *et al.*, 2015). Grasses such as *Cynodon* sp., *Sporobolus* sp., *Digitaria* sp., *Panicum* sp., *Heteropogon* sp. and *Cenchrus* sp. are preferred. Seasonal changes in the quality of vegetation and availability of water have altered both ranging and feeding habits of the African buffaloes (Ryan and Jordaan, 2005; Ryan *et al.*, 2006; Venter and Watson, 2008; Winnie *et al.*, 2008; Tshabalala *et al.*, 2009; Bennitt *et al.*, 2014; Okello *et al.*, 2015). In the absence of fresh green fodder, buffaloes lose health status faster than other savannah ungulates (Macandza *et al.*, 2004). Ryan *et al.* (2012) suggested that high nitrogen content of fresh green forage is correlated with improved body condition of African buffaloes. They occasionally browse on *Combretum* and woody shrubs during the dry season (Macandza *et al.*, 2004; Ryan, 2006). A study by Tshabalala *et al.* (2009) on the seasonal variation of diet of the African buffalo and grass characteristics in the Great Fish River Reserve, Eastern Cape revealed that *Themeda triandra*, *Cynodon dactylon*, *Digitaria eriantha* and a *Panicum* sp. were important during both wet and dry seasons. However, their total dietary contribution decreased as the season changed from wet to dry. *Ptaeroxylon obliquum*, *Acacia karroo* and *Plumbago auriculata* were the important browse species both during wet and dry seasons. During the wet season, grass species contributed 72 % of the diet while only 28 % was contributed by browse species. In the dry season, there was a significant increase in the intake of browse by four percent. Venter and Watson (2008) studied African buffaloes in Nama-Karoo, South Africa, and noted that they forage in the lowland habitat adjacent to riverine thickets containing grasses *Eragrostis lehmanniana* and *Sporobolus fimbriatus* during the wet season. During the dry season, they ranged further from the riverine thickets and moved through lowland habitats and to upland habitats where *Themeda triandra* was abundant. Ryan *et al.* (2007) work in Klaserie Private Nature Reserve, South Africa also noted that buffaloes occasionally browse on *Combretum* sp. and other woody shrubs, particularly during the dry season. In addition, they graze tufts of grass that grow in *Combretum* sp. dominated areas.

Skinner and Chimimba (2005) revealed that buffaloes are selective feeders during the wet season, but non-selective during the dry season. However, the preferred grasses include *Cynodon*, *Sporobolus*, *Digitaria*, *Panicum*, *Heteropogon*, and *Cenchrus* sp. (Sinclair, 1977). The diet of forest buffaloes are also comprised mainly of monocotyledons, primarily grasses (*Poaceae*) and sedges (*Cyperaceae*) (van der Hoek *et al.*, 2013). African buffaloes play a pioneering role in the savanna grazing succession, reducing grassland to the height preferred by more selective feeders (Kingdon, 1997; Nowak, 1999). They have massive cheek teeth, broad incisors and prehensile tongue that gathers and bundle grass before each bite which enables them to feed efficiently on longer grasses. They are voracious feeders. Water is essential for them, like cattle, a physiological requirement, which limits their distribution patterns (Sinclair, 1977; Smith, 1981; Buchholtz, 1990; Redfern, *et al.*, 2003). When food supply begins to dwindle, the herd splits up into smaller sub-groups that live separately to reduce the intra-competition for food (Sinclair and Grimsdell, 1982; Prins, 1996).

#### **1. 2. 4. 2. Activity patterns**

Seasonal changes in the activity pattern of African buffaloes were found to be governed primarily by the quality and quantity of food available (Beekman and Prins, 1989; Ryan and Jordaan, 2005; Ryan *et al.*, 2006; Venter and Watson, 2008; Tshabalala *et al.*, 2009). Thus, their feeding and ranging behaviour are subject to constraints such as the abundance of grass and the availability of water (Redfern *et al.*, 2003; Skinner and Chimimba, 2005). The other factor controlling the activity patterns of African buffalo is ambient temperature. High ambient temperature during the day time result in nighttime grazing favoured during the warmer season and low ambient temperature during the night causes nighttime resting being favoured during the cold season (Grimsdell and Field, 1976; Mloszewski, 1983; Taylor, 1989; Winterbach and Bothma, 1998). Grazing and ruminating times are short during the warm, wet season, when high quality food items are abundant. But, as food quality and quantity decrease during the dry season, grazing and ruminating time increase. An increase in ruminating time during the dry seasons is probably because of the increased lignin and fiber content of the food (Sinclair, 1977; Taylor, 1989; Funston *et al.*, 1994). The herd has a long mid-day rest after the morning grazing peak. The temperature is hottest in the mid-day as observed by Sinclair (1977) in natural habitats. During this period, buffaloes remain resting (lying down or standing) under trees to

escape the intense heat of the day. Buffalo herds not subjected to human predation tend to spend much time grazing and resting during the daytime than night. They continuously graze for about 8-10 hours, in the late afternoon and at dusk (Nowak, 1999). Resting and ruminating may take place at any time of the day, but the favored period is during 12:00–16:00 h, which is also usually the hottest time of the day (Kingdon, 1997; Nowak, 1999). *Syncerus caffer* cannot tolerate water restriction for a long time during hot periods. They go to water at least once every 24 hours, mainly at daytime and most often between noon and dusk (Sinclair, 1977; Prins, 1996). They occasionally take mud baths. Dominant males wallow most frequently, and bulls regularly spend a couple of hours a day in mud holes, especially during the hottest hours of the day. Associated aggressive behaviour, notably digging and tossing mud with the horns, kneeling, neck rubbing, rolling and urinating indicates their high status in the herd (Sinclair, 1977).

A study by Winterbach and Bothma (1998) on the activity pattern of the Cape buffalo in Willem Pretorius Game Reserve revealed that grazing and resting/ruminating were their major activities to the level of 74% of the 24-hour cycle, of which they feed an estimated 40% of the time, and rest for about 34% of their time. They spent 14% of the time in walking and 11% in standing. Drinking and other activities occupied only 1% of the whole 24-hour time. They also noted that night time grazing of the buffalo was favoured during the dry season with resting/ruminating occurring predominantly at night during the winter months. A study conducted by Ryan and Jordaan (2005) on the activity patterns of African buffaloes in the Lower Sabie Region, Kruger National Park, South Africa revealed that they spent 44.5 % of the time feeding and 28.4 % of time resting. The proportion of time on feeding and resting was influenced by the time of the day and season. Feeding and resting activities of an animal fluctuates diurnally. Activity fluctuates in response to environmental factors. Both habitat structure and season also influenced spatial aggregation patterns of the forest buffalo herds. Forest buffaloes had a more aggregated spatial distribution when resting in clearings than when in the forest, and individual positions within the herd in the clearing habitat varied with age and sex (Melletti *et al.*, 2007a). The adult male occupies the centre of the herd, whereas other members (females and juveniles) may occupy less favourable places within the herd. During the wet season, food resources seem to be more abundant and homogeneously distributed, and the herd has a less aggregated spatial distribution than in the dry season (Melletti *et al.*, 2010).

### 1.2.4.3. Home range

Home range of buffaloes differs with sex, age class and herd size. Bachelor and solitary males are the most sedentary. Groups of old males may keep within a small area (Funston *et al.*, 1994). Sinclair (1977) and Bar-David *et al.* (2009) indicated that the size and shape of home range of African buffaloes can be related to social structure, population density, resource abundance and resource distribution. Winterbach (1999) also showed that buffalo home range characteristics were likely to be influenced primarily by the availability of food and water. A study by Eltringham and Woodford (1973) on the home range of the African buffalo in Ruwenzori National Park indicated that their home range vary from 9.4 km<sup>2</sup> to 1000 km<sup>2</sup>. Recorded home ranges of African buffaloes in north-western Mpumalanga in South Africa vary from 127 km<sup>2</sup>–138 km<sup>2</sup> and in Kwazulu Natal 21.6–135.7 km<sup>2</sup> (Winterbach, 1999). Skinner and Chimimba (2005) reported that the African buffaloes have a large home range during dry season than during the wet seasons, because they have to search for adequate quality food and water during the dry season. But, Western (1975) found that home range in the semi-arid Amboseli ecosystem of Kenya decreased during the dry season when the herds concentrated around riverian areas. Home range of savanna buffaloes vary in size from 126 to 1,075 km<sup>2</sup>, supporting population density between 0.17–3.77 individuals per km<sup>2</sup> (Nowak, 1999). Breeding herd of 138 buffaloes ranged an area of 10.5 km<sup>2</sup> in Queen Elizabeth National Park (Grimsdell, 1973; Estes, 1991). The average density of savanna buffaloes was estimated to be 0.05–0.6/km<sup>2</sup> (Prins, 1996). Generally, density was high and range was small in areas with high rainfall (Nowak, 1999).

Ryan (2006) indicated that during the dry season herds travel up to 17 km, while commuting between pasture and water. They move for about 18 hours a day at an average rate of 5.4 km per hour. In Cameroon, Stark (1986) found that the buffaloes move around 7 km in the wet season and 5.6 km in the dry season. Grimsdell and Field (1976) reported 9.6 km on average in Rwenzori National Park, Uganda; Conybeare (1980) reported an average of 6.1 km in the dry season in Sengwa Wildlife Research Area, Zimbabwe; Funston *et al.* (1994) found that in the early wet season the herds in the Sabie Sand Reserve (on the western edge of Kruger National Park) tended to remain in an area around a water hole for up to eight days and then move. He also noted that during the dry season, the herd would make long distance (10 km) movements at night in search of food. The ability of the African buffalo to cope with contrasting environmental

conditions throughout most sub-Saharan ecosystems highlights the high behavioral plasticity of this species (Cornelis *et al.*, 2011).

#### **1. 2. 4.4. Reproduction and development**

*Syncerus caffer* has a pronounced seasonality in reproduction, which is correlated with the quality and availability of fresh shoots of grasses and other leaves. This is also correlated with the rainfall in the area (Grimsdell, 1973). Improved protein levels, occurring approximately a month after the first green flush of the wet season is a trigger for conception. Conception has evolved in a way to synchronize the correlated environmental cues that ensure female buffaloes have good health condition around the time of conception and/or parturition (Ryan *et al.*, 2007). Both mating and calving are largely confined to the rainy season of the year. They mate late in the rainy season and give birth early in the rainy season (Grimsdell, 1973; Sinclair, 1977; Kingdon, 1982). African buffaloes have birthing seasons reported to coincide with the wet season (Grimsdell, 1973; Sinclair, 1977; Prins, 1996; Turner, 2003, Vissher, *et al.*, 2004; van Hooft *et al.*, 2010). Non-seasonal breeding occurs in areas where environmental conditions are favourable year-round. In captivity, *S. caffer* breeds throughout the year (Sinclair, 1977; Kingdon, 1997). The lack of resources in low rainfall years may drive prime breeding females either into non-reproductive condition, or cause them to migrate to better habitats. Ryan *et al.* (2006) suggested that males who join breeding herds face an energetic trade-off between obtaining sufficient food and engaging in reproductive activity. As the grass growing season tapers and the quality of food is reduced, it is likely that both sexes face this trade-off.

Bulls regularly monitor the reproductive status of females by urine smelling. Estrus cycle takes place in the African buffalo every 23–24 days, and the female will be in estrus for 5–6 days. Gestation is approximately 340 days long, which is the longest gestation period in the bovine family. Usually, a single calf is born, but rarely two calves are born (Prins, 1996; Spinage and Brown, 1988; Buchholtz, 1990). An inter-birth interval of two years is normal. It is difficult to ascribe a breeding season to forest buffaloes (Melletti *et al.*, 2007a, 2007b; Korte, 2008). The newborn calf of the African buffalo has a weight of 55–60 kg, and with a thin covering of light brown hair, which helps to camouflage while hidden away and suckled for the first few weeks, until it is strong enough to keep up walking with the herd. Weight at birth in forest buffalo is

around 40 kg (Buchholtz, 1990). Calves share a strong bond with their mothers, and mothers try to protect their infants from predators (Alden *et al.*, 1995). Even though the calves would suckle for up to 18 months, suckling is tolerated by the mother until the next calf is born (Prins, 1996). A longer period of lactation may occur if the female does not conceive again (Sinclair, 1977). The calf reaches sexual maturity between 3.5–5 years of age.

According to Hornsveld (1996), the first lower incisor appears at an age of two years, the second at three years, the third around four and a half years and the fourth at five years of age. As a bovid, the buffalo does not have upper incisors. The horn growth of buffalo was described by Sinclair (1977). In calves, growth starts with a sharp upward growth in a V-shape. By the time of two years, the horns are 300–460 mm long, by three years, 410–690 mm, and by four years, the horns are 610–860 mm long. The boss starts to thicken at an age of 3–4 years, and the shape at adulthood in cows is attained at 4–5 years of age, when the tips also start to sweep backwards. Males reach sexual maturity at 5–6 years of age, but usually do not breed until seven years or older, at which time the horns are fully developed. The typical hairy boss develops at an age of 5–6 years. In bulls older than seven years, the two halves of the boss are merged and the horn tips are worn away. The coat of a newborn calf is black to dark olive-brown. When the calf is few months old, it becomes yellow–brown, with long hairs that create a rough appearance. The coat color darkens with age to reddish chocolate-brown, and turns black in cows at around four years and in bulls at five years of age. During the second year of life, the coat becomes short and smooth. In old bulls, the coat becomes wavy in texture, and in old individuals, it has hairless spots (Sinclair, 1977). In the wild, African buffaloes may live up to 18 years, while in captivity, there are record of living up to 26 years (Buchholtz, 1990; Nowak, 1999). There is a high mortality ratio of around 55–70% for the African buffalo between the period from birth and reproductive maturity. Factors that affect all age groups of them are disease and predation. Lions and humans are the main predators; leopards and crocodiles also occasionally kill buffaloes (Kingdon, 1982; Prins, 1996).

#### **1.2.4.5. Social Organization**

African buffaloes are social animals, which travel in large non-territorial herds, with a male dominance hierarchy (Buchholtz, 1990; Nowak, 1999). Within the herds, there are a number of

smaller social groups, made up of several females and their calves. They live in clans consisting of a dozen or more related cows and their offspring. Bachelor groups containing as many as twelve males are also found within the herd sub-structures (Prins, 1996). Adult males are found either associated with a female group or apart from the herd, in small units of individuals of more or less the same age (Buchholtz, 1990). On the contrary, forest buffalo herds live in quite stable groups, and members are mainly permanent part of it (Chamberlan *et al.*, 1999; Melletti *et al.*, 2007a, b; Korte, 2008). The membership of a herd can vary considerably on multiple temporal and spatial scales, as shown in Kruger National Park, leading to a fission-fusion herd structure where groups often separate and rejoin (Cross, 2005), although more rigid herd structure has been reported in the more temperate Hluhluwe-Imfolozi Park (Jolles, 2004). Recent studies based on larger sample sizes of radio-collared individuals, however, suggest that females and subadults do move between groups and the structure of herds may not be stable (Halley *et al.*, 2002). The fusion and fission activity pattern in the buffalo herd may be related to herd size where the larger herd divides more frequently than smaller herds (Prins, 1989; 1996). It may also be related to season when splitting of the herd depends on food distribution, and abundance (Sinclair, 1977). In the Serengeti, Sinclair (1977) reported that mixed herds tend to split into sub-herds when resources are fragmented during the dry season. In contrast, Halley *et al.* (2002) reported that the herds tend to congregate during the dry season in areas where water and forage are abundant, and split into sub-herds during the wet season to exploit the available habitat more efficiently. They exhibit seasonal social ecology in which they aggregate into large mixed herds during the breeding season, splitting into mixed herds and bachelor groups for the rest of the year. In addition to a seasonal system of group organization, exchange of individuals occurs between groups throughout the year, with males and females engaging in local and long distance dispersals (Grimsdell, 1973; Prins, 1996; Halley *et al.*, 2002). Temporary aggregations of 2,000–3,000 buffaloes occasionally form from several smaller herds, but such large groups lack social cohesion and are only possible in large and rich pasture areas (Prins, 1996). In contrast to the savannah buffalo, which form herds of hundreds to thousands of individuals (Sinclair, 1977; Mloszewski, 1983; Prins, 1996), forest buffaloes live in smaller groups (3–24 individuals), probably because of the patchy distribution of food resources in the rainforest (Melletti *et al.*, 2007a; Korte, 2008; Melletti *et al.*, 2008).

Sex differences in habitat use, and seasonal changes in social affiliation, are widespread in sexually dimorphic ungulate species (du Toit, 2001; van Hooft *et al.*, 2010). Male African buffaloes form groups in the non-breeding season to forage and improve their condition and then compete for mates in the breeding herd during the breeding season (Sinclair, 1977; Clutton-Brock *et al.*, 1982; Prins, 1996). Seasonal aggregations depend largely on resource availability (Winnie *et al.*, 2008). There is a threshold at which the foraging cost of remaining in the group outweighs the reproductive opportunity (Turner, 2003; Turner *et al.*, 2005). Males in bachelor groups spent similar extends of time feeding as females in breeding herds, whereas males in breeding herds spent least time feeding. Their reproductive activities appear to be at the expense of foraging time (Turner, 2003). The probability of survival is substantially less for bulls in bachelor groups compared to bulls in breeding herds, indicating that leaving the breeding herd is undoubtedly a risky strategy for a male buffalo (Sinclair, 1977), because, the large number of individuals in a herd is advantageous as it decreases the risk of predations (East, 1996). Male forest buffaloes have not been observed as bachelor groups (Korte, 2008).The African buffalo can defend the attack of even lions with their horns (Sinclair, 1977; Prins, 1996). Living in herds also has its disadvantages. When food supply begins to dwindle, the herd splits up into sub-groups that live separately, to reduce competition for food (Sinclair and Grimsdell, 1982; Prins, 1996). Thus, food and habitat selection, maintenance of home range, and changes in group size, all seem to optimize the use of available resources in a better way (Sinclair, 1977).

The high degree of coordination within herds containing hundreds of animals that are grouped into sub herds, and the close individual distance in this species, would indicate that communication is continuous and efficient under all conditions of light and cover. Vocal communication is an important channel for buffaloes. They use a set of vocalizations and postures to maintain herd cohesion and order. Vocalization includes the signals to move, direction giving, warning, aggression, mother-to calf distress and dangers (Estes, 1991). Bulls that are injured or about to die can make very loud bellows. Other bulls may or may not react to the sounds. Buffaloes which are badly wounded seek the protection of the herd as noted by Sinclair (1977). Agonistic behaviour such as high horn presentation, lateral display, rubbing face or neck on the ground, ground horning with earth tossing and horning bushes are usually done to

establish dominance status. Hearing is important among buffaloes than vision, to such an extent that blind buffaloes can live in herds (Sinclair, 1977; Kingdon, 1982; Estes, 1991).

### **1.3. Threats**

African buffaloes are susceptible to several infectious diseases. They are known to be a reservoir for foot-and-mouth disease, corridor disease (theileriosis), bovine tuberculosis and bovine brucellosis. The role of African buffaloes in the epidemiology of pathogens such as anthrax, Rift Valley fever and lumpy skin disease is still unclear, and requires more investigations (Caron *et al.*, 2003; Gorsich *et al.*, 2015). No species was more affected than the African buffaloes as a result of rinderpest (Estes, 1991; Sinclair, 1977), but due to the remarkable capacity for recovery, they have repopulated in many areas of Africa. Historical population collapses caused by rinderpest are hypothesized to have resulted in notable genetic losses in the populations of the African buffalo. But according to Wenink *et al.* (1998) and vanHooft *et al.* (2002), the population crash caused by rinderpest did not greatly reduce the overall genetic diversity within the African buffalo populations. Indigenous diseases such as foot-and-mouth disease, brucellosis and corridor disease generally do not pose a threat to the survival of buffalo populations because of the evolutionary development of unique coping mechanisms (Ayebazibwe *et al.*, 2010). African buffaloes are believed to play an important role as biological reservoirs for the foot-and-mouth disease, and it is sometimes transmitted between and within different livestock and wildlife species (Ayebazibwe *et al.*, 2010; Michel and Bengis, 2012; Gorsich *et al.*, 2015). Bovine TB is a major problem in the southern regions of Kruger National Park (Caron *et al.*, 2003). Buffalo is one of the preferred hosts of tsetse fly (Lampery, *et al.*, 1962 as cited in Sinclair, 1977). Transmission of such diseases at the interface of protected areas with human settlements can be exacerbated by mixing wildlife and domestic animals; when wild animals leave the Park boundaries and when domestic animals graze within the Park (Kock, 1999; Sutmoller *et al.*, 2000; de Vos *et al.*, 2001; Smith and Parker, 2010).

One of the main threats for wildlife anywhere in the world is habitat loss and fragmentation. Rising anthropogenic pressure, both through direct human activities and the effects of climate change, renders environmental conditions less predictable across the globe, and inevitably affects resource availability within protected areas (Wiens *et al.*, 2011; Ogotu *et al.*, 2012; Lorrillière *et*

*al.*, 2012). Today, the threat of climate change has become an overwhelming concern in the field of wildlife conservation (IPCC, 2012). Most of the protected areas are used for agricultural activities and settlements all over Africa (Kaltenborn *et al.*, 2005). Poaching has the most significant impact for the disappearance and population decline of larger mammals, particularly the African buffalo and African elephant (Balakrishnan, 1994). Both African buffaloes and forest buffaloes have been greatly reduced by illegal killing for meat and trophies. Human demographic expansion, wildlife overexploitation and habitat degradation results in reduction of population size and fragmentation of geographical distribution of ungulates. These population fragmentations had an impact on the genetic structure of the African buffalo, leading to the identification of three distinct clusters in southern Africa (Heller *et al.*, 2010; Heller *et al.*, 2012; Smitz *et al.*, 2014). The African buffaloes have only few predators such as lion, cheetah, leopard and the Nile crocodile, other than human being. Predation of spotted hyena, leopard and cheetah has been recorded, usually targeting young animals (Sinclair, 1977). Lions kill and eat buffaloes as they hunt in pride. There were incidents in which lone adult lion killed large buffalo bulls (Buchholtz, 1990).

#### **1.4. Conservation**

The 2000 IUCN Red Data List classifies *S. caffer* as lower risk conservation dependent species. It is not listed on any CITES appendix (East, 1999). In the past, the populations of African buffaloes were widespread in the continent, but now there are about 513, 000 individuals across the continent; found mostly in the savannas of eastern Africa (Prins and Sinclair, 2013). Most of them are savanna buffaloes. The future of this species is closely linked to the future of protected areas and well managed hunting zones, as this animal is the frequent target of poachers (East, 1999; Heller *et al.*, 2012; Prins and Sinclair, 2013).

Establishment of more effective protected areas is one of the conservation efforts aimed at to protect wildlife (Fynn and Bonyongo, 2010). There are about 1,100 National Parks and related reserves in sub-Saharan Africa, of which 36 are designated World Heritage Sites (WCMC, 2004). The African buffalo is well represented in numerous National Parks and Protected Areas in the continent (Kingdon, 1997). Prevention of the spread of infective diseases is important for the conservation of African buffaloes (Sutmoller *et al.*, 2000; Smith and Parker, 2010). The

national program initiated by the South African government to produce disease-free buffaloes so as to ensure the sustainability of this species due to threats from diseases results a sustainable number of buffalo herds that are free of the four diseases mentioned earlier, and is one of the conservation efforts to protect this species (Laubscher and Hoffman, 2012). Conservationists accept the principle that indigenous people have the right to use, own, and control their traditional territories (Mackinnon *et al.*, 1986). However, it is difficult when it comes to the implementation with the current human population pressure (Spinage, 1998). Ecologists are arguing that people constitute a threat to nature due to dual problems of population increase and the adoption of new technologies. Effective management of African buffaloes and other wildlife resources can be realized only if the current pressures on the conservation areas are controlled. Involvement of the local people in and around wildlife habitats in conservation program and sharing the benefits from the protected areas are encouraging efforts in the conservation of African buffaloes and all other wildlife in the continent (van Oudtshoorn, 1999). Conservation measures such as setting hunting regulation and issuing hunters with the necessary licenses and permits by the Park and accompanying customers by fully-qualified and licensed guides and controlling poaching are encouraging efforts in the conservation of wildlife including African buffaloes of the region. Establishment of protected areas where African buffaloes are found play crucial role in the conservation of this species.

Ethiopian first wildlife rescue, conservation and education center was established in 2010 in partnership between the Ethiopian Wildlife Conservation Authority (EWCA), Oromiya National Regional State and Born Free Foundation (Chapman, 2010). This center is aimed to bring high quality animal care, public education and wildlife conservation initiatives. It is also expected to work to protect the country's wildlife heritage. The establishments of protected areas, especially in areas where the African buffaloes are found, and such centers undoubtedly play crucial roles in the conservation of the buffaloes. It would be worth to develop buffalo distribution and density mapping at a country scale. Further updating and improving of data sets are important for wildlife conservation activities of the country.

## **1.5. Anthropogenic impacts and human–wildlife conflict**

Throughout the history, human factors have been the major drivers for loss of biodiversity (Hackel, 1999). Ninety-nine percent of the IUCN Red List species are threatened by these factors (IUCN, 2003). The 2003 IUCN Red List indicates that of 5,205 species evaluated in 1996, 25% of all mammals and 11% of all birds were threatened (IUCN, 2003). Recently, some 162 species of mammals and 181 of birds are critically endangered i.e., they are facing an extremely high risk of extinction in the wild (IUCN, 2003). This is more pronounced in developing countries, because they are more dependent on natural resources as their primary source of income (Wilfred, 2010). In developing countries, pressures on natural resources are growing in line with the rapidly growing of human population (Kideghesho *et al.*, 2005). The numbers, types and intensity of human activities affecting wildlife and wildlife habitats are increasing in the developing countries (Akinyemi and Kayode, 2010; Oladeji *et al.*, 2012). Wildlife species, which offer a number of human needs, decline or disappear as human clears wildlife habitat for anthropogenic activities (Masanja, 2014). Habitat loss and fragmentation affect the survival of wildlife species in various ways including influencing animal behavior, abundance, distribution, reducing of the total amount of usable habitats, degrading habitat quality (Akinyemi and Kayode, 2010; Metzger, *et al.*, 2010; Vymyslicka *et al.*, 2010; Atickem *et al.*, 2011; Demeke Datiko and Afework Bekele, 2011; Gundogdu, 2011; Yosef Mamo *et al.*, 2012). These impacts of anthropogenic activities on wildlife habitat and species will vary depending on the spatial and temporal scales, and the persistence of the activities in the landscape. Consequently, understanding the effects of humans on wildlife and wildlife populations, as well as devising strategies to ameliorate these effects, is an increasing challenge for resource managers (Heinen, 1993; Harrison, 2011).

### **1.5.1. Conservation-related conflicts**

#### **1.5.1.1. Resource use conflict**

In developing nations firewood remains the major source of energy for cooking, heating and lighting. According to Bonjour *et al.* (2013) until 2010, around 2.8 billion people, mainly in developing nations, still relied on traditional use of biomass for cooking and heating. The World Health Organization (WHO, 2012) also reported that more than 3 billion people depend on solid fuels including biomass such as wood, charcoal, dung, crop residues and coal to meet their most

basic energy needs (Bonjour *et al.*, 2013). The mis-utilization of wood products by the rural human communities aggravates the degradation of the habitats of wildlife, and is the major threat to protected areas in developing countries today (Evangelista *et al.*, 2007; Kebede, 2009; McElwee, 2010).

Other than harvesting of firewood, wildlife hunting is the most geographically widespread form of resource extraction (Wadley, 2010). Studies in tropical forest ecosystems provide evidences that increased human hunting activities have led to reductions and local extinctions of some wildlife populations. Consequently, the exploitation of wild animal populations has been highlighted as one of the central reasons why species are currently threatened (Aiyadurai, *et al.*, 2010; Metzger *et al.*, 2010). Illegal hunters used many methods to catch their prey, including snares, iron-jaw or gin-traps, pit traps, net drives, firearms, bow and arrow, spears, dogs, poisoning, fire, dazzling by torchlight or gathering by hand (Grey-Ross *et al.*, 2010; Lindsey *et al.*, 2011). Fire is also commonly used by hunters to flush wildlife, clear undergrowth, increase visibility, stimulate green growth to concentrate wildlife, and cover tracks (Lindsey and Bento, 2012). The most common method used by illegal hunters is the use of snares (Hofer *et al.*, 1996). Snare hunting method is undesirable from a conservation perspective as it is highly effective, difficult to control, unselective in terms of the genders or species of animals captured, wasteful, and has severe animal welfare implications due to the manner of capture and confinement, and frequent incidents of severe, non-lethal wounding of wildlife (Lindsey *et al.*, 2009; Lindsey *et al.*, 2011). The drivers of illegal hunting for wildlife are varied. They hunted to obtain wildmeat for direct consumption and/or community trade, trophies (most often skins, fur, teeth, antlers and horns), medicines and other traditional uses (most hard and soft body parts) and as pets (especially primates, birds and reptiles) (Carpaneto *et al.*, 2007; Nasi *et al.*, 2008; Marealle *et al.*, 2010; Brashares *et al.*, 2011; Martin, *et al.*, 2012). While vulnerability varies between species and localities, uncontrolled exploitation could bring about marked wildlife population declines and eventually the extinction of a number of hunted species (Lindsey *et al.*, 2011).

Wildmeat hunting is a widespread problem in many ecosystems all over the world. It occurs extensively in Africa (Lindsey *et al.*, 2011), Asia (Rao *et al.*, 2010), Central America (Smith, 2008), Australia (Bennett and Whitten, 2003) and South America (Peres and Nascimento, 2006).

The problem seems more common in African ecosystems than elsewhere. Studies in West and Central Africa suggest that in many areas, wildmeat is an economically important food and commodity to trade for thousands of rural and urban families and animal parts are also important for their role in rituals (Brashares *et al.*, 2011). In rural Gabon, hunting accounts for around 15 to 72% of the average household income (Starkey, 2004; Coad *et al.*, 2010). In Eastern Africa, unsustainable wildmeat hunting is a conservation concern too (Barnett, 2000). In Kenya, wildmeat hunting occurred in 96% of the protected areas and 25% of the meat in Nairobi butcheries was wildmeat (Olupot *et al.*, 2009). In Tanzania, wildmeat hunting is an important activity and threatens all categories of protected areas including the Selous Game Reserve and Serengeti ecosystem (Loibooki *et al.*, 2002; Metzger *et al.*, 2010; Bitanyi *et al.*, 2012; Nielsen *et al.*, 2013). Recent assessments have highlighted that steep declines in wildlife populations are occurring in most African countries (Craigie *et al.*, 2010) and illegal hunting has been implicated as a key contributing factor (Fa *et al.*, 2005; Scholte, 2011; Lindsey *et al.*, 2012). Wildlife populations in northern Central African Republic declined by 65% during 1985–2005, primarily due to illegal hunting and diseases transmitted by livestock (Bouché *et al.*, 2010) in the Comoé National Park in Ivory Coast wildlife declined by 60–90% during the 1970s to the late 1990s as a result of illegal wildmeat hunting (Fischer and Linsenmair, 2001). Similarly, wildlife populations in Niokolo-Koba National Park in Senegal declined by 60–99% from 1991–2006 as a result of illegal wildmeat hunting (Loibooki *et al.*, 2002). Hunting accelerates extinction, mostly of large mammals (Barnes, 2002; John and Brown, 2009). In Uganda, massive hunting reduced large mammal population by over 90% in the 1970's (Lamprey *et al.*, 2003). In Tanzania, illegal hunting has dramatically reduced the population of African buffaloes, giraffe, impala and topi (Hofer *et al.*, 1996). Although law enforcement patrols attempt to control illegal hunting, the expected economic benefits from the sale of wildmeat, derived from wild animals, are far greater than the costs associated with a low probability of arrest and punitive fines, thus illegal hunting is a persistent, widespread problem for animal species conservation through out Africa (Loibooki, *et al.*, 2002; Mavhunga, 2008; Fa and Brown, 2009; Grey-Ross, *et al.*, 2010; Mbeti, *et al.*, 2011; Gandiwa *et al.*, 2013).

Fire is also a common phenomenon across the African continent (Archibald *et al.*, 2012). It is estimated that 68% of Africa's surface area burns every year (Roy *et al.*, 2008). Some fires are

the result of natural causes such as lightning but most fires are lit by humans (Gandiwa and Kativu, 2009). FAO (2007) also reported that humans are regarded as the main source of wildfire globally, accounting for 59–95% of ignitions. Repeated fire affects many ecological processes, such as nutrient cycling, soil organic matter content, vegetation structure and composition and wildlife communities (Eriksen, 2007; Klop and van Goethem, 2008; van der Hoek *et al.*, 2013; Gandiwa, *et al.*, 2014). Studies from east, west, and southern Africa reported that burning the protected area were mostly livelihood-related uses including range management, thatch production, habitat maintenance, predator-cover reduction, gathering, hunting, agricultural production, firebreak creation, and path clearing (Butz, 2009; Giliba *et al.*, 2011; Gandiwa, *et al.*, 2014). Some of the direct effects of fire on ecosystems fauna is absolute death, wound and causes the displacement of animals and affects their distribution patterns at both local and regional scales (Hassan and Rija, 2011; Gandiwa, 2011; Gandiwa, *et al.*, 2014).

Livestock grazing also has strong negative impacts on wildlife, their habitats, and overall ecosystem function and structure (Morrison *et al.*, 1998; Mishra *et al.*, 2003). Livestock usually compete with wild animals for different habitat resources including forage, water sources and space. The problem can be exacerbated by the local people's idea that high numbers of livestock generate more income and are a measure of wealth status in Africa such as Ethiopia (Hillman, 1993). The resultant high livestock population densities put strain on the habitats of many wild animal species (Evangelista *et al.*, 2007). Livestock often alter the structure and species composition of natural vegetation. In sites where livestock grazing is more extensive, the vegetation types and composition change from more diverse and suitable to less diverse and unpalatable (Kebede, 2009; Yosef Mamo *et al.*, 2012). Carolina and Javier (2001) also reported that livestock grazing and/or browsing, uprooting, trampling, and high fruit/seed predations strongly affect seedling survival and the ability of understory species to regenerate. Unrestricted livestock movements in the forest may also compact soil, destroy seeds or press them deep into the soil where they are not able to emerge easily (Smit *et al.*, 2006; Wassie *et al.*, 2009). The effect of human and livestock disturbances on wild animals is frequently measured in terms of shifts in habitat use and other behavioural responses including reduction in the quality and availability of habitats (Gilroy and Sutherland, 2007; Tadesse Solomon and Kotler, 2013).

Agriculture remains a predominant livelihood activity in Africa. In a situation where agriculture provides low economic returns, natural resources become the main source of income (Butler, 2000). Agriculture is one of the major issues in the effort to curb escalating pressures on protected areas (Mfunda and Røskoft, 2010; Wright and Priston, 2010; Ryan *et al.*, 2015).

The wildlife population has been declining throughout the world at an alarming rate, mainly due to habitat destruction for the expansion of agriculture activities (Gundogdu, 2011). It is more pronounced in developing countries like Ethiopia. In Ethiopia, expansion of agricultural practices, settlement and increasing pressure from human and livestock populations are major threats to several protected areas (Atickem *et al.*, 2011; Yosef Mamo and Afwork Bekele, 2011; Wondimagegnehu Tekalign and Afework Bekele, 2011; Tadesse Solomon and Kotler, 2013; Aramde Fetene *et al.*, 2014). In Serengeti there has been a close relationship between agricultural production and wildlife poaching (Barret and Arcese, 1998; Johannesen, 2005). A study of wildmeat and food security in the Congo Basin also acknowledged the role of agriculture in halting wildlife exploitation intensity (Fa *et al.*, 2003). Mechanized agriculture coupled with high usage of chemical fertilizers has been responsible for wildlife habitat degradation in Africa (Kideghesho *et al.*, 2006; Young *et al.*, 2005). Adoption of low input agriculture, characterized by good management of chemical fertilizers and firm integration of indigenous knowledge would be the best way forward for improving agricultural yield and conserving habitats in the areas of conservation importance (Mkpado and Onuoha, 2008).

#### **1.5.1.2. Human–wildlife conflict**

Human–wildlife conflict (HWC) has been in existence for as long as humans have existed and wild animals and people have shared the same landscapes and resources (Sitati *et al.*, 2005). Human–wildlife conflict cost many lives, both human and wildlife, threaten the livelihoods of millions worldwide and jeopardized long-term conservation goals such as securing protected areas and building constituencies in support of wildlife conservation. No single factor or cause explains human–wildlife conflict across the continent (Naught on-Treves and Treves, 2005). The transformation of global landscapes from predominantly wild to predominantly anthropogenic over the last centuries has created competition between humans and wildlife for space and resources and it reached unprecedented levels because of rapidly growing human populations

and expanding settlements (Ellis *et al.*, 2010; Hoffman, 2011; Kate, 2012; Mwamidi *et al.*, 2012). The transformation of forests, savannah and other ecosystems into agrarian areas or urban agglomerates as a consequence of the increasing demand for land, food production, energy and raw materials, has led to a dramatic decrease in wildlife habitats (Kate, 2012; Kumara *et al.*, 2012; Mwamidi *et al.*, 2012). As habitat gets fragmented, the length of edge for the interface between humans and wildlife increases, while the animal populations become compressed in insular refuges. Consequently, it leads to greater contact and conflict with humans as wild animals seek to fulfill their nutritional, ecological and behavioural needs (Lamarque *et al.*, 2009).

Conflict occurs when requirements of wildlife animals overlap with those of human populations (IUCN, 2003; Mackenzie, 2012). It can take various forms, including wild carnivores attacking and killing livestock or humans, wild species raiding crops, competition for game and/or resources, disease exchange between livestock and wildlife, carcass poisoning, and retaliation killing (Gurung, *et al.*, 2008; Kissui, 2008; Nyirenda *et al.*, 2013; Ocholla *et al.*, 2013). In addition, wild animals that have massive body size like African elephants, buffaloes, rhinos and hippos cause structural damage to fences, electric posts and water pipes as they raid within settlement areas (Peterson *et al.*, 2010). Human population increases adjacent to protected areas, where wildlife population density is high and the resultant encroachments into protected areas and increasing livestock populations have also been reported to result in increases in human–wildlife conflicts (Michalski *et al.*, 2006; Muhammed, *et al.*, 2007; Baranga *et al.*, 2012; Mackenzie, 2012; Zerihun Girma *et al.*, 2012). Beside visible impacts, HWC has indirect or hidden impacts as well (Barua *et al.*, 2013). These hidden impacts include disruption of livelihood and food security through crop or livestock loss. It also involves health impacts, transaction (time and money spent in mitigation measures and claiming compensation) and opportunity cost (lost income) and are often psychological or social in nature (Nyirenda *et al.*, 2013). These hidden impacts are often delayed and are poorly documented. But, it becomes important to understand these impacts or else they have the potential to jeopardize the whole conservation efforts (Barua *et al.*, 2013). Furthermore, political instability and land reforms in some wildlife areas have been linked to increases in human–wildlife conflicts (Le Bel *et al.*, 2011).

Human–wildlife conflict is a global problem, and is occurring in many countries where human and wildlife requirements overlap (Dickman, 2010; Hoffman and O’Riain, 2012; Gandiwa *et al.*, 2013). Despite the fact that all continents and countries, whether developed or not are affected by human–wildlife conflict, developing countries are altogether more vulnerable than developed nations where livestock rearing and agriculture are important parts of rural people's livelihoods (Hackel, 1999; Fairet, 2012). It is one of the most widespread and intractable issues facing conservation biologists today (Dickman, 2010). Crop raiding by large herbivores and livestock depredation by carnivores can reduce tolerance toward species that are already threatened, whereas potential dangers posed by conflicts with large-bodied wild animal species negatively influence local attitudes towards wildlife (Browne-Nuñez and Jonker, 2008). Perceptions about problems and attitudes towards conservation and wild animals are likely to be influenced by social interests and experienced costs and benefits (Gandiwa *et al.*, 2013). Personal beliefs and experiences, and different economic, legal, social and ecological concerns are also other factors that affect the attitude of local people towards wildlife (Adams and Hulme, 2001). In developing countries, among demographic variables, education, gender, age, religions and ethnicity are significant predictor of conservation attitudes (Sah and Heinen, 2001). Attitudes toward the protected area staffs and the perceptions of management practices also affect people's attitude (Ormsby and Kaplin, 2005; Allendorf, 2007). For example, conflicts with managers due to resource extraction, strict rules on natural resources use and access, rude behavior or harassment by Park Rangers generate negative attitudes to local people toward protected areas (Heinen and Shrivastava, 2009; Shibia, 2010). Fear of resettlement and lack of job provision have the same impact (Allendorf, 2007). A low level of awareness regarding conservation issues and protected area management practices and the lack of involvement of the local community in the decision making processes are also important determinants of negative attitudes toward protected areas (Andrade and Rhodes, 2012). People are more likely to appreciate protected areas if benefits gained from them offset the associated costs (Ormsby and Kaplin, 2005). Therefore, the success of long-term sustainable management of wildlife resources depends on local people's support. Assessing local people's attitudes, taking into account their needs, and respecting their opinions should become a management priority (Adams and Hulme, 2001; Triguero-Mas *et al.*, 2010; Melaku Tefera, 2011; Nyirenda *et al.*, 2013).

Human–herbivore conflict is more intense in developing countries (Boer and Banquette, 1998; Joseline, 2010; Nyirenda *et al.*, 2011; Nyirenda *et al.*, 2013). Agricultural activities are expanding in developing countries and it leads to Park encroachment, habitat destruction and further to human–wildlife conflict which in turn increases the loss of crops to pest animals (Boer and Banquette, 1998; Joseline, 2010; Mwamidi *et al.*, 2012; Demeke Datiko and Afework Bekele, 2013). Crop damage affects farmers directly through loss of their primary food and cash resources and indirectly through a variety of social costs such as costs for school and hospital (Hill, 2000; Lamarque *et al.*, 2009). The occurrence and frequency of crop raiding by crop raiding wild animals depends on availability, variability and type of food sources in the natural ecosystem for wild life, the level of human activity on a farm and the type and maturation time of crops as compared to natural food sources (Hill, 2000; Weladji and Tchamba, 2003; Lamarque *et al.*, 2009; Hill and Wallace, 2012; Guinness and Taylor, 2014). In communities with a subsistence economy, even small losses can be of economic importance and can generate negative attitudes towards wildlife and conservation (Naughton-Treves, 1997; Kimega, 2003). Therefore, people living in and around protected areas, who are unable to control the crop losses caused by wildlife, are likely to develop negative attitude towards such pests (Barnes, 1996; Kimega, 2003; Nyirenda *et al.*, 2013). A wide range of mammalian species can cause significant damage locally to food crops in Ethiopia (Demeke Datiko and Afework Bekele, 2013; Aramde Fetene *et al.*, 2014; Mesele Admassu *et al.*, 2014). Large herbivores such as elephants, hippopotamus and buffaloes, also account for most human deaths and/or injuries. The vast majority of attacks are of people harvesting resources from wildlife areas and those defending their farms from crop raiders (Quigley and Herrero, 2005).

Human–carnivore conflicts are also another intensified problem in most of African countries in the recent decades because of exponential human population growth and economic activities (Lamarque *et al.*, 2009). The highest intensity of conflicts tends to occur where humans live adjacent to protected areas (Patterson *et al.*, 2004). These conflicts happen because of competition between humans and carnivores for shared and limited resources (Graham *et al.*, 2005; Gidey Yirga, *et al.*, 2012). For instance, many carnivore species kill prey species that humans hunt, harvest or farm for consumption or recreation (Patterson *et al.*, 2004). Human–carnivore conflict in terms of livestock depredation is perhaps more common and is seen in

several reported cases across the world like pumas and jaguars in Brazil, wolves and bears in North America and Europe (Jackson and Nowell, 1996), lions, hyena, wild dogs and leopards in Africa (Patterson *et al.*, 2004; Mesele Yihune *et al.*, 2009; Gidey Yirga, *et al.*, 2012; Demeke Datiko and Afework Bekele, 2013), leopards and tigers in Asia (Wang and Macdonald, 2006). Conflict can have multiple implications ranging from fear evoked by the presence of the carnivore to fatal attacks on humans (Spira, 2014). Human–predator conflict causes significant economic losses and can lead to retaliatory killing of predators, and thus constitute a threat to both wildlife and human livelihoods (Ogada *et al.*, 2003; Palmeira *et al.*, 2008). As a result, most large carnivore species are experiencing global decline driven almost entirely by human activities and/or conflict with humans. For instance, African lion, spotted hyena, tiger, African wild dog and gray wolf have faced drastic reduction from their original geographic ranges, being largely restricted to reserves or protected areas (Jackson and Nowell, 1996; Hazzah *et al.*, 2013). The Javan tiger and the Bali tiger (Nyhus and Tilson, 2004), the Asiatic lion and the Cheetah have declined substantially due to the human–wildlife conflicts (Nyhus and Tilson, 2004). It is hard to generalize what factors lead to livestock depredation by big cats; studies have shown that depredation rates are correlated to rainfall (Kolowski and Holekamp, 2006), livestock husbandry practices, characteristics of villages and livestock enclosures (Ogada *et al.*, 2003), abundance of natural prey (Gidey Yirga, *et al.*, 2012), and relative availability of large and small stock animals (Kolowski and Holekamp, 2006). Mishra *et al.* (2003) also reported that habitat loss and fragmentation, along with poaching and competition with domestic livestock can deplete the natural prey base and forcing predators to turn to domestic stock for food. Retaliatory action in response to perceived economic loss from livestock depredation hinders the conservation of threatened carnivore species (Graham *et al.*, 2005). According to Ogada *et al.* (2003), retaliatory killings of lions, leopards and spotted hyenas escalate as livestock depredations by these predators increase.

Considering the actual population growth rate of humans, increasing demand for natural resources and the growing pressure for access to land, it is clear that the HWC will not be eradicated in the near future; however, it needs to be managed urgently. A wide range of different management tools has been developed worldwide to address HWC, but most of these are strongly site and species/genera specific and are not widely or easily accessible. They are

also targeted towards different taxonomic groups. Some are efficient in the short-term, while others are efficient in the long-term and, still others are more effective within defined geographic regions or specific taxonomic groups (IUCN, 2003).

Measures aimed at mitigating HWC include physical barriers, guarding, noise, lethal removal, and relocation (Gehring *et al.*, 2010; Mackenzie and Ahabyona, 2012; Prashanth, *et al.*, 2013). None provide complete protection, because of the varied and varying nature of HWC and the taxa involved (Kolowski and Holekamp, 2006). Mitigation strategies aimed at one animal or in one location may be ineffective in other circumstances. For instance the use of domestic guard dogs appears to be a successful strategy for managing predation risk from coyotes, black bears and even cheetahs, but less effective with wolves and grizzly bears (Kolowski and Holekamp, 2006). Although physical barriers such as fences, walls, and ditches can protect property from wildlife damage, their widespread use is limited by the costs of construction and maintenance (Hayward and Kerley, 2009; Thapa, 2010). As a result, alternative mitigation measures have emerged, such as the burning of chili powder, release of specific deterrent pheromones, solar powered lights, and the tagging and monitoring of problem animals (Schlageter and Haag-Wackernagel, 2011). Compensation and insurance schemes can be used to reduce the monetary risks of crop raiding and livestock predation, although their geographic extent and level of capitalization are often limited and their effectiveness is undermined by difficulties in verifying claims (Boitani *et al.*, 2010; Karanth *et al.*, 2012). Modification of farming practices such as planting crops less palatable or appealing to raiders or planting heavily raided crops beyond a buffer of unappealing crops or unsuitable habitat, may present a more effective and sustainable solution to crop raiding than the construction and maintenance of fences or reliance on guards (Parker and Osborn, 2006). Determining the magnitude and drivers of HWC is fundamental to identifying the most promising strategies for effective mitigation, with important consequences both for local people and for wildlife populations in an area (Walpole *et al.*, 2003; Austin *et al.*, 2010; White and Ward, 2010). Overall, many different factors appear to influence the magnitude of conflicts, and it is clear that any mitigation efforts would have to confront the social, political, historical, economic and ecological drivers of conflict in order to develop truly appropriate and effective solutions (Barua *et al.*, 2013).

The present study was aimed to understand on the population ecology of the African buffalo, which is one of the larger herbivores in CCNP. At present, only little is known about the details of the current population size and seasonal distribution pattern of African buffaloes in CCNP. Effective conservation measures cannot be achieved successfully in the absence of clear information about the ecology of the species (Lindsey *et al.*, 2011). At the same time, knowledge about the ecological impacts between human activities and wildlife is important to alleviate the problems for the sound management of the Park and to make it a tourist attraction area in the future. Thus, it is crucial to conduct a detailed ground survey to evaluate the present population status, structure, activity patterns and distribution of African buffaloes and anthropogenic effects in CCNP. The present study is to fulfill this lacuna and to generate scientific data essential for management and conservation of African buffaloes in CCNP.

## **1. 6. OBJECTIVES**

**1.6.1. General objective:** The general objective of this investigation was to study the population status, structure and habitat association of African buffaloes and to assess the anthropogenic impacts in CCNP, Ethiopia.

### **1.6.2. Specific objectives**

- . To assess the current population size of the *S. caffer* in CCNP
- . To find out the population trend of *S. caffer* in CCNP
- . To study the population structure of the species in the study area
- . To assess its distribution in different habitat types and activity patterns in CCNP
- . To investigate the influences of human activities and human–wildlife conflict in CCNP.

## **2. DESCRIPTION OF THE STUDY AREA**

### **2.1. Location**

Chebera Churchura National Park is one of the recently declared(2007) wildlife protected areas of the Southern Nations Nationalities and Peoples Regional State (SNNPRS) of Ethiopia, which is located between  $6^{\circ}39' - 7^{\circ}09'$  N latitude and  $36^{\circ}27' - 36^{\circ}57'$  E longitude, about 580 km south west of Addis Ababa, the capital city of the country (Fig. 5). It covers an area of  $1,215 \text{ km}^2$ , lies within the western side of the Central Omo Gibe Basin. The southern and eastern boundaries are Omo River, Esera and Tocha Woreda (Administrative Districts), respectively. Both these Woredas are in the Dawero Administrative Zone. The west, northwest and north and a small area in the northeast are bounded by the Konta special Woreda. Five small crater lakes and four major Rivers are distributed in different parts of this Park area.

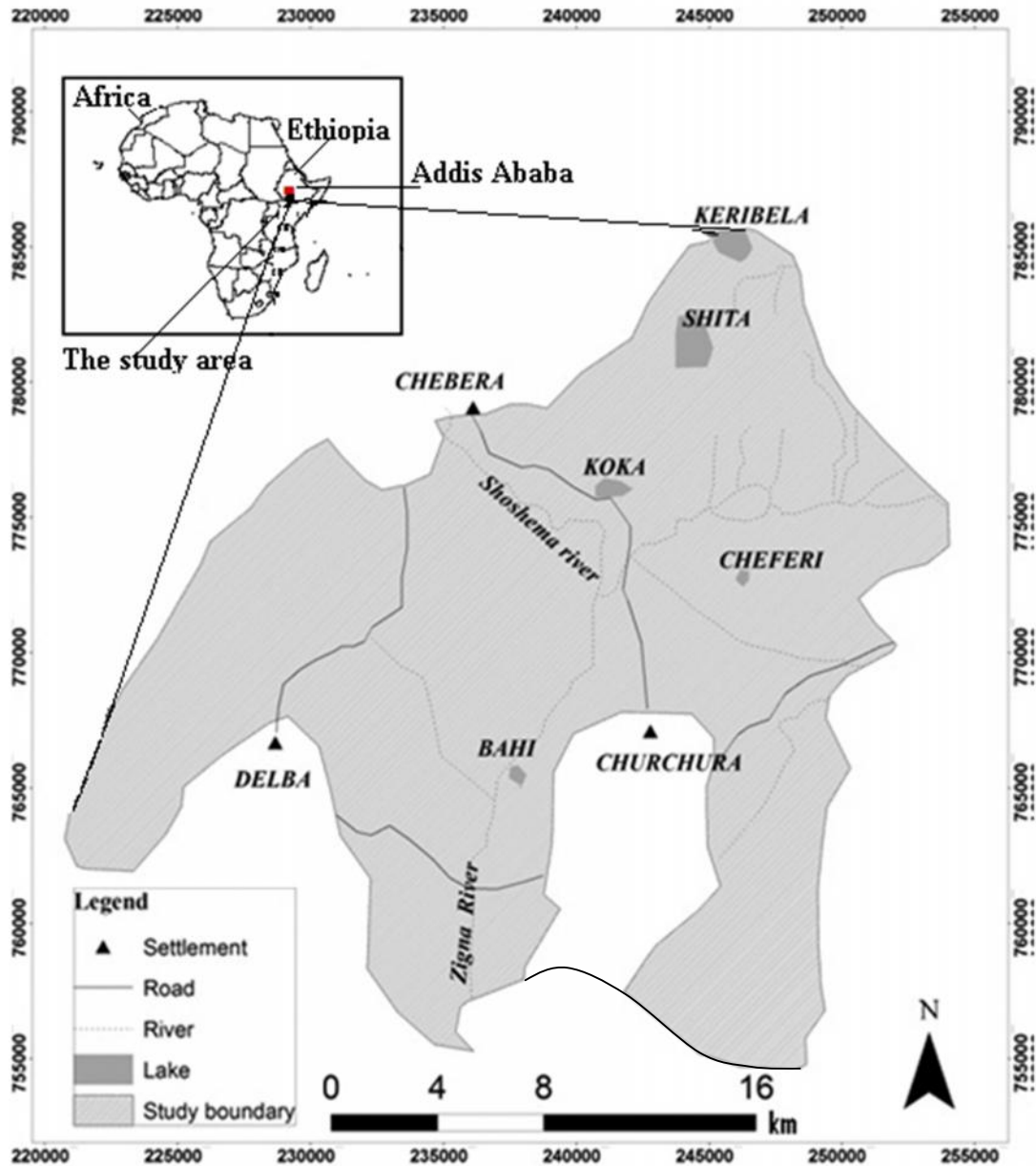


Figure 5. Location map of the study area

## 2.2. Topography

Chebera Churchura National Park is characterized by a unique and highly heterogeneous hilly terrain. Large portion of the study area is highly undulating and rolling interspersed with different valley floors, purely drained bottomland punctuated by different hills. The general pattern of the topographic features of the area is of rolling to steep hills, interfluves between relatively narrow flat to undulating bottom land, which acts as collecting site for run-off water

from the nearby uplands. Valleys and gorges, generally characterize the region (Fig. 6). The altitude of the area ranges from 950 to 2120 m asl at the volcano peaks in the western boundary (Girma Timer, 2005).



Figure 6. Different topographic features of CCNP (Photo: By Aberham Megaze)

### **2.3. Hydrology**

The Shoshema, Zigina, Mensa, and Tikurwuha rivers and their tributaries drain the area. These rivers join the Daworo Zone of the Park, then flow to Omo River, that bounds the Park southwards. However, during the dry season, most of the tributaries dry out before joining Omo River. There are five small and medium sized lakes (Shita, Keribela, Bahi, Koka and Chefre) located at the southeast, west, northwest and north of the Park (Fig. 7). There are also several hot springs and waterfalls in deep gorges in different parts of CCNP.



Figure 7. Lakes and rivers in CCNP (Photo: By Aberham Megaze and CCNP Staffs)

a=Lake Keribela, b=Lake Shita, c= Zigina River, d=Shoshima River

#### 2.4. Geology and soil

Geologically the area is made up of tertiary Jima volcanic as described by Woodroof (1996). These Jima volcanic rocks are divided into lower basalt and upper rhyolites with minor basalts. The study area is mainly characterized by the rhyolite Jima volcanic parent rocks, which crop out in the northeastern parts forming the highlands. The lower basalt based on the Jima volcanic area is exposed in all areas around the Omo gorge, to the south of the study area. Ages of these Jima volcanic rocks are reported to range from the Eocene to Oligocene. Much of the original topography of the Oligocene lava outpourings, therefore, has been modified by 20 million years of water, wind and ice erosion, to produce the landscape of today (Hillman, 1993). The soil type of the north and eastern upland areas of the study area is dark brown to dark reddish brown sandy clay loams to clay, though most area has clay loams. The soil structures are weak tending to be massive with friable topsoil over friable sub-soils. They are non-calcareous. Shallow soil is more prevalent in the areas with steep slopes in the southern parts and the Omo gorge (Damien Darota, 2003).

## 2.5. Climate

As there are no temperature and rainfall records for the study area, the meteorological data used were collected from the Ethiopian National Meteorological Service Agency (ENMSA) station located about 14 km from the study area. Based on 10 years rainfall data (2005–2014), the rainfall in the area is uni-modal, having one long rainy season (between March and September, with a peak in July). The total annual rainfall in the area varies between 1000 and 3500 mm with the mean annual rainfall of 2154 mm. The dry season of the study area is from December to February, with mean maximum temperature varying between 27 and 29°C. The hottest months are January and February while, the coldest months are July and August with the mean maximum and minimum temperatures of 28°C and 12°C, respectively (Fig. 8).

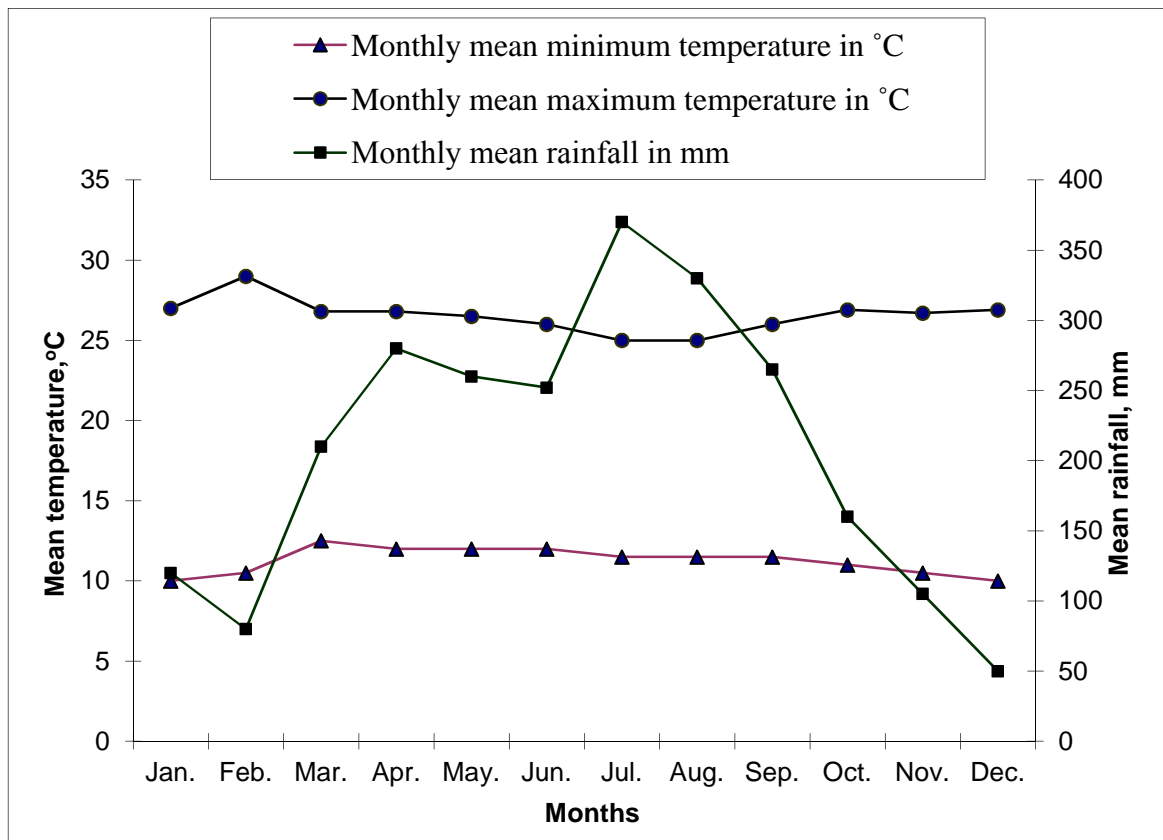


Figure 8. Mean monthly temperature and rainfall in the study area from 2005 to 2014

## 2.6. Vegetation

The range of habitats in CCNP is diverse in altitude and vegetation cover (Fig. 9). These can be categorized into four major habitat types: Savannah grasslands with scattered trees, woodlands, montane forest and riverine forest (Girma Timer, 2005), which are briefly described below.

1. Savannah grasslands with scattered trees (GLT): Savannah grasslands with scattered tree cover the largest part of the study area (around 725 km<sup>2</sup>). The grass is usually tall up to 3 m, and the dominant grass species vary locally with *Panicum* sp. and elephant grass (*Pennisetum* sp.) being common in the area, mixed with tussock grasses. The tree types are predominantly deciduous, which are no more than 6 m in height. The dominant tree species include broad-leaved *Combretum* species in association with *Terminalia albizia*. Fire commonly occurs once a year during the dry season in different localities and in different habitat types. This habitat provides both browse and grass, supporting most of the wild animals in the Park. The grassland provides rich grazing ground for *Syncerus caffer* and other herbivore communities.

2. Woodland (WL): Woodland, dominated by mixed species occurs in the northern upland area next to highland drainages, and at the break between the highland and the lowland. Other types of woodlands also occur in the southern parts of the Park habitat, which is *Combretum* woodland dominated by *Combretum* and *Terminalia* species, occurring at altitude below 1,100 m asl. This type of woodland is a typical habitat with an even distribution of trees, uniform canopy, almost no under story of bushes or shrubs, but typically with a well-developed grass cover. This habitat is 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, Shoshima, Mensa and Omo rivers) near the Omo confluence. This vegetation type has a clear tree-grass formation, typically dominated by tall *Acacia* species. Notable species in the woodlands are *Acacia seval*, *A. brevispica*, *Maytenus arbutifolia*, *Vitex doniana*, *Terminalia brownii*, *Combretum colinum* and *Combretum paniculatum* (Appendix I).

3. Montane forest (MF): This habitat is dominated by trees characterized by a multistoried nature with crown cover of almost 50%. The floristic composition of the forest is commonly rich with climbers and saprophytes. Distribution of trees in 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. The most frequent large trees species are *Olea welwitschii*, *Albizia grandibracteata*, *Ficus vasta*, *Podocarpus falcatus*, *Combretum molle*, *Allophylus abyssinicus*, *Juniperus procera* and broad-leaved tree species.

4. Riverine forest (RF): Riverine forest occurs along the different river sides in the study area and along the smaller perennial water courses. All of these water courses have trees except the southern part where they join with Omo River. The most frequent large tree species along the riverside are *Diospyros mespiliformis*, *F. glumosa*, *Ficus ovata*, *Phoenix reclinata*, *F. sycomorus*, *F. sur*, *Albizia grandibracteata*, *Grewia ferruginea*, *Aspilia mosambicensis*, *Arundo donax* and *Ehretia cymosa*.



Figure 9. Different vegetation types in CCNP, ideal for buffaloes (Photo: By Aberham Megaze)

a=Riverine forest, b=Montane forest, c=Woodland, d=Grasslands with scattered trees

## **2.7. Fauna**

Chebera Churchura National Park supports a wide range of wildlife species. Thirty seven mammalian species were recorded by Girma Timer (2005). These include African elephant (*L. africana*), African buffalo (*S. caffer*), hippopotamus (*Hippopotamus amphibious*), leopard (*Panthera pardus*), lion (*Panthera leo*), Spotted hyena (*Crocuta crocuta*), African wild dog (*Lycaon pictus*), Warthog (*Phacochoerus africanus*), Bushpig (*Potamochoerus larvatus*), Golden jackal (*Canis aureus*), Ground squirrel (*Xerus erythropus*), Porcupine (*Hystrix cristata*) and three species of primates; anubis baboon (*Papio anubis*), vervet monkey (*Ceropithecus aethiops*) and gureza (*Colobus gureza*) (Appendix II). Plate 2 shows few large mammals found in the Park. The Park is believed to possess a good diversity of birds, fish, reptiles and amphibians. A total of 137 bird species were recorded from the Park (Dereje Weldeyohans, 2006) and 16 species of rodents and 2 species of insectivores were also recorded (Demeke Datiko and Afework Bekele, 2013).

## **2.8. Socio-economic status**

### **2.8.1. Ethnic diversity and settlements in the area**

The principal ethnic groups of people found around CCNP are of Dawro and Konta ethnic groups. Other minority groups include Tsara, Menja and Bacha. Dawro ethnic group inhabits the eastern highland and few areas of the southeastern lowland areas. These people do not make extensive use of the lowlands except along the periphery. Konta ethnic group occupies the north and northwestern highland areas. People of the Churchura Peasant Association inhabit the southern lowland. The Konta Koisha and Delba Peasant Associations occupy the southwestern lowland area. Recently, people from Hadia and Wolayta ethnic groups settled in the area through government resettlement program in the southwestern part surrounding the Park.

### **2.8.2. Agricultural practices and land-use system**

Mixed agricultural practices are the sole livelihood of the majority of the inhabitants around the study area. They practice traditional agricultural system that combines perennial and annual cultivation with livestock rearing. Thus, the land-use practice is predominantly traditional shifting cultivation and livestock rearing. Shifting cultivation is common in the south and southwestern lowland on the undulating and rolling plains by residents around the study area.

Once farmed, the area is abandoned for 3–5 years without cultivation. Permanent crops harvested in the area include cereals (teff, maize and sorghum), fruits, enset and vegetables. Enset, sorghum and maize are the major staple crops, and are mainly used for household subsistence. Teff and honey are the major commercial products of the study area. A wide range of fruits and vegetables are also cultivated both for subsistence and for sale. Teff is cultivated mainly for cash (Dawro Zone Report, 2004, Girma Timer, 2005). Minority groups of the people also earn their livelihood by collecting and selling wild honey, spices, wild coffee and edible roots from the forests of some of the wild plants (Dawro Zone Report, 2004). Hence, forest is an important economic source of the local people living around CCNP.

## **2. 2. METHODS**

### **2.2.1. Duration of the study**

A preliminary observation was carried out in August 2012 in CCNP. During this period, essential information such as accessibility, climate conditions, vegetation types, fauna, topography, infrastructure and anthropogenic activities in the area were gathered. Detailed studies were carried out during September 2012–February 2015. Quantitative data were obtained on the population size, structure, herd size, distribution, habitat association and diurnal activity patterns of the African buffaloes. Separation of the study period into dry and wet seasons was important in order to observe the influence of the different seasons and the resulting vegetation communities on the animal. Seasonal differences in the population size, distribution and diurnal activity patterns of the African buffaloes in the study area were studied in detail.

### **2.2.2. Stratification of the study area**

The study area was stratified into four main study units or census zones using aerial photography (scale 1:30,000), satellite imagery and area topography maps (scale 1:50,000 and 1:250,000). The boundaries of each study unit were traced and followed based on the main vegetation types in the study area. These included 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). The extent of the study blocks are given in Table 1. Each of these habitat types was then sub-divided into grids on the map for sampling (Fig.10).

Table 1. Extent of habitat type and the survey blocks in Chebera Churchura National Park

Habitat type	Total extent (km <sup>2</sup> )	Proportion of the total %	Number of blocks
Grassland with scattered trees (GL)	725	60	29
Montane forest (MF)	350	29	14
Woodland (WL)	100	8	4
Riverine forest (RF)	40	3	2
Total	1215	100	49

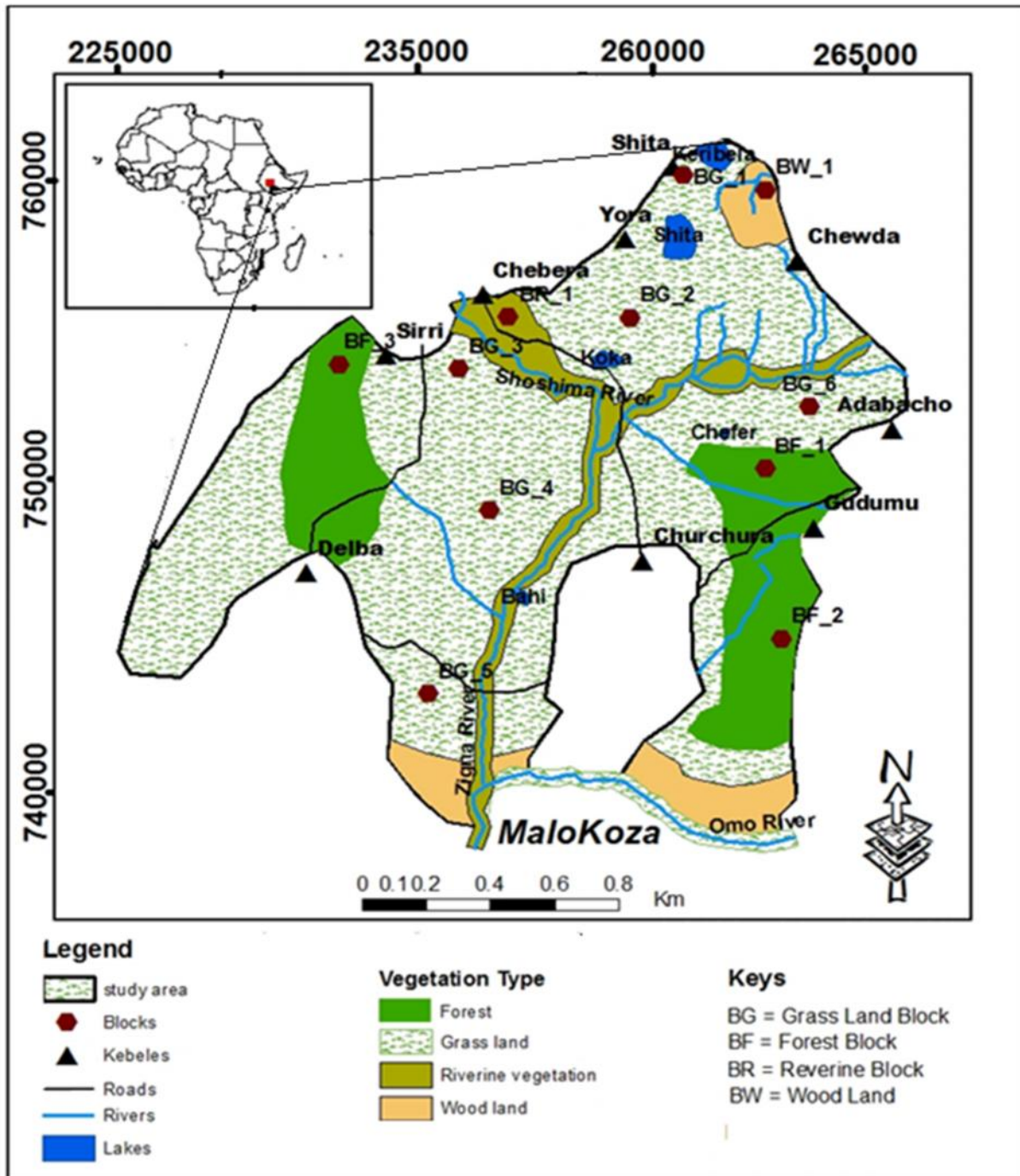


Figure 10. The four vegetation types and observation blocks in the study area

### 2.2.3. Sampling design

A modification of the unequally sized sample unit ratio method (Norton Griffiths, 1978; Ndhlovu and Balakrishnan, 1991) was adopted for sampling. Out of the total blocks of the study area, a number of representative sample blocks were randomly selected. The sampling blocks selected

from each habitat type represent 20–25% of each of the surveyed areas. Randomly selected transects were then established in each block. A total of 37 transects were sampled. The number of transects in each of the census zones varied depending on visibility (Norton-Griffiths, 1978; Ndhlovu and Balakrishnan, 1991). Thus, survey was conducted using subsidiary tracks guided by GPS and compass in each randomly selected block along selected transects. The length of transects varied from 4.5 to 5 km. Consecutive transects were at a distance of 1.0–1.5 km. Transect lines were delineated by poles and/or natural signs. The proportional area of each sampling block in the survey zones, number, total length of transects and the areas sampled are given in Table 2.

Table 2. Number and size of the randomly selected blocks in each census zone

Census zones	Number of sampled blocks	Total area sampled (km <sup>2</sup> )	Number and proportion of transects(n)	Length & width of transect (km)
Grassland	6	150	12(25%)	5x0.6
Montane forest	3	75	15(20%)	5x0.1
Woodland	1	25	4(23.5%)	5x0.3
Riverine forest	1	20	6(33%)	4.5x0.1
	11	270	37	

#### 2.2.4. Population estimate

Sample counts were made using line-transect method to estimate the population size of the African buffaloes in the study area (Grimsdell, 1978; Norton-Griffiths, 1978). Sampling was designed based on straight transect lines or a series of straight-line segments to yield information as recommended by Anderson *et al.* (1978) and Burnham *et al.* (1980) to conduct proper statistical analysis and to avoid error or bias in the analysis. Transects were surveyed systematically with the help of trained and experienced scouts during wet and dry seasons at a constant speed to maximize the probability of seeing all individuals on both sides of the transect (Norton-Griffiths, 1978). Whenever African buffaloes were located, the distance and sighting angle from transects, observable activities, the presence of other large mammal species in the vicinity and the habitat types were recorded (Appendix III). Silent detection method was

followed to minimize disturbances (Wilson *et al.*, 1996). Under normal conditions, buffaloes could be successfully identified from a distance of up to 150m, and the conditions were ideal to around 300m. Repeated counting of the same herd was avoided using recognizable features or unusual features such as herd size, group composition and distinct individuals with deformities on horn, tail and ear (Wilson *et al.*, 1996). Thus, all herds were individually recognized. Transect counts were carried out for each month between (2012–2015) during both wet and dry seasons from 06:00 to 10:00 h in the morning and 16:00 to 18:00 h in the late afternoon, when they were active and when visibility was good. The mean number of individuals observed per transect was pooled together, and extrapolated to estimate the population for the whole study area. Population density was estimated using this population estimate divided by the extent of the study area (Wilson *et al.*, 1996). Therefore, quantitative data were collected during both seasons on the population size, structure, diurnal activity patterns and habitat utilization of African buffaloes. Population trend of African buffaloes was determined by comparing the present finding with previous data.

### **2.2.5. Population structure**

During counting, each of the individuals was grouped into its respective sex and age (adult, subadult, juveniles) classes. Identification of sex and age categories was carried out using body size, pelage, external genitalia, shape and size of horn and mammary glands (Sinclair and Grimsdell, 1978; Ndhlovu and Balakrishnan, 1991). The horns, genital organs and body size were used to classify them as adult, sub-adult, juvenile and calf, with adults and sub-adults also classified as males or females, following the guidelines developed for Cape buffalo to age individuals (Sinclair 1977). Information on the demographic composition and structure such as age class, and sex ratio were used to predict population trend so as to determine whether it is declining, increasing or stable.

### **2.2.6. Herd size**

During each sample count, the location of each of the herds of the buffaloes was plotted on the map of the study area (Lewis and Wilson, 1979). Individuals were considered as a member of the same herd if the distance between them was less than 50 m (Borkowski and Furubayashi, 1998),

responded in a related manner to external stimuli and if moving in the same direction with the rest of the members of the herd.

### **2.2.7. Distribution and habitat association**

Average size of herds observed in different habitat types and localities during wet and dry seasons were taken to compare the distribution of the buffaloes in different habitat types, following the methods of Larson *et al.* (1978) and Norton-Griffiths (1978). Further information on seasonal distribution of the species was gathered from experienced local elders and from questionnaire interview. Separation of the study period into dry and wet seasons was important in order to observe the influence of the different seasons on the vegetation cover and the distribution of animals.

### **2.2.8. Diurnal activity patterns**

Activity patterns of African buffaloes were investigated from October 2012 to September 2015. Focal-animal sampling method was used to study the diurnal activity patterns of the African buffaloes by focusing observations on one individual (pair, group) during a particular sample period (Altmann, 1974; Lehner, 1996). Using this method, several activities of selected individuals could be measured accurately by observing a group at a time. Mixed herds were selected for observation. Bachelor and male herds were not included in the study, as they were not viewed as representatives of the overall herd composition of the African buffaloes in the Park. The dominant activities of seven individuals of mixed herds (one adult male, three adult females, one sub-adult male, one sub-adult females and one juvenile male), which were easily recognizable and approachable were recorded for every five minutes from 06:00 to 18:00 h, following the method adopted by Clough and Hassam (1970). A total of 9136 focal animal observations were recorded during 5761-h observations. Observations of each day were compiled as percentage of animals in different activities for twelve one-hour periods; i.e. 06:00–07:00, 07:00–08:00, 08:00–09:00, 09:00–10:00, 10:00–11:00, 11:00–12:00, 12:00–13:00, 13:00–14:00, 14:00–15:00, 15:00–16:00, 16:00–17:00 and 17:00–18:00 h. Daily time budget of buffaloes was calculated by summing up all observation per day. All the observations were standardized to a percentage basis before analysis to remove the effect of group size because the number of buffaloes per observation varied between consecutive observations. The buffaloes

were followed on foot and observed by unaided eyes and/or by using binoculars. Diurnal activity patterns were recorded during both dry and wet seasons. Observation at night proved difficult due to the difficulties of accessibility and visibility in different parts of the study area and hence, observations at night were very few and excluded from the analysis. As a result, proportional differences between day and night activity patterns were not compared. Observation was facilitated by the preference of the animal for short grassy areas and by selecting strategic sites on the hilly terrain. If the focal animals in the field disappeared from the view, the time interval of its disappearance was recorded. When the out of sight period was longer than the duration of common activities, it was deleted from the sample and duration of the sample period was reduced accordingly. When the out of sight period was shorter, a guess was made about its activity by referring to what it was doing before its disappearance and immediately when it reappeared. All activities displayed and their respective duration were continuously recorded using a stop watch. Activities were recorded as feeding, resting/rumination (lying down), standing, walking (and running), and others (Appendix IV). The latter included all activities that did not feature strongly in the general activity patterns such as wallowing, defecating, urinating, scratching, drinking, grooming and rutting and were merged together for analyses (Clough and Hassam, 1970; Cumming, 1975). Seasonal divisions used in the analysis of the activity were based on the rainfall during the observation periods.

## **2.2.9. Anthropogenic impacts and human–wildlife conflict**

### **2.2.9.1. Questionnaire survey**

The present study was carried out by means of a questionnaire survey and focus group discussion modified from Newmark *et al.* (1994) and Maddox (2003), which is the main source of primary data among the households in the study area of CCNP. The questionnaire was designed to understand the situation of conservation challenges such as resource access and wildlife–human conflicts in CCNP during 2012–2015. The questionnaires contain both open and close ended questions to get information about anthropogenic activities and human–wildlife conflicts in the study area. The use of open-ended questions gave the participants the possibility to think for themselves and freely express their feelings and opinions from which the researcher could get a deeper analysis of the participant attitude and opinions. There was also the possibility to ask counter-questions when it was apparent that the respondent was confused or had misunderstood a

question. The questionnaire was also supplemented with field observations on various aspects of resource use, wildlife benefits and their associated costs. The questionnaire was pre-tested on randomly selected 62 individuals of varying ages, sex and the background among the local communities, which is not included in the main sample group. This helped to identify the anthropogenic activities and problematic animals in the area and to modify the questionnaire accordingly. Data were collected from November 2012 to February 2014, the best period of the year for interviews as only few people work in field during the dry season. Nine villages from 25 Peasant Associations were selected based on the information gathered using the preliminary survey, the distance from the Park, problems related to crop damage and livestock loss, the dependence of local people on the Park and encroachment within the Park area. A total of 354 households were selected randomly for the interview. Names of households were listed on pieces of paper, mixed in a box and randomly drawn one by one without replacement. The participants ranged from 18 to 72 years of age. All respondents were given a brief introduction of the project objectives and purpose of the interview. The questionnaire was administered to 354 households (about 15% of the total number of households), of which 230 (65%) were males and 124 (35.02%) were females. The villages covered were Chebera (n = 48), Serri (n = 21), Dalba (n=44), Yore (n = 42), Shita (n = 39), Churchura (n = 48), Chewda (n=34), Gudumu (n= 48) and Adabachew (n=30) (Fig. 7), ranging from 0 to 5 km away from the boundary of the Park. The questionnaire consisted of a series of structured questions focusing on 12 main areas of interest (Appendix V): These include: (i) demographic data (age, sex, education level, religious, occupation, family size), (ii) natural resource use and other benefits, (iii) the impact of various anthropogenic activities (grazing, wildfire setting, hunting, firewood gathering, agricultural activities and other social economic activities, which could have negative impact on wildlife), (iv) human-wildlife conflict issues, (v) common cultivated crops, (vi) identification of problematic wildlife (species responsible for crop damage, livestock depredation and human kill or injures) and their effects, (vii) protection measures adopted and the period of damage or loss, (viii) number of domestic animal losses, (ix) trends and seasonality of predation, (x) attitudes of people towards wildlife and the conservation area, (xi) knowledge and awareness on the value of wildlife, and (xii) views towards protected area management and staff.

The data were collected using a semi-structured survey design, following a similar format to that used by Maddox (2003). The questionnaire was administered to farmers within their area of farming and/or residence (Hill, 2000), at a random manner based on first come, first-serve basis (Newmark *et al.*, 1994), and alternating male and female respondents as much as possible and different age groups. In some households, the head was interviewed and other people present in a house usually helped in the recall of human impact on the Park and depredation and damage cases. Respondents answered each attitude statement according to their strength of agreement by the following attitude level scores: 1= for strongly agree, 2=agree, 3= neutral, 4= disagree, and 5= strongly disagree (Likert, 1974). The time allocated for an interview was 35–50 minutes, depending to the respondents.

#### **2.2.9.2. Focus group discussion**

Focus group discussion method was used to reinforce the data collected through the questionnaire. Group discussions were organized to obtain direct first-hand information through spontaneous responses from the respondent, and the discussions solicited information about local community perceptions of wildlife and protected areas (Appendix VI). Two focus group discussion sessions were conducted in each of the study village, and the group size in each discussion site varied from 15 to 21. The participants were invited to discuss issues according to their convenience. Park staffs, village leaders, local elders, primary school teachers in the village, other government employees and students participated to discuss their experience concerned with conservation and to gather their information on wildlife in the area (Fig. 11). During such group discussions, the researcher initiated the discussion by stating some of the observations and responses from people interviewed and from questionnaires. The participants were allowed to state their views and suggestions on human activities in CCNP, conflicts, and what should be done to mitigate those conflicts. In addition, agricultural fields were visited to assess the crop fields damaged by wild animals. Indirect evidences like dung, tracks and damage signs such as teeth marks were also used to determine the wildlife species that caused the damage. Moreover, faecal samples of some herbivore pests were collected and analysed to determine the presence or absence of locally abundant seeds in the study area. Information collected from group discussions were collated and summarized using text analysis method, and presented in a

narrative fashion. Thus, the information acquired was triangulated through questionnaire interviews, focus group discussions and field observations.



Figure 11. Interview and group discussion with different villagers (Photo: By Aberham Megaze and CCNP Staffs)

a= group discussion with Chebera villagers, b= group discussion with Sirri villagers, c= group discussion with Yora villagers, d= Questionnaire interview with Delba households

### 2.3. Analyses of the data

Data were analyzed using SPSS version 20 computer software program (SPSS Inc, IL, U.S.A). Appropriate statistical methods such as Chi-square test, descriptive analysis and Correlation Coefficient were used to compute the data. Population estimates for the African buffalo for wet and dry seasons were compared using one-way ANOVA. Animals counted during different seasons, density, sex, age category, group size and habitat association were compared using t-test

for independent samples and Chi-square test. Duration of each of the major activities was calculated by determining proportion of time, expressed as a percentage that the focal group spent on each of the activities. The differences in the duration of time spent in different activities during different hours of the day were also analyzed using Chi-square test and one-way ANOVA. Pearson correlation was done to test the relationship between the different variables in questionnaire responses of local people. Logistic Regression analysis was also used to determine relationships between socio-economic variables and factors affecting attitude of the respondents. Nonparametric Pearson Chi-square tests for goodness-of-fit were used to establish whether the sampled respondents' socio-demographic data were significantly different or not. The results were presented in bar diagrams and frequency tables. Statistical tests were two-tailed with 95% confidence intervals.

### 3. RESULTS

#### 3.1. Population estimate

The results of sample counts of the African buffalo for years I and II are given in Table 3. An average of 229 and 286 individuals were recorded during years I and II, respectively. A mean of 261 and 197 individuals were recorded during wet and dry season of year I and a mean of 313 and 259 individuals were recorded during wet and dry season of year II, respectively (Table 4). The maximum record during the count was 261 and 313 individuals during the wet seasons in both year I and year II, respectively. The population estimates of the African buffaloes for wet and dry seasons were 5,788 and 4,599 heads, respectively. There was significant difference in the number of animals estimated during the two seasons ( $\chi^2 = 21.9$ ,  $df = 1$ ,  $P < 0.05$ ). More African buffaloes were seen during the wet season than during the dry season. The total population estimated was 5193 individuals, and the mean population density estimated was  $4.27/\text{km}^2$ . Data on population trend of African buffaloes in CCNP are given in Table 5. The population estimates of African buffaloes in CCNP indicate an increasing trend from 2006 to 2015.

Table 3. Year-wise population estimate of the African buffaloes in Chebera Churchura National Park (Mean  $\pm$  SE)

Year	Season	Individuals observed	Density/ $\text{km}^2$	Population estimate
I	Wet	261.9 $\pm$ 45.00	4.31 $\pm$ 0.60	5240 $\pm$ 732.30
	Dry	197.9 $\pm$ 58.89	3.26 $\pm$ 0.46	3955 $\pm$ 552.71
	Mean	229.9 $\pm$ 36.83	3.79 $\pm$ 0.53	4597.5 $\pm$ 642.5
II	Wet	313.6 $\pm$ 43.65	5.21 $\pm$ 0.49	6336 $\pm$ 598.08
	Dry	259.18 $\pm$ 66.7	4.32 $\pm$ 0.41	5243 $\pm$ 494.91
	Mean	286.36 $\pm$ 39.34	4.77 $\pm$ 0.45	5789.5 $\pm$ 546.5
Mean (I and II)		258.15 $\pm$ 26.99	4.27 $\pm$ 0.49	5193.5 $\pm$ 595.5

Table 4. Population estimate of the African buffaloes in Chebera Churchura National Park during wet and dry seasons (Mean  $\pm$  SE)

Season	Individuals observed	Density/km <sup>2</sup>	Population estimate
Wet	287.75 $\pm$ 31.11	4.76 $\pm$ 0.55	5788 $\pm$ 662.55
Dry	228.54 $\pm$ 43.92	3.79 $\pm$ 0.43	4599 $\pm$ 526.45
Mean	258.15 $\pm$ 26.99	4.27 $\pm$ 0.49	5193.5 $\pm$ 595.5

Table 5. Population trend of the African buffaloes in Chebera Churchura National Park

Year	Population estimates	Population trend	Methods and Source
2006	2617	Stable/Decreasing	Transect line (Aberham <i>et al.</i> , 2012)
2013	4597	Increasing	Transect line (Present study)
2015	5193	Increasing	Transect line (Present study)

### 3.2. Population structure

#### 3.2.1. Sex and age structure

Age structure and sex ratio of the observed buffalo population during wet and dry seasons for years I and II are given in Tables 6 and 7, and the mean of sex and age structure of buffaloes during wet and dry seasons of two years are given in Table 8. An average of 258 individuals of buffalo was recorded during wet and dry season of years I and II. Among them, females constituted 46.68% and males 42.56% of the population. Male to female sex ratio was 1.00: 1.10. Among the observed individuals, 52.49% was adults, 24.30% subadults, and only 12.44% were young individuals. The ratio of subadults to adults was 1.00: 2.16 and young to others was 1.00: 7.04 (Table 8). There was no significant difference in the age distribution between wet and dry seasons ( $\chi^2 = 6.82$ ,  $df = 1$ ,  $P > 0.05$ ).

Table 6. Age structure and sex ratio of the observed African buffalo population during wet and dry seasons of year I (Mean  $\pm$  SE)

Year I Categories	Number of individuals (Mean $\pm$ SE)		
	Seasons		Mean
	Dry	Wet	
AM	48.90 $\pm$ 9.77	64.18 $\pm$ 10.59	56.54 $\pm$ 7.22
AF	52.27 $\pm$ 14.62	75.45 $\pm$ 12.66	63.86 $\pm$ 9.77
SAM	25.45 $\pm$ 8.99	31.73 $\pm$ 6.19	28.59 $\pm$ 5.37
SAF	23.09 $\pm$ 9.34	31.55 $\pm$ 6.39	27.32 $\pm$ 5.59
JM	14.55 $\pm$ 6.80	15.54 $\pm$ 3.92	15.05 $\pm$ 3.83
JF	12.81 $\pm$ 5.20	16.18 $\pm$ 3.12	14.50 $\pm$ 2.98
Un (A)	20.82 $\pm$ 6.20	27.27 $\pm$ 4.23	24.045 $\pm$ 3.69
Ratios			
M : F	1: 1.00	1: 1.10	1: 1.10
SA: A	1: 2.08	1: 2.21	1: 2.15
SA: O	1: 3.10	1: 3.14	1: 3.11
Y: O	1: 6.23	1: 7.23	1: 6.78

AM=adult male, AF=adult female, SAM=sub-adult male, SAF=sub-adult female, JM=juvenile male, JF= juvenile female, Un=unidentified sex, M=male, F=female, A=adult, SA=subadult, Y=young, O=others

Table 7. Age structure and sex ratio of the observed African buffalo population during wet and dry seasons of year II (Mean  $\pm$  SE)

Year II Categories	Number of individuals (Mean $\pm$ SE)		
	Dry	Wet	Mean
AM	64.63 $\pm$ 11.44	72.9 $\pm$ 9.13	68.77 $\pm$ 7.2
AF	74.45 $\pm$ 19.91	89.18 $\pm$ 13.15	81.82 $\pm$ 11.75
SAM	33.36 $\pm$ 10.29	34.09 $\pm$ 6.06	33.73 $\pm$ 5.83
SAF	33.18 $\pm$ 10.15	38.54 $\pm$ 6.42	35.86 $\pm$ 5.89
JM	14.09 $\pm$ 5.54	20.00 $\pm$ 4.11	17.05 $\pm$ 3.43
JF	14.64 $\pm$ 5.2	20.64 $\pm$ 3.19	17.64 $\pm$ 3.05
Un (A)	24.82 $\pm$ 5.18	38.18 $\pm$ 5.65	31.499 $\pm$ 4.01
Ratios			
M: F	1: 1.10	1: 1.20	1: 1.15
SA: A	1: 2.10	1: 2.23	1: 2.16
SA: O	1: 2.89	1: 3.32	1: 3.12
Y: O	1: 8.02	1: 6.71	1: 7.26

AM=adult male, AF=adult female, SAM=sub-adult male, SAF=sub-adult female, JM=juvenile male, JF= juvenile female, Un=unidentified sex, M=male, F=female, A=adult, SA=subadult, Y=young, O=others

Table 8. Age structure and sex ratio of the observed African buffalo population during wet and dry seasons of year I and II (Mean  $\pm$  SE)

Year I and II Categories	Number of individuals (Mean $\pm$ SE) Seasons		
	Dry	Wet	Mean
AM	56.77 $\pm$ 7.54	68.55 $\pm$ 6.89	62.66 $\pm$ 5.13
AF	63.36 $\pm$ 12.29	82.32 $\pm$ 9.03	72.84 $\pm$ 7.67
SAM	29.41 $\pm$ 6.72	32.90 $\pm$ 4.23	31.16 $\pm$ 3.94
SAF	28.14 $\pm$ 6.82	35.05 $\pm$ 4.48	31.59 $\pm$ 4.07
JM	14.32 $\pm$ 4.28	17.77 $\pm$ 2.81	16.05 $\pm$ 2.55
JF	13.73 $\pm$ 3.59	18.41 $\pm$ 2.23	16.07 $\pm$ 2.12
Un (A)	22.82 $\pm$ 3.93	32.72 $\pm$ 3.64	27.77 $\pm$ 2.75
Ratios			
M: F	1: 1.10	1:1.20	1: 1.10
SA: A	1: 2.09	1: 2.22	1: 2.16
SA: O	1: 2.97	1: 3.23	1: 3.11
Y: O	1: 7.13	1: 6.95	1: 7.04

AM=adult male, AF=adult female, SAM=sub-adult male, SAF=sub-adult female, JM=juvenile male, JF= juvenile female, Un=unidentified sex, M=male, F=female, A=adult, SA=subadult, Y=young, O=others

### 3.2.2. Herd size

The mean number of herd and the mean herd size of buffaloes, during wet and dry seasons for year I and II are shown in Table9. In CCNP the number of herds observed and the number of individuals in each herd was different during the study period. A mean of 9.70 and 12.86 herds were recorded during wet and dry seasons of years I and II, respectively. There was a significant difference in the mean number of herds ( $\chi^2 = 42.5$ ,  $df = 1$ ,  $P < 0.05$ ). The herd size ranged from 2 to 30 individuals and the mean herd size during wet and dry seasons were 29.59 and 16.95, respectively. There was a marked difference in the mean herd size between two seasons ( $\chi^2 = 39.1$ ,  $df = 1$ ,  $P < 0.05$ ).

Table 9. Number of herds and herd size of African buffaloes observed during the wet and dry seasons of year I and II (Mean  $\pm$  SE) of the study period

Season	Number of herds	Herd size
Wet	9.70 $\pm$ 0.73	29.59 $\pm$ 2.57
Dry	12.86 $\pm$ 1.77	16.95 $\pm$ 1.63
Mean	11.28 $\pm$ 0.98	23.27 $\pm$ 1.78

### 3.3. Distribution and habitat association

The relative use of different vegetation communities by the African buffaloes is indicated by the number of individuals observed in each vegetation communities (Table 10). Habitat selection varied seasonally. They showed high preference for riverine vegetation during the dry season. Out of the total, 57.55% of the African buffalo utilized riverine habitat during the dry season, whereas 39.81% used this habitat during the wet season. Grassland with scattered tree habitat was utilized by 27.88% of the buffaloes during the wet season, and 9.64% during the dry season. Woodland habitat was utilized by 14.16% of the buffaloes during the wet season, and 16.45% during the dry season. Montane forest was utilized by 18.15% of the buffaloes during the wet season, and 16.36% during the dry season. The distribution of African buffaloes in different habitat types in the wet and dry seasons showed highly significant variation ( $\chi^2 = 17.54$ ,  $df = 3$ ,  $P < 0.05$ ).

Table 10. Observation of the African buffaloes in different habitat types in Chebera Churchura National Park during the wet and dry seasons of the study period

Number of individuals in different habitats				
Season	GL	WL	MF	RF
Wet	80.22 (27.88)	40.75 (14.16)	52.23 (18.15)	114.55 (39.81)
Dry	22.03 (9.64)	37.59 (16.45)	37.39 (16.36)	131.52 (57.55)
Mean	46.18 (17.9)	39.76 (15.4)	44.32 (17.17)	127.84 (49.52)

GL = Grassland, WL = Woodland, MF = Montane forest, RF = Riverine vegetation.

Numbers in bracket represent % of observed animals

### 3.4. Diurnal activity patterns

Analysis of the diurnal activities of buffaloes showed that significantly more time was devoted to feeding-related activities than other activities. The herds spent on an average 46.93% or 5.63 hr of the day actively feeding, and 40.21% (4.83 hr) resting (standing/lying and ruminating). This shows that 87.17% or 10.46 hr of the day is devoted for feeding and resting/ruminating (Table 11). Feeding was the dominant activity of the African buffaloes in this study area. Feeding activity periods were bimodal with peaks in the early morning hours (06:00-10:00 h) and the other in the afternoon (16:00-18:00 h). Feeding activity drops when they stand or lie down (Table 11, Fig. 12). Resting/ ruminating (lying down) were the second frequent activities. Resting was frequent during the mid-day. The highest incidence of standing was associated with the period before resting/ruminating periods. The morning and the late afternoon activity peaks were most obvious during the dry season than during the wet season. Walking (7.25%) was either combined with grazing or done purposefully. Other activities include drinking, wallowing, defecating, scratching, urinating, fighting and grooming which together occupied only 5.34% of the overall 12 hour day cycles.

Table 11. Percentage of time spent in major diurnal activities by the African buffaloes in Chebera Churchura National Park during wet and dry seasons from 06:00 to 18: 00h

Time of the day, h	Time spent in activities (%)				
	Feeding	Standing	Lying	Walking	Others
0.6:00–07:00	88.81	1.88	1.20	7.39	1.05
07:00–08:00	79.67	7.14	1.14	8.31	4.30
08:00–09:00	59.10	8.90	13.05	10.45	8.30
09:00–10:00	56.38	12.12	15.06	10.40	5.82
10:00–11:00	32.72	30.23	27.45	5.75	3.55
11:00–12:00	19.95	31.66	37.06	4.80	5.30
12:00–13:00	14.90	31.83	45.05	2.51	5.50
13:00–14:00	14.30	34.55	43.25	3.25	4.50
14:00–15:00	17.90	32.50	41.14	5.40	3.01
15:00–16:00	42.90	21.90	17.85	10.90	6.35
16:00–17:00	60.90	11.23	7.88	10.90	9.00
17:00–18:00	75.70	4.36	5.25	6.90	7.55
Mean	46.93	19.03	21.18	7.25	5.34

( Others activities were: drinking, wallowing, defecating, scratching, urinating, fighting and grooming)

### 3.4.1. Seasonality in activity patterns

The overall diurnal activity patterns recorded for African buffaloes during the two seasons are given in Tables 12 and 13. African buffaloes spent 44.91% of their time feeding, 20.75% in resting, 7.8% in walking and 5.49% in other activities during the wet season. During the dry season, they spent 48.95% of the time in feeding, 19.46% in resting, 6.69% in walking and 5.22% in other activities (Fig. 13). The difference in time allocation among the different activities was statistically significant during the wet season ( $\chi^2 = 75.6$ ,  $df=4$ ,  $P<0.05$ ) and during the dry season ( $\chi^2 = 44.7$ ,  $df=4$ ,  $P<0.05$ ). Time spent on grazing was higher during the dry season than during the wet season. There was a significant decrease in grazing and an increase in resting/ruminating during the wet season. When wet and dry seasons components of the herd

activity budget was compared, the buffaloes spent a significantly greater proportion of time feeding during the dry season than during the wet season ( $\chi^2 = 12.65$ ,  $df=1$ ,  $P<0.05$ ) and had a trend towards a greater proportion of time resting during the wet season than during the dry season ( $\chi^2 = 15.6$ ,  $df=1$ ,  $P<0.05$ ). There was no significant proportional differences in wet and dry season activity budget for other activities ( $\chi^2 = 8.75$ ,  $df = 1$ ,  $P>0.05$ ). During both seasons, the African buffaloes allocated significantly more time for feeding and resting than other activities (Table 14). Walking occurred mainly during early morning and late afternoon hours, accompanied by grazing. For walking relatively less time was allocated compared to feeding and resting during both seasons. Maximum time allocated for walking during the wet season was 7.8% and during the dry season, it was 6.69%. Drinking occurred in the daylight hours during both the seasons. Two peaks of drinking bouts occurred, one early in the morning (06:00-08:00h) and the other late in the afternoon (16:00-18:00h) hours during both wet and dry seasons.

Table 12. Percentage of time spent in major diurnal activities of the African buffaloes in Chebera Churchura National Park during the wet season from 16:00–18:00h

Time of the day, h	Time spent in activities (%)				
	Feeding	Standing	Lying	Walking	Others
06:00–07:00	86.80	1.91	1.20	7.89	1.75
07:00–08:00	79.10	7.14	1.14	8.31	4.30
08:00–09:00	55.20	10.30	15.30	10.60	8.20
09:00–10:00	53.43	13.53	18.10	9.20	5.42
10:00–11:00	27.12	31.23	32.40	5.50	3.30
11:00–12:00	14.30	33.21	42.11	4.80	5.20
12:00–13:00	9.70	33.15	48.80	2.61	5.40
13:00–14:00	11.50	35.90	43.20	4.60	4.50
14:00–15:00	19.70	30.60	38.17	7.50	3.80
15:00–16:00	46.60	16.90	17.80	12.70	5.80
16:00–17:00	62.40	10.41	7.16	11.40	8.50
17:00–18:00	73.20	4.42	3.90	8.50	9.70
Mean	44.92	19.05	22.44	7.80	5.49

Table 13. Percentage of time spent in major diurnal activities of the African buffaloes in Chebera Churchura National Park during the dry seasons from 16:00–18:00h

Time of the day, h	Time spent in activities (%)				
	Feeding	Standing	Lying	Walking	Others
0.6:00–07:00	90.82	1.85	0.00	6.88	0.35
07:00–08:00	80.24	7.14	0.00	8.31	4.30
08:00–09:00	63.00	7.50	10.80	10.30	8.40
09:00–10:00	59.33	10.70	12.01	11.60	6.22
10:00–11:00	38.31	29.30	22.50	6.00	3.80
11:00–12:00	25.60	30.10	32.01	4.80	5.40
12:00–13:00	20.10	30.50	41.30	2.40	5.60
13:00–14:00	17.10	33.20	43.30	1.90	4.50
14:00–15:00	16.10	34.40	44.10	3.30	2.21
15:00–16:00	39.20	26.90	17.90	9.10	6.90
16:00–17:00	59.40	12.00	8.60	10.40	9.50
17:00–18:00	78.20	4.30	6.60	5.30	5.40
Mean	48.95	18.99	19.90	6.69	5.22

( Others activities were: drinking, wallowing, defecating, scratching, urinating, fighting and grooming)

Table 14. The mean ( $\pm$  SE) proportion of time (%) spent on different activities by African buffaloes in Chebera Churchura National Park during wet and dry seasons during the study period

Activities	Wet season	Dry season
Feeding	44.92 $\pm$ 8.00	48.95 $\pm$ 7.63
Standing	19.05 $\pm$ 3.70	18.99 $\pm$ 3.60
Lying	22.44 $\pm$ 5.10	19.90 $\pm$ 4.80
Walking	7.80 $\pm$ 0.90	6.69 $\pm$ 0.94
Others	5.49 $\pm$ 0.66	5.22 $\pm$ 0.72

### 3.5. Anthropogenic activities and human–wildlife conflict

#### 3.5.1. Socio-demographic characteristics of the respondents

Data were gathered from a total of 354 respondents of nine villages based on the information gathered using the preliminary survey and the distance from the Park and problems related to human encroachment, crop damage and livestock loss by wildlife. The respondents were of various sex, age-groups, religious groups, occupations and educational backgrounds (Table 15). Out of the 354 respondents, 230 (65%) were males and 124 (35.02%) females. The number of males was significantly higher than that of females ( $\chi^2 = 29.58$ ,  $df=1$ ,  $P<0.05$ ). There was no significant difference in the attitude of male and female respondents towards the Park (Fig. 12). The respondents covered a range of age groups; the youngest was 18 years old, and the oldest 72 years. The majority (68.9%) of the respondents were of 29–49 years old, while 8.1% and 7.9% of the respondents were less than 20 and older than 59 years, respectively (see Table 15). Out of the total respondents, most (80.8%) were married, 5.6% were single, 10.5% were divorced and 3.1% were widowed. Young respondents (18-29 years) showed more positive attitudes towards the Park and conservation than aged groups (Fig. 13). Around 60% of the respondents showed positive attitude and 36% showed negative attitude towards the Park.

Table 15. Socio-demographic profiles of the respondents and their attitude towards the conservation area in Chebera Churchura National Park

Measurements			Attitude towards the conservation area (%)			
Category	Variables	Number of respondents	%	Positive %	Negative %	No idea %
Gender	Male	230	65	63.0	30.5	6.5
	Female	124	35	39.6	41.8	18.6
Mean				51.3	36.2	12.6
Age group	≤18	29	8.2	69.7	27.4	2.9
	20-29	55	15.5	63.9	30.2	5.9
	30-39	85	24	60.5	33.4	6.1
	40-49	104	29.4	57.9	35.5	6.6
	50-59	53	15	53.8	39.3	6.9
	>59	28	7.9	50.7	40.4	8.9
Mean				59.4	34.36	6.2
Education:	Illiterate	194	54.8	44.5	50.1	5.4
	Primary level education	96	27.1	60.2	33.8	6.1
	Secondary level education	28	7.9	71.4	23.3	5.3
	Informal education	36	10.2	45.5	47.1	7.4
Mean				55.4	38.6	6.05
Marital status	Married	286	80.8	61.2	33.2	5.6
	Single	20	5.6	70.2	25.3	4.5
	Divorced	37	10.5	45.3	51.2	3.5
	Widowed	11	3.1	39.5	55.6	4.9
Mean				54.1	41.3	4.6
Family size	1-3	123	36.8	49.5	45.3	5.2
	4-6	200	60	34.7	59.3	6.0
	7-10	8	2.3	30.2	64.3	5.5
	>10	3	0.9	31.6	65.0	3.4
Mean				36.5	58.5	5.02

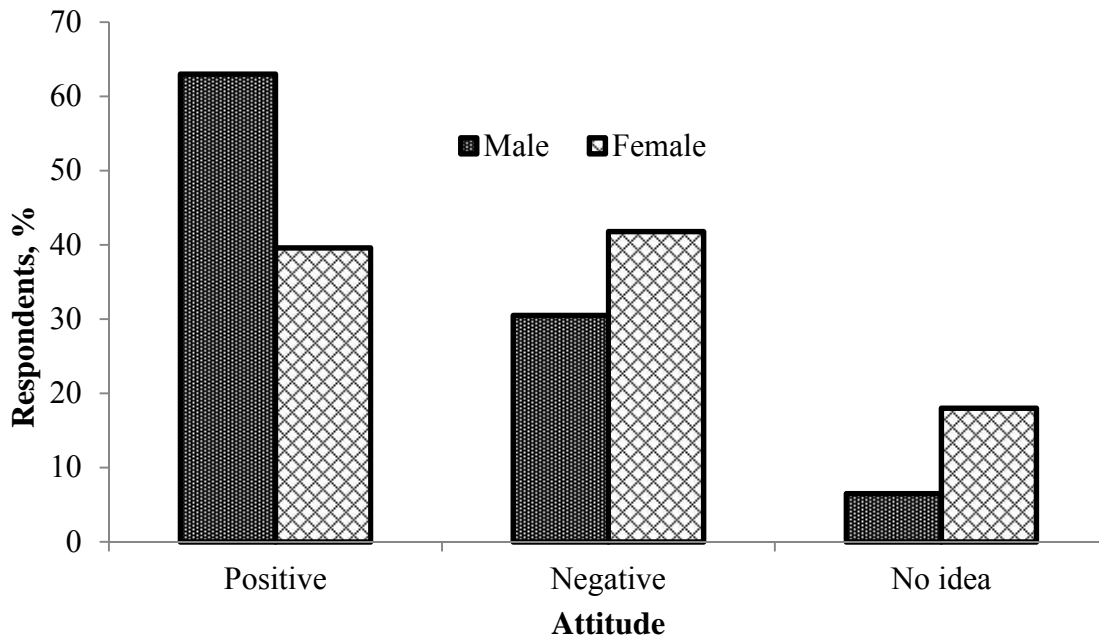


Figure 12. Attitude of male and female respondents towards the conservation area in Chebera Churchura National Park

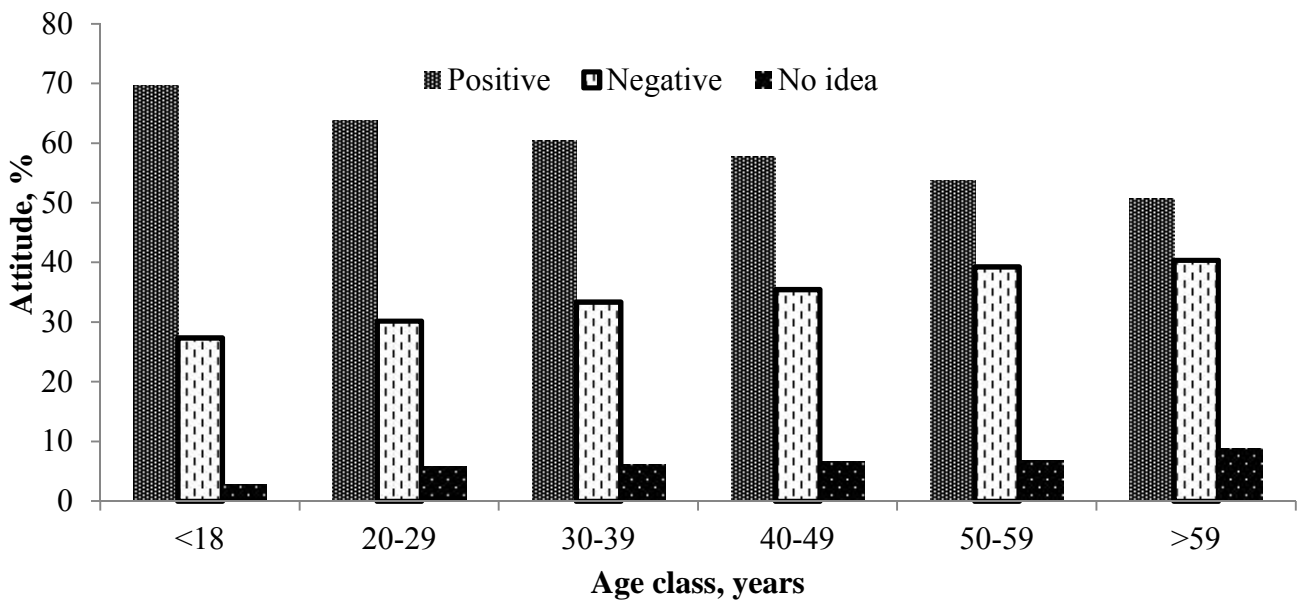


Figure 13. Attitude of different age classes of the respondents towards the conservation area in Chebera Churchura National Park

Most of the respondents (54.8%) were illiterate, 10.2% had informal education, 27.1% had primary education, 7.9% had secondary education and none of them had beyond secondary level education (see Table 15, Fig. 14). There was significant difference ( $\chi^2 = 98.16$ ,  $df=3$ ,  $P<0.05$ ) in educational status among the respondents. The majority of respondents (55.4%) had positive attitude towards the conservation area. On an average, 38.6% had negative attitude towards the Park. Relatively, better-educated groups (primary and secondary education) expressed positive attitude (65.8%) than uneducated respondents (45%). There was significant difference in the attitude between educated and uneducated respondents ( $\chi^2 = 27.5$ ,  $df=3$ ,  $P<0.05$ ). Most (60%) respondents had 4–6 family members. On the other hand, 36.8%, 2.3% and 0.9% of the respondents had 1–3, 7–10 and > 10 family members, respectively (see Table 15). Respondents with large family size (62.9%) had negative attitude towards the conservation area than those with small family size (45.3%).

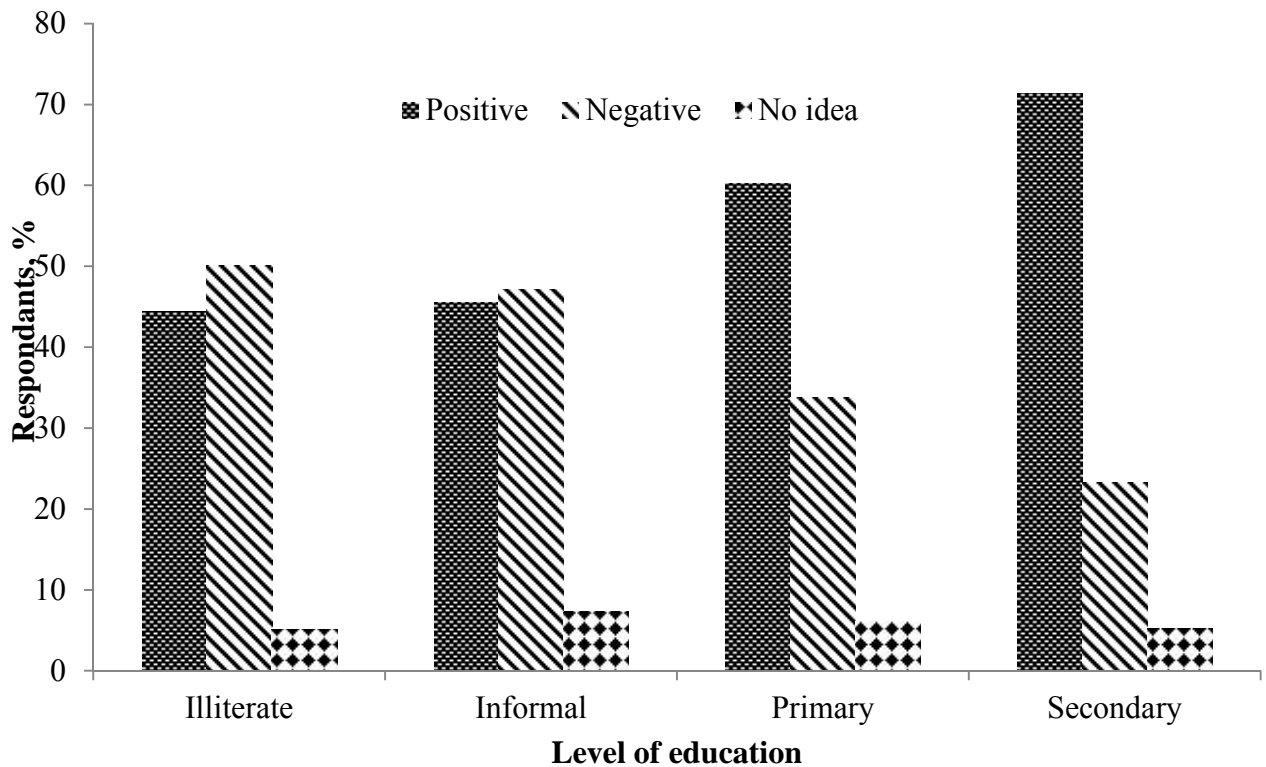


Figure 14. Attitude of respondents of different educational levels towards the conservation area in Chebera Churchura National Park

Majority of the respondents (96.6%) were Christians (Orthodox and Protestant), only 3.3% of the respondents were Muslims and others (Table 16). In the context of religious beliefs majority (53.4%) had a positive attitude towards the conservation area, but on an average 41% had negative attitude. Relatively, those with traditional beliefs had more positive attitude than others. However, there was no significant difference ( $\chi^2 = 39.82$ ,  $df = 3$ ,  $P > 0.05$ ) among the respondents of their attitude towards conservation.

Table 16. Adherence of the respondents to various religious affiliations in Chebera Churchura National Park

Religious affiliation	n=354	%	Attitude towards the conservation area		
			Positive %	Negative %	No idea %
Orthodox	105	29.7	53.5	41.7	4.8
Protestant	237	66.9	49.8	43.6	6.6
Muslim	3	0.8	46.7	48.3	5.0
Traditional beliefs	9	2.5	63.6	30.4	6.0
Mean			53.4	41.0	5.6

Mixed farming (crop cultivations and livestock rearing) were the main means of livelihood (76.8%) of the respondents in CCNP, and few (12.7%) depend on only crop farming. About 10.4% of respondents claimed to have been involved in one or more secondary occupations. The majority of respondents (51.1%) had a positive attitude towards the conservation area, but on an average 40.5% had negative attitude. Relatively, traders had more positive attitude than other groups. The major livestock reared by the local communities were cattle, sheep, goat and pack animals which include donkey, horses and mule (Table 17).

Table 17. Percentage of livelihood activities of the respondent and their attitude towards conservation area in Chebera Churchura National Park

Occupation	(n=354)	%	Attitude towards the conservation area		
			Positive %	Negative %	No idea %
Crop farming only	45	12.7	55.9	35.7	8.4
Livestock rearing only	0.0	0.0	0.0	0.0	0.0
Mixed farming	272	76.8	52.2	38.5	9.3
Trading	17	4.9	58.4	32.7	8.9
Wild honey collection	11	3.1	51.3	40.9	7.8
Timber Production	5	1.4	37.4	54.9	7.7
Others	4	1.0	0.0	0.0	0.0
Mean			51.1	40.5	8.4

### 3.5.2. Utilization of resources

Use of resources from CCNP by the local people is given in Table 18. Majority of the respondents acknowledged getting benefits from the Park. Among the benefits, access for livestock grazing, firewood gathering, fodder collection, wildmeat, wildhoney, wild green pepper, farming and employment as tourist guide are the main ones. Among the respondents, 51.2% used conservation area for livestock grazing, 50.2% for firewood and fodder collection, 15.6% for wildhoney and spices collection, 23.1% for timber cutting and 2% for farming land along the boundaries of the Park. There was no significant difference ( $\chi^2 = 38.34$ ,  $df = 8$ ,  $P > 0.05$ ) among respondents of different villages in the use of various resource from the Park.

Table 18. Percentage of resource utilization by the respondents among different villages in Chebera Churchura National Park

Village	n (354)	Respondents (%)						
		CF %	LG %	FW & FC %	WH & SC %	WM %	TC %	OT %
Chebera	48	0.5	51.5	58.5	5.7	2.1	20	0.3
Sirri	21	4.3	53.4	52.9	21.3	1.2	25.5	0.2
Dalba	44	0.1	50.0	49.5	16.3	1.5	30.3	0.0
Yora	42	2.4	55.7	46.6	12.4	2.1	32.5	0.1
Shita	39	1.4	52.9	48.7	4.5	1.3	27.5	7.3
Churchura	48	3.2	57.5	56.8	26.2	5.6	25.4	1.7
Chewda	34	2.1	45.3	43.6	17.3	2.4	13.5	0.5
Gudumu	48	2.2	48.9	46.9	15.8	5.9	17.8	0.4
Adabacho	30	1.9	45.7	47.9	20.5	1.7	15.3	0.3
Mean		2.0	51.2	50.2	15.6	2.6	23.1	1.2

CF= Crop farming, LG= Livestock grazing access, FW & FC= Firewood gathering, fodder collection and thatching houses, WH & SC= Wildhoney and spices collection, WM= Wildmeat access, TC= Timber cutting for different reasons, OT= Other benefits

The following two conservation-related conflicts were discussed with stakeholders (Park staffs, village leaders and local elders) for further analysis: (i) Resource access conflicts: a consolidation of conflicts surrounding livestock grazing, crop farming, firewood cutting/timber, hunting, wildfire, traditional beekeeping and collection of traditional medicines from the Park and (ii) Human-wildlife conflicts, which centred on crop raiding, livestock predation and human threats to animals by the Park fauna.

### 3.5.3. Resource access conflicts

Communities are highly dependent on a number of natural resources for their livelihoods (such as grazing land, firewood/timber, wild honey, medicinal plants, farmlands, thatching grasses and wildmeat) but, without legal permits, hence conflicts have emerged around these resources (Fig. 15).



Figure 15. Local people around Chebera Churchura National Park utilized different type of natural resources for their livelihoods (Photo: By Aberham Megaze)

a= timber collected from the Park, b= firewood collected from the Park, c= thatching grass collected from the Park, d= livestock grazing in the Park

### 3.5.3.1. Livestock grazing

Majority of the livestock of the respondents (82.3%) grazed inside and around the Park, 39.0% inside the Park and 43.3% in the buffer zone of the Park. Most of the respondents did not have their own private grazing land. Only 17.6% of local people have own grazing land. Villages differed significantly ( $\chi^2 = 48.34$ ,  $df = 8$ ,  $P < 0.05$ ) in livestock grazing in the study area (Table 19). The number of livestock inside the Park was more during the dry season than during the wet season.

Table 19. Grazing sites of villagers in Chebera Churchura National Park

Village	n (354)	Livestock grazing (%)		
		In the Park %	In the buffer zone %	Own grazing land %
Chebera	48	41.5	52.4	6.51
Sirri	21	39.3	48.9	11.7
Dalba	44	40.5	45.8	13.7
Yora	42	44.4	43.8	11.7
Shita	39	37.4	38.9	23.6
Churchura	48	45.6	47.5	6.8
Chewda	34	36.9	37.7	25.4
Gudumu	48	32.0	34.6	33.4
Adabacho	30	33.4	40.4	25.9
Mean		39.0	43.3	17.6

There were 26,357 livestock in and around the Park (Table 20). The discussions held with the local people indicated that there was a dramatic increase in the population of livestock in the present study area. Local people use the Park, mainly for grazing and drinking water. There are also mineral water sites in several places inside the Park, which also the villagers depend upon for their livestock.

Table 20. Number of livestock head in Peasant Associations surrounding the Chebera Churchura National Park

Peasant Associations	Number of livestock						Total
	Cattle	Horse	Mule	Donkeys	Sheep	Goats	
Chebera	1280	100	57	213	640	321	2611
Sirri	721	43	35	100	420	457	1776
Dalba	1455	5	49	70	873	1164	3616
Yora	1116	163	212	156	893	597	3137
Shita	1431	215	244	261	686	359	3196
Churchura	2011	411	560	390	250	1018	4640
Chewda	1350	195	129	147	100	240	2161
Gudumu	1610	511	485	398	225	233	3462
Adabacho	812	182	231	187	227	119	1758
<b>Total</b>	<b>11786</b>	<b>1825</b>	<b>2002</b>	<b>1922</b>	<b>4314</b>	<b>4508</b>	<b>26357</b>

Cattle 44.7%, Horse 6.9%, Mule 7.6%, Donkey 7.3%, Sheep 16.4%, goat 17.1%

(Source: Darwo and Konta Agricultural and Rural Development Coordination Office 2013–2014)

### 3.5.3.2. Firewood and timber extraction

The main source of energy for the people around CCNP was firewood. Local people are heavily relied on traditional mud stove, for cooking using firewood. Among the respondent, 35.9% depends on the Park for firewood and construction materials from inside the Park, while 54.4% collect fire wood and construction materials from the buffer zone. However, 9.6% use other source such as farm area for firewood and construction materials (Fig. 16). During the study period, large numbers of people around the CCNP were observed cutting and carrying firewood and other forest products on their shoulders for house construction and cooking purposes (Plate 3).

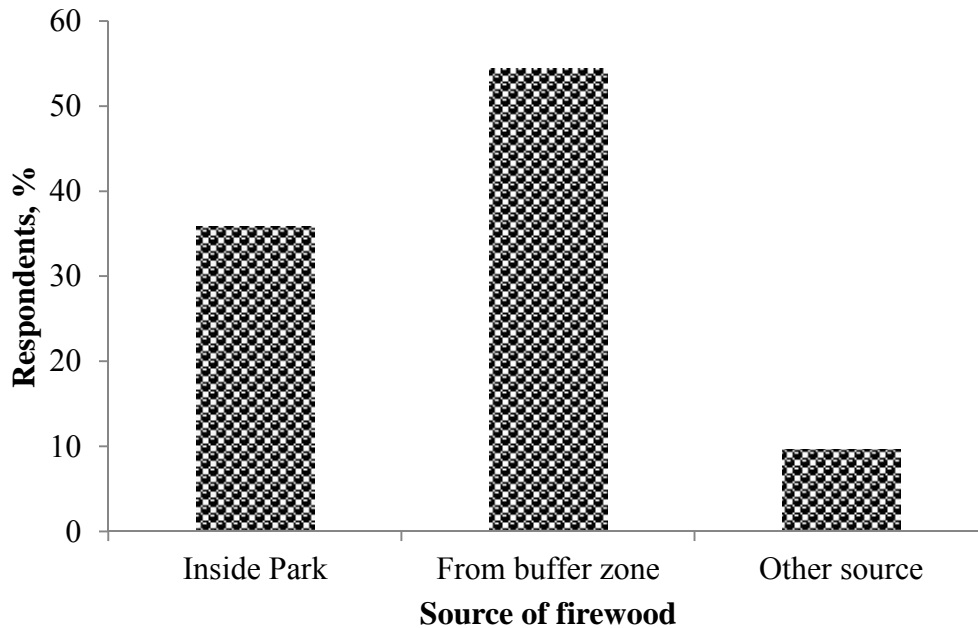


Figure 16. Different sites of fire wood extraction and timber cutting in Chebera Churchura National Park

### 3.5.3.3. Illegal hunting

Majority of the respondents (80.43%) mentioned that getting wildmeat in the locality had been effortless. However, some of respondents (19.57%) stated that it is not easy to get access to wildmeat in their surroundings. There was a significant difference among the respondents view on the access to wildmeat in the CCNP. Among the respondents, 68.70% did not agree in poaching of wildlife by the local community. But, most people during the interview and group discussions asserted that poaching wildlife in the area was intense before the establishment of the Park. However, 31.30% of the respondents revealed that poaching had been practiced by the local community (Fig. 17).



Figure 17. Poaching of different wild animals by the local community in Chebera Churchura National Park (Photo: By Aberham Megaze and CCNP Staff)

a–b=hunted bushbuck in Yora village, c=tusk of African elephant from Sirri village, d=horns of waterbuck and skin of lion from Dalba village

Most respondents across the nine study villages reported that illegal hunters commonly use snaring (locally manufactured traps) (54.8%) and firearms (45.5%) (Table 21). Wire snares were reportedly made from stolen steel wire from forestry nursery sites around CCNP boundaries (Fig. 18, Plate 4). Respondents highlighted that most of the illegal hunting occurred inside the Park, as wild animals were more abundant inside the Park compared to buffer zone. The least reported illegal hunting methods were poisoning (1.24%), hunting with dogs (0.17%) and wildfires (0.12%). Poisoning, mostly using herbicides and pesticides, was used in revenge killings of large carnivores such as spotted hyenas and lions as a way to reduce livestock–carnivore conflicts. Wildfires were used to drive animals towards snares and also to make hunting by dogs easier.



Figure 18. Different illegal hunting methods of the local people in Chebera Churchura National Park (Photo: By Aberham Megaze and CCNP Staffs)

a= Local people preparing snare from the barks of tree, b= snare hunting method, c-d= wildlife killed by using snares in Sirri village

Table 21. Percentage of illegal hunting methods among different villages in Chebera Churchura National Park

Villages	Common illegal hunting methods (%)				
	Snares	Firearms	Poisoning	Wildfire	Hunting with dogs
Chebera	69.4	26.4	3.6	0.5	0.3
Sirri	56.9	40.7	2.2	0.2	0.1
Dalba	58.7	47.8	1.7	0.1	0.2
Yora	56.5	48.0	0.2	0.0	0.0
Shita	53.8	45.7	0.4	0.0	0.0
Churchura	39.3	61.5	2.1	0.3	0.3
Chewda	54.7	45.2	0.0	0.0	0.0
Gudumu	55.1	44.5	0.0	0.0	0.4
Adabacho	48.7	49.8	1.0	0.0	0.2
Mean	54.8	45.5	1.24	0.12	0.17

(Total percentage exceeds 100 for each ward because the respondents were allowed to give multiple answers)

A total of 22 wildlife species, including large herbivores and carnivores were reported to be illegally hunted in the CCNP ecosystem. Most of the respondents in the study sites reported that African buffaloes (71%), warthogs (33%), waterbuck (25%), bushbuck (21%) and African elephant (45%) were the most abundant, preferred and commonly hunted animals. In addition, large carnivores, including spotted hyena (11%), leopard (10%), lion (8%) and wild dog (2%), Anubis baboon (34%) were also illegally killed in the CCNP ecosystem (Fig. 19).

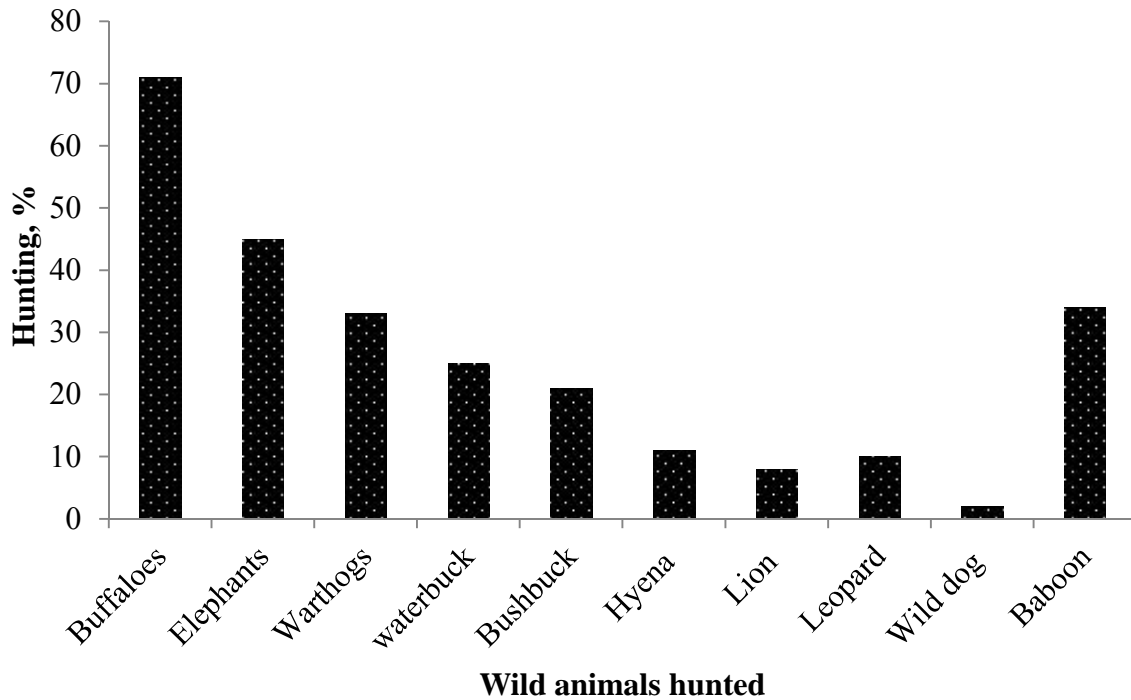


Figure 19. Percentage of wild animals hunted in Chebera Churchura National Park area

The respondents have highlighted five reasons for illegal hunting of wild animals. Out of the total respondents, 40.4% stated the need for wildmeat as a source of protein for domestic consumption, 47.9% stated as revenge as a way to reduce the problem of crop damage and livestock predation, 25.5% stated commercial trade in animal products in order to enhance income, 21.7% reported that wildlife are threats to human being and 2.0% indicated that illegal hunting was done as part of traditional culture and/or to get animal products for use in cultural ceremonies (Table 22). These reasons as stated by the respondents for illegal hunting of wildlife significantly differed among villagers ( $\chi^2 = 59.98$ ,  $df = 8$ ,  $P < 0.05$ ). Unemployment was stated as a reason for illegal hunting during focus group discussions. For some of the respondents, hunting is a hobby. Another reason stated by few during discussions was as revenge against arrests of the villagers by the wildlife officials.

Table 22. Reasons for illegal hunting of wildlife in Chebera Churchura National Park area

Village	Reasons for illegal hunting (%)				
	Wildmeat for domestic consumption	To reduce crop damage and livestock depredation	For commercial trade of animal products	Threats to human being	Traditional/cultural practice
Chebera	54.3	42.3	31.6	15.3	3.5
Sirri	41.5	50.5	35.2	12.7	2.7
Delba	47.8	56.4	29.9	20.6	1.2
Yora	57.4	39.2	28.7	23.2	1.4
Shita	36	53.9	21.5	22.7	1.7
Churcura	61.3	35.8	19.6	28.3	2.1
Gudumu	23.1	43.5	25.3	27.1	1.9
Chwada	20.6	59.1	21.5	17.4	1.3
Advachew	21.5	46.7	15.9	28.4	2.0
Mean	40.4	47.9	25.5	21.74	2.0

The perception of illegal hunting trends in the CCNP ecosystem between 2012 and 2015 differed significantly across the nine study villages ( $\chi^2 = 51.23$ ,  $df = 8$ ,  $P < 0.05$ ). Respondents from Chebera (87%) and Sirri (83%) villages largely perceived that illegal hunting had decreased. Overall, about 20.8% of the respondents perceived that illegal hunting activities had increased, whereas 61.6% of the respondents perceived that illegal hunting activities had decreased, and only 17.5% of the respondents perceived that illegal hunting activities had remained the same. The main reasons given for the perceived decline of illegal hunting in the CCNP ecosystem were that illegal hunters (or poachers) were afraid of being arrested and imprisoned (73.1%). Among the respondents 40.3% perceived that the decline was due to strengthened law enforcement, and the positive impact of conservation awareness created by the Park officials and associated benefits such as cash dividends and provision for wildmeat (Table 23).

Table 23. Reasons for the perceived decline of illegal hunting in Chebera Churchura National Park

Villages	Reason of respondents in each village (%)			
	Illegal hunters afraid of being arrested or imprisoned	Awareness, education and benefits from Park	Illegal hunters afraid of being injured or killed by rangers	Few firearms to use in illegal hunting
Chebera	91.4	60.4	29.5	12.5
Sirri	86.7	59.7	25.3	10.3
Dalba	71.3	55.4	25.9	17.7
Yora	74.5	61.3	21.8	20.5
Shita	77.0	19.9	13.3	6.3
Churchura	55.1	11.3	27.6	34.7
Chewda	57.6	13.6	12.4	22.5
Gudumu	73.3	57.4	22.5	13.6
Adabacho	70.8	24.0	21.9	23.7
Average	73.1	40.3	22.2	17.9

(Total percentage exceeds 100 because the respondents were allowed to give multiple answers)

#### 3.5.3.4. Wildfire

Most of the respondents (97.9%) have replied that wildfire in CCNP habitats recorded were anthropogenic, out of which 88.7% were deliberately set by local people. Deliberate wildfire was set either by hunters (83.5%) or farmers (16.5%) for clearing vegetation on land for cultivation. Wild honey collecting constituted the main cause (76.6%) of the accidental wildfire, followed by on farm cooking (23.2%). Most of the farmer-respondents set fire once a year, usually during the dry season (December to February) (Table 24). Focus group discussants responded that, the local people burn bush and grasses areas during the dry season, to prepare land for shifting cultivation, to get fresh grass access for their livestock and to control the harm by wildlife such as snakes. Illegal hunters also burn the vegetation in order to attract wild games for easy hunting, to make open foot tracks for better visibility and protect themselves from predator wild animals (Fig. 20).



Figure 20. Fire set by the local people around Chebera Churchura National Park (Photo: By Aberham Megaze)

a–b= burned forest habitat of the Park in February, c–d= burned woodland and grass land habitat of the Park (December to February)

Table 24. Cause of wildfire in Chebera Churchura National Park

Respondents (n=354)	Respondents in each village (%)									
	Chebera	Sirri	Dalba	Yora	Shita	Churchura	Chewda	Gudumu	Adabacho	Mean
Sources of wildfire										
Anthropogenic	99.6	98.8	97.5	99.9	95.0	95.6	99.3	99.0	96.5	97.9
Natural	0.4	1.2	2.5	0.1	5.0	4.4	0.7	1.0	3.5	2.1
Source of anthropogenic										
Deliberate	87.3	85.4	90.7	88.6	91.2	86.8	89.7	88.4	90.0	88.7
Accidental	12.7	14.6	9.3	11.4	8.8	13.2	10.3	11.6	10	11.3
Sources of deliberate wildfire										
Hunting	76.4	82.3	81.7	79.8	89.8	74.7	88.2	90.6	87.9	83.5
Vegetation clearing for cultivation	23.6	17.7	18.3	20.2	10.2	25.3	11.8	9.4	12.1	16.5
Sources of accidental wildfire										
Wild honey collecting	79.0	85.9	83.2	77.1	73.8	85.4	71.0	68.6	65.4	76.6
On farm cooking	20.9	14.1	16.0	22.7	26.2	14.3	29.0	31.4	34.6	23.2
Other	0.4	0.0	0.8	0.2	0.0	0.3	0.0	0.0	0.0	0.2

### 3.5.3.5. Illegal farming

Local community living in the surrounding areas of CCNP encroached into the Park area for agricultural land for a long period of time before the establishment of the Park. Especially people from Chebera, Sirri, Shita, Yora and Churchura villages had been practicing illegal farming in and around the Park area. They farmed a variety of crops such as maize, teff, banana, mango, avocado, ginger and 'Enset' (Fig. 21).



Figure 21. Agricultural activities and clearing forest for shifting cultivation in and around CCNP (Photo: By Aberham Megaze)  
 a–b= framer in Chebera village clearing land around the Park for shifting cultivation, c–d= agricultural activities around and in the Park in Sirri village

#### 3.5.4. Human–wildlife conflict

A total of 13 wild species of animals were recorded as problematic animals in the nine study villages (Table 25). Among these, seven animal species were recorded as the most frequently mentioned crop raiding species. These were African buffaloes, common warthog, African elephant, porcupine, hippopotamus, bush pig and Anubis baboon. The other six animal species were recoded as predators of domestic animals. These predators were: Lion, leopard, hyena, caracal, Jackal, serval and Anubis baboon. Among the respondents, 61.5% noted these animals to cause major problems, while 30.0% noted them as causing only minor problems and 8.5% noted them as having no problem. This difference was statistically significant ( $\chi^2 = 43.62$ ,  $df=2$ ,  $P<0.05$ ). Major problem animals as reported are Anubis baboon, African buffaloes, warthog and

African elephants among crop raiding species. Among predator animals, lion, leopard and spotted hyena were stated as causing live stock predation and human injury.

Table 25. Problem animals in terms of ranking by the respondents in Chebera Churchura National Park

Common name	Species name	Ranking by the respondents, %		
		Major Problem	Minor Problem	No Problem
African buffalo	<i>Syncerus caffer</i>	87.5	12.3	0.2
Common warthog	<i>Phacochoerus africanus</i>	70.8	24.3	4.9
African elephant	<i>Loxodonta africana</i>	68.9	25.3	5.8
Porcupine	<i>Hystrix cristata</i>	65.5	27.6	6.9
Hippopotamus	<i>Hippopotamus amphibious</i>	49.5	29.6	20.9
Bush pig	<i>Potamocheirus larvatus</i>	47.0	49.2	3.8
Anubis baboon*	<i>Papio anubis</i>	92.3	7.2	0.5
Lion	<i>Panthera leo</i>	67.5	19.3	13.1
Leopard	<i>Panthera pardus</i>	63.7	25.9	10.3
Spotted hyena	<i>Crocuta crocuta</i>	79.6	20.0	0.4
Jackal	<i>Canis mesomelas</i>	30.6	57.4	12.0
Caracal	<i>Felis caracal</i>	43.7	40.8	15.5
Serval	<i>Felis serval</i>	33.5	50.9	15.6
Mean		61.5	30.0	8.5

( Major problem animals as per the respondents)

The reason that respondents cited for having conflict with wild animals are shown in Table 26. Major reported reasons for conflict with wild animals were due to crop raiding, livestock depredation, threat or killing humans and spread of diseases. Among the respondents, 68.1% reported crop damage and livestock depredation, 7.5% reported only crop damage, 9.7% reported only livestock depredation, 12.3% reported threat to humans (death and injuries) and 0.3% responded as they might cause diseases. Among the respondents, 2.1% reported they did not face any conflict with wild animals in the area. The difference was statistically significant ( $\chi^2 = 97.36$ ,  $df=3$ ,  $P<0.05$ ). The risk of livestock depredation was the main reason for disliking focal

carnivores. Problem caused by wildlife was significantly different ( $\chi^2 = 59.98$ ,  $df=8$ ,  $P<0.05$ ) among the respondents of different villages. Most respondents from Sirri (83.9%), Chebera (81.7%), Churchura (79.4%) and Dalba (73.3%) have reported that they faced great problems of both crop damage and livestock depredation by wild animals in CCNP.

Table 26. Problems caused by wild animals in Chebera Churchura National Park as responded by the respondents

Villages	n=354	Respondents, %					
		CD	LP	BCD & LP	TH	DC	NC
Chebera	48	0.2	0.1	81.7	17.3	0.7	0.0
Sirri	21	0.1	0.0	83.9	16.4	0.4	0.0
Dalba	44	7.9	6.9	73.3	11.1	0.6	0.2
Yora	42	8.7	5.7	69.2	14.6	0.3	2.1
Shita	39	15.6	7.6	65.0	8.5	0.2	3.1
churchura	48	0.3	14.7	79.4	5.5	0.1	0.0
Chewda	34	12.5	16.7	55	11.0	0.3	4.5
Gudumu	48	11.4	15.9	60.5	8.2	0.1	3.9
Adabacho	30	10.7	19.5	45	19.3	0.5	5.0
Mean		7.5	9.7	68.1	12.3	0.3	2.1

CD=Crop damage, LP=Livestock predation, BCD & LP= Both crop damage & livestock predation, TH= Threat to human, DC=Diseases causing agents, NC=No conflict

Types of crops raided by wild animals differed from one locality to another depending on agro-ecological factors. However, maize, sorghum, teff, banana and most vegetables were affected by most pests. Almost all crop raiding animals depended on all cereal crops cultivated around the Park. Moreover, Anubis baboon raids all crops except 'Enset'.

#### 3.5.4.1. Population trends of problem animals

About all those 13 focal wild animal species, majority of respondents had the opinion that population status of vermin animals have increased in the area over recent years (Fig. 22). When asked about population trends, 68.6% of the respondents felt that most animal populations have

increased over recent years. However, 14.6% of the respondents remarked that the wildlife populations have remained without much change and 10.0% stated that they decreased. Only few of the respondents (6.7%) were unsure on the status of wildlife population. The views of the respondents in the trend of the wildlife population in their locality were significantly different ( $\chi^2 = 76.11$ ,  $df=3$ ,  $P<0.05$ ).

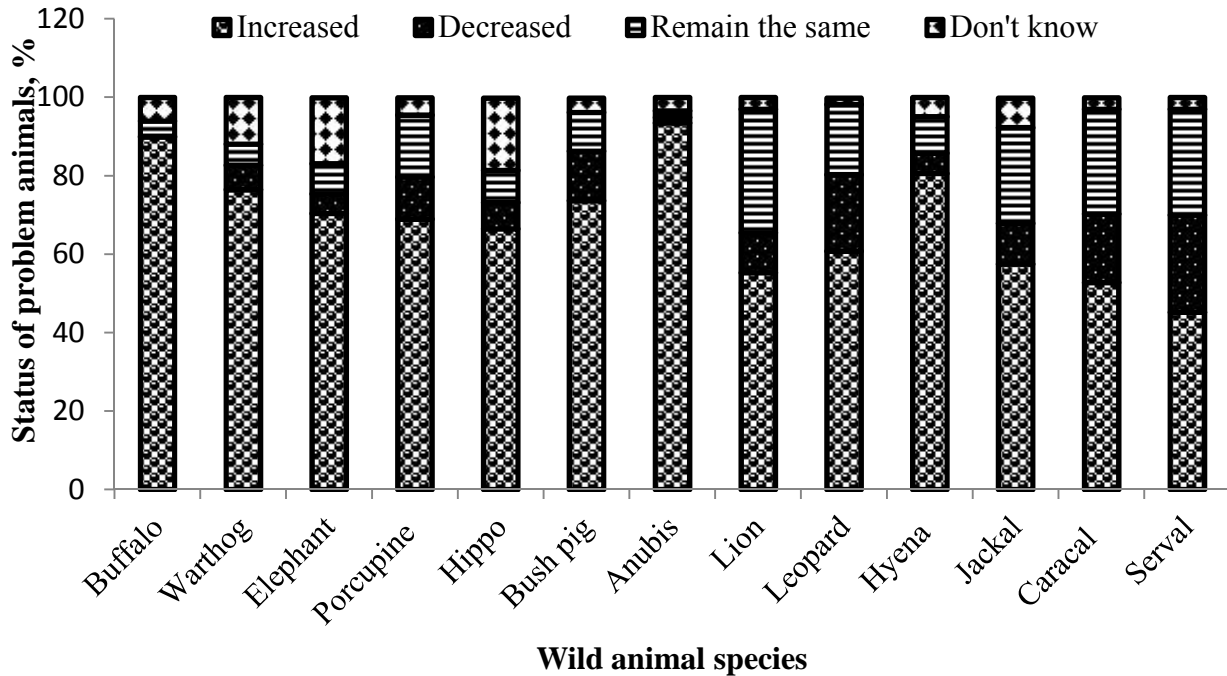


Figure 22. Respondents' opinions on the status of the population of 13 problem wild animals in Chebera Churchura National Park during 2011 to 2015

Majority of the respondents (52.6%) were more likely to want the population of the problem animals to decrease, especially, Anubis baboon (92.3%) and African buffaloes (67.6%) due to high conflict with local people. However, 19.3% of the respondents wanted to see this population of the animals increased, 22.1% wanted the populations to stay the same and only few of the respondents (5.9%) did not respond to this question (Fig. 23). The difference in the opinion was statistically significant ( $\chi^2 = 34.99$ ,  $df=3$ ,  $P<0.05$ ). These views were not necessarily completely clean-cut for African elephants. Thirty six percent of respondents specifically said that they wanted African elephants to remain in the Park, and were happy for them to increase 'elsewhere

in the Park area', but not around their living area. Respondents of different villages had varied opinion on the expected population trend of pest animals ( $\chi^2 = 37.0$ ,  $df=8$ ,  $P < 0.5$ ).

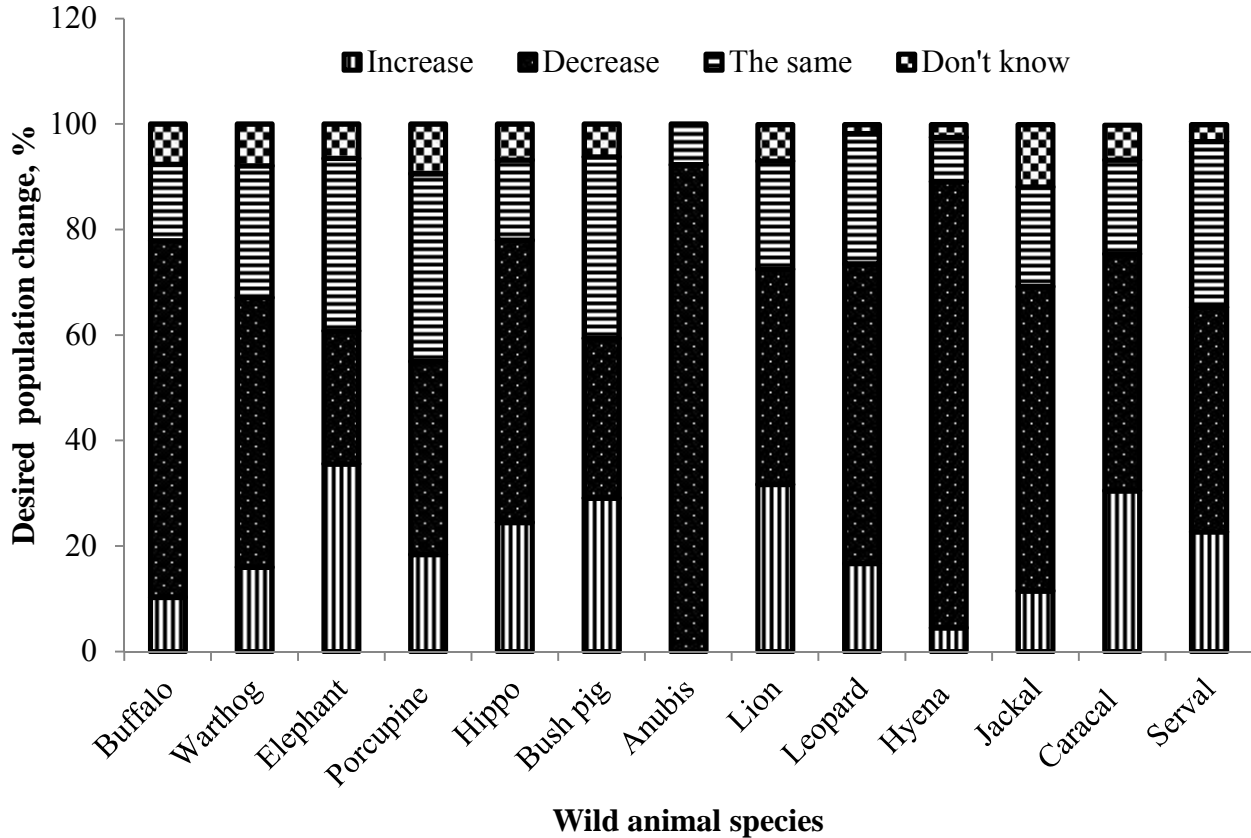


Figure 23. Desired future population trends of the problem animals in Chebera Churchura National Park as stated by respondents

The trends in crop damage and livestock depredation are presented in Table 27. The respondents noted that in all villages crop damage and livestock depredation had increased during the last 5 years. Out of the 354 respondents, 80.4% responded that the trend is increasing. The views of the respondents on this did not differ significantly among the study villages ( $\chi^2 = 20.71$ ,  $df=8$ ,  $P > 0.05$ ). Only, 9.4% noted that the trend is decreasing. More people from Chebera, Serri, Yora and Churchura faced more crop damage and livestock predation than those in the other villages. Relatively, people who live close/near the Park area faced more problems than those living 3 km or far from the Park.

Table 27. Approximate distance of villages from the Park, trend of crop damage, livestock depredation and injury/death to human by pest animals in the last five years in Chebera Churchura National Park

Village	n =354	Distance from the Park (km)	Respondents, %		
			Increased	Decreased	Unknown
Chebera	48	1–2	89.5	2.7	7.8
Serri	21	0–2	91.7	1.8	6.5
Dalba	44	3–5	72.5	12.8	14.6
Yora	42	0–2	85.4	8.3	6.2
Shita	39	3–5	77.8	11.5	10.7
Churchura	48	1–3	89.7	4.2	6.0
Chewda	34	0–2	79.3	7.3	13.4
Gudumu	48	2–3	71.0	15.7	13.2
Adabacho	30	2–4	66.8	20.5	12.6
Mean			80.4	9.4	10.0

### 3.5.4.2. Seasonality in crop raiding

It was recorded that the season of crop damage varies with the cropping practices, but most of the crop raiding occurs during the wet season. Agricultural crops, especially maize, sorghum, banana and enset comprised a major portion of wildlife diets in the CCNP boundary area. These were the crops most cultivated by the farmers and therefore more abundant and accessible to wildlife. Questionnaire survey revealed that the species that most frequently caused crop damage were African buffaloes (31%), followed by warthog and wild pigs (27.6%), elephant (23.1%), porcupine (17%) and baboon, (32.8%). Other large wild herbivores accounted for about 7.9% of crop damage (Fig. 24). Focus group discussions indicate that most of the damages occurred at night. In few cases, crop raiding occurred during the day (morning and afternoon) and at any time. Most of the damages were caused by more than one species. Some time, damages were caused by 2–3 species during the same night. Chebera, Serri, Yora and Churchura villagers were the most affected by wild animals (Plate5).

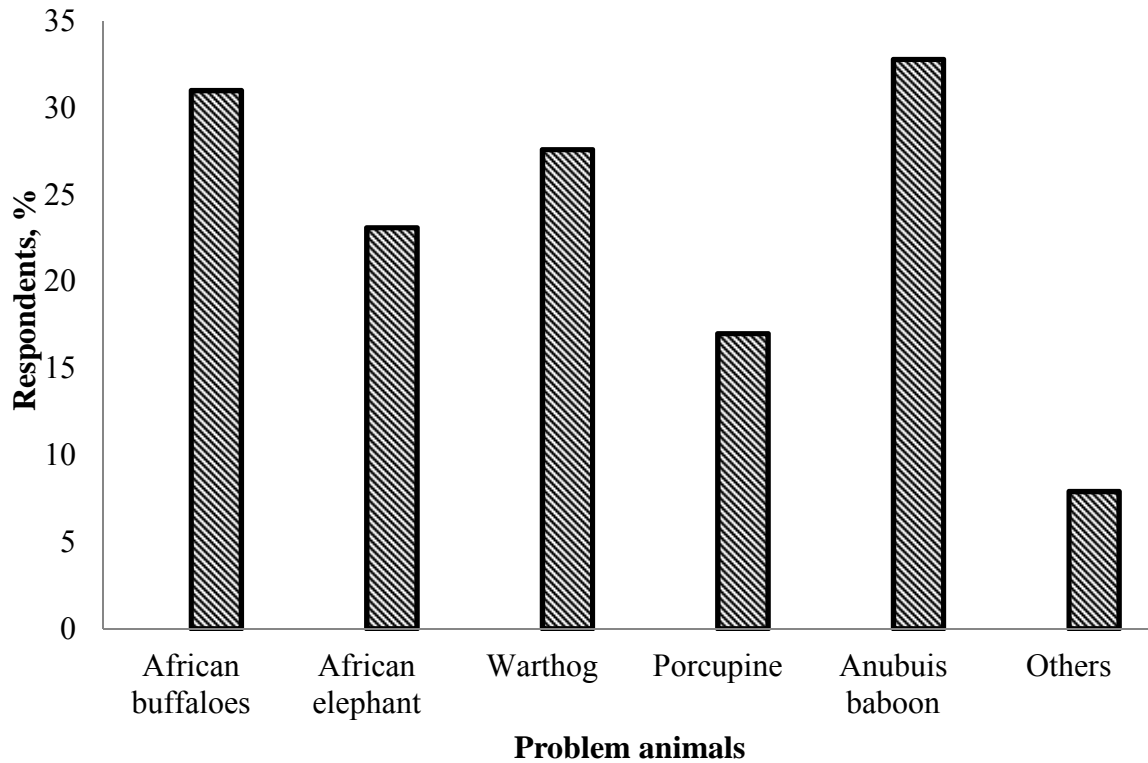


Figure 24. Problem animals in Chebera Churchura National Park that frequently caused crop damages around villages

#### 3.5.4.3. Distance of the villages and livestock depredation

A total of 1449 predator attacks were reported in the last 3 years (2012–2015) (Table 28). The number of predation events was different between the villages. There was a significant difference among villages in the total number of domestic animals killed ( $\chi^2 = 77.25$ ,  $df = 8$ ,  $P < 0.05$ ). Livestock predation intensity increased around the National Park relative to the distance. A total of 221 sheep, 306 goats, 206 cattle, 577 chickens, 36 donkeys and 103 dogs were killed by predators. Distance from the park and the frequency of livestock loss by predators were positively correlated in respect to the number of sampled households.

Table 28. Number of livestock killed by wild predators in the last 3 years (2012–2014) and estimated distance of the villages from the Park

Villages	n=354	Distance to the Park, km	Number of livestock killed by predators					Total loss	
			sheep	goat	cattle	chickens	donkeys		dogs
Chebera	48	1–2	27	52	39	84	0	10	212
Serri	21	0–2	31	43	32	87	1	10	204
Dalba	44	3–5	25	56	30	60	6	12	189
Yora	42	0–2	39	59	36	89	7	11	241
Shita	39	3–5	13	25	11	51	2	10	112
Churchura	48	1–3	33	41	25	65	6	13	183
Chewda	34	0–2	25	21	10	47	2	9	114
Gudumu	48	2–3	15	6	11	45	5	13	95
Adabacho	30	2–4	13	3	12	49	7	15	99
Total	354		221	306	206	577	36	103	1449

#### 3.5.4.4. Seasonality in predation

Livestock loss generally increased during the wet season. Of the total loss, 56.0% occurred during the wet season and 44% during the dry season. Of the total 1449 domestic animals killed by the predators during the study periods, 812 were killed during the wet season and 637 during the dry season (Fig. 25). There was a significant difference between seasons in the number of domestic animals killed ( $\chi^2 = 82.79$ ,  $df=6$ ,  $P<0.05$ ). Of the 354 interviewed households, the proportions of domestic animals killed were: sheep 15.3%, goats 21.1%, cattle 14.2%, chicken 39.8%, donkeys 2.5% and dogs 7.1%. This showed statistically significant difference ( $\chi^2 = 87.36$ ,  $df=5$ ,  $P<0.05$ ) among the domestic animals killed. Lion, leopard, hyena and baboon were responsible for most domestic animal mortalities recorded. Lions were responsible for 40.3% of the cattle attacks while the rest were carried out by hyenas. Most dogs (89.3%) were killed by hyena and caracals. However, chicken were killed mostly (64.8%) by serval and Anubis baboon (12.9%) (Fig. 26). The respondents indicated that lions, caracals and hyenas mainly attacked domestic animals at night. However, predation by baboons, wild dog and jackal occurred during the day time.

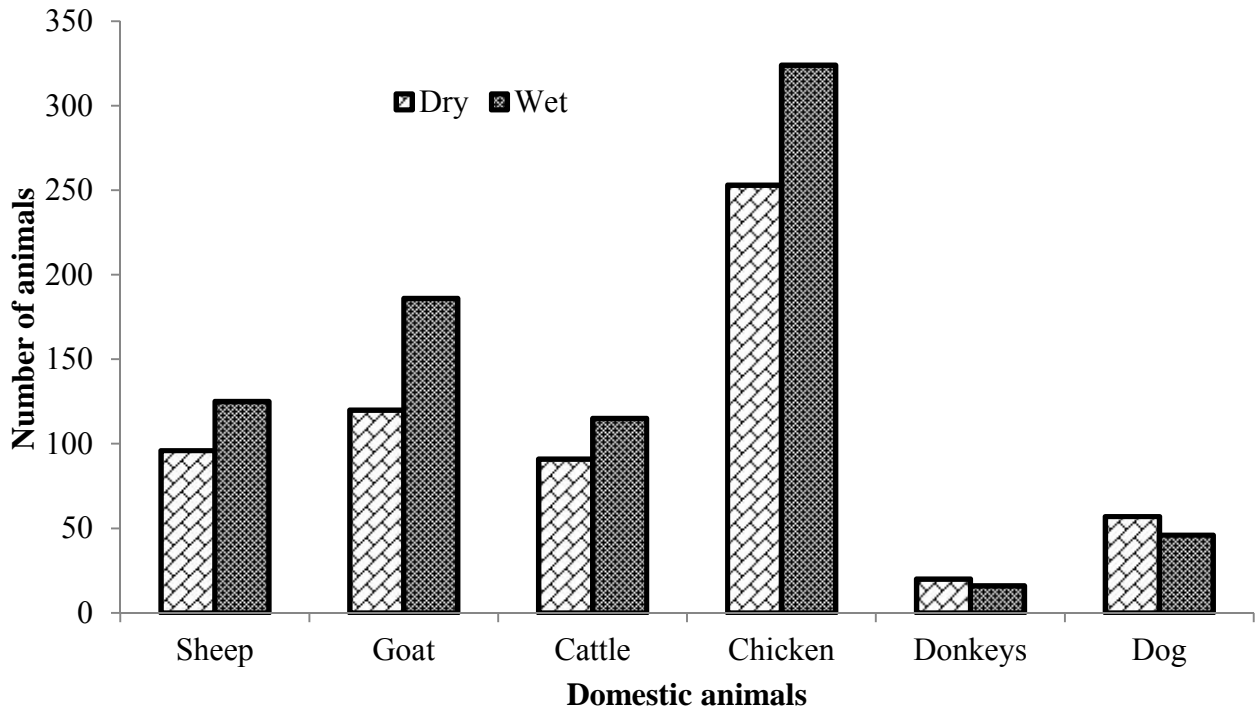


Figure 25. Seasonal livestock depredation during the study period (2012–2014) in village surrounding Chebera Churchura National Park

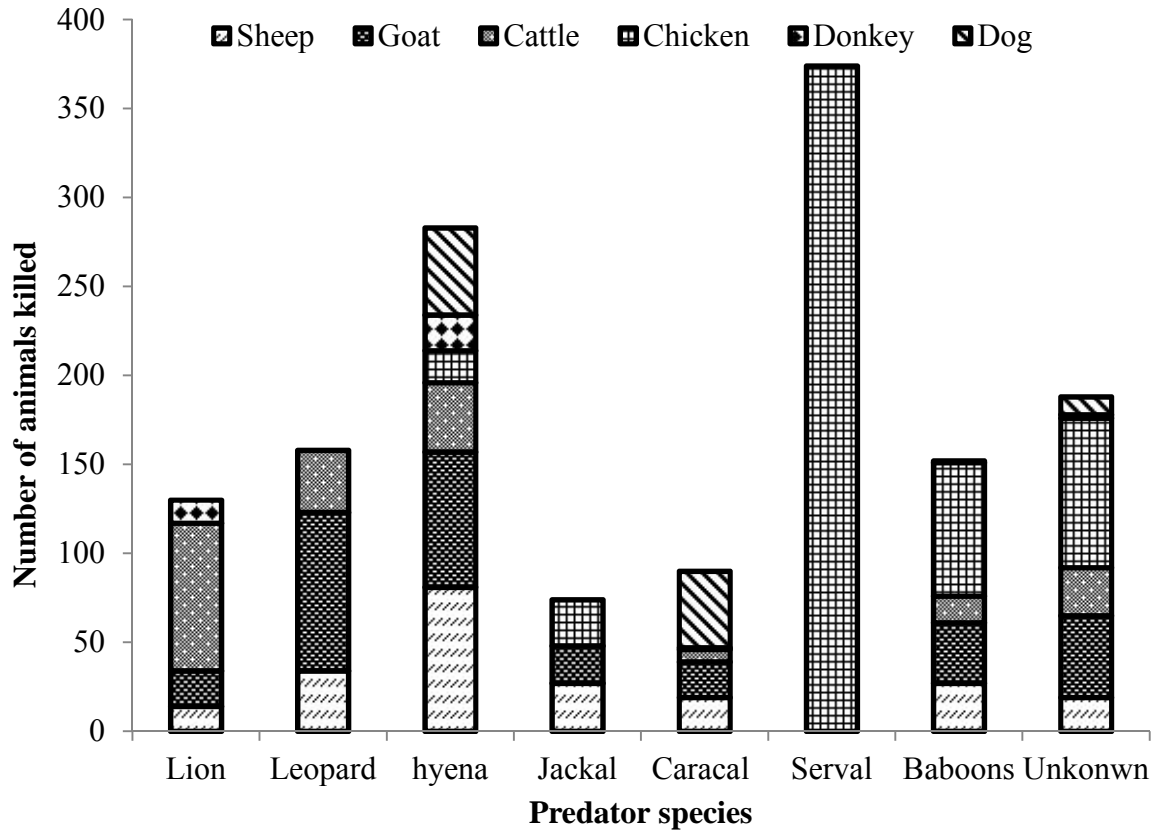


Figure 26. Prey selection by the predator species and number of livestock killed by predators during 2012–2014 in Chebera Churchura National Park

### 3.5.4.5. Wildlife attacks on humans

In the present study area, human deaths and injuries were less common than crop damage and livestock depredation. Mammalian carnivores and herbivores were responsible for numerous fatal attacks on humans (Plate 6). Questioner interview and focus group discussions indicated that the most common wild animals attacking people included lion, leopard, spotted hyena, snakes (different species), elephant and buffaloes. Human attacks were frequently reported from five villages, such as Chebera, Sirri, Dalba, Yora and Churchura. Lions reportedly caused 19% of the attacks, spotted hyena 9.6%, leopards 13%, elephant 19.5%, buffaloes 25.8% and hippopotamus 12.9%. Among such attacks, 67.7% resulted in injuries, and 32.3% of the attacks resulted in death. Mostly death was due to lion attacks (40%) (Table 29).

Table 29. Number of people killed/injured by different wildlife species in Chebera Churchura National Park during the study period (2012–2015)

Wild animals	Type of attack		Site of attack	Time	Activity of victims at the time of attack
	Killed	Injury			
Lion	4	2	In the Park	Day time	Grass cutting
Leopard	-	4	In the Park	Day time	Toilet
Hyena	-	3	Crop field	Night time	Guarding crop
Elephant	2	4	Crop field	Night time	Guarding crop
Buffaloes	3	5	In the Park	Night time	Hunting inside Park
Hippopotamus	1	3	Crop field	Night time	Guarding crop
Total	10	21			31

#### 3.5.4.6. Methods to control wildlife induced damages

There were different approaches adopted by villagers to minimize the wildlife induced damage in the study area. The local people adopted locally available techniques to deter crop raiding and livestock depredating animals. Major techniques deployed was, physical barriers (fence, walls), guarding (watching, watch tower, dogs), fear-provoking stimuli (visual: erection of scarecrows, lighting fires, auditory, exploders, beat drums and distress calls) and chemical repellents (chilies) around the Park (Fig. 27). Watch tower and scarecrow were very common as they were clearly visible in every field bordering the Park. Most respondents reported guarding as an effective method in all villages (85.1%), followed by fear-provoking stimuli (40.9%), physical barriers (27.6%) and chemical repellents (10.3%) (Table 30). Views of respondent of villages were not significantly differed ( $\chi^2 = 48.82$ ,  $df=8$ ,  $P>0.05$ ) in using the different techniques for protection of crops and livestock. No one used only one method alone, but combined and integrated all the local methods to prevent crops raiding and livestock predations.



Figure 27. Different methods of guarding crops by villagers in Chebera Churchura National Park  
(Photo: By Aberham Megaze)

a–b= watch tower in Sirri village, c–d= scarecrows in Yora village

Table 30. Techniques used by villagers to protect crops and livestock in Chebera Churchura National Park

Villages	(n=354)	Type of protection, %			
		Guarding	Fear-provoking Stimuli	Physical barriers	Chemical repellents
Chebera	48	87.4	39.7	30.1	9.7
Serri	21	94.5	44.8	34.8	13.8
Dalba	44	81.4	42.6	33.0	15.7
Yora	42	85.8	43.4	31.9	10.0
Shita	39	82.6	39.6	27.6	5.0
Churchura	48	92.5	41.9	29.1	17.9
Chewda	34	80.7	37.2	19.3	6.5
Gudumu	48	81.0	38.3	20.6	6.8
Adabacho	30	79.7	40.5	21.7	7.5
Mean	354	85.1	40.9	27.6	10.3

The local people in the study area proposed different methods to minimize crop damage and livestock depredation by wild animals. Among the respondents, 71.3% suggested compensation from the government for the damaged crop and livestock depredation. And 12.4% of the respondents wanted to minimize the number of problem animals. Other 9.2% respondents suggested the use of different traditional techniques to minimize the damage caused by wildlife. Only 2.5% of the respondents suggested killing problem animals around them. Few of them (2%) proposed to displace problem animals to other areas. Among the respondents, 2.5% did not respond about the techniques (Table 31). Respondents differed significantly ( $\chi^2 = 74.29$ ,  $df=5$ ,  $P<0.05$ ) in their suggested views to reduce crop damage and livestock depredation by wild animals.

Table 31. Respondents suggestion to minimize the loss of crop damage and livestock depredation by wild animals in Chebera Churchura National Park

Village	Respondents (n=354)	Suggestion, %					
		Kill the problem animals	Displace problem animals to other area	Compen-sation	Use different traditional techniques	Minimize the number of problem animals	Do not know
Chebera	48	2.1	1.2	72.0	11.1	12.3	1.3
Sirri	21	3.7	2.3	67.2	9.0	15.1	2.6
Dalba	44	1.4	1.3	76.2	7.6	10.5	2.9
Yora	42	4.2	2.5	68.5	8.3	13.6	2.8
Shita	39	1.2	0.8	75.9	5.3	12.2	4.4
Churchura	48	3.4	3.0	78.3	4.2	9.8	1.1
Chewda	34	2.2	2.6	64.2	12.2	15.1	3.3
Gudumu	48	0.9	1.5	73.8	13.6	8.7	1.2
Adabacho	30	3.2	2.6	65.5	11.4	14.1	3.0
Mean	354	2.5	2.0	71.3	9.2	12.4	2.5

### 3.5.5. Awareness on conservation

Among the respondents, 45.22% had good knowledge of conservation objectives, whereas 54.78% had no understanding on this matter. Among those respondents who knew the conservation objectives, most of them (31.73%), responded for the purpose of wildlife protection, tourist attraction (20.19%) and for both of the above (19.23%). There was a significant difference among the respondents in the understanding of the purpose of the establishment of the conservation area ( $\chi^2=65.54$ ,  $df=2$ ,  $P<0.05$ ). Most of them obtained the knowledge of the purpose of the conservation area from the awareness creation program of the Park management, from school, during peer discussions and from media.

### 3.5.6. Attitude towards conservation

Among the respondents, 51.4% had positive attitude towards the conservation of wildlife. But, 41.3% had negative attitude, while 7.3% had no idea on this matter (Table 32). There was significant difference in the attitude of respondents towards the conservation area ( $\chi^2 = 31.82$ ,

df=2, P>0.05). Most of the respondents (38.33%) who were positive towards conservation reasoned that they received benefit from the existence of the Park and they also believed that it will be important to save for the future generation. Among those with negative attitude, 33.59% reasoned that they were hindered from the utilization of the wild resource for their own purposes. However, other respondents were angry with predator attacks on the livestock (28.13%), loss of their farmland with permanent crops (21.87%), loss and damage of properties by Park scouts (4.69%) and with unknown reasons (11.72%).

Table 32. Attitudes of people towards the conservation area in Chebera Churchura National Park

Villages	Attitude of local people (%)			
	Respondents (n=354)	Positive	Negative	No idea
Chebera	48	50.6	44.7	4.5
Serri	21	49.1	45.5	5.3
Dalba	44	51.9	41.6	6.4
Yora	42	47.4	45.9	6.6
Shita	39	55.2	35.8	9.0
Churchura	48	49.9	41.5	8.6
Chewda	34	54.3	37.7	8.0
Gudumu	48	53.2	38.3	8.5
Adabacho	30	50.6	40.4	9.0
Mean		51.4	41.3	7.3

### 3.5.7. Focus Group Discussion

The discussants have revealed that activities such as illegal hunting, livestock grazing, wildfire, fuel wood gathering, illegal farming practice, wildhoney and green chili collection were performed by the local people. Hunted animals were elephants, buffaloes, lion, leopard, bush buck, water buck and hippopotamus. They used fire guns for hunting of large animals. Snares and hanging traps were also used by poachers to catch medium to large wild animals. Hunting was mostly carried out during night to avoid being sighted by the Park Patrol Team or the assigned scout. The discussions revealed that the local communities benefited from the Park

resources. Most participants agreed that the resources obtained from the Park area were grazing, firewood, fodder, thatching grasses, wildhoney and spices, wildmeat, timber and job opportunity. Most discussants described the shortage of private grazing land and decreased farmland holding due to the Park around them. This could have increased pressure on the Park area resources for livestock grazing and agricultural expansion. Local communities encroached in to the area of the Park for subsistence agriculture. Based on this issue, few discussants said that if they are supported by government and other stakeholders they were willing and interested to conserve the biodiversity of the Park. Respondents described that to mitigate such impacts due to the illegal activities of the local people, various measures have to be taken by the Park management, such as providing awareness creation, initiatives on the community involvements in the Park management and patrolling the Park area. They also emphasized additional farmland should be provided as compensation and sharing of resource should be allowed. Some of the discussants noted that previously they used to hunt different wild animals and minimize their threat. However, at present, the negative effects of the animals are on the increase. As a result, some of the discussants were dissatisfied with the existence of CCNP. They considered the Park as a limiting factor in improving their livelihood. Some discussants also stated that CCNP has been responsible for their restricted access to resources in the area and further calmed forced relocation. Few discussants considered the Park as useless. They also felt that Park staff members do not like communities around the Park boundaries. They also believed the situation is beyond their control and supported government intervention as a way to find a solution for wildlife in CCNP and the communities around. These few discussants had negative attitude towards the Park management system. Most discussants had positive attitude towards wildlife for its importance to attract tourists, hunting opportunities during drought, enjoyment derived from viewing wildlife and its value for future generation. Almost all discussants had positive attitude towards African elephant even if it raids their crops. Almost all discussants agreed and reported that conserving wildlife is important.

### **3.5.8. Loss of wildlife**

A total of 197 wild animals were killed or died during the study period in CCNP (Table 33). Among these, 34 African buffaloes, 4 lions, 8 African elephants, 5 Leopards, 23 Anubis baboons, 20 bush pigs, 14 common Bushbuck, 18 common waterbuck, 11 warthogs and other

wildlife were found dead due to poaching, revenge of the villagers, wildfire, predator attack and due to unknown reasons. More wild animals were killed by poachers.

Table 33. Wild animals killed in Chebera Churchura National Park due to various factors during 2012–2015

Loss of wildlife due to various factors							
Wildlife killed	Poaching	Revenge	Fire	Predator	Culling	Unknown	Total
Elephant	7	-	-	-	-	1	8
Buffaloes	20	2	-	5	5	2	34
Lion	1	3	-	-	-	1	5
Leopards	3	-	-	-	-	2	5
Anubis baboon	-	7	2	3	6	5	23
Bush pig	3	5	4	5	-	3	20
Bushbuck	10	-	-	3	-	1	14
Waterbuck	7	-	-	9	-	2	18
Warthog	4	2	-	2	-	3	11
Duiker	8	-	-	2	-	-	10
Porcupine	-	7	-	3	-	1	11
Spotted hyaena	1	5	-	-	-	-	6
African civet	-	-	-	-	-	1	1
Hippopotamus	5	2	-	-	3	-	10
Gureza	20	1	-	-	-	-	21
Total	89	34	6	32	14	22	197
Percentage (%)	45.2	17.3	3.0	16.2	7.1	11.2	100

## **4. DISSCUION**

### **4.1. Population estimate and trends**

Detailed studies on the population ecology and dynamics of wildlife in conservation area are fundamental to understand the status, demography and trends of them and to plan appropriate management and conservation activities. Therefore, it is essential to have population estimate of the African buffaloes, from time to time, in order to take suitable management and conservation decisions in CCNP. Separation of the study period in to dry and wet seasons was important to reveal the influence of the two major seasons in the area on the vegetation cover and the distribution of animals. Seasonal changes include alteration in climatic conditions and phonological changes in forage availability and quality, resulting in seasonal herbivore movement. It is also important to understand the habitat requirements of a given type of herbivores in the seasonal contexts, as this is essential in the management of the species during critical seasons when resources are limited (Sinclair, 1977).

The African buffalo population estimate in CCNP showed differences during wet and dry seasons. The wet season census showed high buffalo population estimate compared to the dry season estimates. This was primarily due to the better quality of fodder available during the wet season in the study area. The availability of lush growing grasses and bushes during the rainy season provide better fodder in the grassland habitats. Moderate temperature and cloudy weather conditions appeared to cause the animals to be more active than during the dry season. More young animals (calves and yearlings) were also observed during this season. African buffaloes give birth mainly in the wet season (Sinclair, 1977; Vissher *et al.*, 2004; Turner *et al.*, 2005; Okello *et al.*, 2015), which may explain the results of the present study showing increased population of buffaloes during the wet season. During the dry season, the African buffaloes moved in to riverine and forest habitats of the Park as noted by Macandza *et al.* (2004) and Ryan *et al.* (2006), which made counting difficult. During the present investigation, carcasses of six old bulls were located in the Sirri, around 'Shoshima' river and another in Chebera, Churchura and Yora Peasant Association site during the dry season, supporting the view that there might be more mortality during the dry season as noted by Ryan *et al.* (2012). Shortage of fodder and related physiological stress may also affect calves and yearling. Various stresses in connection with habitat destruction, poaching, predation and diseases as noted by Sinclair (1977), Sutmoller

*et al.* (2000) and Jolles (2004) in the African continent might also have similar effects on the buffalo population in CCNP. There was high proportion of females in the population, indicating that the buffaloes have a potential to increase in number. However, only low proportion of young to that of other aged groups was observed during the present investigation. As the young ones are more vulnerable to predators, they are usually hidden under the dense grasses and riverine vegetation during the wet and dry seasons, respectively. Mortality during the first year of life is high in the African buffalo as the calves become susceptible to predators and diseases (de Vos *et al.*, 2001; Vissher *et al.*, 2004).

The population of African buffaloes had an increasing trend in the present study area. They increased from 2671 heads in 2006 to 5193 heads in 2015. Population size increases of other dominant herbivores were also observed in the present study area. This might be related to the better management activities currently being implemented and the good habitat quality maintained due to reduced anthropogenic disturbances in the Park. Chebera Churchura National Park is at present a National Park. But, during 2006 it was a controlled hunting area. Therefore, there was less effective management activity in the area. Park staff and scouts were employed for effective and regular patrolling of the Park after the establishment of the area as a National Park. Anthropogenic factors that have impacts on the quality and quantity of Park ecosystem might reduce due to better conservation efforts. This might have helped to increase the population of African buffaloes and other wildlife in the present study area. Local respondents also indicated that human intervention was intense before the establishment of the National Park and the area experienced serious environmental problems as a result of deforestation, overgrazing, encroachment and illegal hunting. But, there was better management practice than in 2006. There might also be migration of African buffaloes from adjacent Omo National Park to CCNP, which might also contribute to the increase in buffalo population in the area. Using GPS-tracking on Cape buffalo in the Caprivi Strip (northeastern Namibia), Naidoo *et al.* (2012) showed that part of the buffalo population undertook seasonal migrations. Meseret Ademasu (2006) noted that the African elephants migrated from the Omo National Park to CCNP. Migration of African buffaloes from the adjacent Park might be due to their response to diverse ecological pressures in their habitat. Climatic effects, habitat changes, competition for forage resources, predation pressure and anthropogenic factors might lead African buffaloes to migrate away from their

home ranges as noted by Halley *et al.* (2002) and Naidoo *et al.* (2012). Naidoo *et al.* (2012) have shown that both environmental conditions and anthropogenic factors affect buffalo migration in the tropical environment. Halley *et al.* (2002) also noted that local wildlife migration may occur because of a change in forage quality and quantity, water availability and landscape features such as vegetation composition and structure. Movement strategies allow species to find new resources, escape predation pressure, find new mates and improve their reproductive potential (Scheibe *et al.*, 2009). But, it needs in-depth studies of this notably complex ecosystem in order to gain detailed insight into the interplay of environmental, ecological and anthropogenic factors that affect the population changes of African buffaloes and other wildlife in the present study area.

#### **4.2. Population structure and herd size**

A balanced age structure must be maintained in any animal population for optimal productivity, because deviation from such an age structure could adversely affect the population growth rate. Yet, the ratio of the age classes in a population can be an indication of its current and expected reproductive status (Bothma, 2002). The age ratio of African buffalo population was skewed towards adult populations. One possible reason for the low proportion of young buffaloes in the study area might be due to the presence of predators, such as lion, leopards, hyena and uncontrolled fire exposing the young ones to dangers. A proper count of the young buffaloes was also difficult during the study period as they were usually hidden under the dense grasses and riverine vegetation. Sinclair (1977) and Vissher *et al.* (2004) have also reported that mortality during the first year of life is high in the African buffaloes as the calves were more susceptible to predators and diseases.

The sex ratio of the buffaloes observed during the present study agrees with the earlier observations in different parts of Africa (Grimsdell, 1978; Prins, 1996 and Vissher *et al.*, 2004; Turner *et al.*, 2005; van Hooft *et al.*, 2010). The sex ratio of the African buffaloes in CCNP skewed in favour of adult females. Female-biased sex ratio among adults has been reported in many ungulate populations. Even if an equal sex ratio of animals at birth is assumed, there is an increased mortality in young male ungulates (Ndhlovu and Balakrishnan, 1991; Dereje Yazezew *et al.*, 2011). The possible reason for the skewed sex ratio of African buffaloes may be largely

due to increase in mortality of male buffaloes due to predation. After 10 years of age, male buffaloes leave the natal herd and distribute in less favourable habitats, and suffer an increased predation pressure compared to the females of the same age class, which stay in the natal herd (Sinclair, 1977; Ryan and Jordaan, 2005; Turner *et al.*, 2005). Hay *et al.* (2008) also noted that bulls had almost four times the risk of predation in bachelor groups compared with adult females in mixed herds, while the predation rate of adult males and adult females in mixed herds was not statistically different. Sinclair (1977) also reported that bachelor males benefited from association with breeding herd and reduced the risk of predation by the dilution effect and cooperative defense. Breeding herds use more open habitats than bachelor groups. Habitats that have good visibility might be relatively safe, as they provide for early detection and evasion of predators, and might reduce the risk of attack. In the present study area, adult bachelor herds were observed using the banks of rivers and at the edges of the springs and swamps in the Park, which are habitats that have low visibility of predators. While nursery herds are free to seek the best grazing areas in their home range, bachelor herds remain at the peripheral areas. Poaching also affects adult males in CCNP more than females, as they are chosen for their large size (Abreham Megaze, *et al.*, 2012). Fighting and competition for food and mate may possibly force bachelor males to marginal habitats that are poor in food quality and also exposed them to predators. Prins (1989, 1996) noted that the herd environment is a more physically taxing for a bull because of the demand for moving longer distances, competing for resources, and maintaining social status with other bulls in the presence of cows. He documented changes in the condition of buffalo bulls as they move between social environments, and found that bulls lost body condition while associating in breeding herds and gained body condition when associating in bachelor groups. In some of the animals, it was difficult to distinguish their sex due to invisibility from a distance, and the swift movement of them through the tall grasses and dense vegetation when they were approached during the study period. The large number of breeding females in the present study area indicates that if better conservation measures are taken by the Park management and other concerned bodies, the population of Africa buffaloes will further increase in the future.

In CCNP, buffaloes were seen in smaller herds during the dry season and in larger herds in the wet season. The fusion-fission activity patterns of the herd during different seasons might be

probably be due to changes in the availability of resources as noted by Macandza *et al.* (2004) and Tshabalala *et al.* (2009). Such behavioural adjustments made by the buffaloes in the present study area could be explained by their ability to sustain themselves in their environment. Korte (2008) and Winnie *et al.* (2008) also suggested that herd sizes tend to be smaller where food resources are poor. Cross (2005) noted that as buffalo move through heterogeneous environments, they adjust herd size to accommodate variations in forage distribution and availability (in both quantity and quality), leading to change in herd size. Small herd size of African buffaloes might reflect adaptations to a poor-quality environment, allowing them to better meet their energetic requirements. But, Ryan *et al.* (2006) suggested that seasonal differences in herd size are perhaps influenced by social factors such as mating, not foraging constraints and play in the fission–fusion herd structure. In contrast, herd size of the forest buffalo showed no major variation between wet and dry seasons (Melletti *et al.*, 2007a; Korte, 2008). They lived in smaller herds than the African buffalo, which could facilitate better inter-individual tolerance and reduce competition for food (Melletti *et al.*, 2007b).

During the dry season, in CCNP grasses were dry, fires were common and most of the rivers and streams were dried out. It was observed that buffaloes in CCNP generally avoided both grasslands and woodlands that had been burned, only returning to such areas months after fires. Therefore, during this time, buffaloes disperse and form smaller groups for intensive foraging of the available resources. This might help them to get dispersed forage in all available habitats including those of marginal areas. By living in small herds, they might get access to extra resources that are too sparse for large herds. These strategies of buffaloes may alleviate malnutrition problems during the dry season, as many of the large herbivore populations in the tropics (Sinclair, 1977; Ryan and Jordaan, 2005; Venter and Watson, 2008; Tshabalala *et al.*, 2009). Adult male buffaloes leave the herd and form their groups during the dry season, but they return to the herd during the wet season. Prins (1996) noted that movements of adult bulls into and out of mixed herds were clearly related to changes in physical condition. Bulls entered a mixed herd when their body conditions were good. During their stay in the herd, they lost their body condition. During the bachelor stage, they regained body condition, which indicates better living conditions for bulls with bachelor status than in a mixed herd. A seasonal movement of bulls between herd types was also reported by Funston *et al.* (1994) in the Sabi Sand Wildtuin,

South Africa. Due to their selection of riverine woodland habitats, bachelor males may be in a better condition than bulls in the herd at the onset of the breeding season, giving them a competitive advantage in acquiring mates. Movement of bulls was related to the improvement of body condition in bachelor groups, and diminished body condition in breeding herds was also reported by Prins (1989). Old males remain permanently separated from the large breeding herds and form their own bachelor herds of 3–4 individuals, as indicated by Macandza *et al.* (2004) and Venter and Watson (2008). The present observation shows that herds of 2–4 old males in the dry season always forage in small patches of green grass, on the banks of rivers, and at the edges of the springs and swamps in CCNP. Young males move away from the herd in the beginning of the dry season. Even dominant males may leave the herd for part of the dry season. Unlike African buffaloes, adult male forest buffaloes were consistently observed with the same herd throughout the year (Korte, 2008). Eltringham and Woodford (1973) reported that African buffaloes were congregated in larger herds of 51–100 individuals. The average herd size in the Serengeti was 350 individuals (Sinclair, 1977). But, in the present study area, the herd size of the African buffalo was smaller. This smaller herd size of the African buffaloes in the CCNP may be justified in the context of patchiness and quantity of food resources on the landscape. The pattern of herd size in different habitat types of the study area was different. During the wet season, *S. caffer* formed larger aggregations in grassland with scattered trees than in the forest and riverine habitats. This might be due to the abundance of food sources in the grassland as compared to the dry season, to support large feeding herds of African buffaloes. Individuals of forest buffaloes distributed themselves in a more aggregated spatial pattern when resting in clearings than in forest (Melletti *et al.*, 2008, 2010). Korte (2008) also reported that forest buffaloes depend on open habitat adjacent to continuous forest for resting. In CCNP, late dry season is the most critical time for the African buffaloes. During this season, the buffaloes move into riverine vegetation. This is probably related to the habitat complexity and stability as compared with other habitat types. Even though the habitat is of high quality, it may not be able to support large herds of such large mammal populations. Hence, it becomes essential for them to be in smaller herds, as small herds can utilize scattered resources more efficiently than in large herds.

### **4.3. Distribution and habitat association**

A central focus in animal ecology is to consider the association of an animal with its environments, particularly the varieties of habitats it occupies or prefers. Habitat selection by animals reflects a strategy that enhances survivorship and successful reproduction (Western, 1975; Funston *et al.*, 1994; Bennitt *et al.*, 2014). Therefore, knowledge about the relationship, habitat preference and the ecological requirements of large herbivores are important for any wildlife management programme, and to gain an understanding of animal ecology. Habitat selection by an animal relates to the fitness of that animal to that habitat which it prefers. Availability of food, the extent of the area available for various activities, absence of competition, cover to escape from predators, availability of surface water, opportunity for reproduction and escape from climatic extremes, all determine the preference of herbivores for a specific habitat type (Funston *et al.*, 1994; Bennitt *et al.*, 2014). Water and pasture conditions or a combination of all essential resources act as major factors governing the distribution of wildlife in natural habitats (Western, 1975; Grimsdell, 1978; Balakrishnan and Essa, 1986; Smit, 2011; Bennitt *et al.*, 2014). Herbivores also require a certain level of protein in their forage. Almaz Tadess and Masresha Fetene (1999) showed that during wet season, the biomass of the grass species reach their peak. On the other hand, the protein content of the grasses decline during the dry season, as a result of which, the herbivore community face shortage of nutritionally rich food during the dry season. It was noted that the crude protein contents of grass falls below the maintenance level required for the ruminants during the dry season. The present observation on buffaloes in CCNP also confirms this. Habitat requirements of African buffaloes were closely associated with the availability of surface water, nutritionally rich food and protection in CCNP.

Buffaloes show seasonal differences in their habitat selection. The seasonal pattern of diet quality was reflected in the loss and gain pattern of body conditions of buffaloes over the season. It was observed that they have peak body health conditions at the end of the rainy season or the beginning of the dry season and it was lowest at the end of the dry season. They also respond to different forage quality and quantity by altering their home range size and herd size as noted by Ryan *et al.* (2012). A comparison of the seasonal changes in habitat association of the buffaloes in CCNP shows that the buffaloes have high preference for riverine vegetation during the dry season and grassland vegetation during the wet season as reported earlier (Ryan *et al.*, 2006;

Aremu *et al.*, 2007; Cornelis *et al.*, 2011; Prins and Sinclair, 2013; Bennett *et al.*, 2014). Late dry season is the most critical time for buffalo populations when the forage quality and quantity decrease, streams dry, temperatures increase, and grass fires common in the present study area, forcing the African buffaloes to leave both grassland and woodland habitat. During this period, they move in to riverine vegetation and tend to concentrate near the riverine habitat and lake shores as their essential food and water requirements could have been met with in this habitat type. Furthermore, protection is also available in this habitat. This is probably related to the habitat complexity and stability as compared to other habitat types.

The riverine vegetation is high in species richness (Redfern *et al.*, 2003). The Meka riverine vegetation located in northern part of the CCNP is a narrow strip, with permanent water resources and a hot spring, which supports an exceptionally high density of buffaloes and other large mammals such as African elephants. It was observed that African elephants were important in checking the growth of bushes and to promote grass regeneration, thereby creating conducive habitat for the African buffaloes and other large wildlife in this habitat. But, patches that were used by buffaloes during the dry season were also grazed by elephants and other grazers. Grazing by these competitors may reduce the amount of food for buffaloes. Ecologically, African buffaloes are important by opening up habitats that are preferred by short-grass grazers (Winterbach, 1999). But, the riverine habitats located near human settlements. Thus, human impact was high in this area. It was observed that the buffalo herds were very shy in this habitat, presumably because of poaching. The dependence of local people on Park resources for their livelihood was very high in this habitat. The hot spring, which is located around the riverine vegetation has a large influence on the seasonal movement of people and livestock in the Park, and the sustainability of the practice has been questioned and remains a central issue for conservation of wildlife in the area. The forest also appears to satisfy all needs, but small patches of grass and other food sources. Therefore, it is more important to these small herds of buffaloes, especially bachelor males, as the small groups could feed on the scattered shade grasses in the forest more efficiently than the large herds.

Forage and water availability are important in terms of influencing distribution and behaviour of African buffaloes (Sinclair, 1977; Prins, 1996). Seasonal distribution of buffaloes in the area

correlated with the availability and abundance of green forage and water in different habitat types. Comparison of the seasonal changes in habitat association shows that the buffalo has high preference for riverine vegetation in the dry season and grassland vegetation in the wet season. During the wet season, African buffaloes were observed in grasslands with scattered trees. It was common to observe a large population of the species in grasslands. They gradually moved from the main riverine vegetation as the area became wet. The flooded riverine habitat may force the animals out or to the grasslands with scattered trees that had previously been burned during dry season which has re-growth as lush green sward, at the intermediate stage of growth. Therefore, selection for grassland habitat during the wet season coincided with increased productivity in that habitat due to the growth of annual grasses. But, during the dry seasons (especially in January and February) clumped distribution of buffaloes was observed in the riverine vegetation. The association of buffaloes with the riverine vegetation increased significantly from the end of the rainy season. In addition, tufts of grass that grow in *Combretum*-dominated woodland areas persist into the dry season with green growth. Therefore, only small number of buffaloes was observed in woodland.

Therefore, the optimum habitat (the highest positive association) for buffaloes during the dry season was the riverine vegetation in the present study area. During the wet season, previously avoided vegetation type was utilized to a greater extent as they become more suitable feeding habitat as a result of the rain, and the buffalo concentration in the riverine vegetation decreased. Scattered distribution was observed particularly when the rain was evenly distributed in the Park. The present study shows that African buffaloes showed an almost random association with the four habitat types (scattered tree grassland, woodland, forest, riverine forest) through out the study periods. Their distribution was not uniform across the four main habitats in the study area. This confirms with the study of Sinclair (1977) in Serengeti National Park of Tanzania. Burning practice of the area is found to be one of the main factors influencing the movements and distribution of African buffaloes and other wild animals especially during the dry season. Moreover, poaching was a major factor concerning their distribution in the study area.

#### 4.4. Diurnal activity patterns

In natural habitats, animals spend most of their time in foraging activities (Beekman and Prins, 1989), and the activity patterns are correlated with their daily mode of life (Delany and Haplod, 1979). For ruminants in general, a regular daily pattern of alternating feeding and resting bouts is typical (Scheibe *et al.*, 2009). Similarly, the present observations showed that the feeding activity of the African buffaloes was longer than other activities. Further, they spend a significantly greater proportion of time feeding during the dry season than during the wet season. This might be related to the decrease in the availability of food and shortage of its nutrient quality during the dry season. Hence, they spend more time looking for green, palatable grasses in the dry season than in wet season. Prins (1996) noted that under different food conditions, buffaloes can choose different ways of partitioning their time budget. Winnieet *al.* (2008) also reported that in savannah ecosystem, as the dry season progresses, available forage lignifies and becomes unpalatable to the point where even a bulk grazer must become selective. High feeding peaks in the early morning and late afternoon were as a result of low temperatures and limited disturbances by human activities, creating conducive feeding atmosphere. Ambient temperature is the main cause in reducing or even terminating grazing activity and initiating resting during the middle of the day (Grimsdell and Field, 1976; Mloszewski, 1983; Taylor, 1989; Funston *et al.*, 1994). Lewis (1977) found that ambient temperature accounted for more than 80% of the variation in the daily activity of African buffaloes as they were highly susceptible to heat stress due to their coat characteristics. Similarly, Melletti *et al.* (2007b) reported that grazing and resting were the main behavioral activities of forest buffaloes between water and forest edge. But, they did not record an increase in grazing during the dry season, probably because there is much less seasonal variation in tropical rain forest than in savannah ecosystems.

Resting was the second important activity of buffaloes in CCNP during both the dry and wet seasons. During the wet season, buffaloes spend long time without grazing, presumably because of the better quality food they have in the habitats around. But, no significant change was observed in the grazing pattern of forest buffaloes, except for resting during wet and dry seasons, probably due to less seasonal variations in tropical rainforests compared with savannah ecosystems (Melletti, *et al.*, 2007a). Buffaloes had a long mid-day rest after the morning grazing

peak, when temperature increases (Turner *et al.*, 2005; Melletti *et al.*, 2007a). During the mid-day, buffaloes rest under shades to escape from the intense heat of the day. Ryan and Jordaan (2005) found that African buffaloes tend to rest more during the day time than during the night. They also pointed out that buffaloes spend significantly greater proportion of time feeding during night. Wallowing was another observed activity of bulls in the wet season. This was clearly associated with high atmospheric temperature. Apart from a thermoregulatory function, it has been suggested that wallowing might have an effect to control ectoparasites (Sinclair, 1977; Prins, 1996).

Water may not be a limiting factor for buffaloes in the present study area. During the present study, two main period of diurnal drinking was observed in the early morning and afternoon hours, in both the dry and wet seasons. Previous studies have indicated that buffaloes drink only once a day (Sinclair, 1977). Winterbach and Bothma (1998) found that African buffaloes drink in the early afternoon in Willem Pretoria's Game Reserve, whereas Grimsdell and Field (1976) found that they drink in the mid-morning in Ruwenzori National Park in Uganda. This shows that there might be differences in the timing of drinking based on the habitat types or the geographical locations. Feeding and resting activities of an animal fluctuate diurnally in response to environmental factors. In the present study area, food and temperature might be the major factors responsible for such behavioural variations of African buffaloes.

#### **4.5. Anthropogenic activities and human–wildlife conflict**

##### **4.5.1. Socio-demographic variables**

Many factors such as personal beliefs and experiences, different economic, legal, social and ecological concerns affect the attitude of local people (Adams and Hulme, 2001). In developing countries, education, gender, age, religions and ethnicity are important predictors of conservation attitudes, among demographic variables (Sah and Heinen, 2001). Of the socio-demographic factors examined in the present study area (education, age, gender, family size and religions), education and age were important predictors of the relationship between local communities and protected area.

Education was an important factor in understanding the role of protected areas and conservation, and hence influenced attitude towards conservation. The value people place for wild animals will often depend heavily on their understanding of the value of wildlife (Mishra *et al.*, 2003). Finding of this research also indicated that those respondents who were educated had more positive attitude towards conservation than those with less or no education. In the present study area, the younger residents tended to have better education levels than the older respondents. This might be due to the fact that the former had access to education than their counterparts who lived in the past. The educated people have more knowledge on conservation related issues, which could have resulted from high level of interaction at learning or educational institutions and exposures with media. This may be attributed to high level of understanding of the importance of wildlife conservation among the educated people as indicated by Anthony (2007). Keane *et al.* (2010), Tomi evi *et al.* (2010) and Liu *et al.* (2010) also reported that higher levels of education associated with higher environmental awareness and understanding, as well as development of positive attitude towards conservation. The role of education is a key to better opportunities for employment, and therefore, a means for alternative livelihood, which might also explain this result. Local people with good education level were participating not only on agricultural activities, they were also involved in other activities such as anti-poaching (scouts), accompanying tourists and working in local government organizations. This might reduce their dependency on resources from the protected areas. Thus, they had less contact with Park resources. Anthony (2007) also indicated that education provides one dimension of economic heterogeneity through differential earning opportunities, and illiterate people are likely to harvest more Park products than educated people. These findings concur with those at Koss Tappu wildlife reserve in Nepal, where respondents with higher household literacy rates had positive attitude towards the reserve (Heinen, 1993). It is also similar to the findings of Akama *et al.* (1995), who have reported that as the level of education increases, the level of negative attitude towards the reserve and conservation activities decrease. The present result, however, contradicts with the findings from South Africa, where all the levels of education negatively influenced conservation attitudes, mainly because users equated conservation with the prevention of access to resources (Robertson and Lawes, 2005). There are also studies that do not show any correlation between attitude and education. Gadd (2005) in his study found that education level had no effect on attitudes. It can be inferred that a society with high percentage of educated

people may have high level of awareness than those with low level of education to influence positive attitudes. A low level of awareness regarding conservation issues and protected area management practices with the lack of involvement of the local community in the decision making processes and in management groups might also be important determinants of negative attitudes of the local people at the present study area (Bitanyi *et al.*, 2012).

Conservation may be quite difficult in the future in areas like CCNP with poor level of education of the community living around. Educating the public about the potential benefits associated with a protected area can be an important tool in avoiding and resolving protected area conflicts, especially over the long-term, and can be critical in gaining support for the establishment of a protected area. In situations where protected areas have been established without prior public education, consultation, or dialogue with local communities regarding the reasons for and benefits of the area, the predictable outcome has been conflict, especially when there has been a negative impact on local communities associated with the protected area, as evidenced from different parts of the African continents.

As a factor, age has a significant influence on the attitude of the local people towards conservation. Young age class showed positive attitude than adult age class. It might be due to the fact that younger respondents were more educated than adults. Further, the older respondents with large herd size are more dependent on Park resources for their subsistence. As a result, any restriction on the resource use or lack of involvement in decision making can generate less favorable attitudes. The elder respondents also felt that the Park would threaten their economy by reducing access to expanded farming and pasture land, settlement, fuel wood collection and extraction of forest products. They were also more likely to have been adversely affected by the wildlife damages and restriction in their use associated with the reserve's establishment than younger respondents. On the other hand, the young people may not take a risk of going into the Park to undertake Park-related activities and agreed that the extent of the protected area was inadequate and therefore should be increased in size. Similar results were reported for older residents in five protected areas in Tanzania; when they supported for abolition of protected areas more than young residents (Newmark *et al.*, 1993).

Gender, religious affiliation, and marital status were not significant predictors of conservation attitudes of local people in the present study area as indicated by Kaltenborn and Bjerke (2002). It might be because of equal access to Park benefits regardless of gender and religion, and that the costs of the protected areas have affected both gender and different religious groups. Occupation of the respondents also had effect on their attitude. Most of the respondents mainly depended on livestock and crop cultivation as sources of household income. Thus, respondents who derived income from farming and livestock tended to hold negative attitude towards conservation area. On the other hand, respondents who had other sources of income tended to be more positive towards conservation area. Livestock holding were important predictors of the relationship between local communities and protected area. Those with more livestock had negative attitude towards protected areas than those with less number of livestock. People with more cattle are more likely to interact with the protected areas through restrictive, prohibitive and punitive laws. They are likely to be arrested and fined when found with livestock in the protected areas. Kaltenborn *et al.* (1999) also noted that the negative attitude towards large carnivores was correlated with the number of livestock which one held. The present result also shows that large family size had a positive relationship with park dependency than small family size. The effect on the probability of Park products utilization of increased family size is further pronounced when the household lacks other income generation options such as formal employment. They had also negative feelings towards conservation efforts. This is related with the restrictions imposed by the reserve authorities in collecting Park resources. Demand for additional farmland and pasture might be another recurring source of conflict between Park staff and local communities in CCNP. Kgathi *et al.* (2004) also found a positive significant relationship between household size and firewood consumption in Mmankgodi, Botswana.

#### **4.5.2. Conservation-related conflicts**

##### **4.5.2.1. Livestock grazing**

Protected area management, particularly in the developing world, faces many challenges. Among these, Park–people conflicts are very serious. Restrictions imposed on resources use, crop damage by wildlife, human injury and death caused by wildlife, livestock losses to big cats, and exclusion of local communities in the decision making processes are some of the causes of Park–people conflicts (Heinen, 1993). Most of the local people around CCNP areas were dependent on

subsistence agriculture and livestock rearing, and their household economy depended mainly on agricultural and livestock production. Mizutani *et al.* (2012) noted that livestock constitutes a major financial and social asset for the rural poor, particularly in Africa where it acts positively in times of droughts and poor harvest. Among the various human activities undertaken in the present study area, livestock grazing, firewood collection, wildfire, hunting, and farming had the greatest impacts on biodiversity in CCNP. Grazing was the predominant anthropogenic activity in the area. Cattle, goat, sheep, donkey and horse were the major livestock reared and provided important source of income and nutritional supplements for the respondents. Thus, livestock usually intensively compete with wild animals for same habitat resources, including forage and water sources, and might have strong impacts on wildlife, their habitat and overall ecosystem function and structure. Cleaveland *et al.* (2002) indicated that interactions between livestock and wildlife populations are a key issue in livestock economies worldwide, particularly in east and southern Africa, where many communities live in close contact with wildlife. Most of the respondents consider the Park as their communal pasture area and they rely on the Park for grazing and watering of their cattle, especially during the dry seasons. They did not agree with a ban on livestock access to the Park. It was observed that livestock encroached up to 5–10 km inside the Park to graze and access surface water during the dry seasons. They were herded deeper into the surrounding grasslands, riverine forest and woodlands, but in the wet season, livestock grazing was concentrated near the settlements due to the availability of surface water and forage resources. This dependence of local people on the resources of the Park might affect wildlife management practices. Demeke Datiko and Afework Bekele (2011) also observed similar problems in Nechisar National Park in Ethiopia.

Extensive livestock encroachment in the predominantly wildlife grazing zone might lead to their direct or indirect interactions enhancing chances for disease transmission, competition for forage resources, and influence the habitat use of wildlife, mostly during the dry season, when resources are limiting. For example, the mineral spring water locally known as ‘Hora’, which was used by wildlife, especially African buffaloes and elephants, was much encroached by expanding livestock. As a result, wild animals avoided use of ‘Hora’ during the day time. Discussions with the local people have revealed that the mineral water has medicinal properties, and considered to act as an appetizer, which would help to enhance milk production in cattle. As the diet of the

cattle and the large wild herbivores were overlapping, the wild herbivores suffer from competition by being excluded from the important forage sources due to the over exploitation of livestock. Thus, the impact of livestock activity affects range quality for wildlife and might reduce the potential for ecotourism by reducing the quality of wildlife viewing as indicated by Oladeji *et al.* (2012). Stephens *et al.* (2001) also noted that the high number of livestock has negative impact in the Bale Mountains National Park in terms of tourist attraction. The increase in livestock numbers in the Park also resulted in the increases in livestock depredation by large carnivores and causes conflict between local people and wildlife and also the Park managements.

#### **4.5.2.2. Firewood extraction**

According to the respondents, most of the local people used the resources of the Park. Trees were cut for construction of houses, firewood and for livestock fences. Collections of spice/medicinal plants were major threats to wildlife in CCNP area as noted by Giliba *et al.* (2011) on Meru catchment forest reserve in Tanzania. The most used resources of the Park at the local level were firewood. Firewood was the main source of energy for domestic purpose in the study area. The most common method used by households to collect firewood was cutting the fell down dried wood from the ground. However, when dried firewood is scarce, households employed other alternative measures to ensure energy security, by cutting live trees and small medium sized branches from trees, which have ecological impacts leading to deforestation and land degradation. It might have also a negative impact on wildlife because trees provide a habitat for a wide range of wildlife, and when removed, could lead to local extinctions. It might also minimize the feeding ground and mating site of the wildlife in the Park. Some times alternative fuel sources such as cattle dung, trees on farm and agricultural residue (crop residues) are also used by local people, and this might help to decrease pressure on the firewood extraction from the Park. It was observed that in some villages such as Delba, Gudumu, and Shita, household travel longer distances (about 3 km) and spent more than two hours for firewood collection. Those who live closer to the Park collect firewood more frequently than those who live far areas from the Park. Field observations have revealed that women and children were the main firewood collectors. The possible explanation for female being firewood collectors and users in the study area appeared to be in keeping with the traditional role of women as the cook at home. This might affect women's participation in other socio-economic activities as well as the level of

education of children. Collection of firewood might also affect children's enrolment and performance in school. The problems were more chronic in the wet season of the year. It was frequently observed that many of the local people go to the Park area to cut trees and collect wood during the wet seasons. They also frequently debark standing trees in the plantation to get materials for traditional beehive building. Lack of alternative energy sources in the study area might lead more people to depend on the reserve directly for resources. The local people had no access to modern energy sources such as electricity, solar energy and biogas. Therefore, firewood remains the primary source of energy and local people were heavily relied on firewood and traditional mud stove instead of modern stoves such as kerosene and gas stoves. They also use thatch as roofing material, traditional medicinal plants, timber for house construction and furniture and grasses and tree fodder as livestock feeds. This dependence on the resources of the Park might increase conflict between local people and Park staff and further might affect wildlife management practices in the present study area.

#### **4.5.2.3. Illegal hunting**

Human population increase, encroachment, and illegal activities such as hunting in protected areas, result in habitat loss and degradation thus influencing wildlife abundance and their distribution (Metzger, *et al.*, 2010 and Scholte, 2011). Illegal wildmeat hunting is a serious threat to the conservation status of many species in Africa (Coad, 2007; Nielsen and Meilby, 2013). Even in parts of comparatively affluent countries such as South Africa and Botswana, illegal wildmeat hunting is a significant threat to conservation (Bushmeat Crisis in Africa, 2004). The CCNP, like many of Africa's protected areas, has also been under increasing pressure from hunting. This study has revealed that illegal hunting was fueled by various factors, including the need for wildmeat for household consumption, commercial trade in wild animal products in order to raise income, for sale of animal body parts for quick cash income of people with few alternative livelihood options in the study area, revenge killing and as a way to minimize human-wildlife interactions. In addition, revenge killings of wildlife after arrests of local people were also recorded in the present study area. Respondents reported that most illegal hunting was fueled by human-wildlife conflicts, such as crop raiding and livestock depredation. This might be related with the views of villagers, that hunting of problematic animals is a good way to scare off crop raiding animals and reduce depredation of their livestock. Hunting of problematic

animals by villagers has also been reported in Serengeti (Kaltenborn *et al.*, 2005). Ungulates going out of the reserve in search of palatable grazing during the rainy season when some part of the reserve often floods, come across farms, which are very near the reserve boundary, and hunters might take advantage of the situation under the umbrella of protecting their crops and depredation of their livestock. The link between illegal hunting and human–wildlife conflicts reported in this study is comparable with earlier reports from elsewhere in Africa. For example, in eastern and southern Africa, demand for more land for agricultural and livestock production has increased antagonism between humans and wildlife to the level of illegal hunting of problem animals (Wilfred, 2010).

A large percentage of people interviewed admitted hunting crop raiding animals and expressed great dissatisfaction with the Park authorities for not doing anything to prevent crop raiding and predation of livestock. Focus group discussions also indicated that farmers around CCNP regard hunting as one effective method to protect crop and livestock from wildlife than only guarding. They stated that they were forced into illegal activities to protect their livelihoods, irrespective of whether hunting is legal or not. The discussant revealed that buffaloes found outside the Park should be killed and eaten by communities in compensation of their lost crops. This report was also supported by Borner *et al.* (2007) and Skonhofs (2007), who revealed that if the local people bear the actual cost of conservation without obtaining significant benefits from it, they will develop negative attitude towards wildlife conservation. People who advocated hunting in the Park have farms located near the Park edge and are consequently likely to be most affected economically by crop raiding and depredation of livestock. This might be because their farms were visited regularly by wild animals, due to the proximity to the Park edge and losses from their farms had a relatively greater impact because the owners relied on a greater percentage of the crops and livestock in order to survive. The respondents also indicated that illegal hunting is typically more frequent in areas with poor anti-poaching enforcement and tends to be high when food-shortages were severe. From a wildlife conservation standpoint, agriculture has the potential for ensuring food security, and thereby reducing wildlife exploitation as indicated by Fa *et al.*(2003) and Wilfred and MacColl (2010).

Hunting is undertaken as a means to supplement household food, for financial gain through the sale of animal products or as retaliatory killing. The residents around CCNP area clearly indicated that community involve in illegal use of wildlife resources, although few of the informants denied illegal hunting of wildlife in CCNP. Respondents from Yora villages were more reluctant to admit the presence of poaching activities in their areas. It was observed that the respondents' fear of disclosing information and specific non-responses to sensitive questions on illegal hunting. Likewise, some respondents seemed to provide information defending the communities against the legal systems. This might be because poachers were afraid of being arrested or imprisoned due to strengthened law enforcement. Respondents indicated that most illegal hunters were local people and they used wildmeat as an alternative protein source to meat from livestock. In some cases, wildlife is hunted specifically for body parts that are used for traditional ceremonies or for sale. Focus group discussions have revealed animal products to be commercially traded included ivory from African elephant, skins from species such as leopard, lion and *Colobos monkey*. The respondents from Delba and Sirri villages also indicated that illegal hunting was conducted for traditional and cultural purposes. They reported that the mane of lion and leopard skin were used to make helmets for male dancers during the ceremonies. Big antelopes such as bush back and buffaloes skins were used in the past for making traditional beds for adults and mats for drying grains (maze, teff and sorghum), and were also used in the past for making traditional bags for storage and carrying grains and the sleeping mats. Ivory was used for making traditional dancing rings wore during the ceremonies. Some antelope horns were used as whistles in traditional ceremonies.

Result of the present study suggests that illegal hunting was strongly related to the distance of the village from the Park boundary. The relationship between wildlife exploitation and distance from protected areas has also been reported in other wildmeat studies elsewhere (Coad, 2007; Smith, 2008; Nyahongo *et al.*, 2009; Coad *et al.*, 2010). The results of this study suggest that poaching by people living around the Park was higher than by villagers who were far from the reserve. Most of the study villages adjacent to CCNP were within 1-3 km of the reserve boundary. These were the most problematic villages as far as wildlife poaching was concerned. Being closer to the reserve might be advantageous because of easy or cost effective access to wildlife resources. Greater distances mean increased time, effort and costs for hunters to find wildlife and transport

meat or other wildlife products to their home or place of sale. Greater time spent in protected areas also increases the risk of being apprehended by scouts. The result of the present study also revealed that Park areas close to human settlements had low counts of buffalo population compared to areas further inside the park, possibly due to illegal hunting and competition for forage with livestock. During the study period, it was observed that large numbers of African elephants tended to concentrate close to the Park headquarters, possibly for security reasons as reported earlier (Balakrishnan and Ndhlovu, 1992). During field observations, the presence of human footprints was located within the Park area, which made it impossible to distinguish between the footprints of honey or firewood collectors and illegal hunters. Focal discussions indicated that honey collecting was a cause for illegal hunting. It provided a legal reason to enter the reserve, but managers and rangers complained that the majority of people were using this permission to mask illegal activities, particularly hunting, once they were within the Park. Poachers were typically caught when game scouts located and followed spoor. When they were deployed in areas where poachers were known to use snares, the scouts were allocated firearms. However, generally they were not armed due to the fear among the management of liability in the event of a fatal interaction between scouts and illegal hunters. Field observations showed that Park scouts were dissatisfied in their work due to inadequate salaries, equipment, training and effectiveness of anti-poaching in CCNP. The respondents indicated that most illegal hunters were with low levels of education and livestock ownership and in some cases, hunters enjoyed elevated social status as a result of their profession as noted also by Brown (2007).

Illegal hunters preferred a range of animal species with different body size, from large to small-bodied animals. African buffaloes, African elephants, water buck, bush buck, bush pig, common warthog, leopard and lions were among the most targeted and preferred species, whereas hippopotamus were amongst the least targeted and illegally hunted species. Differences in illegal hunting animal preferences and targeted species might be explained by variations in the abundances of animal species. Abundant large herbivore species were more frequently mentioned as being preferred than less abundant species. Ndibalema and Songorwa (2007) and Averbeck *et al.* (2009) have also reported that large herbivore species are the prime target for illegal hunting. A variety of illegal hunting methods were used in the CCNP. Common hunting methods include snare, firearms, poisoning and hunting with dogs. Snare hunting methods were

the most commonly employed hunting method in CCNP, this might be because snares were silent killer, easy to use, easily available hunting tools because they were constructed by local blacksmiths from steel car springs and were produced in a range of sizes from those large enough to catch buffaloes, to those designed to kill small antelopes. The local people also used snares made from tree barks or from animal skins. It has been suggested that with increased law enforcement efforts in the area, illegal hunters were likely to switch to less detectable methods such as snaring. Snare trapping is a particularly undesirable hunting technique from a conservation perspective. It was difficult to locate, making trapping challenging to control, indiscriminate killer and affected most mammals including some species not generally considered food items (Hofer *et al.*, 2000; Fa and Brown, 2009; Muboko, 2011). Snares occasionally injured humans. The hunting methods least reported in this study were using poisoning, use of dogs and wildfires. Firearms were most commonly used to target large mammals such as African elephant, African buffaloes and common warthogs. This hunting method enabled the killing of larger game within a shorter period, therefore, economically more profitable. Private firearm owners, some local “community police” and scouts might have been potential sources of firearms used in illegal hunting.

In the present study area, crop loss from wildlife and livestock depredation-derived hunting was at as a high level as the need for wildmeat. Poverty might also have been a reason for hunting wild animals in the area. As indicated by the respondents, wildmeat was the cheapest source of protein and it represented a crucial source of meat for the poorest households around the CCNP. A recent study by Lindsey *et al.* (2011) in south-eastern Zimbabwe also reported that key drivers of the wildmeat trade included poverty and food shortages, failure to provide benefits to communities, inadequate investment in anti-poaching in some areas under wildlife management and weak penalty systems that do not provide sufficient deterrents to illegal wildmeat hunters. On the contrary, in Gabon and Equatorial Guinea, wealthier households consumed higher proportions of wildmeat than poor households (Wilkie *et al.*, 2005; Fa and Brown, 2009). The result of this study also supported by other studies in Serengeti, which indicated that most local people considered wildmeat and wildlife body parts to be a source of protein and a means of generating income (Barnett, 2000; Campbell *et al.*, 2001; Holmern *et al.*, 2007; Nielsen *et al.*, 2013). Most of the respondents perceived that illegal hunting activities had declined in CCNP

between the years 2006 to 2015 due to increased Park protection by strengthened law enforcement. Increasing conservation awareness and education would help to further reduce illegal hunting and promote wildlife conservation. Most studies of illegal hunting in developing countries commonly take the view that illegal hunting is poverty-driven. The assumption is that alternative economic income opportunities and increasing opportunities for employment would have a positive effect on reducing illegal hunting activities.

#### **4.5.2.4. Wildfire**

According to the results of the present study, contribution of natural fires such as those caused by lightning is very small in comparison to the number of fires set by humans. Anthropogenic activities such as wild honey extraction, land clearing for shifting cultivation, obtaining good quality pasture for livestock, controlling the harm by wildlife such as snake and collection of the fire-killed wood in the boundaries of the Park increased the occurrence of fire during the dry seasons. The vast majority of wildfires were intentionally set for illegal hunting and extraction of natural resources from the Park. Informants revealed that illegal hunters frequently burn areas prior to hunting, to stimulate grass growth to attract wild games for better hunting, to make open foot tracks for better visibility and protect themselves from wild animals. Field observation in Park also indicated that local people practiced the production of honey through traditional means. The source of traditional honey production was both from the natural caves and man-made beehives. Honey collectors use many areas of the Park for traditional bee-hive hanging. But the Park management frowned at this practice because this was presented as a source of sudden fires that might ravage the Park. When the local people cut honey, they use fire in order to scare and smoke out the bees to avoid the sting.

According to the local informants, the local people set fire to protect themselves and their livestock from predator attacks. There were an increased risk of cattle loss to lion, hyenas and leopards in tall grass and shrub vegetation. Therefore, the local people near the Park boundary burnt heathland so that the cattle could spot lions, hyenas and leopards from far and avoid them. Reptiles were also feared and so villagers burn to clear vegetation around the village to increase visibility and reduce reptile habitat. Furthermore, public road users set fire around road side of the Park to clear paths for ease of walking and visibility. Human encroachments near protected

areas that have attributed to increase in fire occurrences were also reported for Gonarezhou National Park, Zimbabwe (Gandiwa *et al.*, 2013). Field observations also indicated that, during the dry season the study area was left as a fire mosaic, with different areas burnt at different times. Regular burning has significant ecological effects on the wildlife living in the affected ecosystems. Some of the direct effects of fire on ecosystems fauna is immediate death, smaller mammalian species and reptiles are burnt to death; however, other are wounded and die later due to injuries sustained during fire occurrence in their habitat (Hassan *et al.*, 2008; Klop and van Goethem, 2008). In the CCNP, some animals, such as baboons, bush pigs and snake have been recorded to have died as a result of wildfires (Park staffs, personal communication). Fire burning also might affect the distribution of large wild herbivores such as African buffaloes and African elephants during the late dry season. Recently burnt areas with no re-growth were avoided by most of large mammals. However, it was also observed that buffalo herds continuously shifted the majority of their feeding activity to those patches that were burned most recently and with re-growth of grasses.

#### **4.5.2.5. Illegal farming**

Other anthropogenic pressure in the CCNP was agricultural activities. Focus group discussions revealed that historically, encroachment on wildlife habitats for agricultural activities and illegal hunting have been employed in the Park. Local community living in the surrounding area used to encroach into the Park area for shifting cultivation and livestock grazing for a long period of time before the establishment of the Park. Especially the people from Chebera, Sirri, Shita, Yora and Churcura villages had been practicing illegal farming in the Park area. Human population growth around the Park and poverty might be the main causes of clearing of new lands for agriculture which was the most feasible strategy of increasing crop output because they had limited alternative survival strategies which increasingly caused destruction and outright loss of some important habitats in the Park ecosystem. This might also be related with poor performance of agriculture and livestock production in the area. Expansion of agricultural land by clearing the vegetation which otherwise could have been used by wildlife directly reduced habitat ranges and availability of wildlife. One of the main consequences of the loss of habitats is the decrease in natural resources available for wildlife. The destruction of natural vegetation around protected areas and in some cases the total disappearance of buffer zones might force herbivore species to

feed in cultivated fields. Field observation in CCNP indicated that the growth rate of cultivated areas was high at the periphery of protected areas. This might also be the cause of human–wildlife conflicts around the Park area. Increasing anthropogenic pressure, due to continuously increasing demands for farming, grazing land and illegal hunting might reduce the availability and quality of habitats for African buffaloes and other wildlife in the present study area. Similar results were also reported earlier by Atickem *et al.* (2011), Tadesse Solomon and Kotler (2013), Aramde Fetene *et al.* (2014), Mesele Admassu *et al.* (2014) and Ryan *et al.* (2015).

#### **4.5.3. Human–wildlife conflict**

Human–wildlife conflict should be recognized as one of the most critical conservation challenges facing protected areas today. Conflicts become more intense where livestock holdings and agriculture are an important part of rural livelihoods. Competition between rural communities and wild animals over natural resources is more intense in developing countries, where local human populations tend to suffer higher costs (Conover, 2002). Chhangani *et al.* (2008) also noted that a wide variety of vertebrate pests come into conflict with humans in Africa. A wide variety of different social, cultural, economic and political factors interact to create human–wildlife conflict, and therefore no single scheme is likely to be the ‘silver bullet’ that will resolve all the underlying problems as indicated by Anthony *et al.* (2010). Therefore, collecting baseline information is a vital step in managing human–wildlife conflict (Tewodros Kumssa and Afework Bekele, 2008). This helps to understand the timing and location of conflict, the behaviour of the involved wildlife and the perceptions of affected stakeholders. In the present study area, a wide range of wild animals cause problems for local people. The large wild herbivores and carnivores were the animals representing the greatest threat to humans and responsible for the majority of human–wildlife conflicts. Farmers also ranked rodents as number two pest next to large herbivore pest, probably because they are least able to control them compared to the other pests as indicated by Demeke Datiko and Afework Bekele (2013).

Crop damage and loss of livestock by wildlife were the major causes of Park–people conflict in CCNP. For farmers living in proximity to Park boundaries, crop loss and livestock predation represent a considerable barrier in securing a sustainable livelihood, especially crop loss as it is closely related to food security and income. Crop damage is a particular risk to households that

are less resourced and don't have access to diverse sources or any source of income as indicated by (Guinness and Taylor, 2014). Apart from economic burden, these conflicts might be responsible for inflicting other losses and risks such as injury/death while protecting crops and property, increased manpower for guarding crops and an increased level of risk of contracting diseases both from wildlife and environmental factors. In the present study area, wild animal raids variety of crops. The crop damage was mainly caused by different species per occurrence, more than 3–4 species per night. The highest numbers of incidents of crop raiding were caused by African elephants, African buffaloes, baboons, hippopotamus, warthog and bush pigs. Baboons are the most destructive crop raiding animals around CCNP. They came at any time during the day and consume whatever crop was in the field. They tended to raid fields surrounded by large trees and rocky hillocks, which provided cover for them. These vantage points provide them with easy escape routes and made it difficult for guards to follow them. Hill (2000), Baranga *et al.* (2012), Hill and Wallace (2012) and Guinness and Taylor (2014) noted that primates are particularly successful crop raiders due to their cooperative behaviors, opportunistic lifestyle, non-specialized diet and omnivorous diet, and their ability to learn rapidly and change their behavior accordingly. In addition, injuries to people mostly occur as a result of chance contact between human and elephant, buffaloes, hippo, lion, leopards and hyena, usually along paths to and from the dwellings, in the Park and water sources. According to the respondents, wildlife population has increased after the establishment of the areas as a National Park. The most probable reason might have been linked to the establishment and management activities carried out in the last few years in the Park. Increase in wildlife populations, particularly large herbivores and carnivores, as a result of conservation activities have also been reported to result in increased human–wildlife conflicts (Le Bel *et al.*, 2011). Linkie *et al.* (2007) and Dickman (2010) suggested that season, variety and characteristics of crops, food availability, distance from the Park, nearest farm or village to the Park boundary and farm protection methods will have an impact on crop raiding by wildlife. The present investigation also revealed that the availability, variability and type of food sources might be important factors attracting wild animals to farmland, leading to crop raid and depredation, thus developing human–wildlife conflicts.

Another adverse effect of the human–wildlife conflict in CCNP was the killing of domestic animals by predators. Livestock plays a vital role in the local economy of local people. It was an important source of protein, income or commercial asset, savings and social standing. Therefore, carnivores attack on livestock is a significant problem for rural populations. During the present investigation, predators such as lion, hyena, leopard and baboon often killed domestic animals in the area. The decline in numbers of natural prey, settlements adjacent to Park boundary and farms around to the Park might be one of the major reasons why carnivores shifted their diets to livestock, which were easier to capture and had limited possibilities of escape as noted by (Mishra *et al.*, 2003). Moreover, lion, leopard, hyenas and baboons attacked people in the area occasionally. Local people occasionally reacted with retaliation killings of those predators, where no distinction was made between the animal that actually caused the damage and other non-culpable individuals. Studies elsewhere have also shown that tolerance of local communities on predators depends on the extent of predation on their livestock (Kolowski and Holekamp, 2006). Okello and Wishitemi (2006) also indicated that if wildlife-induced damages to human property and life are neither controlled nor compensated, negative local attitudes towards conservation and wildlife resources become entrenched. Living alongside carnivores might have caused a variety of additional costs aside from the direct impact of depredation, as people have to invest more heavily in strategies such as livestock herding, guarding and predator control. The respondents noted that the effect of carnivores had increased since the establishment of the Park. As the number of wildlife increases around the Park, conflict may also increase. For all focal species, most respondents disliked the animals. A desire for total elimination of hyenas and baboons was expressed. Breitenmoser (1998) and Marker *et al.* (2003) have also made similar findings especially with large carnivores. However, even if carnivores cause a problem on livestock and human welfare, they also perform a vital role in controlling some of the wildlife pests. For instance, leopards and lions also prey on baboons, warthogs, wild pigs, and this control the size of their prey populations. Therefore, if the leopards and lions were to be minimized/eliminated, herbivore pests would increase in number and would cause more damage to crops. As a result, it is very important to recognize the pest control services these predators provided. Crop raiding frequency and intensity and sometimes on the human welfare and livestock damage might have caused farmers to develop a negative attitude and view wildlife as a nuisance rather than an asset.

In the present study area, mammalian carnivores and herbivores were rarely involved in human injury and deaths. Quigley and Herrero (2005) indicate that wild animal attacks upon humans clearly have particularly significant impacts in terms of causing intense conflict. In most cases deaths occurred while people were protecting their crops against raiding animals (usually at night), when people accidentally come into close contact with the animals, especially on paths near water at night or when people encountered injured animals such as African buffaloes whose normal sense of caution was impaired or herding cattle, walking at night between neighboring villages were the cause of death.

#### **4.5.3.1. Distance of the villages from Park and human–wildlife conflict**

In many parts of Africa, the conflict between local people and wildlife is one of the most serious problems where villagers are located adjacent to nature reserves (Newark *et al.*, 1994; Mackenzie, 2012). The present study also showed that living in close proximity to protected areas imposed costs such as loss of crops and livestock to wildlife, injury and death and time and resources spent to guard wildlife. An increasing distance from the Park boundary, causes crop raiding and predation on livestock to decrease. Human settlements and agricultural fields within 0–1 km of the Park boundaries were in the high-risk zone for the damage from the Park wildlife. In the present study, distance to the Park was strongly correlated with crop loss and depredation risk. For instance, in villages such as Chebera, Serri, Yora and Churchura, high levels of predation were observed. These villages were nearer the Park than the other villages and therefore were affected more by predators and crop loss. Similar findings were also observed in Serengeti National Park, Tanzania (Holmern *et al.*, 2007) and Tsavo ranches in Kenya (Patterson *et al.*, 2004).

Predators will take domestic ungulates when opportunity arises. The exact reasons why carnivores prey on domestic animals are poorly understood. In some areas, it is thought that livestock are easy prey (Maddox, 2003). Other factors, such as age and sex of the predator may also play an important role. Many authors also recognized that when wild preys were abundant, predators preferred them to livestock (Butler, 2000; Polisar *et al.*, 2003). Hayward *et al.* (2007) also noted that selection of livestock species corresponded to the size of the predator in accordance with the size of their natural prey. This can also be related to the ease of capture and

limited escape abilities of the livestock. The result of the present study shows that human–wildlife conflicts were perceived to be prevalent in the present study area. Conflicts with wildlife over crops, livestock predation and human safety issues were reported in all nine villages. Local residents asserted that some populations of large herbivores and carnivores, particularly African buffaloes, elephants, baboons, warthog, wild pig, spotted hyena, leopards and lions had increased. These assertions were based largely on recorded increases in crop damage and livestock depredation by large herbivores and carnivores between years 2012 to 2015.

#### **4.5.3.2. Predation and season**

Livestock predation usually follows seasonal patterns (Michalski *et al.*, 2006; Holmern *et al.*, 2007). Seasonal changes in rainfall are linked to the intensity of predation. During the present study, it was recorded a peak in predation/loss of most livestock during the wet season. This was similar to what was observed in Cameroon around Waza National Park (Bauer, 2003) and Tsavo National Park, Kenya (Patterson *et al.*, 2004). This might be related to the variation in wild prey dispersal with season. In addition to a good habitat cover for protection, the prey animals might secure their food nearby and limit their movement, which minimizes exposure to predators during the wet season. However, during the dry season, wild herbivores tend to concentrate near water sources within the protected area, where it is probably easier for predators to prey on them (Kays and Patterson, 2002). As the wet season progresses and water is more readily available, prey populations might disperse widely. In areas with low mean prey density, it may be easier for predators to prey upon livestock. As a result, livestock in villages bordering the Park become an alternate source of food. Lions mostly preyed upon adult cattle and donkeys. In contrast, hyenas and leopards primarily killed small stock and dogs. Hyenas and leopards mostly attacked livestock at night, whereas lions often attacked grazing livestock during the daytime. These behaviours made lions the most vulnerable to direct retaliatory killing, although some villages specifically targeted hyenas with poison. Human carnivore–conflict may be related with the efficacy of livestock husbandry techniques. Husbandry techniques have a great impact on livestock predation as indicated by (Ogada *et al.*, 2003; Marker *et al.*, 2005; Holmern *et al.*, 2007). Guarding herds and active defense are essential features of animal husbandry. Where herdsmen are present, predation rate is generally lower than free-ranging herds (Breitenmoser, 1998). In the present study area, many of the herders were small children, reducing the

effectiveness of predation. Dogs were reported to be efficient against serval and baboon attacks but not against lions or caracal. Similar cases were reported from Serengeti National Park, where hyenas killed dogs (Holmern *et al.*, 2007; Gehring *et al.*, 2010). Therefore, improving the technique of livestock protection is likely to be the most viable method of conflict resolution.

#### **4.5.3.3. Methods to control wildlife induced damages**

Human–wildlife conflict is a complex problem, requiring a combination of approaches to manage the conflict, including wildlife barriers, protecting property and removal of the specific problem animals, but most of these are strongly site and species specific, and are not widely or easily accessible (Norton-Griffiths and Southey, 1995; Shivik *et al.*, 2003; IUCN, 2003; Parker and Osborn, 2006; Gehring *et al.*, 2010). The strategies aimed at one animal or in one location may be ineffective in other circumstances. The farmer’s choice of these interventions depends on a number of factors such as the presence and severity of crop damages (Bailey, 2011), the availability of local resources and the specific type of animal causing the destruction (Weladji and Tchamba, 2003). The local people of the present study area deployed various methods to protect their crops and livestock from pest animals. They used repellents in the form of fire, noise and chemicals and construction of different physical barriers, guarding, fear-provoking stimulus such as scarecrows, beat drums and chemical repellents for deterring crop raiding wildlife. Parker and Osborn (2006) stated that deterrents were likely to be more effective against pest animals. This was also true in the study area.

The effectiveness of methods to prevent damage by animals remains unclear. Respondents indicated varying views regarding the degree of effectiveness of wildlife damage control methods. They perceived that guarding when used with other methods is quite effective and had a low capital investment but often is tedious and time consuming. Some of the important factors mentioned by respondents, which might play an important role in the choice of methods for wildlife damage control, are time and cost involved. The behaviour and preference of each pest are quite different, however, for larger animals, guarding was the sole resort to prevent crop losses and livestock predation in the area. Manual guarding as a most widely used crop protection measure was also reported by Bauer (2003), Chhangani and Mohnot (2004), Ocholla *et al.* (2013) and Prashanth *et al.* (2013). Beside the visible impacts, human–wildlife conflict has

indirect impacts. Losses might generate other costs to household members, including an increased need to guard fields, which creates labor bottlenecks in certain seasons, disruption of schooling because children are needed to help guard family fields, increased risk of injury from wildlife and increased risk of contracting diseases. Hoare (1992) and Barua *et al.* (2013) also noted that human–wildlife conflict has a wide-ranging negative social impact, which includes missed school and work, additional labour costs, loss of sleep, fear and also restriction of travel. Plant hedges of various species and fences made of dead thorny branches were also used as traditional barriers against most carnivores and ungulates in the present study area, but these do not deter baboons and elephants because the fences and trenches were not strong enough in holding these larger animals. Burrowing animals, such as warthogs, can easily breach barriers, constructing pathways which allow access for other forms of wildlife. Watch tower and scarecrow were very common as they were clearly visible in every field bordering the Park. Watchtowers provided good vantage points, built around cultivated fields and increased the farmers chances of being alerted to the presence of potentially harmful wildlife before damage had occurred. Scarecrow was used against monkeys and birds and on some incidences in combination with watch towers. Some farmers were trying to use beehive fences as deterrents to keep African elephants out of crops as indicated by King *et al.* (2011). Moreover, as noted by Parker and Osborn (2006), alternative crops such as ginger and chili have been encouraged in Zimbabwe. As a result, farmers, who were considered to be in high-conflict areas, have shifted from cultivating food crops to growing cash crops. Without properly addressing human–wildlife conflict in the effort to conserve wildlife and their habitat, conservation efforts will lose stability and progress, as well as the support of local communities. Developing effective and well-targeted conservation strategies is dependent upon fully understanding the complexities of the local situation in order to develop truly appropriate and effective solutions.

#### **4.5.4. Attitude of local people towards wildlife**

Attitudinal studies are increasingly being adopted as tools for evaluating public understanding, acceptance and the impact of conservation interventions (Anthony, 2007; Ramakrishnan, 2007). This is because, understanding local people attitude about conservation is the key to improve the protected areas-people relationship if protected areas are to achieve their goals (Oli *et al.*, 1994; Weladji *et al.*, 2003; Mekbeb *et al.*, 2010). Many factors influence the conservation attitudes of

local people positively or negatively. The magnitude of the resultant effects of each particular factor is determined by the historical, political, ecological, socio-cultural and economic conditions and this may call for different management interventions (Mehta and Heinen, 2001; Ormsby and Kaplin, 2005; Ryan *et al.*, 2015). The understanding of all these factors is important to improve the relationship between local residents and protected areas. In the present study area, increasing demand of the use of Park resource, wildlife imposed constraints and socio-demographic factors (age, gender, education level, and religion and occupation) were the possible reason in shaping local people attitudes.

The result of the present study showed that most of the respondents had positive attitude towards the conservation area, despite the conflicts and problems encountered. They valued the areas for their potential for tourism revenues and resource use in times of need. Respondents who expressed value for protected areas tended to be younger and better educated, and those who had previously received some tangible benefit from the reserve. As indicated by Adams and Hulme (2001), Heinen and Shrivastava (2009) and Shibia (2010) benefits and costs created by protected areas strongly influence attitudes. Tewodros Kumssa and Afework Bekele (2014) also noted that educated and young people with access to information and awareness mostly supported the presence of Park. Some of the respondents admitted to illegally gathering firewood, thatching grasses, and using pasture from the Park and they felt that these resources still belonged to them. Others also indicated that they had benefited from the Park through job opportunities, social services such as transport during emergency cases, whereas other respondents had negative attitudes due to frequently faced problem by wild animals, banned agricultural activities within the Park boundaries and lack of compensation for property damage by wild animals. Similar findings have been reported by Ormsby and Kaplin (2005), Allendorf (2007) and Nyirenda *et al.* (2013); people are more likely to appreciate protected areas if benefits gained from them offset the associated costs. Schumann *et al.* (2008) and Mekbebe *et al.* (2010) also noted that the more benefits people receive from wildlife and conservation activities, the more positive they are towards wildlife and conservation. On the other hand, benefits alone do not necessarily lead to positive attitudes as noted by (Gillingham and Lee, 1999). Species which cause great damage are not seen positively even if they also produce benefits for the human community (Schumann *et al.*, 2008).

Most discussants around CCNP clearly believed that the Park's future depended upon good relationships between Park staff and local communities. Toward this end, many locals felt that community relations could be improved by allowing access to traditional resources like pasture, firewood, wild honey, key grazing area during drought and key water points. Conflicts with Park officials due to resource extraction, strict rules on Park resources use and access were observed during the study period, and it might generate negative attitudes to local people living around the Park. Heinen and Shrivastava (2009) and Shibia (2010) indicated that attitudes toward the protected area staffs and the perceptions of management practices influence local people attitudes. Lack of awareness towards conservation issues and lack of involvement of the local community in the decision making processes might also be important determinants of negative attitudes toward protected areas as indicated by (Fiallo and Jacobson, 1995). Therefore, understanding attitude of local people can produce useful information that could be incorporated into the decision-making process and lead to resolution of conflicts between local people and Park authorities by improving attitudes and altering behaviour of the local people.

## **5. CONCLUSION AND RECOMMENDATIONS**

### **5.1. Conclusion**

Result of the present study provided information on some aspects of ecology of the African buffaloes in CCNP. It gives baseline information for further studies on this species. The population trend indicates that there is a significant increase in the number of African buffalo populations in CCNP. This increase might be due to the implementation of wildlife management and conservation measures. Park scouts were regularly patrolling the Park area to control illegal hunting and other activities in the Park area. But, specific conclusion might not be possible on the trends of African buffalo population, in this area in the absence of regular census carried out in the Park.

Some of the observed changes in herd size with seasons coincided with changes in habitat use patterns. The largest herd size was recorded during the wet season. The relatively high level of breeding females revealed that there was high potential for increase of population of buffaloes in CCNP. However, the observation of low percentage of calves and yearlings revealed that there was high level of calf mortality. This may be due to high level of predation, diseases and drought or as a result of cumulative effect of all these factors.

The distribution and utilization of different vegetation communities by the African buffaloes could be explained in terms of seasonal changes. The present study showed that in CCNP the buffalo adjusted its range use, herd size, activity patterns and habitat selection to the critical environmental changes experienced in the reserve. Seasonal variation in the quality and abundance of forage affected the habitat preference of the African buffaloes. During the dry season, resources were scarce and the buffaloes restricted their activities in the riverine area and forest habitats. As the rainy season progressed, the animals are scattered over the areas, as the resources were abundant through out the Park. It is possible to conclude that the food, water and protection were decisive to determine the distribution of the African buffaloes in the present study area. However, the degree of disturbance by grazing livestock, shifting cultivation and poaching by local people seems to contribute much in their distribution.

African buffaloes in CCNP spend more time foraging in the dry and wet seasons than any other activity. Season had an effect on the time apportioned during foraging and resting behaviour by African buffaloes. They allocated more time to feeding year round, and that their overall activity budget was more directly responsive to seasonal climate change and seasonal food distribution.

Park–people conflict was a serious challenge in CCNP. Understanding the conflict and its cause is crucial to the development of effective conservation programmes in the Park. The result of the study revealed that most of the local people depended on the natural resources of the Park for their livelihoods. They collected firewood, wildhoney, medicinal plants and thatching grasses, they poached animals, grazed cattle and farmed around and in the Park disregarding to Park laws and legislations, as a result conflicts emerged around use of many of those resources. The effects of these human activities in and around the Park cause habitat alteration, displacement and local migration of wildlife species. Hunting pressure and competition of cattle with wild games for food, water such as hot spring ‘Hora’ and space affected the distribution of ungulates in the Park. The presence of cattle and domestic dogs might also make the Park carnivores vulnerable to disease transmission. Fire was a common phenomenon in the area during the dry seasons. Most of the fire was set by local people with areas near the Park boundary. Those uncontrolled wildfire spreaded to the protected area coupled with illegal hunting, uncontrolled expansion of agriculture, grazing and harvesting of vegetation threatening the function of the protected area system. Therefore, like most protected areas in Ethiopia, CCNP also faced significant challenges in meeting human and wildlife needs. It is widely acknowledged that the future of most protected areas depends on the degree to which local people concerns, needs, and aspirations are addressed by conservationists. Stakeholder involvement regardless of gender, age, or economic status, from the very beginning of a conservation effort, leads to effective plans that better assure environmental stewardship.

Human–wildlife conflict was an increasing concern in CCNP. This might affect the livelihood of the farmers around CCNP. Human–wildlife conflict coupled with low level education and awareness led to an increased negative human attitude towards wildlife with potentially negative effects for conservation. Local people close to the Park boundaries were highly vulnerable to pest animals. The measures adopted by the local farmers to prevent crop damage and livestock

predation were traditional methods and were not effective against wildlife treats, particularly against large herbivores and carnivores. Therefore, it was important to monitor conflict situations over time. It would help to pinpoint where the worst conflict occurs and direct deterrent efforts to where they are most needed. It would be also important to identify, test and validate wildlife deterrence methods to reduce crop damage and livestock depredation. Moreover, limited number of professionals and scouts, insufficient financial resources and lack of infrastructure and poor logistic facility in the Park were major challenges for effective conservation activities. There was a need to develop schemes where local people perceive tangible economic benefits they may tolerate wildlife in their surroundings. Conservation awareness aimed at changing the attitude of local people, provision of essential infrastructure facilities and of living condition should have been given focus by the management of the Park and the regional governments.

Chebera Churchura National Park harbors many large mammal species, birds and other wild animals. Therefore, it can serve as an important center for conservation of the country's wildlife and tourist attraction area in the future. Besides its wild animal potential, the Park has impressive landscape and crater lakes. There is a need to improve the understanding of the ecological, social and cultural dimensions of conflict situations in the area, to mitigate anthropogenic impacts and human-wildlife conflict in CCNP. It needs urgent action to solve the problems, otherwise the Park will no longer act as a conservation area for the wildlife as the situation in most of the other National Parks of the country. The findings further suggest the need to initiate long-term monitoring to analyze trends in the incidences of human-wildlife conflicts and human impact on the Park. Therefore, future conservation approaches in CCNP should place more emphasis on the human dimensions of biodiversity conservation than purely scientific studies of species and habitats in the Park. Effective management of African buffaloes and other wildlife resources can be realized only if the current pressures on the conservation area are controlled.

## 5.2. Recommendations

Based on the results and conclusion of the present study, the following recommendations are suggested:

- Continuous long-term studies of ecological aspects should be carried out to pinpoint the causes of the population fluctuation of the African buffaloes.
- Education is one of the factors, which have positive impact on the attitude of local people, and knowledge of biodiversity conservation. It is necessary for Park officials in collaboration with Regional Government and technical partners to develop environmental awareness programs for the local people around CCNP. This could be done especially for the youth mainly in schools and in villages, and for adults through informal educational methods.
- Local community should be involved in all stages of conflict resolution, including decision making, planning and management of wildlife in order to develop positive attitude towards wildlife.
- Benefit sharing is critical in gaining local support for wildlife conservation. Therefore, the local community should receive a share of revenues from tourist fees and from related economic activities (e.g. tourist facilities), and also to compensate them for their wildlife related losses.
- Through participation, alternative livelihood strategies (diversify sources of income) should be developed to overcome the sanctions that conservation strategies will impose on local people in terms of access to resources.
- Set up a bee-keeping association for the local people as beekeeping is a good income-generating activity for resource-poor people, and is environmentally friendly and sustainable with no outside resources requirements.
- Crops damaged by wildlife depend on the taste of the crops planted. The food habits of the wildlife should be systematically studied and local communities should be encouraged to grow unpalatable crops to wild animals. This can deter wild animals from farmlands.

- Strengthening law enforcement, increasing awareness and environmental education, and developing mechanisms to reduce human–wildlife conflicts will assist in further minimizing illegal hunting activities in the CCNP ecosystem.
- Encouragement of local inhabitants to harness other forms of biomass energy and alternative energy source such as biogas plants and solar energy in collaboration with conservation partners and other stakeholders in order to reduce pressure on the resources in the Park.
- Continuous monitoring and evaluation process of human–wildlife conflicts are needed for future conservation measures.
- As the area is large, employing additional scouts and empowering them with training and necessary equipment for effective and regular patrolling of the Park area is very important.
- Chebera Churchura National Park has great potential for ecotourism. Encouraging investors for infrastructure development such as to open hotels, restaurants and lodges in the area can attract both local and international tourists, which will benefit the Park, villagers around and the Governments.

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## 7. LIST OF APPENDIXES

### Appendix I. Dominant plant species in each habitat collected and identified during the study period

Local name	Family name	Scientific name
Zainba	Arecaceae	<i>Phoenix reclinata</i> Jacq.
Shimawula	Rutaceae	<i>Teclea nobilis</i> Del.
Unknown	Fabaceae	<i>Dichrostachys cinerea</i> (L.) Wight & Am. (1834)
Zamo	Fabaceae	<i>Albizia grandibracteata</i> Taub. (1895).
Zamo	Fabaceae	<i>Albizia gummifera</i> ( J.F.Gmel) C.A.Sm. (1930).
Unknown	Fabaceae	<i>Albizia schimperiana</i> Oliv. (1871)
Unknown	Fabaceae	<i>Entada abyssinica</i> Steud. ex A.Rich. (1847)
Unknown	Sapindaceae	<i>Allophylus abyssinicus</i> (Hochst). Radlekofer (189)
Tuke	Rubiaceae	<i>Coffea Arabica</i> L
Wogara	Oleaceae	<i>Olea welwitschii</i> (Knobl.) Gilg & Schellenb
Assa Genbela	Moraceae	<i>Ficus vasta</i> Forsk. (1775)
Bota Moruwa	Moraceae	<i>Ficus sur</i> Forsk. (1775)
Unknown	Moraceae	<i>Ficus thoning</i> Blume (1836).
Moruwa	Moraceae	<i>Ficus Ovata</i> Vahi
Atta	Moraceae	<i>Ficus glumosa</i> Del.
Glesho Genbela	Bignoniaceae	<i>Terminalia brownii</i> Fresen. Cham
Gereche	Euphorbiaceae	<i>Bridelia scleroneura</i> Mull. Arg.
Sisa	Fabaceae	<i>Acacia seyal</i> Del. (1813)
Dulo	Verbenaceae	<i>Vitex doniana</i> Swee.
Sobo	Combretaceae	<i>Combretum collinum</i> Fresen.
Unknown	Combretaceae	<i>Combretum collinum</i> Vent.
Unknown	Combretaceae	<i>Combretum paniculatum</i> Vent
Unknown	Combretaceae	<i>Terminalia brownie</i> Fresen.
Unknown	Combretaceae	<i>Combretum adengonium</i> A.Rich
Unknown	Ulmaceae	<i>Celtis Africana</i> Burm.f.
Unknown	Meliantaceae	<i>Bersama abyssinica</i>
Unknown	Icacinaceae	<i>Apodytes dimidiata</i>
Digiso	Euphorbiaceae	<i>Combretum moll</i> G. Don.
Geleshookashe	Costaceae	<i>Costus</i> sp
Lusha Gumre	Tilliaceae	<i>Grewia ferruginea</i> Hochst.

Unknown	Tiliaceae	<i>Grewia molis</i> Juss
Unknown	Tiliaceae	<i>Grewia flavescens</i> Juss.
Gomere	Tilliaceae	<i>Grewia bicolor</i>
Gariw	Euphorbiaceae	<i>Bridelia micrantha</i> (Hochst.) Baill
Kisho	Asteraceae	<i>Aspilia monssambicensis</i> (Oliv.)
Unknown	Asteraceae	<i>Solanecio giggas</i> (Vatke) C. Jeffrey
Unknown	Asteraceae	<i>Vernonia ampla</i> P.Hoffm
Unknown	Asteraceae	<i>Vernonia amygdalina</i> Del.
Hanchecha	Phytolaccaceae	<i>Phytolacca dodecandra</i> L Herit
Graambush	Asteraceae	<i>Vernonia filigera</i> Oliv.
Sebicha	Boraginaceae	<i>Ethertia cymosa</i> Thonn.
Iterwanja	Piperaceae	<i>Piper capense</i> L.F.
Dinderata	Capparidaceae	<i>Capparis erythrocarpus</i> Isert.
Ladeya	Apocynaceae	<i>Carissa spinarum</i> L.
Anka	Euphorbiaceae	<i>Croton macrastachyus</i> Del.
Unknown	Simaroubaceae	<i>Brucea antidysentrica</i> / J.F. Mill
Unknown	Euphorbiaceae	<i>Bridelia micrantha</i> (Hochst) Baill.
Unknown	Papilionideae	<i>Erythrina abyssinica</i> Lam.ex.DC.
Unknown	Apocynaceae	<i>Carissaa edulis</i> (Forssk.) Vahl
Kossometa	Rosaceae	<i>Hagenia abyssinica</i> (Bruce) J.F.Gmel(1791)
Ocha	Myrtaceae	<i>Syzygium guineense</i> DC.
Qale	Poaceae	<i>Hyprrrhenia anthistrioides</i>
Kalicho	Poaceae	<i>Panicum maximum</i> Jacq.
Kalicho	Poaceae	<i>Hyparrhenia cymbaria</i> (L.)stapf.
Woshlange	Poaceae	<i>Arundo donax</i> L
Unknown	Poaceae	<i>Oplismenus hirtellus</i> (L.) p. Beauv.
Surra	Poaceae	<i>Cynodon dactylon</i>
Kisho	Asteraceae	<i>Aspilia monssambicensis</i> Oli
Tsersa	Cyperaceae	<i>Cyperus laevigatus</i>
Gelesho okash	Zingiberaceae	<i>Aframomum alboviolaceum</i>
Itri wanja	Boraginaceae	<i>Ethretia cymosa</i> Thonn.
Mokota	Boraginaceae	<i>Cordia africana</i> Lam.
Buloo	Solanaceae	<i>Solanum incanum</i> L.
Gerchecha	Fabaceae	<i>Albizia schimperiana</i> Oliv.

**Appendix II. Species of mammals recorded in the Chebera Churchura National Park during the study period**

<b>Common name</b>	<b>Scientific name</b>
Anubis baboon	<i>Papio anubis</i>
Gureza	<i>Colobus gureza</i>
Vervet Monkey	<i>Cercopithecus aethiops</i>
Bush baby	<i>Gelato senegalensis</i>
Ground squirrels	<i>Xerus erythropus</i>
African elephant	<i>Loxodonta africana</i>
African buffalo	<i>Syncerus caffer</i>
Hippopotamus	<i>Hippopotamus amphibious</i>
Common warthog	<i>Phacochoerus africanus</i>
Waterbuck	<i>Kobus ellipsiprymus</i>
Bushbuck	<i>Tragelaphus scriptus</i>
Bush pig	<i>Potamochoerus larvatus</i>
Common Duiker	<i>Sylvicapra oreotragus</i>
Golden Jackal	<i>Canis aureus</i>
Caracal	<i>Felis caracal</i>
Serval	<i>Felis serval</i>
Wild dog	<i>Lycaon pictus</i>
Honey Badger (Ratel)	<i>Mellivora capensis</i>
African civet	<i>Civettictis civetta</i>
White tailed mongoose	<i>Galerella flavescens</i>
Spotted hyena	<i>Crocuta crocuta</i>
African wildcat	<i>Felis silvestris</i>
Leopard	<i>Panthera pardus</i>
Lion	<i>Panthera leo</i>
Aardvark	<i>Orycteropus afe</i>
Porcupine	<i>Hystrix cristata</i>



**Appendix IV. Data sheet used for diurnal activity patterns**

Time of the day	Activity patterns				
	Feeding	Standing	Lying	Walking	Others activities*
0.6:00-07:00					
07:00-08:00					
08:00-09:00					
09:00-10:00					
10:00-11:00					
11:00-12:00					
12:00-13:00					
13:00-14:00					
14:00-15:00					
15:00-16:00					
16:00-17:00					
17:00-18:00					

\*Others activities: Drinking, wallowing, defecating, scratching, urinating, fighting, grooming and courting

**Appendix V. A sample household questionnaire used for the study**

1. Name of respondent -----
  - a. Sex     Male/ Female
  - b. Age category  
18,            20-29,            30-39,            40-49,            50-59,            >59
  - c. Marital status -----
  - d. Family size-----
  - e. Occupation-----
  - f. Religion: Muslim, Orthodox, Protestant, others
  - g. Number of people per village-----
2. Residence
  - a. Village/Kebele-----
  - b. District-----
  - c. Distance from the Park-----
  - d. Dominant and common plants that occur in the area-----
  - e. For how long have you been a resident of this area-----?  
Where were you living before moving to this place (if moved in recently) \_\_\_\_?
  - f. GPS location-----
3. Education Level:        a. Illiterate    b. Primary    c. Secondary    d. Others
4. Source of income: Herding----- Farming-----and other, specify-----
5. If farming, type of crops,
  - a. ...., c....., e-----
  - b. ...., d....., f. -----, g. others and Size of farm land-----
6. Do you own livestock? Yes/No, if yes
  - a. No. of cattle-----        d. No. of donkeys-----
  - b. No. of sheep-----        e. Chicken -----
  - c. No. of goats-----        f. Others: specify -----
7. Do you have grazing land? If yes; a. communal/private b. In the Park c. Grazing in your farm d. both
8. If in the study area, for how long they graze?

a. 1-2 months    b. 2-4 months    c. 5-7 months    d. above 7 months

i. Do you have more livestock today than five years ago? a. Yes    b. No

9. Are you dependant on the National Park for livelihood activities? Yes/No, if yes, how? what?

10. i, Where do you collect fire wood and use other resources (wood, grass)?

a. From the Park      b. Outside the Park

ii, Do you practice bush burning in the Park? Yes/no, if yes could you mention the purpose and season of the year?

iii. Do you have practice hunting? Yes/No. If yes,

a. What is the prevalence of illegal hunting and what are the commonly used hunting methods?

b. Which wild animal species are commonly hunted illegally?

c. Hunting preferences (a, small sized wildlife, b, medium-big sized wildlife)

d. What are the main reasons for illegal hunting?

e. What strategies or mechanisms are currently in place to minimize illegal hunting?

Do you have any of the following problems because of wildlife? Yes/No

a, Crop damage If yes, go to 11

b, Predation If yes, go to 25

c, Disease transmission (which)

d, Harassment

e, Others (specify)

**A. Herbivore and crop damage**

11. What kind of problems do you face because of these animals?

Animal type	Crop damage	Predation	Threats on humans	Disease
African elephant				
Hippopotamus				
African buffaloes				
Common warthog				
Bush pig				
Porcupine				
Vervet monkey				
Anubis baboon				

12. How is the extent of damage by wildlife?

- a. Very high b. high c. less d. No

13. Type of damaged crop(s) by animal type

Animal type	List of damaged crop(s) types
African elephant	
Hippopotamus	
African buffalo	
Common warthog	
Bush pig	
Porcupine	
Vervet monkey	
Anubis baboon	

14. Can you sort these pictures into animals that are cause major damage, minor damage or no damage around this household, and explain why?

Animal type	Damage		
	Major	Minor	No
African elephant			
Hippopotamus			
African buffalo			
Common warthog			
Bush pig			
Porcupine			
Vervet monkey			
Anubis baboon			
Others			

15. What do you think about the population status of problem herbivores since the last 5 years?

Animal type	Population status			
	Increased	Decreased	The same	Don't known
African elephant				
Hippopotamus				
African buffalo				
Common warthog				
Bush pig				
Porcupine				
Vervet monkey				
Anubis baboon				
Others: specify				

16. What do you think about these animals?

Animal type	Attitude		
	No problem	Like	Dislike
African elephant			
Hippopotamus			
African buffaloes			
Common warthog			
Bush pig			
Porcupine			
Vervet monkey			
Anubis baboon			
Others			

17. What do you feel about the population change of these animals in the Park?

Animal type	Desired population change			
	Increased	Decreased	Stay the same	Don't know
African elephant				
Hippopotamus				
African buffalo				
Common warthog				
Bush pig				
Porcupine				
Vervet monkey				
Anubis baboon				
Others				

18. Which animals are the most problematic in terms of crop damage? Please rank them

a. ----- b. ----- c. ----- d. ----- e. ----- f. -----

19. What is the tendency of the crop damage from time to time?

a. Increasing b. Decreasing c. Unknown

20. Do you get help from other sources to solve your problem? Yes..... No.....

If yes, from where do you get the help?

21. Describe the different techniques you use to control (minimize) the damage caused by pest animals on crops. i....., ii....., iii.....

22. How do you minimize the damage?

a. Physical barriers (fence, walls)

b. Guarding (watching eyes, dogs)

c. Fear-provoking stimuli (visual, scarecrows, lighting fires)

d. Auditory: exploders and distress calls

e. Chemical repellents

23. What do you do when you find out that the crop is damaged by large herbivore pests?

a. Report to the Park offices c. Use poison to kill predators

b. Use traps d. Kill (shoot, snares, axle and gun)

e. Others: please specify-----

**B. Carnivores and livestock predation**

24. Do you have problems with these predators? Yes/No, if yes, what is problem?

25. What kind of problems do you face because of these animals?

Species	Threat				
	large livestock	Small livestock	Chickens	humans	Diseases
Lion					
Leopard					
Wild dog					
Hyena					
Jackal					
Caracal					
Serval					
Baboon					
Average					

26. Can you sort these pictures into animals that are a major threat, minor threat or no threat surrounding this household, and explain why?

Species	Threat		
	Major	Minor	No threat
Lion			
Leopard			
Wild dog			
Hyena			
Jackal			
Caracal			
Serval			
Baboon			
Others			

27. What do think about the population status of problematic carnivore since the last 5 years?

Animal type	Population status			
	Increased	Decreased	The same	No change
Lion				
Leopard				
Wild dog				
Hyena				
Jackal				
Caracal				
Serval				
Baboon				
Others: specify				

28. What do you feel about the population change of these animals in the Park?

Animal type	Desired population change			
	Increase	Decrease	Stay the same	Don't know
Lion				
Leopard				
Wild dog				
Hyena				
Jackal				
Caracal				
Serval				
Baboon				
Others				

29. Attitude of people towards each animal

Animal type	Attitude		
	No problem	Like	Dislike
Lion			
Leopard			
Wild dog			
Hyena			
Jackal			
Caracal			
Serval			
Baboon			
Others			

30. Please indicate the predator species and number of livestock you have lost in the last three years during wet and/or dry season?

Livestock type	Predators								
	Season	Lion	Leopard	Wild dog	Hyena	Caracal	Jackal	Baboon	Serval
Sheep	Wet								
	Dry								
Goat	Wet								
	Dry								
Cattle	Wet								
	Dry								
Donkeys	Wet								
	Dry								
Dog	Wet								
	Dry								
Chicken	Wet								
	Dry								
Others	Wet								
	Dry								

31. Which animals are the most problematic in terms of livestock predation?

a. ----- b. -----c. ----- d. ----- e----- f. -----

32. Where and when are livestock frequently attacked by carnivores in this area?

Predator	Location of attack		Season		Time of attack			
	Home	Forest	Wet	Dry	Mo	Md	Ev	Nt
Lion								
Leopard								
Wild dog								
Hyena								
Jackal								
Caracal								
Serval								
Baboon								
Others: Specify								

Mo = morning, Md = midday, Ev = evening, Nt = night

33. What is the preferred size of livestock by predators?

34. Please, provide an estimate of predators removed over the past 3 years and methods used

Total	Method/s used	
a. Lion	-----	-----
b. Leopard	-----	-----
c. Hyena	-----	-----
d. Jackal	-----	-----
e. Wild dog	-----	-----
f. Caracal	-----	-----
g. Anubis baboon*	-----	-----
f. Other: specify	-----	-----

35. Have you ever asked for help on how to prevent livestock losses to predators?  
Yes/No, if yes, state where assistance was sought, if no, state reasons.

36. Have you been compensated for any of your livestock killed by carnivores? Yes/No  
Please explain: \_\_\_\_\_

37. Where do losses occur?

a. Livestock kraal----- c. Field-----

b. Near water----- d. Others: please specify-----

38. What do you do when you find out that you have lost livestock to a predator?

a. Report to the Park offices c. Use poison to kill predators

b. Use traps d. Kill (shoot, axe, gun)

e. Others: please specify-----

39. Do you keep a guard dog with the livestock/cattle? Yes/No. If yes, how many?

40. Why do you keep these dogs? \_\_\_\_\_

41. How do you minimize the loss livestock by predators?

a. Physical barriers b. Guarding c. Fear-provoking stimuli d. chemical repellents

### **C. Attitudes and knowledge of local people to wards wildlife/park**

42. Do you think that the presence of National Park benefited the community? Yes/No, if yes, in what way? -----

43. Are there any resources that you have been prevented from the National Park?

Yes/No, if yes, do you know the reason? If yes, mention-----

44. Do you think conserving wildlife is important? Yes/No

45. Do you want to involve yourself in managing the protected areas? Yes/No, if no, why?

46. What do you think about the presence of the Park around you?

a. Like b. Dislike c. No idea

47. Who do you believe to be the cause of the problem? a. wildlife b. People.

Reason out-----

48. Do you get any benefit from the Park? Yes/No, if yes, would you mention them.....?

49. Do you agree to move out, if the government arranges to you other settlement place?

Yes/No,if no, why?

50. Do you think that the National Park staffs are doing good work? Yes/No

51. What do you think the effects on your economy if there is no conservation area here?

a. Positive effect, how? b. Negative effect, how? c. Neutral effect

52. Do you think that livestock and wildlife can live together? Yes/No, if yes, how?

53. Do you think the presence of people and livestock nearby the Park affect the National Park?

Yes/No, if yes, in what way?

54. Do you know mammals that occur in the Park? Yes/No, if yes, mention their name.

55. What do you expect about problems of wildlife in the future?

a. Increasing b. Decreasing c. The same d. Unknown

56. Do you know the main objective of the Park? Yes/no

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

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

59. Importance of the presence of the Park to surrounding people? a, road maintenance b, incomes from tourism c, development projects d, infrastructure

60. Your expectation about the Park management? a, more involvement of local people b, more land for agriculture c, more revenue from protected areas management

## **Appendix VI. A. Focus group discussion with local people and Park officials**

1. In what way and what benefits have been realized until now from the Park?
2. Do you think that local people and livestock affect wildlife? Who caused the problems?
3. How do local people and wildlife in the National Park coexist in peace and harmony?
4. To increase the local community benefits and at the same time to manage wildlife in the National Park, what should be done?
  - a. By the local people?
  - b. By conservationist?
  - c. By government?
5. Is there any Human wild animals' conflict in your area?
6. Which pest wild animals is more cause crop damage?
7. What is the main deriving cause of HWC in your area?
8. In which season the crop damage is serious and what is the reason behind?
9. How farmers protect pest wild animals from their property and how much it is effective?
9. Is there any organization participate on solving the problem of crop raiding pest wild animals?
10. Is there a shortage of farm land in your area; if yes how solve the problem?
11. Is habitat of wild animals is fragmented due to human and natural causes in your area?
12. Is there any protected forest area in your residence?
13. Is there the option of expanding farm land from Park boundary to overcome shortage of farm land?
14. In order to bring sustainable development for both the national Park and the local community, what do you suggest?

## **B. Park staff questionnaire**

1. Do surrounding communities face problems? Yes No
2. If yes, what are these problems?
3. Are you aware that local communities have rights of use of wild resources surrounding their villages? Yes/ No
4. If yes, do you think they are using them? Yes No
5. If no, why is it so?
6. What have you done so far to improve their knowledge about their rights? Specify.....

7. What kind of problems are you facing due to the local communities? (Please rank them) (poaching, firewood collection, thatch collection, grazing, clearing forest for farm extension, others).
8. How do you think they perceive you?
9. What do you think about the relationship between your colleagues and local people?
10. Do you think local communities are getting any benefit from the Park? Yes No
11. If yes, what are the benefits? If more than one, please rank them. Employment, recreation, income from tourism, rural development, meat from culling or hunting, others (specify)

LIST OF PLATES

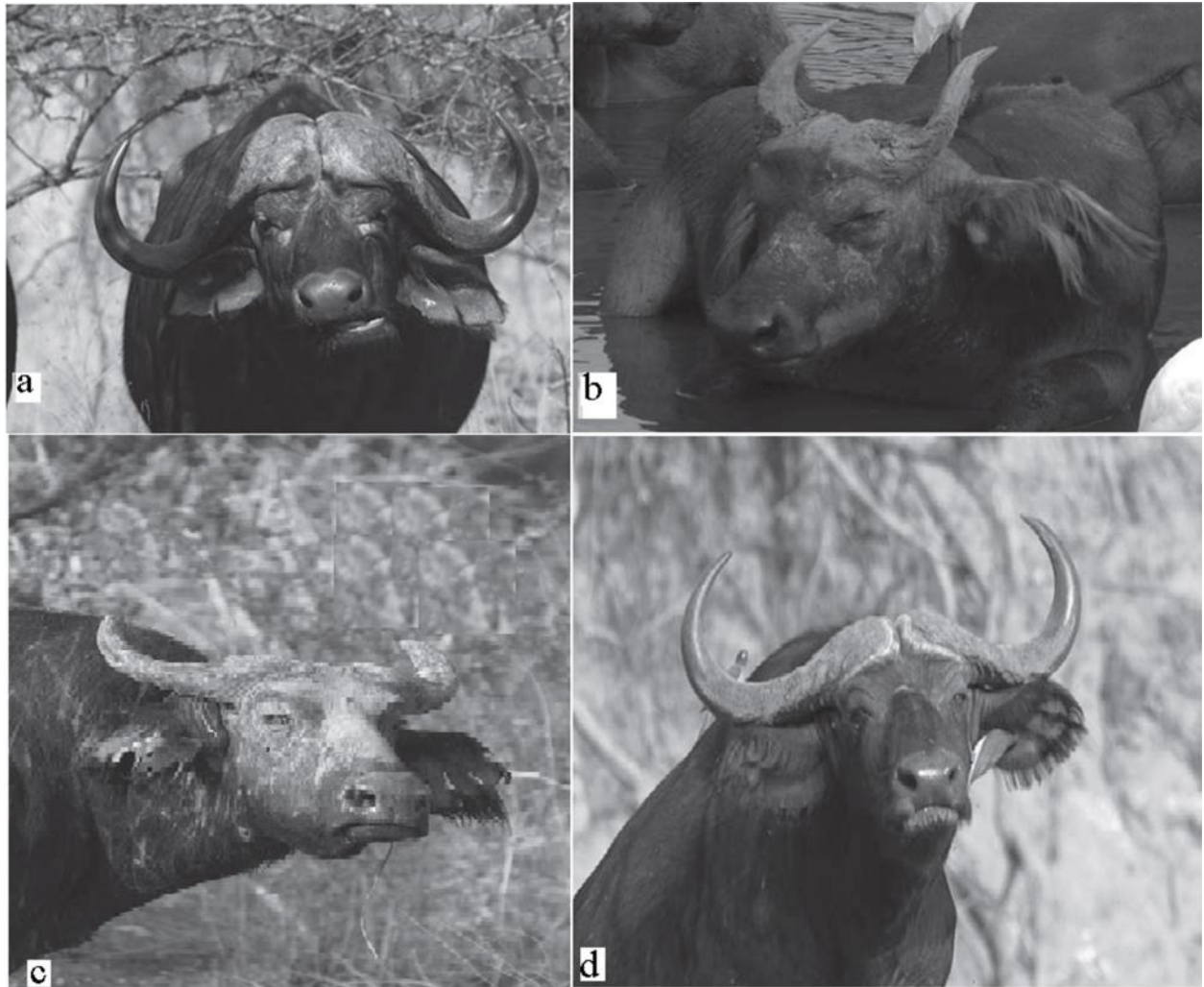


Plate 1. The morphological variability of African buffaloes across its range

Note: the differences in body size, horns shape and size of the four African buffalo sub-species  
a=Cape buffalo male, b= forest buffalo male, c= West African savanna buffalo male, d= Central African savanna buffalo male



Plate 2. Few large mammals of Chebera Churchura National Park (Photo: By Aberham Megaze)  
a= African elephant, b= African buffalo, c=Hippopotamus



Plate 3. Local people gathering firewood from the Park (Photo: By Aberham Megaze)



Plate 4. Snare-traps are difficult to locate, and can be extremely dangerous for humans (Photo: By CCNP Staffs)



Plate 5. Crop damaged by wildlife around the Park (Photo: By Aberham Megaze)  
 a–b= maize crop raided by different wild animals in Sirri village, c= sweet potato crop was damaged by wild animals in Chebera village, d= different type of fruit raided by Anubis baboon in Dalba village



Plate 6. Ascar sustained by a man from buffalo attack (Photo: By CCNP staff)