ADDIS ABABA UNIVERSITY
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The Population Status of African Elephant (*Loxodonta africana*, Blumenbach, 1797) in Chebera-Churchura National Park, Ethiopia

By
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DEDICATION

This thesis is dedicated to those who lost their lives for the sustainable existence and utilization of the wildlife resource of Ethiopia, including Ato Shenife Dulla, who was the game warden of Mago National Park.

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ABSTRACT

A study on the history and status of the population of African elephant (*Loxodonta africana*) and human-elephant conflict in Chebera-Churchura National Park was conducted from July 2005 to March 2006. This study was aimed to fill information gap on the population status of the elephants of the south western mid-altitude forest in the country. Data on the population history, seasonal movement and distribution and the human-elephant interactions in the area were collected based on the questionnaire survey and field observations. The population size and abundance of elephants in the area was determined from dung counts survey. The dung density was determined based on line transect survey and a total of 45 transects with a length of 68.3 km were surveyed within high and medium density strata. The age and sex structure of elephants were categorized based on the body size comparison, footprint measurements and bolus circumference measurements.

The history of the elephant population of the area appeared to have started within the last three decades when it was seen for the first time in the area. The elephant population came to the area from the side of Omo National Park. The population has been increasing in size and extent of distribution since the late 1990s to cover the present study area and its surroundings. However, following an intensive poaching and habitat degradation due to human activities since the transitional government, they are confined to two localities in CCNP. The elephant population has two groups localized in the northern and the western parts of the Park within 250 km^2 area. The elephant population has extended wet season home range that was determined by habitat and human factors.

The population size of the elephants was estimated to be 85 ($\pm$ 24) with a density of 0.007 elephants/km^2. Defecation and dung decay rates were 16.57 ($\pm$ 2.044) droppings/ elephant/ day and 0.0133 ($\pm$ 0.0017) droppings/day respectively. The elephant population was expressed as young and growing population, but with less number of juveniles and calves, might be due to mortality and/or reproductive pressure from elephant density or human factors. The more skewed sex ratio in favor of females (1:2) and less number of males above 20 years of age were probably due to selective poaching for adult males with relatively larger tusk.

The human-elephant conflict was associated with the size and distribution of the elephant population, commonly distributed before one and half decades ago. The impact of elephants on the surrounding communities was localized to four villages (20% of the boundary line). However, habitat loss and killing of elephants by human activities continued till the present. These findings of the study are important in making management decisions and are base lines for future monitoring of elephants of the area.

1. INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

Ethiopia is endowed with diverse biological resources as a result of its altitudinal variation and associated climatic, vegetational and topographic diversity. It is also one of the few countries in the world known to possess unique and characteristic fauna and flora with a significant level of endemism.

So far 277 species of mammals, 861 species of birds, 201 species of reptiles, 63 species of amphibians, 150 species of fish and more than 5000 species of plants are identified and recorded in Ethiopia (Hedberg and Edwards, 1989; Hillman, 1993; Yalden *et al.*, 1996; EWCO, 2000). Out of the mammalian, avian, and plant species recorded so far, 11%, 2%, and 12% respectively are endemic respectively (Hedberg and Edwards, 1989; Tilahun *et al.*, 1996).

These varied biological resources are for the most part found in protected areas that consist of eleven national parks, three sanctuaries, eight game reserves and eighteen controlled hunting areas. The protected areas cover a total of about 175,000 km^2, which is about 16 % of the country's total land area (EWCO, 2000).

One of the diverse wildlife species being conserved in Ethiopia's protected areas is the African elephant, *Loxodonta africana* (Blumenbach, 1797). Until the turn of the 19th century, the African elephant was widely distributed in the country (Largen and Yalden, 1987). Since then, however, the poaching of elephants for ivory and problems associated with human population growth and expansion has reduced the species range and number drastically. As a result, it is restricted to remote protected areas and a few fragmented populations also exist in the western mid-altitude forests of the country (Largen and Yalden, 1987; EWCO, 1991; Yirmed Demeke, 1997; Blanc *et al.*, 2003).

Elephants that inhabit protected areas in the remote savanna ecosystems are faced with illegal hunting by poachers. As a result, the range and population size of these elephant population is also decreasing with time (EWCO, 1991). The increased habitation of elephant range by humans also

increases the confinement of elephants into smaller and smaller areas. This in turn increases frontiers where elephants are conflicting with human for limited resource (Dublin *et al.*, 1997).

For the sustainability of the few and small elephant populations that currently exist in Ethiopia, proper management of the populations and their habitat are essential. This kind of management requires understanding population characteristics and other key ecological attributes of the elephant (Poole, 1996).

The Southern Nation Nationalities Peoples Regional State (SNNPRS) is one of the few Regional States of Ethiopia that have diverse biological resources. The region is located in the southern quadrate of the country ($4^0$27'-$8^0$30'N and $34^0$55'-$39^0$11'), bordered by Kenya to the south, Sudan to the southwest, the Gambella Regional State to the northeast and the Oromia Regional State to the east and southeast. The region has an estimated area of 113,359 km^2 (about 10% of the country) and an estimated human population of 14 million (about 18% of the Nation) (SNNPRS, BoPS., 2001).

The SNNPRS has a wide geographic variation which includes rugged mountains, deep gorges, river valleys, the Great Rift Valley and lakes. The altitude of the region varies from 360 meter above sea level at Lake Rudolf to over 4200 meter above sea level at the Guge Mountain. As a result, the region is known to have several potential and actual wildlife resources. These wildlife resources, however, are mainly restricted to five national parks, two wildlife reserves and seven controlled hunting areas. These protected areas cover a total of about 35,000 km^2 that is about 20% of the country. A total of ten IBAs including a few of the above protected areas are also identified in the region (Tilahun *et al.*, 1996).

Three of the national parks, two wildlife reserves and three controlled hunting areas occurring in the region are home of the African elephant (EWCO, 1991; Manspiezer and Yilma Delellgne, 1992; Hillman, 1993; Yirmed Demeke, 1997; Girma Timer, 2005). These protected and other unprotected areas in the region hold more than 50% of the total elephant population in the country (Allen-Rowlandson, 1990; Yirmed Demeke, 1997).

The Chebera-Churchura National Park is one of the protected areas in the SNNPRS where there are elephants (Bati Chego *et al.*, 2002; Girma Timer, 2005). It is also one of the areas where essential ecological information that are fundamental for sustainable management and conservation of the elephant population are lacking. These ecological attributes include population history, seasonal movement and distribution, population structure, feeding and habitat association of the elephant population and human-elephant conflict in the area (Dublin and Tayler, 1996). The present study has attempted to look at some of these ecological factors that affect the sustainability of the elephant population in the area.

1.2 Literature review

1.2.1 African elephant

Elephants are the largest of all existing terrestrial mammals. They are impressive with regard to their size, behavior and social organization. The bulky body size, the long proboscis and the big tusks have adaptive functions and are believed to have resulted from natural selection (Hanks, 1979).

The African elephant (*L. africana*) and its close relative, the Asian elephant (*Elephas maximus,* Linnaeus, 1758), originated in the Sub-Saharan Africa in the early Pleistocene and *E. maximus* later moved to Asia during the Late Pleistocene, while *L. africana* remained in its place of origin (Aguirre, 1969; Poole, 1996).

Both species of elephants have fused nose and upper lip elongated to make a long flexible trunk, which is the chief organ of smell and touch. It is also used for eating, drinking, dust and water bathing, as well as communication. The ears are large and are used to control body temperature. Blood circulating through the large vessels in the ears is cooled by flapping. The eyes are small with poor vision. The large neck formed in a way to support a pair of tusks. The skin is very thick and almost hairless in adults. It commonly has a grayish-black color, however, varies among species and subspecies.

The African elephant is bigger in size than the Asiatic elephant with a shoulder height of 340 cm and a weight of about 7000 kg. It is gregarious in nature, with a social structure organized around females and calves (Hanks, 1979). It has two subspecies, the savanna, *L. a. africana*, and forest subspecies, *L. a. cylotis*. The savanna elephant is larger in size, has sparser body hairs and more triangular ears than the forest elephant (Kingdon, 1979).

In a savanna sub-species, elephant family units usually contain about 10 individuals, although several such family units may join together to form a clan consisting of 60 to 70 members, led by a large female. The forest sub-species, on the other hand, lives in much smaller family units.

Temporary associations of a few males also exist in both sub-species although members of such groups join and leave at will (Moss, 1996).

Unlike the Asian elephant, both sexes of the African elephant carry tusks (Kingdon, 1979). Males and females of the African elephant reach sexual maturity at about 10 years of age, although males become sexually active much later due to sexual constraints (Mutinda, 1996). The gestation period takes 22 - 24 months and a female usually gives birth to a single calf every 2 to 9 years. Females can remain fertile until 55 – 60 years of age (Moss, 2001).

1.2.2 African elephant conservation

The conservation and management of the African elephant is a complex undertaking, requiring skills and strategies that deal with its population both in and outside the protected areas throughout its range. The increased proximity of human population and the expansion of their activities into elephant range is increasingly calling wildlife authorities to consider not only the welfare of the species and its habitat, but also the problems that arise between neighbors competing for limited resources.

African elephant, once inhabited most of the continent from the Mediterranean Coast down to its southern tip (Cumming *et al.*, 1990). Although continent-wide there is a general paucity of accurate data, it is clear that elephant numbers have fallen drastically during the second half of the last century. In 1979, there were an estimated 1.3 million elephants in Africa but by the year 1989 this had shrunk to some where around 0.6 million (Douglas-Hamilton, 1989). As a result, the African elephant was placed on Appendix I of the Conservation of International Trade in Endangered Flora and Fauna (CITES). At present, they are listed on Appendix II of CITES, as Endangered by the IUCN and Threatened by the USFWS. Table 1 shows the regional distribution of the remaining elephant populations in Africa.

The current estimates place the total range of the African elephant at about 5.9 million km^2 within 37 African countries (Fig. 1) (Blanc *et al.*, 2003). Out of this area, only 1.1 million km^2, about 20 percent of the total, is designated as protected area of one or another form. In reality, the proportion

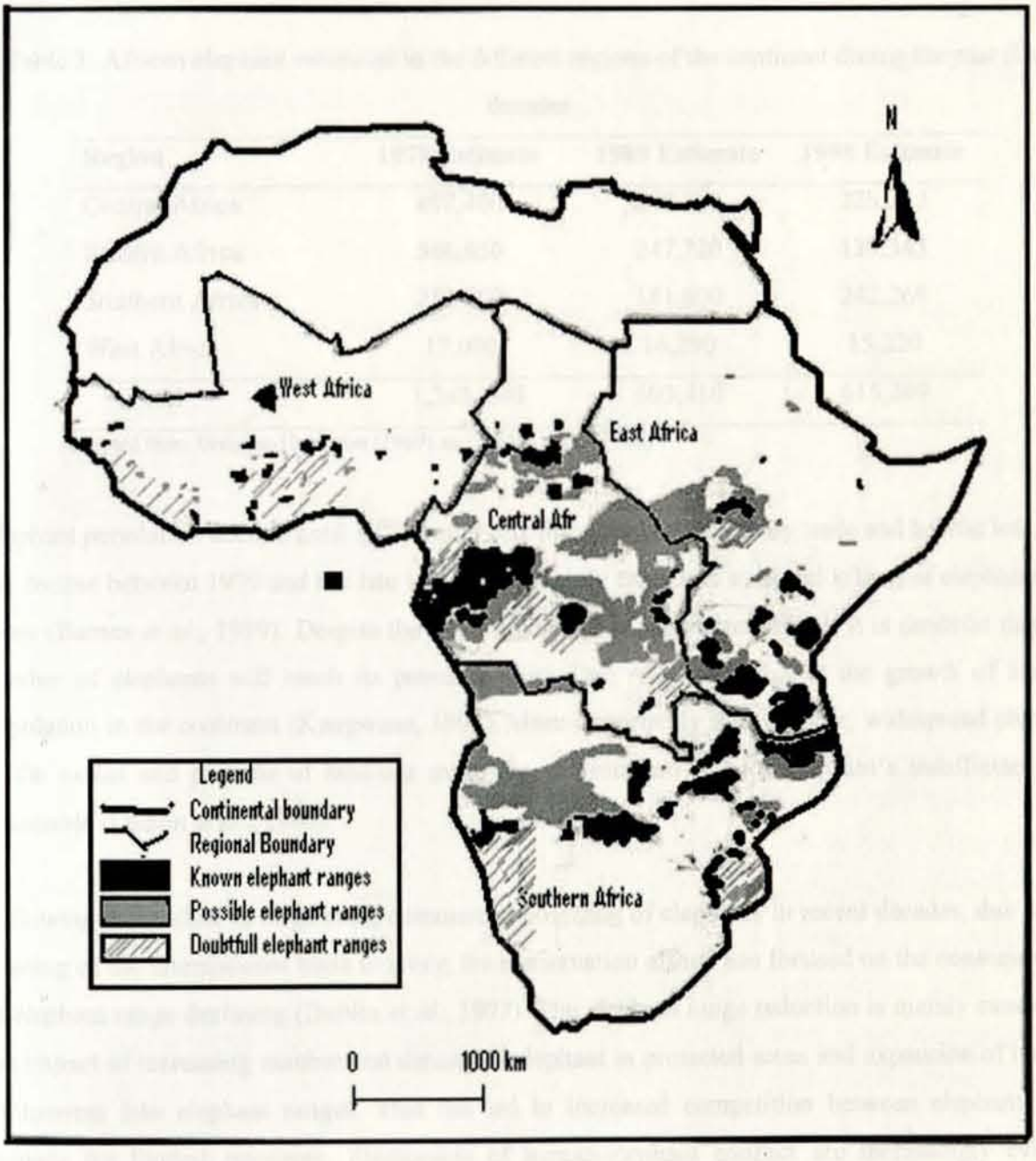


Figure 1. The current range of the African elephant

(Source: Blanc *et al.*, 2003)

of the elephant range under protection is even smaller due to the fact that the budget for protected area management and anti-poaching measures are inadequate (Barnes *et al.*, 1999).

Table 1. African elephant estimates in the different regions of the continent during the past four decades

Region	1979 Estimate	1989 Estimate	1998 Estimate
Central Africa	497,400	247,800	228,237
Eastern Africa	546,650	247,720	129,343
Southern Africa	282,200	181,600	242,269
West Africa	17,090	16,290	15,220
Total	1,343, 340	693,410	615,269

Adopted from Douglas-Hamilton (1989) and Jordan *et al.* (1998)

Elephant population decline until 19th century was linked to both the ivory trade and habitat loss, but the decline between 1979 and the late 1980's was mainly attributed to illegal killing of elephants for ivory (Barnes *et al.*, 1999). Despite the most successful conservation efforts, it is doubtful that the number of elephants will reach its previous level. One reason for this is the growth of human population in the continent (Kangwana, 1996). More importantly than number, widespread changes in the extent and patterns of land-use make the environment left for elephant's insufficient and unsuitable (Dublin *et al.*, 1997).

Following the decline in large-scale commercial poaching of elephants in recent decades, due to the banning of the international trade in ivory, the conservation efforts has focused on the consequences of elephant range declining (Dublin *et al.*, 1997). The elephant range reduction is mainly caused by the impact of increasing number and density of elephant in protected areas and expansion of human settlements into elephant ranges. This has led to increased competition between elephants and humans for limited resources. Flashpoints of human-elephant conflict are increasingly evident particularly along the boundaries of protected areas (Hoare, 2000).

In such a situation, information on elephant range and number is vital for their effective conservation and management (Moss, 1996; Bluestone, 1997). As a result, the African Elephant Database (AED), a computerized information system that stores population estimates and associated geographic information has been developed and implemented since 1986 (Burrill and Douglas-Hamilton, 1987; Douglas-Hamilton *et al.*, 1992; Barnes *et al.*, 1999; Blanc *et. al.*, 2003).

1.2.3 The African elephant in the Ethiopian context

1.2.3.1 History and status

Ethiopia is one of Sub-Saharan African countries that have elephants (Blanc *et al.*, 2003). Until the turn of this century, the African elephant had a very wide distribution and was more common in areas with altitudes ranging from sea level to 2500 m (Largen and Yalden, 1987; Yirmed Demeke, 1997). Since that time, however, it has been greatly reduced in number and its altitudinal range has contracted. In the central Rift Valley and the valley of Awash River, elephants became extinct between 1900 and 1934. The remnant herds pushed progressively further towards low altitude arid areas around the periphery of the country. The greatest portion of elephants inhabit these areas while only few of the elephant populations lives in the mid and high altitude forests of western Ethiopia as small fragmented populations (Allen-Rowlandson, 1990; EWCO, 1991).

In terms of diversity, Largen and Yalden (1987) recognized three races of Savanna or Bush Elephants in Ethiopia. These are *L. a. knochenhaueri*, L. *a. oxyotis* and *L. a. orleansi*. Among these, *L. a. knochenhaueri* used to occupy areas up to central Rift Valley. Currently, however, it is restricted to the Mago Valley. *L. a. oxyotis* occupied parts of the country west of Omo River in the South up to the Valley of Takeze River in the North, with the largest concentration of this race is found in the vicinity of the southwestern border. *L. a. orleansi* has been recorded from eastern Ethiopia, adjacent to the Somalia border. The only surviving representative of this race is found between Babile Elephant Sanctuary and the Environ of Webi-Shebeli. Figure 2 shows the current distribution of the African elephants in Ethiopia.

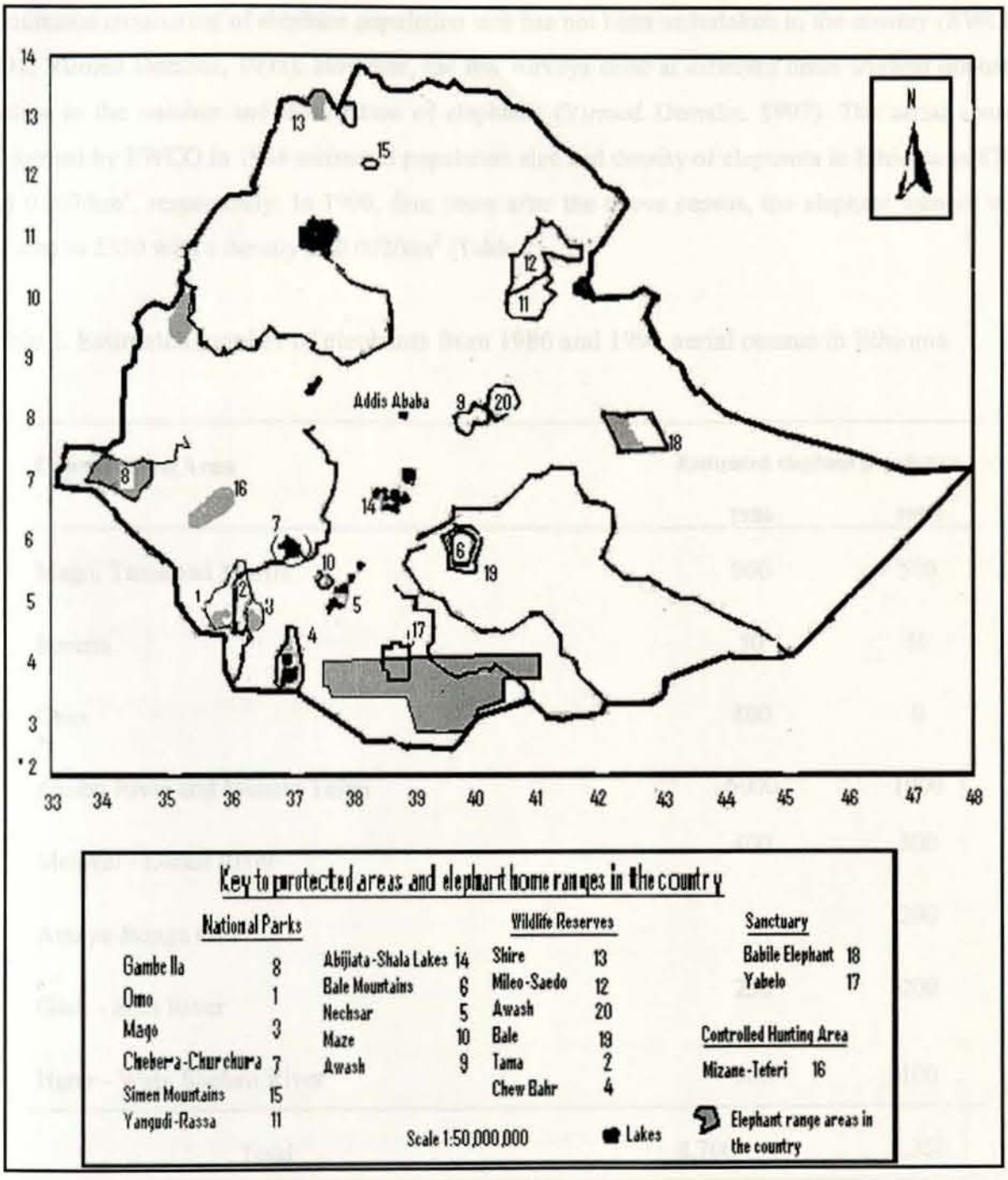


Figure 2. The present distribution of the African elephant

(Source: Blanc *et al.*, 2003)

Continuous monitoring of elephant population size has not been undertaken in the country (EWCO, 1991; Yirmed Demeke, 1997). However, the few surveys done at different times showed dramatic decline in the number and distribution of elephants (Yirmed Demeke, 1997). The aerial census performed by EWCO in 1986 estimated population size and density of elephants in Ethiopia as 8700 and 0.007/km^2, respectively. In 1990, four years after the above census, the elephant number was reduced to 2350 with a density of 0.002/km^2 (Table 2).

Table 2. Estimated number of elephants from 1986 and 1990 aerial census in Ethiopia

Census zone/Area	**Estimated elephant population**	
	1986	**1990**
Mago, Tama and Murlle	900	500
Borena	50	50
Omo	800	0
Akobo River and Mizane Teferi	6000	1000
Metekel - Dabus River	400	300
Amaya-Bonga area	-	200
Gash - Setit River	250	200
Harar - Wabi Shebeli River	300	100
Total	8,700	2,350

Adopted from Largen and Yalden (1987) and Allen-Rowlandson (1990)

The most recent summary of elephant estimates based on data of different categories gives the number of surviving elephants in the country as around 768 with a density of 0.0006/km^2 (Table 3).

The causes for the reduction in the number and home range of the African elephant in Ethiopia can be seen from two points, elephant killing, and habitat degradation and fragmentation (Blanc *et al.*, 2003). Habitat loss and degradation is the main factor responsible for the recent decline of elephant population size in the country (Largen and Yalden, 1987; Yirmed Demeke, 1997).

Table 3. The most recent elephant estimates in Ethiopia

No.	Location/Area	AESR, 2002	Yirmed Demeke, 2005
1	Mago and Omo National Parks	324	400
2	Mizan Teferi Controlled Hunting Area	500	-
3	Gambella National Park	200	150
4	Dabus Valley Controlled Hunting Area	200	50
5	Chew Bahr Wildlife Reserve	60	10
6	Babille Elephant Sanctuary	65	148
7	Shire Wildlife Reserve	10	10
	Total	1359	768

Adopted from Blanc *et al.* (2003) and Yirmed Demeke (2005)

The Ivory trade in Ethiopia has been practiced since 1899 when enormous numbers of elephants were killed for profit (Largen and Yalden, 1987). Ethiopia is identified as having the largest unregulated ivory market in East Africa (Blanc *et al.*, 2003).

1.2.3.2 Conservation

The survival of big mammals like elephants in their entire habitat is incompatible with the requirements of a developing country like Ethiopia. Therefore, they can only be preserved in areas especially left aside and protected for this purpose (Dublin *et al.*, 1997). Currently most of the elephants in Ethiopia reside in protected areas, which include four national parks, one elephant

sanctuary, two wildlife reserves and 7 controlled hunting areas (Table 4) (EWCO, 1991, 2000; Yirmed Demeke, 1997).

Table 4. The elephant home ranges and their conservation status in Ethiopia

Location	Conservation Status	Size (km^2)
Omo	National Park	4,068
Mizan Teferi	Controlled Hunting Area	-
Akobo	Controlled Hunting Area	5,049
Jikau	Controlled Hunting Area	3,375
Omo west	Controlled Hunting Area	4,561
Tedo	Controlled Hunting Area	2,347
Metekel-Dabus Valley	Controlled Hunting Area	2,127
Shire	Wildlife Reserve	753
Gambella	National Park	5,061
Amaya-Bonga (CCNP)	National Park	1250
Mago	National Park	2,162
Borana	Controlled Hunting Area	45,366
Babille	Elephant Sanctuary	6,982
Fafa and Errer Valley	Unprotected	6,982

Adopted from EWCO (1991) and Yirmed Demeke (1997)

Although there are efforts being made by concerned bodies to improve the management of protected areas that have elephants and to upgrade the conservation status and to bring other areas under protection, the population size and home ranges are greatly decreasing in and outside protected areas (Largen and Yalden, 1987; Allen-Rowlandson, 1990; Yirmed Demeke, 1994; Graham *et al.*, 1996; Cherie Enawgaw, 1998).

Lack of awareness in all groups of people, lack of political will to improve the management and protection of protected areas, deep rooted political and civil unrest and free trade of ivory in the market, lack of proper land-use and wildlife policy and other socio-economic problems cast shadow on the conservation and management of the elephant population in the country (Yirmed Demeke, 1997).

2. OBJECTIVES

2.1 General objective

The present research project was planned to assess the history of elephants, their present population status, population characteristics and human- elephant interaction in CCNP, with special emphasis on elephant conservation.

2.2. Specific objectives

- To determine the history of the elephant population
- To determine the seasonal movement and distribution pattern of elephants
- To determine the feeding and habitat association of the elephant population
- To estimate the population size, and age and sex structure of elephant population
- To determine the history, distribution and nature of human-elephant interaction
- To make contribution towards the conservation of elephants in the country in general and that of the CCNP in particular.

3. DESCRIPTION OF THE STUDY AREA

3.1 Location and topography

CCNP is located at about 370 km from Awassa (the capital of the region) and 590 km from Addis Ababa (the capital of the country) in the southwestern part of the country (Fig 3). The park is located between 35°55'00'' and 36°57'17''E latitude and 6°56'05'' and 7°08'02''N longitude within the western side of the central Omo Gibe Basin. It has an estimated area of 1200 km^2 and is bounded by Konta Special Wereda to the north and west, Omo River to the south, Dawro Administrative Zone to the east and southeast (Fig. 3).

The prominent topographic feature of the CCNP is highly undulating terrain that is interspersed with different valley floors and punctuated by different hills. There are perennial and seasonal rivers rise from nearby highlands and flow into the park.

3.2 Climate

The area can be divided into two thermal zones; 'Kola' Thermal Zone with altitudinal variation from 550 – 2400 meters above sea level and temperature ranging from 21^{0}C – 27.5^{0}C, and 'Weinadega' Thermal Zone with altitudinal variation from 1500 – 2400 meters above sea level and temperature ranging between 11^{0}C and 16 ^{0}C.

According to the data collected at the metrological station located 11 km from the study area, the area is characterized by having unimodal type of rainfall, a single long season with uniform distribution of rainfall, from March through September with the peak in July. The average annual rainfall in the area is around 1780mm (Fig. 4). The dry season of the area includes December, January and February. The hottest months are January and February while, the coldest months are July and August with the mean minimum and maximum temperature of 12^{0}C and 28^{0}C respectively.

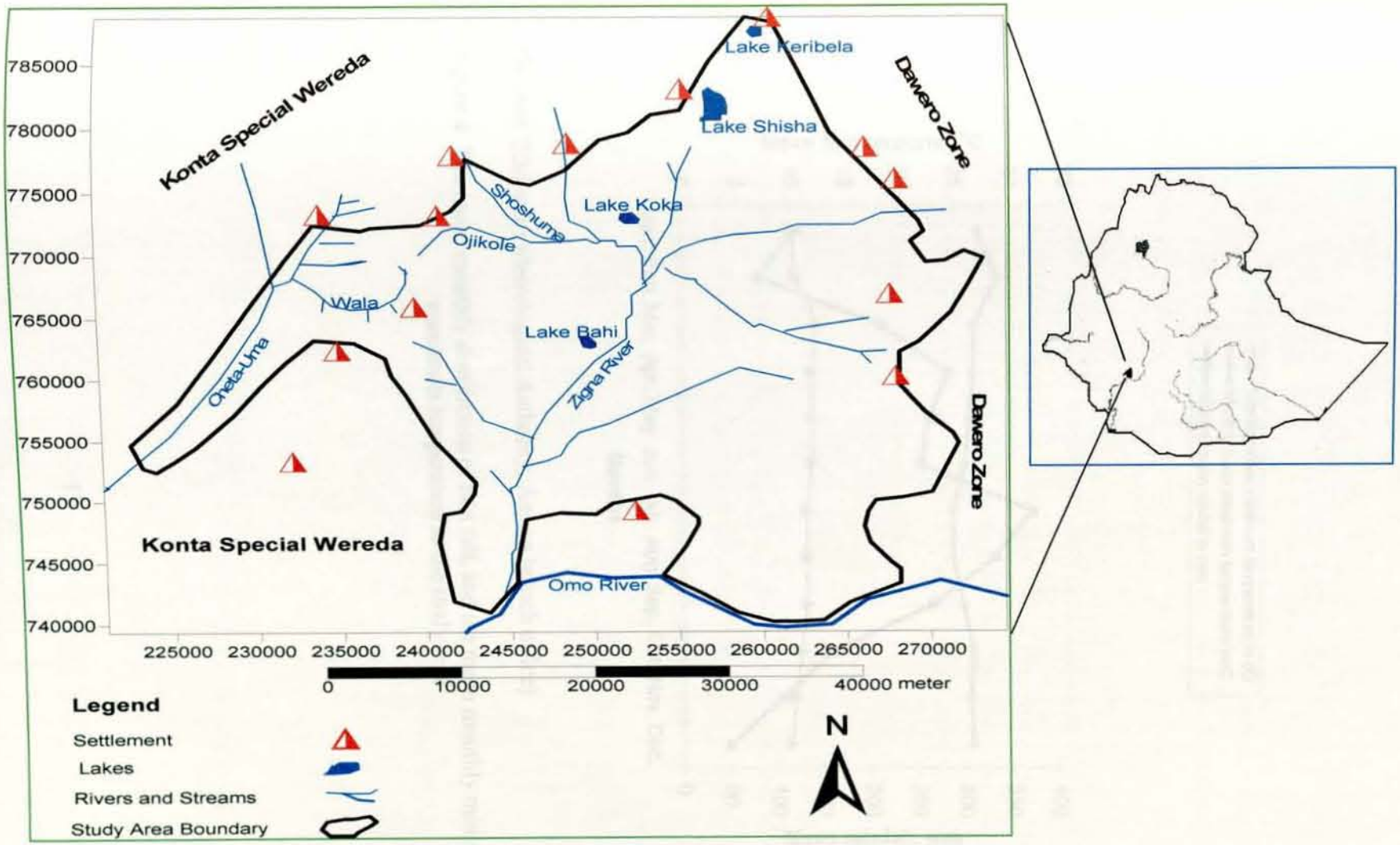
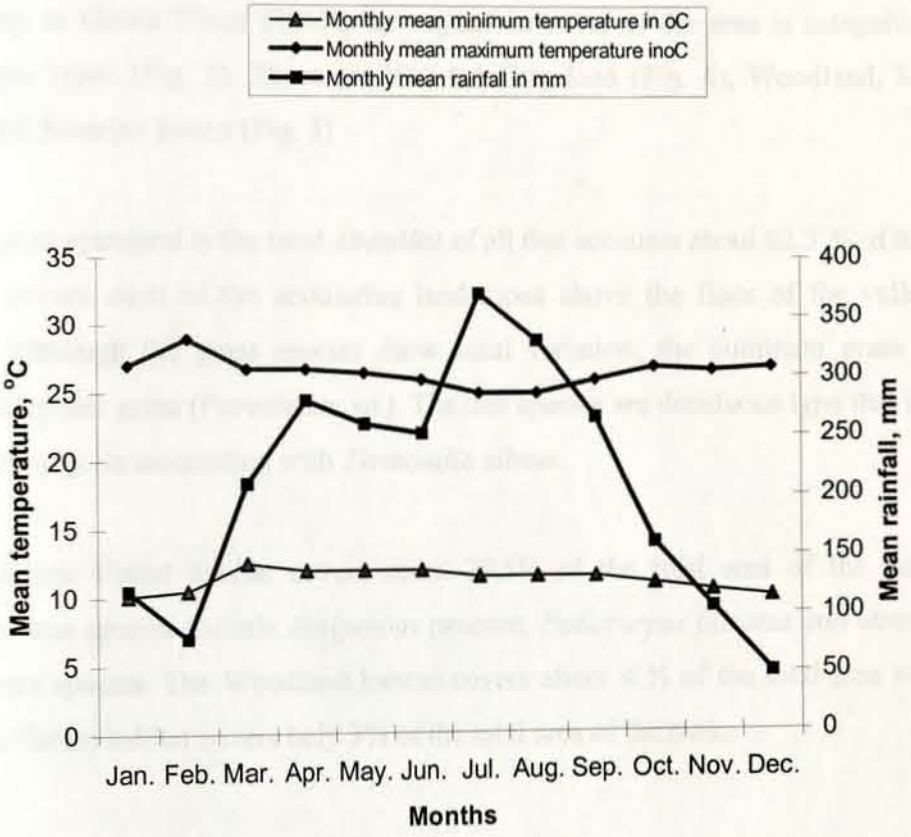


Figure 3. Location map of the study area



(Source: Ethiopian Metrological Authority, Amaya branch office)

Figure 4. The mean monthly distribution of rain fall, and the mean monthly minimum and maximum temperature in the study area

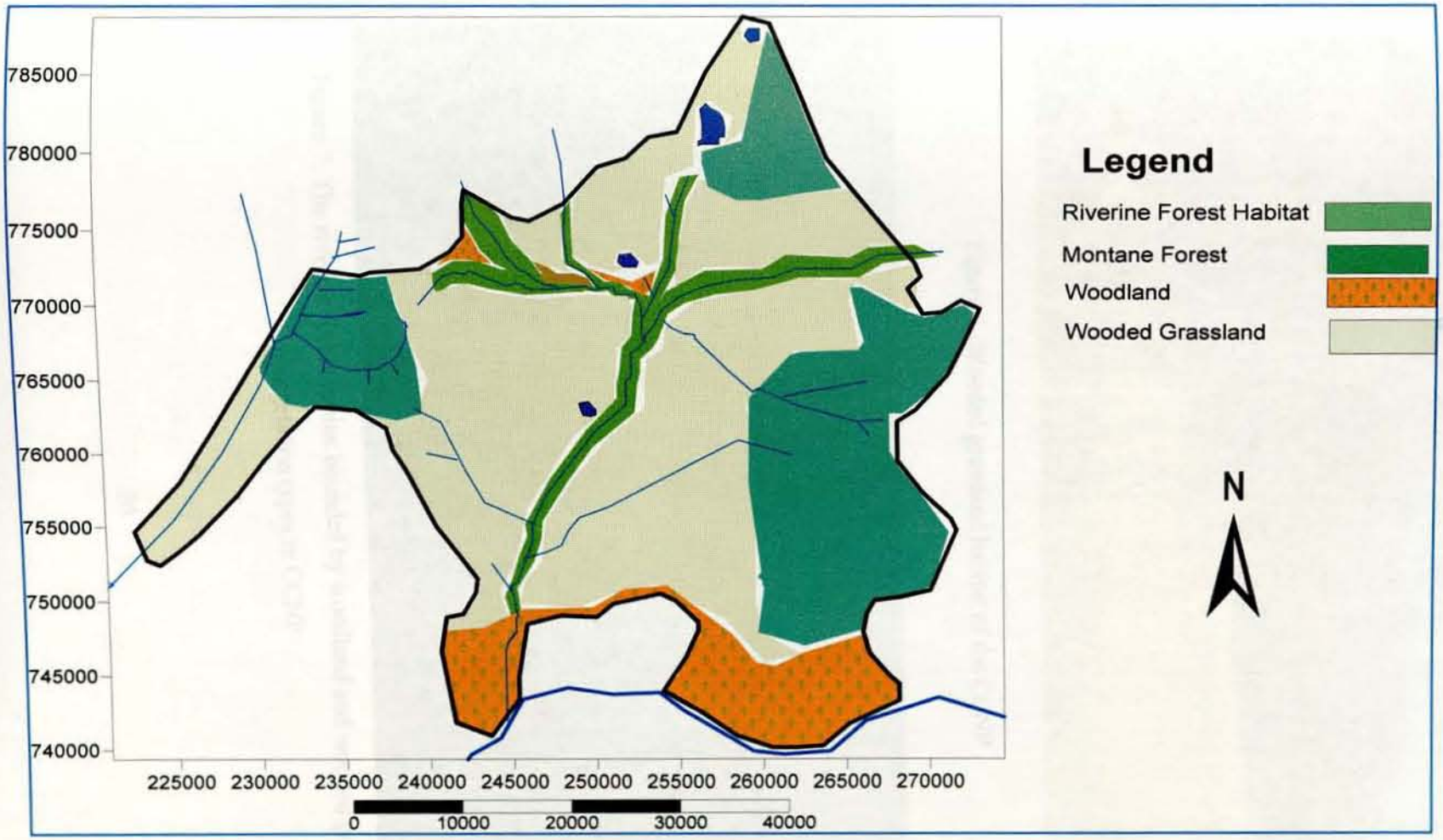
3.3 Flora and fauna

3.3.1 Flora

According to Girma Timer (2005), the vegetation cover of the area is categorized into four major types (Fig. 5). These are Wooded Grassland (Fig. 6), Woodland, Montane Forest and Riverine Forest (Fig. 7)

The wooded grassland is the most abundant of all that accounts about 62.5 % of the study area. It covers most of the undulating landscapes above the floor of the valleys and gorges. Although the grass species show local variation, the dominant grass species include elephant grass (*Pennisetum sp.*). The tree species are deciduous type that includes *Combretum sp.* in association with *Terminalia albiza.*

The Montane Forest habitat covers about 29.5% of the total area of the park. The dominant tree species include *Juniperous procera*, *Podocarpus falcatus* and other broad-leaved tree species. The Woodland habitat covers about 8 % of the total area while the Riverine Forest habitat covers only 3% of the total area of the park.



Adopted from Girma Timer (2005), Ethiopian Mapping Authority and Field observation

Figure 5. The vegetation map of the area

Figure 6. Wooded grassland habitat of the CCNP

Figure 7. The riverine forest habitat bounded by woodland and wooded grassland vegetation types in CCNP

3.3.2 Fauna

According to Girma Timer (2005), a total of 37 big mammalian species are identified and recorded in the area. These include African elephant (*L. africana*), African buffalo (*Syncerus caffer,* Sparrman, 1779) (Fig. 8), hippopotamus (*Hippopotamus amphibious,* Linnaeus, 1758), leopard (*Panthera pardus,* Linnaeus, 1758), lion (*Panthera leo,* Linnaeus, 1758), Spotted hyena (*Crocuta crocuta,* Ebdeben, 1777), African wild dog (*Lycaon pictus,* Temminck, 1820) and three species of primates. Most of these mammalian species are common in the forest habitats. Although no biological study is done so far to determine other faunal species in the area, it has also believed to have good diversity of birds, fish, reptiles and amphibians.

Figure 8. African buffalo in the grass habitat in the study area

3. 4 Conservation status

The area was not officially included in any of the protected area system in the country (Yirmed Demeke, 1997), but there was trophy hunting practiced until the ban of elephant killing in 1992. Thus, it might be considered as part of the Mizan Teferi Controlled Hunting Area. The idea to include the area under the protected area system of the country was initiated in the nearest past. Since then the regional government has made efforts to make survey on the wildlife resources of the area. In 2004 the proposal for the establishment of the CCNP was presented to the regional council and in August 2004, the regional council proclaimed the area as a national park.

At present, the regional government has already started building offices and outposts and organizing workshops, which involve all stakeholders (Almaz Beyero, pers. comm.). The region also encourages postgraduate students from AAU, the Department of Biology, to conduct different ecological studies, which will help in providing information that are vital for the conservation and management of wildlife resources and their habitat in the area.

3.5 Socio-economic status

3.5.1 Ethnic diversity

The principal nationalities found around CCNP are Dawro and Konta Nationalities. These people play major roles in the social, cultural and economic activities of the area. The other minority groups include Tsara, Menja and Bacha. These minority groups, although maintain some social, cultural and economic relationship with others, are culturally disrespected and traditionally engaged in less profitable economic activities (KSW, Agri. & Rura. Dev. Off., 2002).

3.5.2 Agricultural practices and land-use

More than 95% of the surrounding communities practice mixed agriculture while others depend on one of the two or other economic activities. More than 90% of the farmers of the surrounding areas plough the land using oxen; the rest, mainly form the above

minority groups, use hand tools. These minority groups of people also lead their livelihood by collecting and selling wild honey and roots of some of the wild plants (KSW, Agri. & Rura. Dev. Off., 2002). They are also involved in game hunting and fishing in the rivers found in the area for subsistence use.

The average size of land per household is two hectares, which includes living compounds. In mid-altitude relatively drier areas, clearing forest that is far away from the living compound has been a common and wide-spreading agricultural practice. This land-use system is more serious especially in and around forest reserves found closer to human settlements.

The permanent crops harvested in the area include coffee, banana, enset and avocado, and there are also cash crops that are found naturally in the forest. The main seasonal crops include teff, maize, sorghum, beans and peas. Although most of them are used both for home consumption and income generation, teff is cultivated mainly for cash.

4. MATERIALS AND METHODS

4.1 Materials

Standard questionnaires, relevant published and unpublished literature, GPS, binocular, photographing camera, video camera, hip-chain, steel meter tape, data sheets, topographic map of the area and its surroundings (1: 50,000 and 1: 250,000) and other necessary field gears were used for this study.

4.2 Methods

Three major activities were carried out during the study. These include preliminary and preparatory field survey, data collection and data analysis. Each of these activities involved the application of different methods that were appropriate for the achievement of the objectives are shown below.

4.2.1 Preliminary and preparatory field survey

The objective of the preliminary and preparatory field survey was to know the location, topography, and habitat types and their distribution in the study area; to get first hand and secondary general information on the history, size, distribution and movement pattern of the elephant population of the study area and to get general information on the human-elephant interaction in the study area.

This was done in two parts. The first part was undertaken in July 2006 prior to wet season data collection. In this session, the selection and training of the field assistants was conducted and information on the history, distribution and movement pattern of the elephant population and on the history of human-elephant interaction collected based on field survey and discussions.

The field assistants were game scouts of the national parks in the SNNPRS and local assistants who were selected based on their knowledge of the study area, their ability to speak the local language and Amharic and their past experience as guides for safari hunters.

4.2.2 Field study and data collection

Field study and data collection was conducted starting from the end of July 2005 to March 2006. The objective of the field study and data collection was to collect relevant first hand data and information on the history of the elephant population of the study area, the current status, seasonal movement and distribution: population size and abundance, sex ratio, age structure, and feeding and habitat association of the elephant population of the study area. During this study, relevant information on the human-elephant conflict in the study area was also collected. The different methods, which were applied for the various data collection, are outlined below.

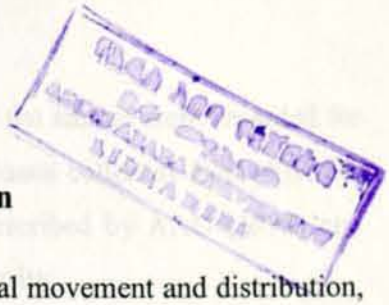
4.2.2.1 History of the elephant population

Standardized questionnaire was developed (Appendix I) and 10 randomly selected individuals from each of the eight villages found around the park were interviewed. Discussions were also held with elders, community leaders and political leaders at the Zone, Wereda and Kebele levels (Fig. 9).

(A)

(B)

Figure 9. Data collection based on group discussions (A) and individual questionnaire survey (B)



4.2.2.2 The Current status of the elephant population

Study of the current status of the elephants involves seasonal movement and distribution, population size and abundance, sex ratio and age structure, and feeding and habitat association of the population of the study area. During this study, relevant information on the human-elephant conflict in the study area was also collected. The different methods used and activities carried out for the various data and information collection are outlined below.

4.2.2.2.1 Seasonal movement and distribution

Dry and wet season distribution and movement pattern of elephants were studied based on direct observation of identified elephant groups and indirect observation of elephant signs, foot prints, dung piles and feeding signs (Whyte, 1996). Data was also collected from questionnaire survey and discussions with key informants. Information about habitat type was recorded on the notebook and the routes were recorded using GPS. The GPS recorded routes were marked on geo-referenced map of the area using Surfer Version 8.0 and the routes and the seasonal home range of elephants were mapped using Arc view Version 2.3.

4.2.2.2.2 Feeding and habitat association

The methods used to determine the feeding and habitat association of elephants included analyzing their habitats, and collecting and identifying of the plant species they consume. Those species of plants consumed by elephants were identified by observing them while feeding, closely examining the bits or remains they leave and their feeding signs apparent from plants. Information was also gathered through discussions held with local people and key informants, who pointed out the plant species that serve as the staple food of elephants (DeBoer *et al.*, 2000).

The habitat type, local name and part of the plants used by the animal were recorded for collected species of plants (Appendix II). The plant specimens collected from different habitats of the study area were labeled and pressed as described by AAU (1995) and identified in the National Herbarium of Addis Ababa University.

4.2.2.2.3 Population size and abundance of elephant

The size of elephant population in the area was estimated indirectly from dung counts, the most commonly used and most precise method for counting elephants (Burnham *el al.*, 1980; Jachmann and Bell, 1984b; Barnes and Barnes, 1991; Jachmann, 1991; Dawson and Dekker, 1992; Barnes, 1996; Morrison *et al.*, 2002; Prasad, 2005). It is applicable in areas where habitat features limit direct sighting or where the density of elephants is very small or declining (Dawson and Dekker, 1992; Morrison *et al.*, 2002).

The survey needs three parameters; defecation rate of elephants, dung decay rate and dung density of the study area. It also takes one important assumption, the environment is in a steady state with regard to the number of dung-piles (Barnes, 1993, 1996; Walsh and White,1999; Barnes, 2001). It means the proportion of fresh dung-piles deposited each day is equal to the proportion of old dung-piles disappearing that same day.

It is rare for elephants to be evenly distributed across a study area. Therefore, prior to dung count survey, the area was stratified to conduct dung count survey (Barnes *et al.*, 1994; Barnes, 1996).

As a result, the following activities that were appropriate for the methods applicable for the study were undertaken.

4.2.2.2.3.1 Stratification and transect layout

Based on field survey on the dry season habitat use pattern of elephants, the study area was divided into three strata having more or less homogenous dung density (Norton-Griffiths, 1978; Barnes, 1996). These strata were high-density, medium-density and low-density strata (Fig. 10).

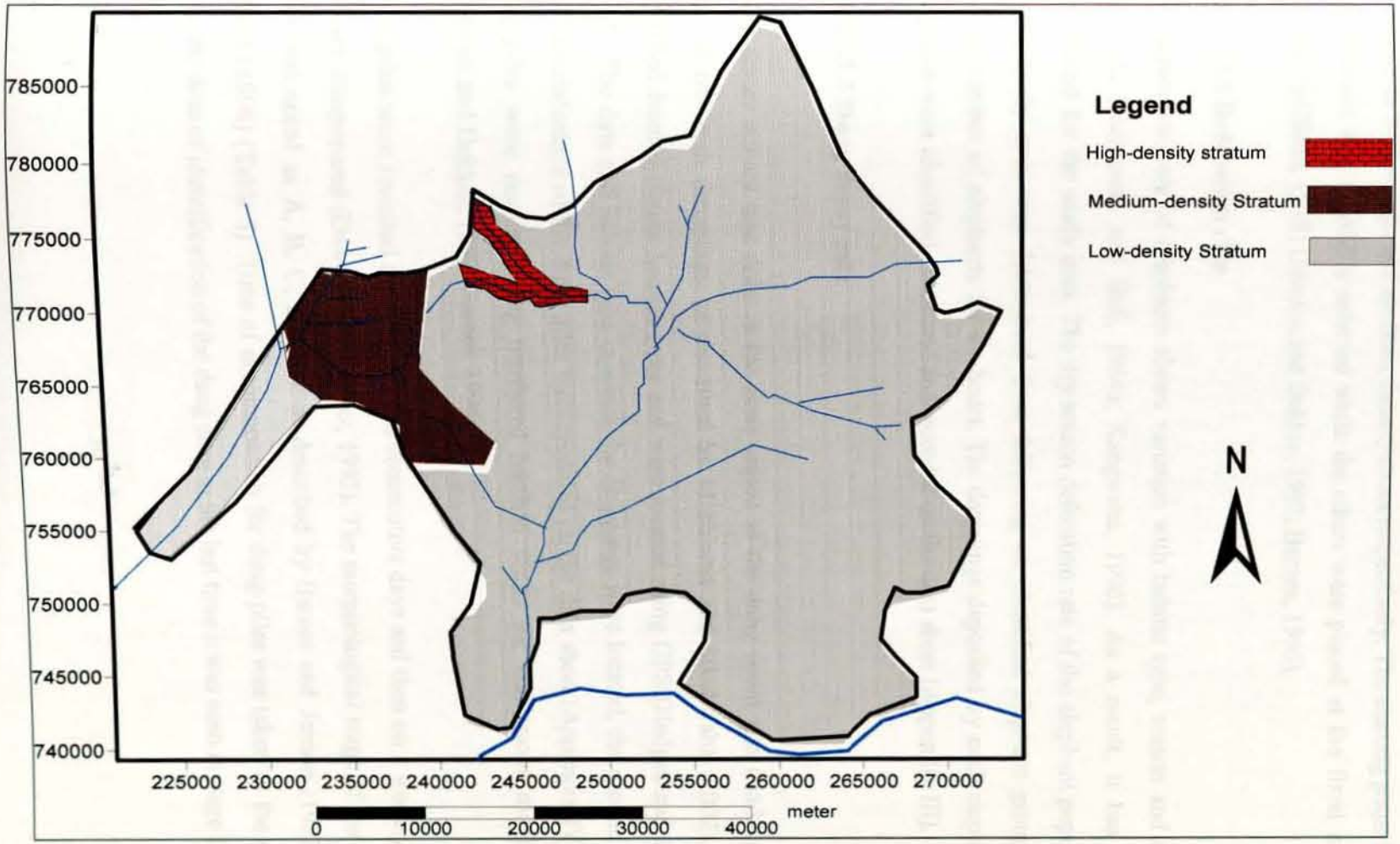


Figure 10. High, medium and low density strata in the study area

Transect survey was taken in the high and medium density strata only because no dung pile was observed in the low-density strata. Rivers flowing along the longest axis of the strata were used as baseline to set transects (Dawson and Dekker, 1992; Barnes, 1996) and transects were laid out at regular interval of 0.1 km and 2 km distance perpendicular to the rivers within high and medium density strata respectively. The starting point for the first transect was randomly selected while the others were placed at the fixed interval (Norton-Griffiths, 1978; Dawson and Dekker, 1992; Barnes, 1996).

4.2.2.2.3.2 Defecation rate

The defecation rate of elephants shows variation with habitat type, season and age of elephants (Jachmann and Bell, 1984a; Kangwana, 1996). As a result, it has to be determined for the study area. The dry season defecation rate of the elephant population of the study area was determined from following an identified elephant group with known number of elephants for six hours. The droppings deposited by each elephant in the group were identified, measured and recorded on the data sheet (Appendix III).

4.2.2.2.3.3 Dung decay rate

Dung decay survey was done in the same season as the dung count was conducted. A total of 64 fresh droppings, as described by Mubalama and Sikubwaba (2002), were identified from different habitat types and were located using GPS (Hedges and Tyson, 2002). The date and habitat type in which the droppings were located, the ground cover and circumference of the dung piles were recorded on the data sheet (Appendix IV). The dung-piles were marked using numbered bamboo sticks for continuous monitoring (Dawson and Dekker, 1992; Barnes, 1996).

Dung-piles were revisited for the first three consecutive days and then on a weekly basis till they disappeared (Dawson and Dekker, 1992). The morphological stage of the dung-piles was noted as A, B, C, D and E as described by Barnes and Jenson (1987) and Barnes (1996) (Table 5). Time of decomposition for dung-piles was taken as the period from the date of identification of the dung piles to the last time it was seen at stage D.

Table 5. Description of morphological stages of dung piles

Dung morphology	Description
A	Very fresh, moist with odour
B	Intact and fresh but dry with out odour
C	Some of the boli get disintegrated
D	All boli get disintegrated to form amorphous flat mass
E	Decayed to stage not detected at a range of two meter

Adopted from Barnes and Jenson (1987) and Barnes (1996)

4.2.2.2.3.4 Dung count

A total of 45 transects having a total length of 69.3 km were surveyed in the area. Sampling efficiency for each stratum was determined based on dung density estimated from the preliminary survey and the size of the stratum (Norton-Griffiths, 1978; Barnes, 1996; Plumptre, 2000). As a result, line transects having a total length of 37.3 km and 32 km were surveyed for high and medium density strata respectively.

The length covered along the transect line and perpendicular distance from the center of the transect to the center of the dung-pile was recorded by using hip-chain and measuring tape, respectively (Fig. 11) (Barnes, 1996). The morphological stage of the observed dung-piles was determined as in the decomposition rate survey (Barnes, 1996). The length from the starting point to the end was used to determine the total length of each transect while the perpendicular distance was used to calculate the probability density function (Dawson and Dekker, 1992; Plumptre, 2000). All these data were recorded on the datasheet prepared based on Dawson and Dekker (1992) (Appendix V).

Figure 11. Dung count survey along the transects to determine the dung density in the study area

4.2.2.2.4 Age structure and sex ratio

4.2.2.2.4.1 Aging elephants

Elephants are grouped in to five age groups (Manspiezer and Yilma Delellegne, 1992; Lee and Moss, 1995; Moss, 1996); calf ($\leq$ 1 year old), juvenile ($1 < X \leq 4$ years old), intermediate ($4 < X \leq 9$ years), sub-adult ($9 < X \leq 15$) and adults (> 15 years) (Williams, 2002). Aging the elephant population of the study area was conducted based on different methods; the body size comparison (Lee and Moss, 1995; Moss, 1996), hind footprint length (Western *et al.*, 1983) and dung-piles circumference (Jachmann and Bell, 1984b; Morrison *et al.*, 2002).

Elephants grow throughout their lifetime (Hanks, 1979; Moss, 1996). The larger an elephant is, therefore, the older its age. The body size comparison was done relative to the height of adult female elephant in the group. Calves are those pass beneath the front legs of the adult female; juveniles are those pass under the throat; intermediates having

height below the eye and sub-adults are having height above intermediates but below the adult female. Adult males are those having height greater than the adult females in the group (Manspiezer and Yilma Delellegne, 1992).

Footprint length was measured from the outer edge of the wrinkled imprint to the middle of the toenail of hind-foot. Footprint lengths of less than or equal to 21.80 cm were grouped as calves, between 21.80 and 27.20 cm were of juveniles, between 27.30 and 33.70 cm were of intermediates, between 33.80 and 44.10 cm were of sub-adult male or adult female and footprint length greater or equal to 44.20 cm were of adult male (Western *et al.*, 1983).

The mean of the circumference of three non-deformed bolus from a single defecation was considered as dung-pile circumference. Based on age specific dung-pile circumference, droppings having circumference less than or equal to 20 cm were grouped under calf, between 20.5 and 31.8 cm were grouped under juvenile, between 32 and 43.7 cm were grouped under intermediate, between 44.7 and 51.2 cm grouped under sub-adult male or adult female and more than or equal to 52.5 cm were grouped under adult male (Jachmann and Bell, 1984b).

4.2.2.2.4.2 Sexing elephants

The sex ratio of the elephant population of the area was determined by direct observation and analysis of an elephant group. As a result, out of the 24 elephants in the group, the elephants above 9 years of age were analyzed (Moss, 1996). The observed elephants' sex was determined based on physical characteristics; comparing body size, analyzing shape of the tusk, the head and the back (Manspiezer and Yilma Delellegne, 1992; Moss, 1996).

Males have much thicker, heavier and more tapering tusks than the females, the tusks of which tend to be uniform in circumference until the tip. Males have rounded head that is broader between the eyes, whereas, females have pointed head with narrower area between the eyes (Manspiezer and Yilma Delellegne, 1992; Moss, 1996). Whenever possible, reproductive organs were also observed to identify the sex.

4.2.3.2.5 Human-elephant conflict

The data and information collected with regard to human-elephant conflict include damages caused by elephants on humans or their belongings and damages caused by humans on elephants that included killing (Kangwana, 1996).

The data collection was mainly done through questionnaire survey and field observation during the study period.

Information on the history of human-elephant conflict was collected during the questionnaire survey conducted to collect data on the history of the elephant population. As a result, four villages were identified as areas of active human-elephant conflict. In these villages populations were defined as households living within 300 m from the boundary and 500 m along the boundary of the study area (Kangwana, 1996).

The questionnaire has been prepared in a way that it addresses all the necessary information regarding human-elephant conflict (Appendix VI). Questionnaire survey has

involved 20% of the total population, and the households living in the third house from randomly selected starting point were interviewed.

Field assessment was undertaken during day and night to directly observe the conflict and its impacts. Notes on elephant signs in the area, elephant group involved in crop raiding, the time in the night when elephants come and leave crop lands, and control measures used by the local people and the response of elephants to these measures were recorded.

Any illegal activity including elephant killing was also recorded. This included the sign and kind of illegal activity, the time and date of the activity and the possible origin of the individuals taking part in the activity. The age of the elephants that were found dead in the area was determined from lower jaw molar teeth eruption as described by Jachmann (1988) and Manspiezer and Yilma Delellegne (1992).

4.2.4 Data analyses

The data and information collected for the population history and human-elephant interaction from the questionnaire survey was analyzed using SPCC packages Version 11.

Analysis of the data gathered for the determination of population size and abundance was done using ELEPHANT software (Dawson and Dekker, 1992; Barnes, 1996). The program was used to calculate the defecation rate and the dung decay rate for the total area, and the dung density, the elephant density and the perpendicular distance function for each stratum. Then, an estimate of elephant number for each stratum was determined by multiplying the elephant density by the area of the strata. Finally, the total estimate of population size was determined by adding the number of elephants estimated for each stratum.

5. RESULTS

5.1 History of the elephant population

Out of a total of 80 individuals involved in the questionnaire survey, 69 (86.25%) claimed that elephants were seen in the study area for the first time in early 1970s, 6 individuals (7.5%) said that the elephants came a long time ago while 5 individuals (6.25%) did not know as to when elephants came to the area for the first time. Most of the individuals who participated in the interview (97%) shared the idea that the elephants probably came from an area called Shoru or Sharma (named after a river Sharma), in the southwestern part of the study area, very close to the northern boundary of Omo National Park.

Both the questionnaire survey and the discussions with selected individuals indicated that elephants followed two routes to occupy the present area. The first route follows Omo River to move around the Lastae Mountain and then continued westward to meet Cheta-Uma, the present western range. The second route follows Omo River up to the junction where Zigna River meets Omo and then moves along Zigna River to the present north and central home range.

In the late 1970s and early 1980s, elephants were said to have increased both in number and distribution to occupy almost all parts of the present CCNP and some other parts in the north, east and west. The bidirectional movement between the area and the place of origin was believed to have continued until the early 1980s. More than 83% of the respondents also mentioned that there was a marked decline in the size and distribution of elephants between the past and the present.

Out of those individuals interviewed, 51.25% said that the decline in number and distribution was mainly due to intensive poaching during the transitional government period. Others (27.5%), however, said that it was due to both illegal killing and emigration to other areas. In fact, 8.75% of the respondents claimed that it was only due to emigration while 12.5% said that they didn't know the causes.

5.2 Current status of the elephant population

5.2.1 Seasonal movement and distribution

Results of the questionnaire survey and the discussion with the key informants showed that the distribution and movement pattern of elephants was significantly changed in the last one and half decades. During the Dergue Regime, elephants were common in and outside the present CCNP. At present, however, they are localized to two areas, the western and the northern parts of the CCNP (Fig. 12). These two groups of elephants were reported not to have interaction for the last three to five years. However, a group of elephants was observed crossing from west to north in March 2006, might be as a result of disturbances from poachers. Accordingly, the total home range of elephants of the CCNP was close to 250 km^2.

According to the field observations, the northern population has a wet season home range that extends up to the Zigna River, Lake Bahi in the south and Boka Forest in the northeastern parts of the park. For about one-third of the wet and all of the dry seasons, however, the population was confined to the riverine forest of Shoshima and Ojicole Rivers (less than 10% of the total sub-home range).

The western elephant population has dry season home range that extends from Agare Forest in the north to Cheta-Uma in the south and Tesae River in the east. Unlike the other elephant group, there was no significant difference between the dry and wet season home ranges for this group. However, it became more concentrated to the central and northern parts of its range, mainly to the Wala River, and the Kuya and Agare Forests, during the dry season.

The northern elephant population movement pattern follows the riverine forest of the Shoshima River to Yora Forest. A few elephants, however, cross the Shoshima River and proceed southwards along the western part of the Zigna River to Lake Bahi. From Yora Forest, the groups appear to take two routes; eastwards to Boka Forest or northwards to Lake Shita.

The western population used the Wala River as a bridge to move north and southwards. The northward movement follows Kuya Forest, at the northern tip of Wala River, and then to Shande River, then back to Wala to make a full trip. It proceeds southwards following two routes; following Wala River till Cheta-Uma or getting out of the Wala River and then moving to Mekena Forest and Tesae River.

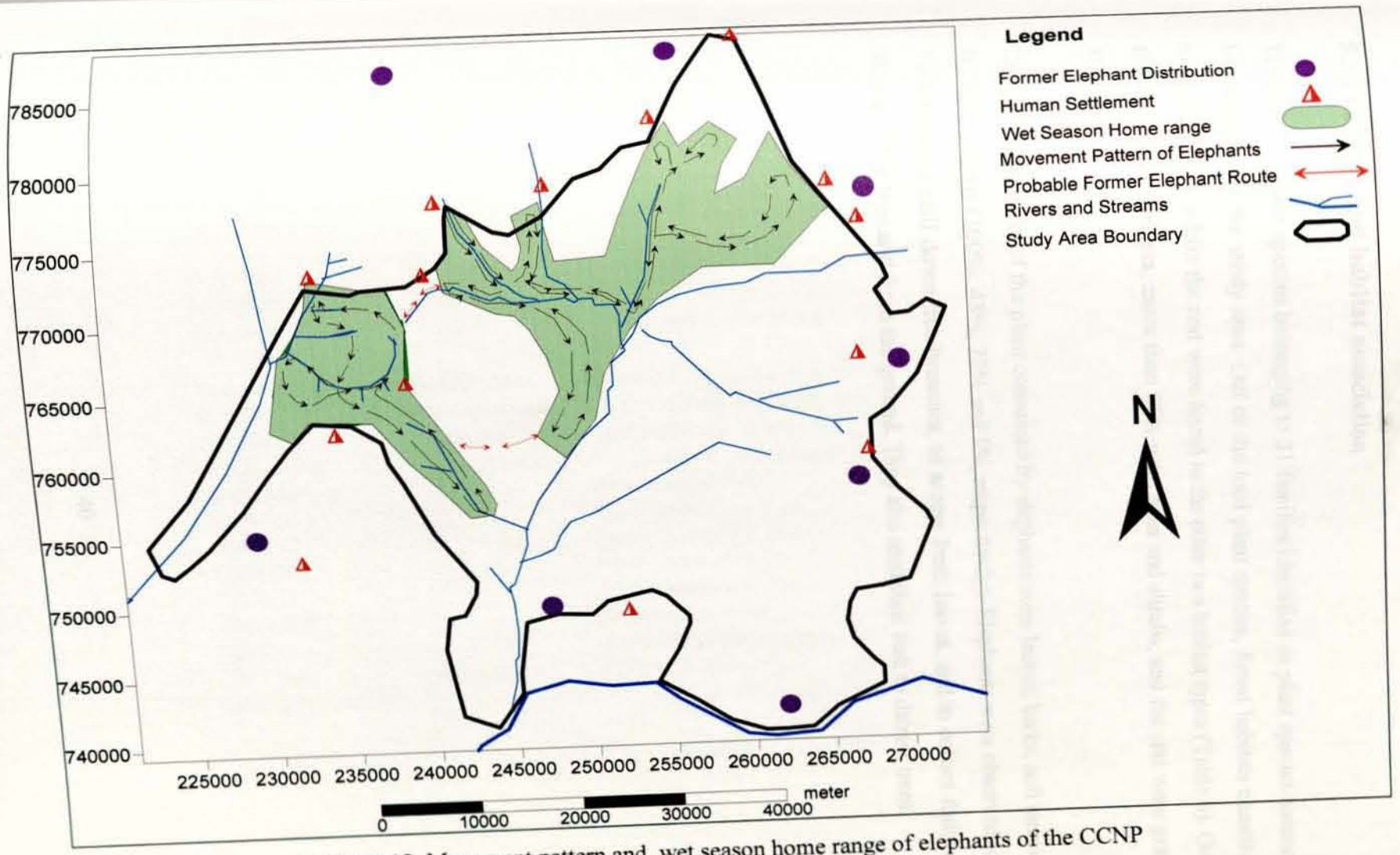


Figure 12. Movement pattern and wet season home range of elephants of the CCNP

5.2.2 Feeding and habitat association

There are 51 plant species belonging to 31 families identified as plant species consumed by elephants of the study area. Out of the total plant species, forest habitats constituted more than 90%, while the rest were found in the other two habitat types (Table 6). Out of these species of plants, more than 80% were trees and shrubs, and the rest were grasses and herbs.

The dominant parts of the plant consumed by elephants were leaves, barks, soft stems and buds, and fruits (100%, 43%, 22% and 5%, respectively). Elephants were observed to use their trunk to pull down tree branches, to access fresh leaves, and to collect fruits from the top of the tree and from the ground. They also used their tusk to debark trees.

Table 6. List of identified species of plants consumed by elephants

Local name	Family	Scientific name	Habitat type	Parts consumed
Boka (K)	Rubiaceae	*Rothmannia urcelliformis*	Forest	Leaves and bark
Mentserku (K)		*Psycoteria orophila*. Petit	Forest	Leaves, soft stems and fruits
Zemo (K)		*Psydrax schimperiana* (A. Rih.) Bridson	Forest	Leaves
Lemeche (K)	Melliaceae	*Ekebergia capensis* Sperm	Woodland	Leaves and buds
Hagilo (K)	Flacortiaceae	*Flecortia indica* (Burm. F.) Merr	Forest	Leaves and stems
Shisha (K)	Ulmacea	*Celtis africana* Burm. F.	Forest	Leaves and bark
Metshia (K)	Pittosporaceae	*Pittosporium viridiflorum* Sims	Forest	Leaves and bark
Shola (A)	Moraceae	*Ficus Lutea* Vahl.	Forest	Leaves, barks and fruits
Shoho (K)		*Ficus umbellate* Vahl.	Forest	Leaves, bark and fruits
Boea (K)		*Ficus thonningii* Blume.	Forest	Leaves, bark and fruits
Wela (K)		*Ficus vassta* Forssk	Forest	Leaves and bark
Aerka (K)		*Ficus ruspolii Warb.*	Forest	Leaves and bark
Zetuma (K)		*Trilepisium madagaxcariense* DC	Woodland	Leaves and bark
Solo(K)		*Antiaris toxicaria* Lesch.	Forest	Leaves and stems
Gera (K)	Asteraceae	*Vernonia* sp.	Forest	Leaves and bark
Gera gembusa (K)		*Vernonia adoensis* Sch. Bip. Ex. Wap.	Forest	Leaves
Buzo (K)		*Vernonia ampla* P. Hoffm.	Forest	Leaves

Note: - 'K' is the plant name in the local language of the area (Knonta) and 'A' for Amharic names

Table 6. List of identified species of plants (continued....)

Local name	Family	Scientific name	Habitat type	Parts consumed
Boshka (K)	Sterculiaceae	*Dombya torrida* (J.F.Gmel.) P. Bamps	Forest	Leaves and soft stem
Zenbaba (A)	Areceaceae	*Phonix reclinata*	Forest	Leaves, stems and fruits
Cheta (K)	Fabaceae	*Albizia schimperiana* Oliv.	Forest	Leaves and soft stem
Bdelo (K)		*Abrus phcatorius*	Forest	Leaves
Kenkelo (K)		*Piliostigmli thonningii* (Schum.) Milne Redh.	Woodland	Leaves, barks and fruits
Boka (K)	Combertaceae	*Terminalia brownie* Blume.	Forest	Leaves, bark and fruits
Illala (K)		*Terminalia laxiflora* Engl.	Forest	Leaves, buds and fruits
Ambae (K)		*Combertum molle* R. Br. Ex G. Don	Wooded grassland	Leaves and fruits
Losha gomerea (K)	Tiliaceae	*Grewia ferruginea*	Forest	Leaves, soft stems and bark
Fatawo (K)	Celastraceae	*Maylenus arbutifolia* Hochstex	Forest	Leaves and buds
Doga (K)	Myrsinaceae	*Masea lanceolata* Forssk	Forest	Leaves, soft stems and bark
Solo(K)		*Masea lanceolata* Forssk	Woodland	Leaves and bark
Dodea (K)	Vitaceae	*Ampelocissus schimperiana*	Forest	Leaves
		Cayratia iburnsis (Hook.F.) Suesseng	Forest	Leaves and soft stem
Tura (K)	Annonaxeae	*Uvaria leptocladon* Oliv.	Forest	Leaves and soft stem
Chewela (K)	Rutaceae	*Diphasia dainelli* (Pichi.) Sperm.	Forest	Leaves and bark
Tsetselo (K)	Selastreacea	*Maytenus addatloes*	Forest	Fresh leaves and stems
	Sterculiaceae	*Dombya torrida* (J.F.Gmel.) P. Bamps	Forest	Leaves and soft stem
Ashingae (K)		*Pennisetum* sp.	Grassland	Whole part

Table 6 List of identified species of plants (Continued....)

Local Name	Family	Scientific Name	Habitat Type	Part of Plant Consumed
Gerchu (K)	Apocynaceae	*Oncinotis tenuiloba* Steps.	Forest	Leaves
Hoso (K)	Sapindaceae	*Paullinia pinnota*	Forest	Leaves, soft stems and bark
Tselahae tsema (K)	Costaceae	*Costus afer* Ker-Gawl.	Forest	Leaves, stems and roots
Geasho (K), (A)	Rhamnaceae	*Rhamnus prinoides*	Forest	Leaves, steams and fruits
Tsemo (K)	Anacardiaceae	*Rhus ruspolii* Engl.	Woodland	Leaves and bark
Griche (K)	Euphorbiaceae	*Bridelia scleroneura* Mull. Arg.	Forest	Leaves and bark
Seaknesa (K)		*Acalypha ornate* A. Rrich	Forest	Leaves
Bosa chyesha (K)		Achalia sp.	Forest	Leaves
Besana (A)		*Croton macrostachyus* Del.	Woodland	Leaves and bark
Zuzea (K)		*Brisellia scleroneura*	Forest	Leaves and bark
Tunja (K)	Piperaceae	*Piper longum* L. F.	Forest	Leaves
Gelasho Tunja (K)		*Piper capense* L. F.	Forest	Leaves
Asengo (K)	Rosaceae	*Prunus africana* Hook.	Forest	Leaves and bark
Sobo (K)		*Prunus africana* Hook.	Forest	Leaves and bark
Shemele (A)	Poaceae	*Arundinaria alpina*	Woodland	Leaves
Bedilo (K)	Leguminaceae	*Abrus precatorius* L.	Forest	Leaves and bark
-	Compositae	*Crisium englerianum* O. Hoffm.	Woodland	Leaves
Gulo(K)	Lamiaceae	*Ocimum urtcifolium* Roth.	Forest	Leaves and soft stem

5.2.3 Population size and abundance of elephant

5.2.3.1 Defecation rate

A total of 116 droppings were found and counted after 42 elephant-hours. It was determined that the overall mean defecation rate for elephants in the study area was 16.57 droppings elephant $^{-1}$ day $^{-1}$ ($\pm$ 2.044 at 95% CL). Defecation rate for adult females (n=1), for intermediate female (n=3), for juveniles (n=2) and for adult male (n=1) was found to be 16, 17.33, 18 and 12, respectively (Table 7).

Table 7. Dry season sex- and age-specific defecation rates for elephants in CCNP

Elephant group	Age and sex of the elephant	No of droppings/6hrs	Defecation rate (elephant/day)
Cow/calf	Adult female	4	16
	Intermediate female	5	20
	Intermediate female	4	16
	Intermediate female	4	16
	Juvenile	4	16
	Juvenile	5	20
Lonely Male	Adult male	3	12
	Average	29/6hrs	16.57

5.2.3.2 Dung decay rate

The dry season mean dung decay rate for the study area was determined to be 0.0133 droppings day^{-1} ($\pm$ 0.0017 at 95% CL.). The mean number of days for the disappearance of dung piles was 73.20 ($\pm$ 3.055 at 95% CL).

The rate of dung disappearance was relatively low during the first seven weeks of defecation. This was followed by rapid disappearance rate until the seventeenth week while the last few dung-piles persisted (Fig. 13). As a result, the distribution curve for dung survival in the study area is a reversed sigmoid curve and it is negatively skewed (Kurtosis= -0.658).

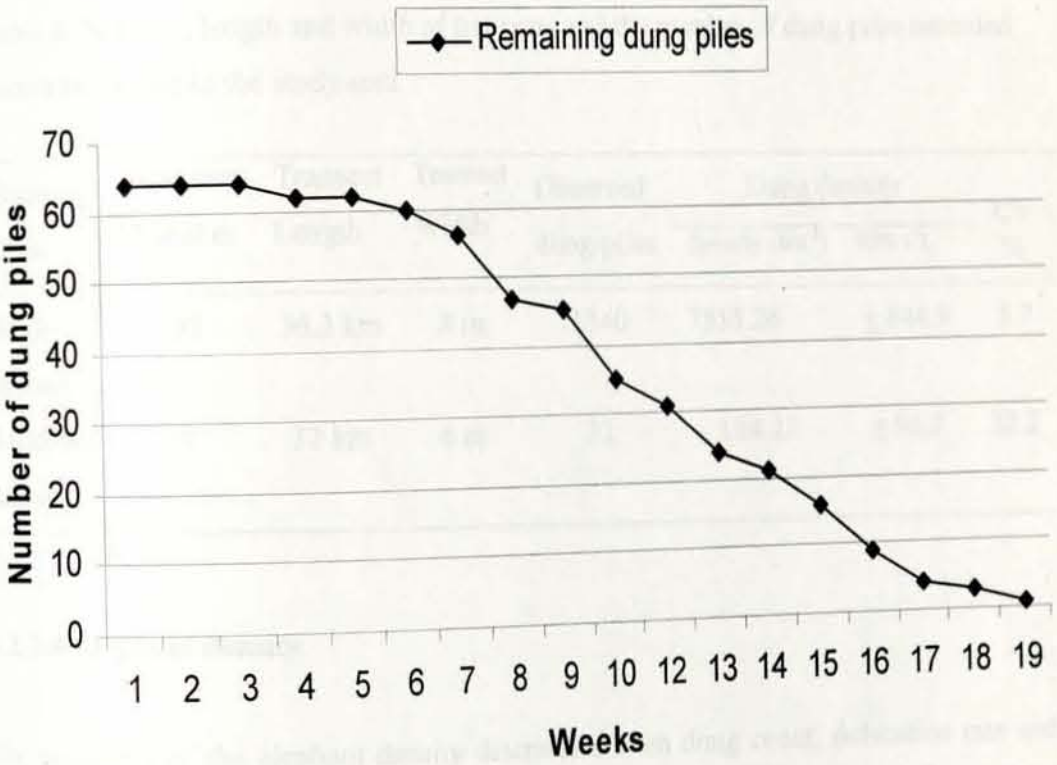


Figure 13. Weekly dung-piles disappearance in the study area

5.2.3.3 Dung density

A total of 1372 (1340 and 32 from the high- and medium-density stratum respectively) droppings were counted for the total transect. The dry season dung density was determined to be 7558.26 droppings km^{-2} (± 844.9 at 95% CL) and 124.22 droppings km^{-2} (± 96.7 at 95% CL) for high- and medium-density strata respectively (Table 8).

Table 8. Number, length and width of transects and the number of dung piles recorded within two strata in the study area

Stratum Type	Transect Number	Transect Length	Transect Width	Observed dung-piles	Dung density		CV %
					Density (km^{-2})	95% CL	
High-density	37	36.3 km	8 m	1340	7558.26	± 844.9	5.7
Medium-density	8	32 km	6 m	32	124.22	± 96.7	32.2

5.2.3.4 Elephant density

The estimates of the elephant density determined from dung count, defecation rate and dung decay rate for high and medium density strata were 5.98 elephant km^{-2} with 95% confidence interval of 4.66 and 7.3 elephants km^{-2}, and 0.10 elephant km^{-2} with 95% confidence interval of 0.03 and 0.17 elephants km^{-2}, respectively (Table 9).

Table 9. The estimated elephant density in each stratum and in the total study area

Stratum	Area (km^2)	Elephant density (km^{-2})		Elephants $stratum^{-1}$	
		Density	95%CL	Number	95%CL
High-density	12.44	5.98	± 1.32	74.4	± 17
Medium-density	104.4	0.10	± 0.07	10.4	± 7.3
Low-density	1129.00	–	–	–	–
Total area	1255.48	0.07	± 0.022	84.8	± 24.3

Therefore, the total estimate of number of elephants in the study area was 85 with a 95% confidence interval of 61 and 109 and the mean estimated elephant density of 0.07 elephants km^{-2}.

5.2.4 Age structure and sex ratio of the elephants

5.2.4.1 Age structure

A group of 24 elephants were observed and their body sizes were compared. Among the observed elephants, there were 1 calf, 2 juveniles, 9 intermediates, 11 adult females or sub-adult males (three sub-adult males and eight adult females) and 1 adult male.

A total of 235 hind footprint measurements were taken for elephants in the study area. Accordingly, the measure was 12 for calves, 14 for juveniles, 98 for intermediates, 75 for sub-adult males or adult females and 38 for adult males.

A total of 569 droppings were measured in the study area. Out of which, 2 for calves, 13 for juveniles, 245 for intermediates, 228 for sub-adult males or adult females and 81 for adult males. The proportion of the five age groups resulted from the above three methods is shown in Table 10.

Table 10. Proportion of the age groups of the elephant population of the study area based on the three methods employed in the study

Age categories	Body size comparison	Footprint length	Boli circumference
Calves	4.2	5	0.3
Juveniles	8.3	6	2
Intermediates	37.5	42	43
Sub-adult males or adult females	45.9	32	40
Adults	4.2	16	14

5.2.4.2 Sex ratio

Out of 12 elephants above 9 years of age, 4 (37%) were males and 8 (67%) were females. Therefore, the male to female sex ratio for elephants in the area was 1:2. Fig. 14 shows adult bull elephants in CCNP. Summary of age and sex structure of elephants in CCNP is shown in Table 11.

Table 11. Estimated age-sex structure of elephants of the CCNP

Age class	Percentage	
	Males	Females
Adult	5	
Sub-adult male or adult female	12	33
Intermediate		41
Juveniles		6
Calves		3

Figure 14. Adult bulls in the secondary vegetation closer to the riverine forest in CCNP

5.2.5. Human-elephant conflict

5.2.5.1. Elephant poaching

According to the questionnaire survey, 65% of the respondents claimed that elephant poaching had been practiced in the area while the rest said it was not practiced in the area. Out of those claiming the presence of elephant poaching, 37% said it was practiced until the establishment of EPRDF while most (63%) claimed it is practiced even now in the area. Regarding the period at which elephant poaching was intense, most of the respondents (86%) said it was very intense during the Transitional Government, 7% of them said it was during the Dergue Regime, while the remaining said they did not know about it. The result was also supported by information generated from discussions held with elders and informants. According to the discussions most people were unfamiliar with elephants, have had fear for them and were unaware of ivory trade during the 1970's and 1980's.

The main causes reported to contribute for intense elephant poaching during the Transitional Government were illegal firearm trade, and political and social instability in the country. Subsequent restoration of political and social order in the country, local disarmament of illegal firearms and the initiatives taken by the local governmental body to protect the area might reduced the poaching pressure on elephants.

As the other sources of data and field survey in the area revealed, even if efforts were exerted since 1996 to control elephant killing, there is still limited poaching for ivory (Table 12). The data gathered showed the northeastern, south central and southwestern parts of the study area are danger zones for elephants and other animals. The main localities from where poachers originated were Chuchura, Boka, Bake seda, Cheta, Yora and villages far in the south-western part of the park (Fig. 15).

Table 12. Number of elephants recorded as killed by poachers from 2002-2006

Year	Number of elephant killed	Location	Legal status
2002	Two (One adult female & one juvenile)	Yora Kebele	Ivory wasn't seized and individuals were not identified
2006	One (intermediate female)	Chebera Kebele	Killer not identified but the ivory was seized and those that collected the ivory were identified and brought to court

Adopted from Konta Wereda Rural development Office, local informants and field observation

Illegal activities occurred in the study area during the study period include elephant killing, ammunition, firing, snaring, livestock grazing, cutting and debarking trees, fishing, and collecting wild honey and edible roots. One elephant was found killed by people from the surrounding villages. There were 10 gunshots heard during the study period, of which some were targeted on elephants. In the dry season of the study period, more than 60% of the area was burnt by fire caused by the local people.

5.2.5.2 Crop raiding

Elephants were consistently raiding crops and attacking crop-stores around their home range till the end of 1980s. They were also causing social problems including preventing people from walking at night. There was also a report that elephants killed a person while he was on his way to a market place. Due to this, early settlement of people was based on the distribution and movement pattern of elephants in a given area, that is, they preferred to settle in areas that were less inhibited by elephants activities.

Based on the questionnaire survey conducted in eight villages around the park, four localities (Chebera, Sere, Yora and Agare) were identified as having problem of crop raiding by elephants (Fig. 15). Other wild animals such as Olive baboons (*Papio anubis*, Lessen, 1827), Vervet monkeys (*Chlorocebus aethiops*, Linnaeus, 1766), Giant forest hog (*Hylochoerus meinertzhageni*, Thomas, 1904), African buffalos (*S. caffer*), Crested

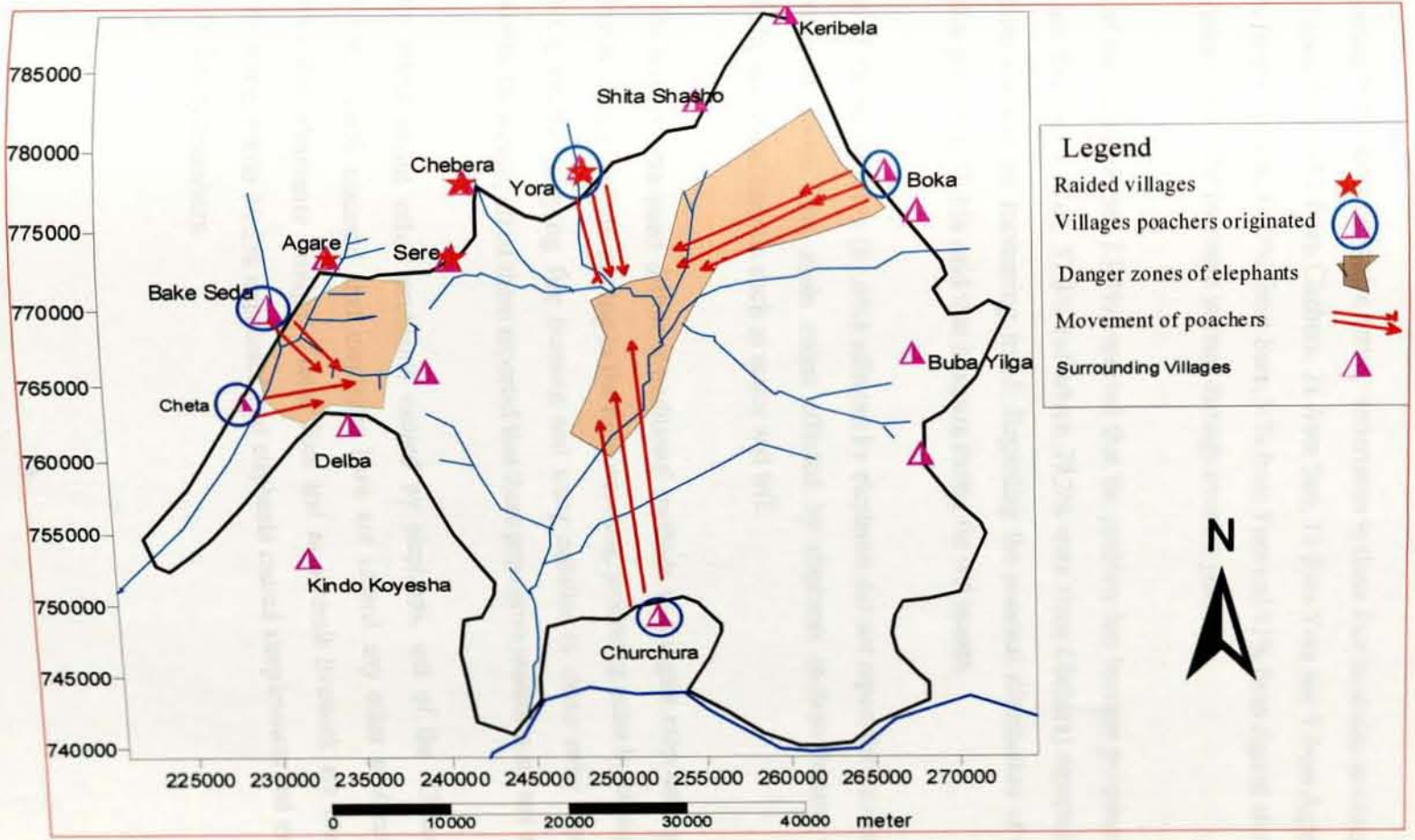


Figure 15. Crop raided villages, villages where poachers were originated and danger zones for the elephants of the study area

porcupine (*Hystrix cristata*, Linnaeus, 1758) and Hippopotamus (*H. amphibious*) were reported to take part in crop raiding, while the first three have had prevailing effect. Wild animals reported to attack livestock were Leopard (*F. parudus*), Lion (*P. leo*) and Spotted hyena (*C. crocuta*).

According to the questionnaire survey undertaken in these four localities involving a total of 73 households (32 from Chebera, 21 from Seri, 11 from Yora and 9 from Agare), 39 % (75% from Chebera, 14.3% from Sere, 9 % from Yora and 11% from Agare) claimed that elephants caused the increase in crop damage over the years.

Out of the respondents, 73.3% reported that the problem has become prominent within the last five years. Yet, 57.3% (of which 79.2% were from Chebera) reported that the problem showed an increasing trend. Regarding the seasonal distribution of the crop damage problem, 71.1% said that it occurs during the wet season.

Most of the households (81.6%) affected by elephants did not report the incident to any government body. The main crops affected by elephants include banana, cassava, avocado, enset and cereals such as maize and teff.

All the respondents used different traditional methods to mitigate crop damage due to elephants. These include staying in the field watching, producing noise by biting drum or shouting loudly, keeping fire burning and using missiles to chase away approaching elephants. However, all of them reported that these preventive measures are not effective.

When asked about other problems caused by elephants, out of the 73 households surveyed, 46.6% claimed that elephants have not caused any other problem, 33.3% claimed that elephants brought Tsetse flies and as a result livestock are attacked by trypanosome, while 30.2% expressed that elephants caused sleeplessness and extra labor cost on family members.

With regard to benefits derived from the presence of elephants in the area, 6.8% claimed that they have benefited, All these respondents were from Chebera. The rest claimed that they did not see any benefit. On the other hand, 59.5% of those who were interviewed felt responded that they lost what they intended to get from their crop. Yet, 23.8% said that they would be happy if elephants are not there while 42.9% feel unhappy and the remaining 33.3% feel nothing.

Field verifications carried out in March 2006 (early rainy season) in Chebera village revealed that out of 20 households, 14 (70%) had crop-raiding problem during the first two weeks of the month). However, no crop damage by elephants was reported in other sites. The main elephant group taking part in crop-raiding was the bulls group having 3 to 6 members, sometimes followed by cows and calves group having 5 to 8 elephants. The elephants, it was learnt, usually came to croplands in the evening from 9:00 pm to 12:00 pm and usually stayed until 4:00 am to 6:00 am.

With regard to the need and importance of establishing protected area, many (69.9%) of the interviewed in the above locations did not know the benefits and needs for the establishment of protected areas and the conservation of wild animals including elephants while others claimed that there are benefits obtained from the establishment of a protected areas and conservation of wild animals. However, the decision was influenced by income that they can earn. Most of the respondents (64.4%) did not see any future benefits out of protecting the area, and many of them (75.3%) appeared to see elephant conservation as a future threat to their survival while the rest have no fear about it.

6. DISCUSSION

6.1 History of the elephant population

The study area is one of the few western mid-altitude forest areas, where elephants are known to exist. However, unlike other home ranges of elephants in the country where elephants had been living for decades (Largen and Yalden, 1987, Hillman, 1993; Yirmed Demeke, 1994; Cherie Enawgaw, 1998), the CCNP elephant population appears to be relatively new to the area. The population probably originated from the area near or around the Omo National Park and was later pushed up due to man-made factors to its current home range seeking for refuge. Like other countries in the continent, the dispersal and isolation of this population in its current home range might be caused by intensive poaching, human settlement and agricultural expansion (Cumming *et al.*, 1990).

The elephant population in the study area was significantly reduced within the last 15 years with only a small number of elephants remaining. The local people mentioned that emigration of elephants to their place of origin as a cause for this population decline. But since the corridor between the study area and the original place of the elephants has been habituated by armed agriculturalists, it is unlikely for emigration to be the main cause for the decline in population size.

Like many other wild animal species and other elephant populations found in many parts of the country (EWCO, 1991; Tesfaye Hundessa, 1997; Yirmed Demeke, 1997; Cherie Enawgaw, 1998), the elephant population in the area might have also been affected by social and political instability following the downfall of the Dergue regime. The problem was, however, further aggravated by uncontrolled firearm and ivory trade (Yirmed Demeke, 1997; Blanc *et al.*,, 2003). Unlike other protected areas such as Mago National Park (Yirmed Demeke, 1994) and other countries in Africa (Bhima *et al.*, 2003), where elephants are also killed for their meat, the cause for elephant killing in the study area was for its ivory. But few groups of people eat the meat of elephants.

6.2 The status of the elephant population

6.2.1 Seasonal movement and distribution

The observed movement of elephants from the western group might be an indication that the elephants had prior knowledge of the route and the area of shelter. The two groups that currently exist in the park were probably forming one group or freely moving as two groups within the two home ranges. The settlement and increased expansion of agricultural activities in areas like Delba, Kuya and Shewa kela and intensified illegal activity of village in the south and eastern part of the study area were the probable factors that hindered the former movement of the elephants of the study area (Barnes *et al.*, 1991).

The high abundance of elephants to the forest habitats was probably due to the availability of enough forage and shelter to hide themselves (Mpanduji, 2002; Danquah, 2004). The shift in habitat preference from savanna into forest habitats may be due to the pressure from poaching as reported in Zimbabwe (DeBoer *et al.*, 2000) and Bia National Park, Ghana (Short, 1983).

The extended wet season distribution of elephant groups might be associated with the availability of water in small streams and temporary swamps, the growth of fresh leaves of broad-leaved trees in the woodland and wooded grassland habitats and the availability of long un-burnt grass, which is preferred by elephants (Smith *et al.*, 1995; DeBoer *et al.*, 2000). On the other hand, the reduced home range of the elephant groups in the dry season might be due to the drying out of small streams and ponds, shading of leaves of trees in woodland and wooded grassland habitats, incidence of fire and intensified illegal activities. Observations during the study period confirmed the high frequency of illegal activities during the dry season.

6.2.2 Feeding and habitat association

The number of plant species identified as being consumed by elephants was few (51) when compared to the findings of DeBoer *et al.* (2000) in the Maputo Elephant Reserve, Zimbabwe (95 plant species). The difference in the number of plant species reported as consumed by elephants in the study area and MER might be due to the different methods used in the two studies. In MER, faecal analysis based on epidermis reference collection was used and this method may provide better opportunity to identify more species. In the present study, however, attempts were made to identify plant species based only on direct observation of feeding elephants and their feeding signs. Information on feeding was also acquired from discussions with the local people. This method may not allow the identification of as many species as faecal analysis method. It was also possible that the two areas might differ in the vegetation composition.

The proportion of grass, herbs, shrubs and trees identified for the study area was in agreement with that of DeBoer *et al.* (2000). The significant proportion of browse species of plants indicated that the elephant population of the area was browser. This also illustrated the confinement of the elephants in the forest habitat due to both habitat and human factors. According to DeBoer *et al.* (2000), the change in the food preference of elephants of MER from grazing elephant to browsing is associated with the change in habitat preference of the elephants in reaction to poaching.

The forest habitat was the very preferred habitat for elephants of the CCNP. This habitat provided shelter and significant proportion of their diet. It is also the most preferred habitat for large mammals recorded for the area (Girma Timer, 2005). Elephants are known to play ecological role by opening the forest canopy to let the movement of the big games living in the area (Dublin and Tayler, 1996).

Elephants occupied parts of the woodland and wooded grassland during the mid and late wet seasons. This distribution pattern is perhaps one of the causes for small proportion of plant species identified and recorded from these habitats.

6.2.3 Population size and abundance

6.2.3.1 Defecation rate

The dry season overall mean droppings produced elephant $^{-1}$ day $^{-1}$ (16.57) in the area was greater than the dry and wet season defecation rate of elephants of the Kasungu National Park, Malawi which is 15.7 droppings elephant $^{-1}$ day $^{-1}$ (Jachmann and Bell, 1984a) but less than that of Shimba Hills Ecosystem, Kenya, which is 19 droppings elephant $^{-1}$ day $^{-1}$ (Litoroh, 2003). The difference in the defecation rate of the study area from the above two studies was probably due to the type of food consumed by elephants, the number, sex, age structure of elephants observed of the seasonal variation. Defecation rate is known to differ among individuals' age and sex group, and on a daily and seasonal basis (Dawson and Dekker, 1992).

The defecation rate of the lonely bull in the study area (12 droppings elephant $^{-1}$ day $^{-1}$) was rather the same as the dry season defecation rate of bulls in Ruaha National Park, Tanzania, which is 12 droppings elephant $^{-1}$ day $^{-1}$ (Barnes, 1979).

6.2.3.2. Dung decay rate

It is difficult to determine dung decay rate for an area because it is time and labor intensive (Laing *et al.*, 2003). As a result, most studies conducted in Ethiopia and other African countries, used results of other studies to analyze population size of the areas (Yirmed Demeke, 1994; Cheri Enawgaw, 1998; Bhima *et al.*, 2003). Dung-piles from different age groups of elephants were identified from all habitat types. Therefore, it is believed to be more representative of the study area (Barnes, 1996).

There were almost no dung-piles observed decomposed by the activity of dung beetles in the study period. The mean time of dung survival in CCNP (72.3 days) was greater than

the mean time of dung survival in the Virunga National Park (VNP), Democratic Republic of Congo (54.787 days) (Mubalama and Sikubwaba, 2002). This is probably due to seasonal variation. This study was conducted in the dry season, whereas that of the VNP was conducted in the dry and wet season. It is, however, known that the dung survival in wet season is shorter than during dry season because of the activity of dung-beetles (Jachmann and Bell, 1984b; White, 1995; Mubalama and Sikubwaba, 2002). Thus, mechanical disturbance was perhaps the main factor responsible for the decomposition of dung-piles.

6.2.3.3 Dung density

The dung density between the first and the second strata was significant. This shows the area is well stratified based on habitat use pattern of the elephant population in the study area.

Maximum sampling efficiency was allocated for high-density stratum for the dung count. As a result, the coefficient of variation for dung density was estimated as very small (5.7%). Sampling efficiency achieved for the medium-density stratum was relatively small when compared to the size and dung density variation within a stratum. As a result, the coefficient of variation was relatively very high (32.92%). The total length of transects recommended based on analysis from the ELEPHANT software was 81 km.

6.2.3.4 Elephant density and population size

The relative high confidence limit in the elephant population size estimation of the study area (84.8 $\pm$ 24.3 at 95%CL) was probably due to the smaller population size and uneven distribution of elephants in the medium density stratum. The smaller the study area, or the smaller the population estimate becomes, the wider is the confidence limit (Dawson and Dekker, 1992).

The elephant density in the high- and medium-density strata showed significant difference (χ^2 = 7231, d.f.=1, P< 0.05). This might be resulted from the significant variation in habitat use pattern of elephants in the study area, where more than 85% of elephants have been confined to less than 5% of the total area, less than 15% of the elephants inhabited about 8% of the total area and more than 80% of the study area wasn't inhabited by elephants during the dry season.

The overall elephant density of the area (0.07 elephant km^{-2}) was greater than the overall elephant density for the country based on the recent elephant estimates such as, 0.002 elephant km^{-2} (Allen-Rowlandson, 1990), 0.001 elephant km^{-2} (Blanc *et al.*, 2003) and 0.0007 elephant km^{-2} (Yirmed Demeke, 2005). When the elephant density in the area is compared to other elephant home ranges in Ethiopia, based on Blanc *et al.* (2003) and Yirmed Demeke (2005), it is greater than that of Omo and Mago National Parks and Babile Elephant Sanctuary.

6.2.4 Age structure and sex ratio

6.2.4.1 Age structure

The number of elephants observed and analyzed for age was very small (27% of the total estimated for the area). Because of habitat factors, elephants can easily hide in the forest. Thus, it may cause inaccurate estimation of some age groups (Williams, 2002). However, since the elephant group observed in the study area was a mixed group having all age and sex groups, it might produce relatively good estimate of age structure for the entire population.

The result of age structure determined by body size comparison was in agreement with results from the other methods for some age categories. It was comparable with result from the boli circumference and footprint length for the intermediates (χ^2 = 0.757, d.f.= 1, P>0.05 and χ^2 = 0.640, d.f.= 1, P>0.05), for sub-adult male or adult female age group (χ^2 = 0.625, d.f.=1, P>0.05 and χ^2 = 3.6, d.f.=1, P>0.01), and the boli circumference result

for calves and footprint result for juveniles ($\chi^2 = 1$, d.f.= 1, P>0.05 and $\chi^2 = 0.572$, d.f.= 1, P>0.05 respectively).

However, the result from body size comparison was not supported by the result from the boli circumference for calf, juvenile and adult male categories ($\chi^2 = 4$, d.f.= 1, P<0.05, $\chi^2 = 3.57$, d.f.= 1, P<0.05 and $\chi^2 = 20.2$, d.f.= 1, P<0.05 respectively).

The number of elephant estimated from footprints and boli circumference was in favor of the intermediates and adults than calves and juveniles, probably due to the problem of visibility of the dung-piles and footprints of juveniles and calves than other age groups (Mubalama and Sikubwaba, 2002). Therefore, direct observation of elephants may be the best method to determine the number of calves and juveniles than the other methods.

There were no data on age structure of the elephant populations in Ethiopia to make a comparison. However, the proportion of calves and juveniles in the study area taken from body size estimate as significantly smaller than that of Samburu and Buffalo Spring Wildlife Reserves, Kenya (Wittemyer *et al.*, 2005). However, there was no significant difference with that of Tasvo National Park, Kenya (Leuthold, 1976). The relative small number of elephants in the above age groups might be due to the increased calves mortality or reproductive stress due to the density or human factors. Studies showed that mortality of calves is greater than other age categories (Leuthold, 1976) and social stress from poaching is reported to be one of the main variables influencing reproductive outputs (Aleper and Moe, 2006).

The age structure of the elephant population indicated that it was revived from poaching pressure during the Transitional Government. However, the small number of adult male elephants in the area implied the existence of selective poaching for ivory (Barnes and Kapela, 1991). The estimated age structure of the elephants of the area, regardless of the genetic variation within the population, showed potentially growing elephant population under proper management and conservation of the area.

6.2.4.2 Sex ratio

The demographic study of the elephant population in Amboseli National Park, Kenya, showed male to female ratio of elephants at birth which was almost close to 1:1 but sex-specific mortality of males result an increase of females (Moss, 2001).

The male to female sex ratio of elephants of the study area was less than the normal. However, it was more skewed relative to some other studies (Williams, 2002; Aleper and Moe, 2006). The most skewed adult elephant sex ratio of the study area was probably caused by age and sex-specific selective poaching. Mature males are preferable than females to be killed for ivory, because of their larger tusks (Pilgram and Western, 1986; Moss, 2001; Wittemyer *et al.*, 2005). The few male elephants observed in the study area have had relatively very small tusks which also supported selective killing by poachers. Besides this, the sex and age of recently identified killed elephants might indicate a shift in the killing of females having relatively bigger tusks. The shift from targeting male elephants, with relatively little role as social repositories, to matriarchs could have serious impact on the elephant population (McComb *et al.*, 2001).

6.2.5 Human-elephant conflict

The political and social instabilities are known to be the major factors which aggravate the loss of natural resource, including wildlife of most countries (Leuthold, 1976; Cumming *et al.*, 1990). It will get worse when illegal firearm trade is intensified. The 1991 government change in Ethiopia resulted in extensive illegal firearm trade in the country and consequently in the loss of wildlife resources. The effective law enforcement efforts by the local government, the very somber punishment of individuals involved in elephant killing and/or ivory trade and the limited possession of firearms during the Dergue regime were perhaps the main causes for very little, if any, elephant poaching practiced in the above period.

The failure to take action to revert illegal firearm possession in the past fifteen years makes the country lose its wildlife resources due to poaching (Shibru Tedla, 1995; Yirmed Demeke, 1997). Since 1995, however, local disarmament of illegal firearms from the local people and the interest local officials have developed and the action they have taken to bring the area under protection could have played major role in minimizing elephants and other wildlife killing in the area.

Local administrative officials also recognized the villages as the origin of poachers. But most of these areas are situated faraway from administrative centers or are located in remote areas and, hence difficult to access. This is perhaps the main cause for individuals, locally assigned to control illegal activities, to take part in wildlife killing using firearm provided from the local government.

The history of the impact of elephants on human was related to the history of the population size of elephants, which had been very intense and widely distributed before 15 years ago. Thus, besides an increase in human settlement and agricultural expansion, the distribution and extent of crop raiding decreased to the extent of being discernible only in four distinct localities. The extent of human injuries and deaths due to elephants was relatively small as compared to areas in other African countries (Thouless, 1994; Johnsingh and Joshua, 1994).

Thouless (1994) mentioned that the extent of crop raiding varies depending on habitat type, elephant use pattern and distance from the boundary. The relatively high incidence of crop raiding in Chebera was also related to the above three factors. Crop raiding takes place during wet season with its peak in June and July that may be due to the optimal stage of growth of cultivated crops. In Sere and Agare, elephants rarely attacked agricultural fields because elephants less frequently visited these kebeles. The crop fields mainly affected by elephants in Yora were those found in the middle of the natural habitat.

The irrigation scheme that was being implemented in Chebera has involved 50 households and located in an area frequently used by elephants near the boundary of the park. The resettlement program undertaken in Delba and local resettlement programs proposed to take place in Agare and some other areas were also localized within 0.3 to 1 km distance from the elephant range. The shifting cultivation which takes place in almost all corners of the park has been intensified following the political situation after the May 2005 election.

The parallel efforts being made on resettlement, on the one hand, and the conservation of elephants, on the other hand, will surely be posing more challenge on the park management. This is so because as the number of elephants increases when conserved, their conflict with farmers will get worse. As a result, the management needs to work even harden on mitigating this problem.

Because of the negative impact elephants have on the livelihoods of villager and the ratification of wildlife laws on the setting up of protected areas, mostly excluded communities from accessing the resource they used to freely enjoy, makes elephants less tolerable than other species (Malima, 2004). Lack of awareness about the need for wildlife conservation, of benefits and absence of any hope of getting future benefit from wildlife including elephants seems to further reduce the level of tolerance of communities living around CCNP.

Like studies in other African countries, conflict mitigating measures used by the local people were reported as ineffective (Osborn and Parker, 2002; Malima, 2004). This is perhaps due to the short-term effect it has on elephants, because elephants become habituated soon (Thouless, 1994).

7. CONCULUSION AND RECOMMENDATIONS

7.1 Conclusion

According to the result of this research, relatively significant number of elephants take refuge in CCNP. The history of the elephant population was very recent but the population size and range of the elephants showed significant decline in the last fifteen years due to poaching during the transitional government period. The elephants originally came from a place called Shoru, in the side of Omo National Park. They have had two routes, following Uma River to the present western home range and along Zigna River to the present northern home range.

Elephants of the area have, in the past, covered almost all parts of the present CCNP and some more areas in north, east and western side of the area. However, nowadays they are localized in the northern and north western part of the study area. The distribution of Elephants of the CCNP showed seasonal variation that has minimum expansion in the wet season. It became more localized to forest habitats in the dry season because of availability food and water and illegal activities from the local people. Wet season small streams and ponds distributed in the area dry off and broad-leaved trees shed their leaves during the dry season.

The elephant population in the area was very young with small number of adults and relatively large number of intermediates and sub-adults. The small number of calves and juveniles in the population might be due to population stress or high mortality of calves. The sex ratio of elephant population of the area was skewed towards more number of females and the number of adult males was relatively smaller and it is an indication for the presence of selective elephant poaching.

Fifty one species of plants grouped under 29 families were identified as consumed by elephants. But the proportion of tree and shrub species to grasses and herbs indicated that elephants in the area were browsers. This food preference is resulted from the forest

habitation by the elephants that seek cover from poachers. Almost all parts of the plants were consumed by elephants, however, leaves and barks were the most preferred.

The history of human-elephant interaction was associated with the density of elephants in the area. It was intense when the elephant population size was high. Elephants used to come to agricultural lands, raid crops, destruct crop-stores and harass people in almost all parts of the CCNP. However, nowadays, crop raiding and other elephant related problems are localized to less than 20% of the former ranges.

The disarmament of the local communities after the restoration of political stability in 1994, to minimize the risk of tribal conflict reduced the intensity of illegal activities in the area. The local government officials have also showed interest in establishing the national park to bring the remaining elephant and other wildlife population under protection. As a result, the intensity of elephant killing in the area was significantly reduced. Activities of the regional government and the support and inspiration from local leaders will revitalize the elephant population of the CCNP

In sum, this young elephant population has a lion's share of the estimated elephant population of the country and has a growing potential from demographic perspectives, age and sex ratios. It has localized distribution and human induced threats that will affect the habitat and exaggerates the conflict with the local community to impose problem in the survival of the elephant population in the area.

7.2. Recommendations

The result drawn from the study provides information on the population characteristics of elephants and human-elephant interaction in CCNP. The study area has great ecological role in the conservation of around 10% of the elephant population in the country. Therefore, to maintain the elephant population and its habitat, the following measures are recommended:

- The present CCNP has not been designated in any of the protected area systems in the country. However, it was considered as a controlled hunting area and elephant killing was practiced before it was banned in 1992. The regional government, however, established the area as a national park based on the request from the local administrative bodies and after successive wildlife survey in the area.

  There is a plan to build park office and outposts, and to hire game scouts and other staff for the park management though it has not been implemented so far. Therefore, the park office should be opened soon to start the day-to-day conservation activities in the area. To perform the conservation activities better and to facilitate tourism, it is better if the park office is built in Amaya Town due to its accessibility and proximity. To undertake effective law enforcement activity, enough number of outposts needs to be built in different parts of the park and sufficient scouts need to be hired from villages that are closer to these patrol stations.

- The regional and local resettlement programs are bringing too much people to the areas that are natural habitats for elephants and other wild animals. It will enhance human-elephant conflict in these areas. The local resettlement program and irrigation scheme planned to be undertaken in Agare and Chebera villages respectively, should consider the habitat use pattern of elephants in the area and problems that crop up as a result should be considered prior to the implementation.

- The people living around the park seem to have poor understanding of the importance of conserving wildlife resources. This has made the people careless about the resource and they do not refrain from killing the animals and destroying their habitat for short term benefit. As long as there is lack of active participation and support of the local community, the effort of concerned bodies will not bring a significant change.

  Therefore, awareness creation programs should be encouraged in a way that people at the grass root levels will be reached. The park administration should also have professional and material organization to perform its activity efficiently. The income generated from wildlife utilization should be involved in community based development projects in the area and maximum effort is needed to secure grant from different sources to develop the area.

- Large proportions of elephants were localized in small portion of forest habitats. However, these habitats are threatened by local forest product utilization and shifting cultivation. These activities would represent a potential source of conflict between the national park authority and the local people, and there are threats for the conservation of the elephants and their habitat. Therefore, it is necessary to prepare a management plan to mitigate land-use conflict in the area.

- Limit of the viability of population was set by three constraints - ecological or demographic, genetic and social (Young and Isbell, 1994). The elephant population of the area was estimated to account for 10% of the total of the country. Yet, it is a very small population from the ecological point of view. It is found to be the descendant of elephants of Omo National Park. Hence, these information should be assessed from genetic analysis of the population.

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APPENDIX I

POPULATION HISTORY AND HUMAN-ELEPHANTS INTERACTION

A/ Movement, Distribution and Population Size of elephants

1/ Are elephants found in this area? _____

2/ When were elephants seen for the first time in this area? _____

3/ From where did the elephants come originally? _____

4/ In which specific areas elephants formerly found? How about these days?

_____

_____

_____

5/ When you compare the elephant population size of the present and the past, is it increasing or decreasing?

_____

6/ What do you think are the main causes for this change?

_____

_____

_____

B/ CROP RAIDING

1. Do elephants come to agricultural lands and/or living compounds? _____

When? _____

2.1. Do elephants create problem on human beings and/or their property (crops, crop stores, livestock, etc)?

2.2. If yes, please describe incidents you remember.

_____

_____

_____

3.1. Do you think local communities have benefited from the presence of elephants in this area?_____

3.2. If yes, what kind of benefit(s)?

_____

_____

4.1. How about in the future? Do you think they will be beneficial? _____

4.2. If yes, in what way?

_____

_____

5. Do you think people feel they are incurring loss due to the presence of elephants?

_____

6. What measures are required to reduce or avoid damages caused by elephants?

_____

_____

_____

C/ HUMAN-WILDLIFE CONFLICT

1/ What are the wild animals (other than elephants), which affect humans in the area?

A/ Crop raiders: 1. _____ 2. _____ 3. _____

B/ Livestock or human attackers: 1. _____ 2. _____

3. _____

2/ What are measures taken by the local people to avoid these problems?

_____

_____

_____

3/ How much of the harvest is lost by wild animals?

_____

D/ ELEPHANT POACHING

1/ Was elephant poaching practiced in the area? _____

If yes, when? _____

How about now? _____

2/ When was/is the elephant killing very intense?

_____

3/ What were/are the causes for intense elephant poaching in the above period?

_____

4/ Where in the area is elephant poaching practiced? _____

5/ From where do poachers come? _____

6/ What did you know about the sport hunting practiced in the area before 1992GC?

_____

_____

_____

7/ What do you feel when people come and kill elephants?

_____

_____

8/ What do you think are the measures that need to be taken to conserve the remaining elephant population in the area?

_____

_____

_____

APPENDIX II

PLANT SPECIMEN COLLECTING FORM

No.	Local name	Location	Habitat type	Plant type	Season	Part of plant used			Source of data		
						Leaf	Bark	Fruits	Direct observation.	Feeding sign.	Informants

APPENDIX III

DRY SEASON DEFECATION RATE OF ELEPHANTS

(Data Collection Form)

Date _____ Duration _____

Starting Time _____ Ending Time _____

No.	Age and Sex	Bolus circumference	1st	2nd	3rd	4th	5th	6th	7th	8th

APPENDIX IV

DUNG DECAY RATE

Starting Date _____ Ending Date _____

Location _____ Habitat Type _____

No.	Date of Identification	Canopy Cover	Circumference	N^{th} Day			N^{th} Week															
				2	3	4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Number of Remaining Dung-piles																							

APPENDIX V

Dung Count Data Sheet

Strata Number _____ Transect No. _____

Starting Point _____ Ending Point _____

Date _____ Compass Bearing _____

No.	Distance from the Starting Point	Distance from the Center	Stage of Decay	Boli circumference

APPENDIX VI

Human-elephant Conflict

Kebele - _____

Sex - Male/Female, Age- Young/Adult/Old

Social Status: - Household/Local leader/Elder/Expert/Political leader

Family size - _____ No of wives _____ Occupation _____

Education – No / Non-formal/primary/secondary and above

How long have you been in the area? (1- 3) (4 – 10) (10 – 15) (More than 15} years

Size of Agricultural land _____ (Ha.)

Human-elephant Conflict

1/ Do elephants come closer to your living compound/agricultural land? (Yes/No)

2/ Do theyt create any problem in your property? (Yes/ No)

3/ For how long has it been happening? (1 – 3), (4 – 10), (10 – 15), (Before 15 years ago)

4/ In what season does it occur? (Dry/Wet/Irrespective of season)

5/ How is the trend of destruction the animals bring?

(Decreasing/Increasing/Undetermined/

6/ Do you report such incidents to any governmental body? (Yes/No).

If Yes, to whom?

_____

If No, why not?

_____

7/ What are the counter-measures you take?

1/ _____

2/ _____

3/ _____

4/ _____

8/ Are these counter-measures effective? Yes/No.

If No, why not?

_____

_____

9/ Do elephants bring other social problem? (Yes/No)

If Yes, what are the major problems?

A/ _____

B/ _____

C/ _____

10/ Did you or your close relative kill elephants? (Yes/No)

If Yes, why? _____

11/ Do you get any benefit so far from the presence of elephant in this area? (Yes/No).

If Yes, what benefit?

_____

_____

12/ Do you feel you are losing due to the presence of elephants in this area? (Yes/No).

If Yes, what?

_____

_____

_____

13/ What do you feel if elephants are not here?

A/ Happy

B/ Unhappy

C/ Nothing

14/ Do you know why the government wants to conserve elephants? (Yes/No).

If yes, why?

_____

_____

15/ Do you have fear of conservation of elephants in the area? (Yes/No).

If Yes, why?

_____

_____

_____

16/ Do you thick you get any benefit from elephants in the future? (Yes/No)

If yes, what benefit?

_____

_____

19/ Do you think you have the role to play in the conservation of elephants? (Yes/No)

If yes, what will be your role?

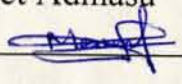
_____

_____

Declaration

I, the under signed, declare that this thesis is my original work. It has never been submitted in any institution and that all sources of material used for thesis have been dully acknowledge.

Name: Meseret Admasu

Signature: 

Date: _____