College of Natural and Computational Sciences, Department of Zoological Sciences

Current status, Habitat Association and Feeding Habit of African Elephant (*Loxodonta africana)* in Babile Elephant Sanctuary, Ethiopia

A Thesis submitted to the school of graduate studies of Addis Ababa University, in partial fulfillment for the degree of Master of Science in general Biology

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September, 2019

Addis Ababa, Ethiopia

DECLARATION

This thesis is my original work, has not been presented for a degree in any university and all sources of materials used for the thesis has been gratefully acknowledged.

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Date_____

Statement of supervisors

This thesis has been approved for submission to the department of zoological science for public defense.

Name_____

Signature_____

Date_____

Abstract

Ethiopia is one of the Sub-Saharan African countries where elephants are indigenous. Conservation of African elephant (Loxodonta africana) in Ethiopia was closely related to the conservation of biodiversity and also to the sustainable development of the country in its ecotourism. The major objective of this research was to assess the current population status, habitat association and feeding habit of African elephant in Babile Elephant Sanctuary (BES). This research was conducted from October 2018 to June 2019. To conduct this research; both primary and secondary data (direct field observation, questionnaire survey and group discussion) were collected. This research undertaking faces certain limitations such as unwillingness of some experts to provide secondary data and time constraints. Finally this research reviewed that currently the anthropogenic activities highly affects the population status, habitat association and feeding habit of elephants in BES. As a result, this research recommend that there should be needed a nationwide public awareness campaign about the need of wildlife conservation.

Key words: *Anthropogenic, conservation, elephants, feeding habit, habitat association, population status, sustainable, wildlife*

Acknowledgment

I would like to express my sincere and special gratitude to my advisor Dr. Habte Jebessa for his constructive criticisms and constant guidance from the onset of proposal development to the completion of this work. I also would like to thanks the ministry of education for its financial support.

I also would like to express my heartfelt thanks to many people assisted directly and indirectly during field data collection. Scouts of Babile Elephant Sanctuary; your eyes and ears, and amazing sense of direction, always made sure that we got back safely each day.

I am grateful to my fellow colleagues, thank you for sharing and exchanging ideas, moral support and spending countless hours encouraging me to finish. I also presented my thanks to my families and friends for their continuous support during this study.

ACRONYMS

asl	above sea level
AED	African Elephant Database
AESR	African Elephant Status Report
AESG	African Elephant Specialist Group
BES	Babile Elephant Sanctuary
EHAZPEDO	East Hararge Administrative Zone Planning and Economic Development Office
ES	Elephant Sanctuary
EWCA	Ethiopian Wildlife and Conservation Authority
EWCO	Ethiopian Wildlife and Conservation Organization
EWNHS	Ethiopian Wildlife and Natural History Society
FDREPCC	Federal Democratic of Ethiopia Population Census Commission
IUCN	International Union for the Conservation of Nature and Natural Resources (or World Conservation Union)
GPS	Geographic positioning system
SPSS	Statistical Package for Social Sciences
WCMC	World Conservation Monitoring Center
WCODE	Wildlife Conservation Organization for Democratic of Ethiopia
WSD	Wildlife for Sustainable Development
WR	Wildlife Reserve
WS	Wildlife Sanctuary
WRI	World Resource Institute
WWFN	World Wide Fund for Nature

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1. INTRODUCTION

1.1 Background of the Study

Ethiopia is endowed with diverse biological resources. This is as a result of its altitudinal variation and associated climatic, vegetation 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, (Hedberg and Edwards, 1989; Tilahun *et al*., 1996).

One of the diverse wildlife species being conserved in Ethiopia's protected areas is the African elephant. Until the turn of the 19th century, the African elephant was distributed widely 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 eastern semi-arid regions of the country (Largen and Yalden, 1987; EWCO, 1991; Yirmed Demeke, 1997; Blanc *et al*., 2003). African elephants (*L. africana*) are the largest living land animals on the Earth and perhaps one of the most intelligent. They are the engineers in that they create and maintain ecosystems and it is believed to be a crucial keystone species for Africa. African elephants are also 'flagship' species for their habitats; that is charismatic representatives of the biodiversity within the complex ecosystems they inhabit (Cargnan and Villard, 2002). Elephants are large animals and they need a lot of space to survive, their conservation will help to maintain biological diversity and ecological integrity over extensive areas and so help many other species (Western et al., 1989). 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 is also decreasing with time (EWCO, 2000). 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 this few and small elephant populations that are currently exist in Ethiopia; needs proper management of the populations and their habitat (Poole, 1996).

1.2 Statement of the problem

African elephants are the biggest living land animals. Once numbering millions across the African continent, their population has been decimated by the 1980s due to systematic poaching. The status of the species currently varies greatly across the African continent. Some populations stay vulnerable due to poaching for meat and ivory, habitat loss, and conflict with humans, whereas others are secure and increasing. So the result of this research would help to know the factors that affect the population status of African elephant in the study area and to solve the problems.

1.3 Objectives of the study

1.3.1 General objective

- The present research is planned to assess the current status, habitat association and feeding habit of African elephant (*Loxodonta africana*) in Babile Elephant Sanctuary.

1.3.2 Specific objectives

The specific objectives of this research are to;

- assess the current population status of African elephant in Babile Elephant Sanctuary
- review the feeding habit and habitat association of African elephant in BES
- identify the major factors affecting the population status of African elephant in BES
- Estimate the age and sex structure of elephant population at BES

2. Review of Related Literatures

2.1 Distribution and habitat of African Elephant

African elephants live widely in Sub-Saharan Africa, in dense forests, Sahelian scrub, or deserts. They are found in varieties of habitats, ranging from savannah to forest. They are extremely catholic in its range; and tends to move between varieties of habitats. It is found in dense forest, open and closed savanna, grassland and, at considerably lower densities, in the arid deserts of Namibia and Mali. They are found over wide elevation ranges-from mountain slopes to oceanic beaches, and from the northern tropics to the southern temperate zone. It is a full migrant animal (Blanc *et al*., 2007).

2.2 Classification

Recent genetic evidence (large genetic distance, multiple genetically fixed nucleotide site differences, and extremely limited hybridization) suggest that African elephants should be divided into two distinct species; the bush elephant *(L. africana)* and the forest elephants (*L. cyclitis)* (Roca *et al*., 2001, 2005). The forest elephant (*L.cyclitis)* is smaller in size and darker in color than the savannah elephant and also they have straighter, downward-pointing tusks, and lives in central and western Africa's equatorial forests. Forest elephants are more generally threatened than the bush elephants due to poaching and loss of forest habitat for agriculture and fuel wood (Ferreira *et al*., 2008).

Table1; Taxonomic hierarchy of African elephants (L.africana)

Kingdom	*Animalia*
Phylum	*Chordata*
Class	*Mammalian*
Order	*Proboscidae*
Family	*Elephantidae*
Genus	*Loxodonta*
Species	*Africana*

2.3 Social and reproductive behaviors of elephants

2.3.1 Social behavior

Elephants are arranged into several social groups. The first and most common are large herd led by a matriarch (Douglas and Hamilton, 1972). This consists of a related group of females incorporating mothers, their young, grown daughters and their offspring. Herd size may range between 2 and 24, but 9 to 11 is common. However, reliable accounts have recorded elephant herds numbering 200 individuals and more (Turkalo and Fay, 1995). These usual numbers may be due to habitat degradation or limited resources, encouraging herds to gather around available resources. The members of this family group keep together, rarely venturing 50m from their nearest neighbor. Activity, direction and rate of movement are all set by the matriarch; who is recognized as the largest cow. When the herbs are disturbed, they all cluster around and turn to the matriarch for leadership and experience play such a crucial role in the lives of elephant herds, the females' lifespan extends far beyond their age of reproduction. Long term post reproductive survival is also true of man, but otherwise quite rare in the animal kingdom. When matriarchs become between 50 and 60 years old, they either leave or are abandoned by the herd, and the next oldest cow assumes leadership.

Male elephants leave the maternal herds at adolescence around 10 to 15 years (Sukumar, 2003). Separation is a gradual process, and the adolescent bulls may become peripheral, following the maternal herd at a distance. They do not necessarily leave voluntarily, but are pushed out by the older females or their mothers due to an intolerance of the boisterous and sexual precociousness of pubescent males. After becoming independent, they either wander alone, or more commonly join bachelor herds. These herds typically number between 2 and 14, but may grow up to 144 individuals in some sort of temporary arrangement.

Elephants are at their most fertile between the age of 25 and 45 (Owen and Smith, 1990). Calves are born after a gestation period of up to nearly two years (Hodges *et al*., 1994). The calves are cared for by their mother and other young females in the group, known as allomothers. Elephants use some vocalizations that are beyond the hearing range of humans to communicate across large distances. Elephant mating rituals include the gentle entwining of trunks.

Fig.1; Group of elephants which are led by matriarch at BES (Source; Bantihun Asaye; June, 2019)

2.3.2 Reproductive behaviors of elephants

African elephants show sexual dimorphism in weight and shoulder height by age 20, due to the rapid early growth of males. By age 25, males are double the weight of females; however, both sexes continue to grow throughout their lives. Female African elephants are able to start reproducing at around 10 to 12 years of age, and are in estrus for about 2 to 7 days (Jainudeen, Eisenberg & Tilakeratne, 1971). The gestation period of an elephant is 22 months (Laws, Parker *et al*., 1975; Poole and Moss, 1981) and fertile females usually give birth every 3 to 6 years, so if they live to around 50 years of age, they may produce 7 offspring (Moss, 2001). Females are a scarce and mobile resource for the males so there is intense competition to gain access to estrous females. Post sexual maturity, males begin to experience musth, a physical and behavioral condition that is characterized by elevated testosterone, aggression and more sexual activity. Musth also serves a purpose of calling attention to the females that they are of good quality, and it cannot be mimicked as certain calls or noises may be. Males sire few offspring in periods when they are not in musth. During the middle of estrus, female elephants

look for males in musth to guard them. The females will yell, in a loud, low way to attract males from far away. Male elephants can also smell the hormones of a female ready for breeding. This leads males to compete with each other to mate, which results in the females mating with older, healthier males. Females choose to a point that they mate with, since they are the ones who try to get males to compete to guard them. However, females are not guarded in the early and late stages of estrus, which may permit mating by younger males not in musth (Sike, 1971).

Males over the age of 25 years compete strongly for females in estrous, and are more successful than larger and more aggressive they are. Bigger males tend to sire bigger offspring. Wild males begin breeding in their thirties when they are at a size and weight that is competitive with other adult males. Male reproductive success is maximal in mid-adulthood and then begins to decline. However, this can depend on the ranking of the male within their group, as higher-ranking males maintain a higher rate of reproduction. Most observed matting's are by males in musth over 35 years of age (Poole, 1989). Twenty-two long observations showed that age and musth are extremely important factors; "… older males had markedly elevated paternity success compared with younger males, suggesting the possibility of sexual selection for longevity in this species. Males usually stay with a female and her herd for about a month before moving on in search for another mate. Less than a third of the population of female elephants will be in estrus at any given time and gestation period of an elephant is long, so it makes more evolutionary sense for a male to search for as many females as possible rather than stay with one group (Chandrasekharan, Radhakrishnan, cheeran and Leedharan, 1992).

Elephants have second longest potential life span of all terrestrial mammals after human. This is primarily due to the fact that elephants only have six molar teeth during their life. When the last is either worn away or lost, they cannot feed and thus they die. This occurs at around 65 years of age (Moss, 2001).

2.3.3 The elephants feeding habit and their teeth

2.3.3.1 Tusks and trunk of elephants

There are many striking features belonging to the elephant. This is essentially an

extended nose. This is a very powerful organ, which is highly flexible and dexterous. The tip of the trunk ends in two almost finger like prehensile projections, capable of some very precise co-ordination (Hanks, 1972). The organ is used in drinking by sucking water up it, and then squirting it into the animal's mouth. It is also used in eating, with the prehensile tips picking food from the ground or directly it into the mouth. The trunk is also obviously for smelling.

The second striking feature is also the feature that has almost resulted in the animal's extinction, its tusks. Although both sexes may possess them, they are far larger in the males. In the cows if they grow the tusks at all, they cease growing when the cows are fully mature at 20 to 30 years. However, tusk growth in males begins almost exponentially from the time they mature to the time they die. Not only do they grow longer, but they thicken substantially. Their two pillars of ivory are basically elongated upper incisor teeth that protrude from the mouth (Hanks, 1972).

Ivory has been much sought after four millennia. It has been used in a multitude of ways from carved figurines to knife handles. It has been ground up for traditional medicines and manufactured as cue balls and piano keys. For these reasons the elephant has been ruthlessly hunted to the point of near extinction (Ferreira *et al*., 2008).

While feeding, elephants use their trunks to pluck at leaves and their tusks to tear at branches, which can cause enormous damage to foliage. A herd may deplete an area of foliage depriving other herbivores for a time. African elephants may eat up to 450 kg of vegetation per day, although their digestive system is not very efficient; only 40% of this food is properly digested. The foregut fermentation used by ruminants is generally considered more efficient than the hindgut fermentation employed by proboscidean and perissodactyls; however, the ability to process food more rapidly than foregut fermenters gives hindgut fermenters an advantage at very large body size, as they are able to accommodate significantly larger food intakes. Elephants are not very efficient feeders, not only in their physical taking of vegetation, but also digestively (Harris *et al*., 2008). In fact, elephants only digest some 40% of what they eat, and being of such immense size, they require at least 170kg of plant matter daily. Elephants are also highly dependent on a stable water supply, drinking up to 160 liters of water per day.

They play a major role in maintaining the linkages in food web and the extermination of this

species is expected to cause dramatic changes or extinctions in ecosystems. Moreover, elephants play an important role as umbrella species, maintaining biodiversity of the ecosystems they inhibit (Western *et al,*. 1989).

2.3.3.2 The elephants Teeth

Elephants have four molars; each weighs about 5kg and measures about 30cm long. Elephants replace their teeth four to six times in their lifetimes. Around 40 to 60 years of age, the elephant loses the last of its molars and will likely die of starvation, a common cause of death (Fatti *et al,*. 1980). African elephants have 24 teeth in total, six on each quadrant of the jaw. The enamel plates of the molars are fewer in number than Asian elephants. The elephant's tusks are firm teeth; the second set of incisors becomes the tusks. They are used for digging for roots and stripping the bark from trees for food, for fighting each other during mating season, and for defending themselves against predators. The tusks weigh from 23 - 45kg and can be 1.5- 2.4m long. Unlike Asian elephants, both male and female African elephants have tusks. They are curved forward and continue to grow throughout the elephant's life time (Jachmann, 1988).

2. 3.3.3 Elephants intelligence

African elephant has a brain comparable in size and complexity to those of humans and other primates (Cozzi *et al.*, 2001). This certainly contributes to the popular belief that elephants have exceptional brainpower. However, recent literature suggests that elephants are not extraordinarily intelligent but are, like many species; well adapted to cope with the natural spatial and temporal variability they face (Hart *et al*., 2007). Hart *et al*., (2008) also suggest that elephants perform poorly when compared to chimpanzees and humans in cognitive feats. They can recognize individual calls from 1–1.5km away (McComb *et al*., 2003), and know the individual calls of about 100 other elephants (McComb *et al*., 2000).

Another aspect of elephant behavior is their reaction to other elephants that are disabled or dead (Hart *et al*., 2007). They can distinguish between elephant remains and those of other species, and often spend time investigating elephant corpses (Moss, 1988; McComb *et al*., 2006).

2.3.3.4 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.

2.4 Conservation status

The BES has conservation significance for many reasons. In the first instance BES presents a conservation concern since it has lost and is still losing its African elephants and other wildlife resources. The area is extremely important for the conservation of African Elephant *(L. africana),* Black-manned Lion (*Panthera leo*), Cheetah (*Acinonyx jubatus)* and Leopard *(Panthera pardus).* The site also affords protection to several antelope species, notably Lesser Kudu and Greater Kudu. Generally, BES protects a representative ecosystem within the Somali-Masai biome and still has pockets of relatively intact ecosystem. The area is known for its riverine vegetation; Acacia scrub/bush land and open plains. The local people can also benefit from these resources as it can be a means of generating and improving its livelihood. Besides its ecological values, the area provides diverse economic benefit from tourism in the years to come since it is situated close to the tourist destination areas in eastern Ethiopia.

With the exception of some sites at Gobelle and Erer, the sanctuary has not received effective protected area management directives in the past.

Recovery of the ecosystems at BES is a possibility but requires a coordinated effort. However, human-Elephant conflict, investment, repeated droughts, grazing pressure and other adverse human activities have aggravated the resource depletion in the sanctuary.

3. Material and Methods

3.1 Description of the study area

3.1.1 Location and topography

Before the establishment of Babile Elephant Sanctuary, the vast area surrounding the present Sanctuary was known as a game-hunting site, called Harar-Wabi Shebelle Hunting Area. The most notable large game animals hunted in the region were lions and other mammals. Later on, concerns grew over the small elephant population that had long been known to inhabit this semi-arid eastern region of the country. The "stress" situation of the elephants in the area, mainly due to crop raiding conflicts with the local farmers, was reported to the then Emperor Haileselssie-I during his visit to Fafum, eastern Ethiopia (Stephenson, 1976). In 1970, based on the report, the Emperor issued an order for the designation of the present conservation area as a Sanctuary. The vast controlled hunting area was reduced in order to establish the Babile Sanctuary with an area of 6,982 km^2. So, BES was established to conserve a significant population of Elephants in Eastern Ethiopia. It happens that the population at BES is also the last remaining eastern most population in the Horn of Africa. Besides its relic Elephant population, this site also harbors other significant fauna and flora (Yirmed Demeke et al., 2006).

The Babile Elephant Sanctuary (BES) is situated at the semi-arid trans-boundary between the Oromiya (22.3 %) and Somali (77.7 %) regions of Ethiopia, about 560 km southeast of Addis Ababa (Yirmed Demeke, 2008). It is situated between latitudes 08° 22' 30" - 09° 00' 30" N and longitudes 42^0 01' 10" - 43° 05' 50" E. The elevation ranges from 850 to 1785 m asl. The area is drained by Daketa, Borale and Erer Rivers. This sanctuary is established to conserve the only known isolated and ecologically distinct population of elephants (Barney *et al*., 1999; Hillman 1993).

The rural part of Babile district contains a human population of 75,970 (38,371 males and 37,599 females) (FDREPCC, 2008).

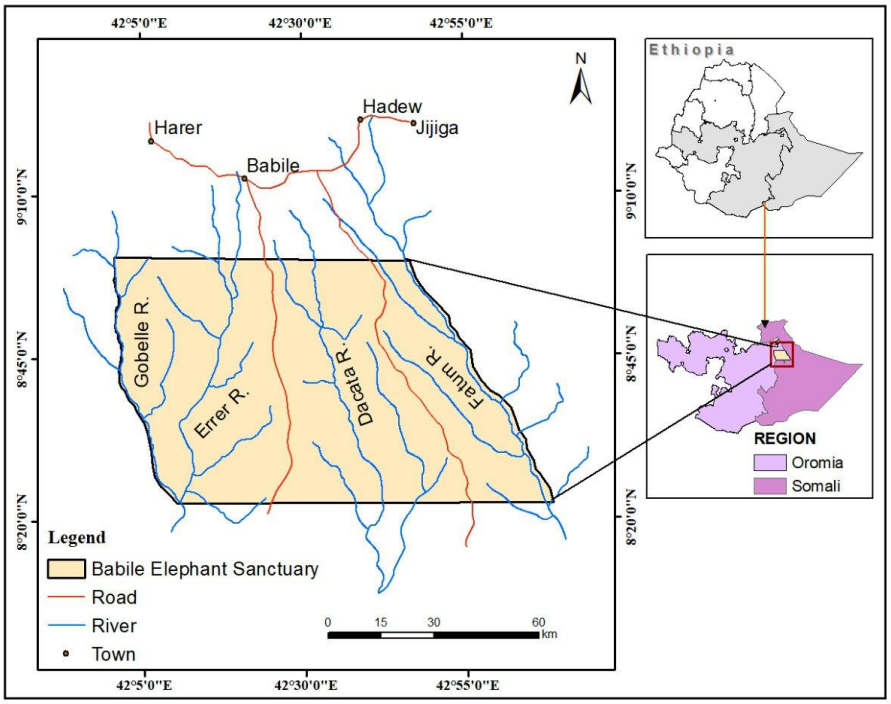

Figure 2; Location map of the study area (Babile Elephant Sanctuary)

3.1.2 Climate

The study area lies in the semi-arid region. Mean monthly minimum and maximum temperatures recorded were 13.0 °C and 26.3 °C, respectively. The mean annual rainfall is 517.2 mm, with high variation from year to year, ranging from 451.7 mm to 1,275.5 mm. The vegetation of the Sanctuary is represented by *Acacia commiphora* woodland, desert and semi desert scrubland and evergreen scrub (Anteneh Belayneh, 2006; White, 1983).

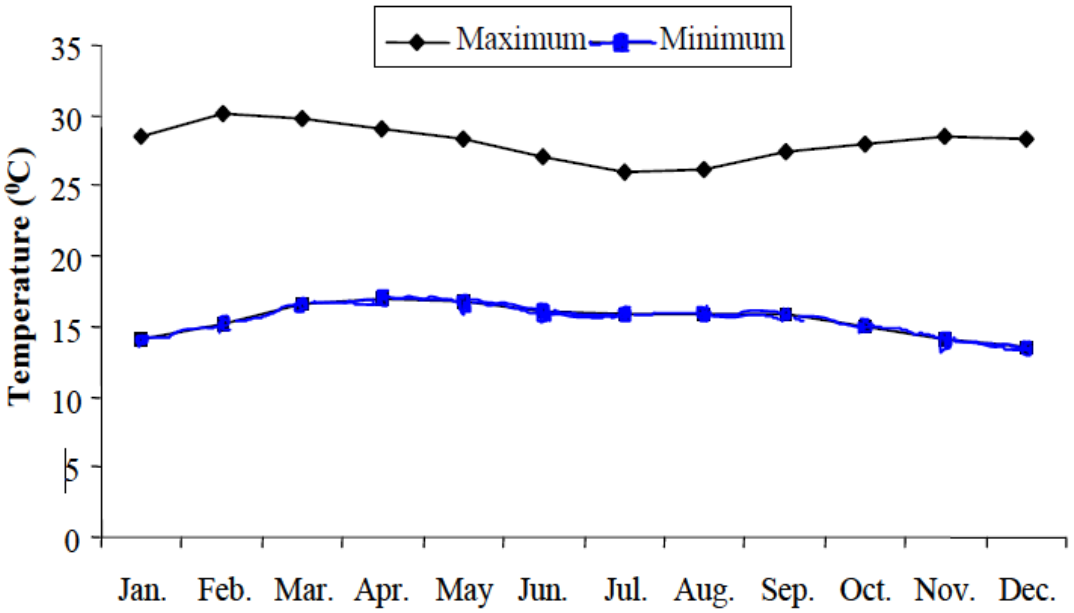

Figure.3; Mean monthly temperature data of BES over 2009-2018 (Source, Ethiopian national metrological agency, Jijiga branch)

3.1.3 Flora and fauna

3.1.3.1 Flora

In general, the Sanctuary is represented by *Acacia-commiphora* woodland, desert and semi-desert scrubland and evergreen scrub ecosystem (White, 1983; Anteneh Belayneh, 2006). The area is a semi-arid plain surrounded by a chain of rocky hills (EHAZPEDO, 2004).

Generally, the vegetation of BES is described into two major categories according to Stephenson, 1976) and Yirmed Demeke *et al*., (2006).

i. **Riverine vegetation**: this type of vegetation has dense stand in the valley bottoms becoming sparser and poorer in composition as one progress away from the valley floors. The densest stand is found in the Upper Erer in a narrow stripe from the northern boundary to south for about 25 km. Remnants of this type of vegetation are also seen in Gobelle Valley and in some areas east of Erer but with insignificant proportion. The riverine species in both valleys is comprised of *Acacia robusta, Tamarindus indica,*

Oncoba spinosa, *Acokanthera schimperi*, *Capparis tomentosa* and *Terminalia spinosa* (Anteneh Belayneh, 2006).

ii. Woodland vegetation: these woodlands form the major habitats for elephants and are the ensest and extensive in the valley bottoms while becomes sparse and low in composition as one progresses southwards. More open woodlands, which can afford cover and food for elephants, occur on the broader plateau between the Gobelle and Erer Valleys. The main tree species in Upper Dakata Valley include *Acacia tortilis*, *A. seyal*, *A. zanzibarica*, *Tamarindus indica* and *A. clavigera* (Demel Teketay, 1995). In the semiarid areas drought tolerant species such as *A. mellifera* and *A. nilotica* are highly favored. Elephants use this vegetation as food when regularly crossing from one valley to the other.

Figure 4; Riverine vegetation at BES (Source;Yirmed Demeke; November, 2006).

3.1.3.2 Fauna

Reconnaissance reports indicate that the BES has diverse animal species (mammals, birds and reptiles) adapted to the semi-arid environment.

The mammals of Babile were grouped into 22 species belonging to five orders and 11 families (Hillman, 1993).

The large mammal species that the Sanctuary include the African elephant *(Loxodonta fricana africana)*, lion (*Panthera leo)*, leopard (*Panthera pardus)*, spotted hyaena (*Crocuta crocuta*), bat-eared fox (*Otocyon megalotis*), black and white colobus monkey (*Colobus guereza*), hamadryas baboon (*Papio hamadryas)*, aardvark (*Orycteropus afer*), Menelik's

bushbuck *(Tragelaphus scriptus meneliki)*, bush pig (*Potamochoerus larvatus*), common bushbuck (*Tragelaphus scriptus*), lesser kudu (*Tragelaphus imberbis*), greater kudu (*Tragelaphus strepsiceros*), oribi (*Ourebia ourebi*) and Salt's dik-dik (*Madoqua saltiana*). Salt's dik-dik is the most numerous (Hillman, 1993; Yirmed Demeke *et al*., 2006).

Babile Elephant Sanctuary is one of the 73 important bird areas of Ethiopia (EWNHS, 1996). In terms of occurrence, birds are better known than other faunal groups in BES. This sanctuary supports the endemic Salvadori's serin (*Serinus salvadorii*), which is only restricted in the eastern lowlands. The Black-winged lovebird (*Agapornis taranta*) is endemic (restricted only in Ethiopia and Eritrea), which is confined to the highland vegetation in the northern section of BES (EWNHS, 1996). Generally, 191 species of birds comprising 17 orders and 51 families were documented from the Sanctuary (Hillman, 1993; Yirmed Demeke *et al*., 2006). The African rock python (*Python sebae)* and some unidentified snake species, agamas, geckos and skinks are found in BES.

Figure 5; Grazing animals of cattle's, goats and camels in BES (Source; Bantihun Asaye; June, 2019)

3.2 Stratification and transect layout

Based on field survey on the dry season (December to January, 2019) habitat use pattern of elephants, the study area was divided into three strata having more or less homogenous dung density. These strata were high-density, medium-density and low density strata.

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 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. 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 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.

3.3 Current status of elephant population

Studying the current status, habitat association and feeding habit of African elephant also involves seasonal movement and distribution, population size and abundance, sex ratio and age structure of the elephants in the study area. During this study, relevant information on the human-elephant conflict in the study area were also collected by questionnaire survey and discussions with key informants. The data were collected from December 2018 to March 2019 for dry season and from May to July 2019 for wet season.

3.3.1 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 were also collected from questionnaire survey and discussion with key informants. Information about habitat type was recorded on the notebook and the routes were recorded using GPS.

3.3.2 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).

3.3.3 Population size and abundance of elephant

In the study area the size of elephant population was estimated indirectly from dung counts, it was the most precise and commonly used method for counting elephants (Burnham *et al.*, 1980; Jachmann and Bell, 1984b; 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.

3.3.4 Age structure and sex ratio

3.3.4.1 Age structure of Elephants

Elephants are grouped in to five age groups (Manspiezer and Yilma Delellegne, 1992; Mee and moss, 1995; Moss, 1996); calf (< 1 year old), juvenile (1< x < 4 years old), intermediate (4 < x < 9 years), sub-adult (9 < x < 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).

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).

3.3.4.2 Sex ratio of elephants

The sex ratio of 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.

3.3.5 Population size estimate by using defecation rate, dung decay rate and dung count

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 IV).

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 III).

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 2). 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 2; Description of morphological stages of dung piles

Dung morphology	Description
A	Very fresh, moist with odor
B	Intact and fresh but dry without odor
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)

A total of 45 transect having a total length of 69.3 km was 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 (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). All these data were recorded on the datasheet prepared based on Dawson and Dekker (1992) (Appendix- IV).

3.4 Field study and Data collection

Field study and data collection was conducted starting from October 2018 to June 2019. The objective of the field study and data collection was to collect relevant firsthand data and information on the current status, seasonal movement and distribution, sex ratio, age structure, and feeding and habitat association of the elephant population in the study area.

Data were collected with regard to the status of African elephant (*L. africana*), both primary and secondary data, direct field observations, questionnaires surveys and group discussions with the local peoples and sanctuary scouts were made to collect the relevant information. The questionnaire was prepared so that it includes information's regarding elephant population status, feeding habit and habitat association of elephants in the study area. Notes on elephant signs in the area, elephant groups involved in crop raiding, control measures used by the local people and the response of elephants to the measures were recorded.

3.4.1 Data analysis

The data and information collected for the population history and human-elephant interaction from the questionnaire survey was analyzed using SPSS 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 Software was used to estimate the defecation rate and dung decay rate for the study 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 calculated 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.

4. Results

4.1 Estimation of the elephant population

For a questionnaire survey; there were 60 key informants (10 individuals from six kebeles) out of which 36 are males and 24 are females. They were grouped into three age categories (young, adult and old). Based on their educational background; they were also grouped into four categories (illiterate, non-formal education, primary school and secondary school & above).

From a total of 60 respondents involved in the questionnaire survey, 34 (56.66%) claimed that elephants were seen in the study area for the first time by early 1970s, 20 individuals (33.34%) said that the elephants came a long time ago while 6 respondents (10%) did not know as to when elephants came to the area for the first time.

The distribution and movement characteristics of the elephants are limited; except in the south-eastern section of the Sanctuary, were clearly defined. Elephants of the Sanctuary were categorized into two distinctive clans or groups based on their movement patterns and their apparent associations to each other. The first group is referred as the Gobelle group and found along the Gobelle River in the western part of the Sanctuary; the second smaller group is referred as the Erer group and found in the area surrounding the Erer River in the central region of the Sanctuary. My observations and interview records show that elephants currently use three major valleys in the Sanctuary: Gobele, Erer and Dakata. While movements are primarily north–south, movements also occurred east–west. Elephants have not been observed to cross east of Dakata Valley to Fafum for the past 15 years, and hence the Dakata Valley is now the eastern limit of elephant movement and distribution. It was difficult to accurately delimit the south-eastern destinations accurately, because of inaccessibility and security problems. However, interviews with pastoralists reveal that the previous seasonal migratory corridors to the south to Wabi Shebelle River and west to Chulul and Mojo Rivers are now completely interrupted.

4.2 Population size and abundance of elephants

4.2.1 Defecation rate

A total of 116 droppings were found and counted after 42 elephant-hours. It was estimated that the overall mean defecation rate for elephants in the study area was 16.66 droppings elephant/ day/(±2.044 at 95% CL). Defecation rate for adult females (n=1), for intermediate female (n=2), for juveniles (n=2) and for adult male (n=1) was found to be 16, 17.33, 18 and 12, respectively (Table 3).

Table 3; Dry season sex- and age-specific defecation rates for elephants at BES

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
	Juvenile	4	16
	Juvenile	5	20
Lonely male	Adult male	3	12
	Average	25/6hrs	16.66

4.2.2 Dung decay rate

The dry season mean dung decay rate for the study area was estimated to be 0.0133 droppings/ day (±0.0017 at 95% CL). The mean number of days for the disappearance of dung piles was 73.20 (± 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. 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) (Fig. 5)

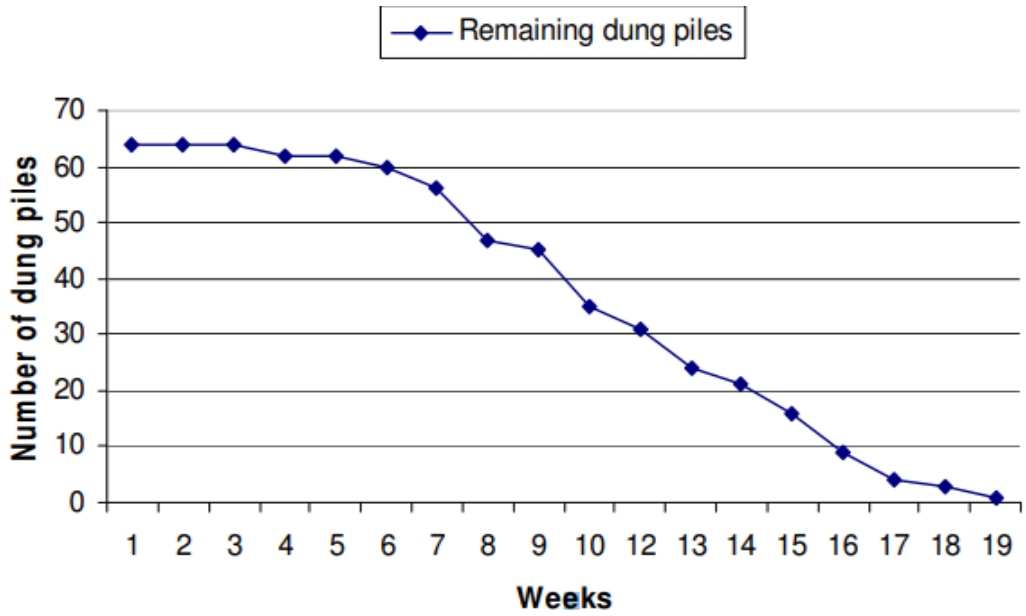

Figure 6; Weekly dung-piles disappearance in the study area

Due to ecological factors; as the time interval increases, the rate of dung decay also increases and after the seventeenth week the dung becomes completely disappeared.

4.2.3 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 4).

Table 4; The estimated elephant density in each stratum and in the total study area

Stratum	Area (km^2)	Elephant density (km^2)		Elephant 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	1245.84	0.07	±0.022	84.8	±24.3

Therefore, the total estimate of number of elephants in the area (1245.85km^2) was 85 with a 95% confidence interval of 61 and 109 and the mean estimated elephant density of 0.07 Elephants/ km^2.

4.3 Age structure and sex ratio of elephants

4.3.1 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.

Based on the three methods employed in the study 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 are shown in Table 5.

Table 5. 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 cicumference
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	42	16	14

4.3.2 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.

4.4 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 BES. At present, however, they are localized to two areas, the western (Gobelle group around the Gobelle river) and the southern (Errer group around Errer river) parts of the sanctuary. 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 2019, might be as a result of disturbances from poachers.

4.5 Feeding and habitat association

There are 14 plant species belonging to 13 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.

Scientific name	Local name	Family	Part Consumed
Annona cherimola	Gishta	Annonaceae	Leaves and fruits
Arachis hypogea	Lewiz	-	Pod and leaves
Carica papaya	Papaye	Caricaceae	Leaves and fruits
Casimiroa edulis	Ambuka	Rutaceae	Leaves and fruits
Cucurbita pepo	Duba	Cucurbitaceae	Leaves, stems and fresh fruits
Ipomoea batatas	Mitatis	Convolvulaceae	Leaves, stems and tubers
Lagenaria siceraria	Buqqe	Cucurbitaceae	Leaves and stems
Lycopersicon esculentum	Timatime	Solanaceae	Leaves and fruits
Mangifera indica	Amba	Anacardiaceae	Leaves, bark and fruits
Musa paradisiaca	Muza	Musaceae	Leaves and fruits
Psidium guajava	Zeyituna	Myrtaceae	Leaves, bark and fruits
Saccharum officinarum	Alla	Poaceae	Leaves and stems
Sorghum bicolor	Bishinga	Poaceae	Leaves, stems and seeds
Zea mays	Boqollo	Poaceae	Leaves, stems and seeds

Table 6; plants consumed by elephants (local names are in Oromifa language)

4.6 Human-elephant conflict

4.6.1 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.

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.

4.6.2 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 elephant's activities.

5 Discussions

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 sanctuary were probably forming one group or freely moving as two groups within the two home ranges. The pastoral settlement and agricultural activities in areas like Dendema, Dewreta, Burka Bombe and Minader intensified illegal activity of village in the south and eastern part of the sanctuary were the probable factors that hindered the former movement of the elephants (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 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.

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.

To estimate the population size and abundance in the study area, the research uses elephants defecation rate and dung decay rate as follow:

The dry season overall mean droppings produced /elephant/day (16.57) in the area was greater than the wet season defecation rate of elephants of the Kasungu National Park, Malawi which is 15.7 droppings/elephant/day (Jachmann and Bell, 1984a), but less than that of Shimba Hills Ecosystem, Kenya, which is 19 droppings/elephant/day (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 and of 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/ day) was rather the same as the dry season defecation rate of bulls in Ruaha National Park, Tanzania, which is 12 droppings/ elephant/ day (Barnes, 1979).

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; Cherie 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 BES (72.3 days) was greater than 60 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.

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.

The relative high confidence limit in the elephant population size estimation of the study area

(84.8, ±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 (X^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).

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 (X^2 = 0.757, d.f.= 1, P>0.05 and x^2 = 0.640, d.f.= 1, P>0.05), for sub-adult male or adult female age group (X^2= 0.625, d.f.=1, P>0.05 and X^2 = 3.6, d.f.=1, P>0.01), and the boli circumference result for calves and footprint result for juveniles (X^2 =1, d.f.= 1, P>0.05 and X^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 (X^2 = 4, d.f.= 1, P<0.05, X^2=3.57, d.f=1, p<0.05 and X^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.

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.The male to female sex ratio of elephants of the study area was less than the normal. 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). So, 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. Conclusion and recommendation

6.1 Conclusion

In general, all elephant areas in the country are marginal lands and until recently were inhabited by many people. Elephants occupy these areas not by choice, but because they have been displaced from more suitable habitat by humans. 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 are 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. Today, 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 inside and outside protected areas. Lack of awareness in all groups of people, lack of established structure and political will to improve the management and protection of protected areas, population growth and dependency of agriculture, illegal settlement and enrichment of wildlife area, illegal trade of ivory in the market, lack of proper land-use and wildlife policy and other socio-economic problems cast shadow on the conservation of elephant population in the sanctuary.

6.2 Recommendations

Therefore, to maintain the elephant population and its habitat, the following measures are recommended:

- The present BES has considered as a controlled hunting area and elephant killing was practiced before it was banned in 1992. To undertake effective law enforcement activity, enough number of outposts needs to be built in different parts of the sanctuary and sufficient scouts need to be hired. 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.

- Therefore, there is a great need of reform the country's wildlife policy and legislation. The currently national elephant conservation proclamation needs to be completed through the development of detailed regulations to ensure adequate protection of the country's threatened wildlife species like elephants. There should also be needed a nationwide public awareness campaign about the need of wildlife conservation, the various forms of utilization and the law-enforcement procedures. The increasing encroachment of human populations with their domestic livestock into wildlife conservation areas and the consequent destruction seriously threatens the existence of wildlife in the country and has to be halted.
- The people living around the sanctuary 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. 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 conserve the elephants.

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8. Appendixes

APPENDIX -I

Part-I; ELEPHANT POPULATION HISTORY AND HUMAN-ELEPHANTS INTERACTION

A/ Movement, Distribution and Population Size of elephants:

1/ Are elephants found in this area? Yes / No

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 your agricultural lands and/or living compounds?

_____

If you answer YES, When?

_____

2. Do elephants create problem on human beings and/or their property (crops, crop Stores, livestock, etc.)? Yes/No_____

2.1 If yes, please describe incidents you remember.

_____

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

3.1 If yes, what kind of benefit(s)?

_____

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

_____

4.1 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 1992G.C?

_____

_____

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?

_____

Part-II; 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 _____(in hect-)

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

2/ Do they 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/ Very happy B/ Happy C/ Unhappy D/ 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 think you get any benefit from elephants in the future? (Yes/No)_____
i. If yes, what benefit? _____
_____

17. Do you think you have the role to play in the conservation of elephants? (Yes/No)
_____
If yes, what will be your role? _____
_____

7. LIISKA

LIISKA -I

Qaybta-I; TAARIIKHDA CIIDAMADA ELEPHANT IYO HAMBALYO-ELEPHANTS INTERACTION

A / Dhaqdhaqaaq, Qaybinta iyo Tirada Dadka Maroodiga:

1 / Maroodiyaal miyaa laga helay aaggan? Haa/ Maya

2 / Goorma ayaa maroodiyadu markii ugu horreysay laga arkay aaggan? _____

3 / Halkee maroodiyayaashu asal ahaan ka yimaadeen? _____

4 / Meelahee cayiman maroodi hore ayaa laga helay? Sidee maalmahan?

_____

5 / Markaad isbarbar dhigto tirada maroodiga ee xaadirka ah iyo kan hadda jira, miyaa kordheysa ama yaraanaya?_____

_____

6 / Maxaad u maleyneysaa inay yihiin sababaha ugu weyn ee isbedelkaan?

_____

B / Dalag:

1. maroodiyadu ma u imaadeen dhul beereedkaaga iyo / ama xeryaha lagu nool yahay?

_____

Hadaad ku jawaabtay HAA, goorma? _____

2. maroodiyadu dhibaato kuma abuuraan bina aadamka iyo / ama hantidooda (dalagyada, Dukaamada dalaga, xoolaha, iwm)? Haa/ Maya_____

2.1 Hadday haa tahay, fadlan sharax dhacdooyinka aad xasuusato.

_____

3. Ma u malaynaysaa in bulshooyinka maxalliga ahi ka faaiideysteen jiritaanka maroodiyaasha aaggan? _____

3.1 Hadday haa tahay, faa iido noocee ah? _____

_____

4. Sidee mustaqbalka ku saabsan? Ma u malaynaysaa inay faa'iido yeelan doonaan?

_____

4.1 Hadday haa tahay, qaabkee? _____

_____

5. Ma u malaynaysaa inay dadku dareemaan inay khasaare u horseedaan jiritaanka maroodiyaal _____

6. Tallaabooyin noocee ah ayaa loo baahan yahay si loo yareeyo ama looga fogaado waxyeelada ay sababaan maroodiyaasha?

_____

C / risaaq binu-aadamka duurjoogta

1 / waa maxay xayawaanka duurjoogta ah (aan ka ahayn maroodiga), oo saameeya aadanaha aagga?

A / Duuliyayaashii Diyaaradda: 1. _____ 2. _____ 3. _____

B / Xoolaha ama dadka weeraraya: 1. _____ 2. _____3. _____

2 / maxay yihiin tillaabooyinka ay qaadaan dadka deegaanka si ay uga badbaadaan dhibaatooyinkaas?

_____

3 / intee leys goosanayaa ayaa waxaa lumiyay xayawaan duurjoog ah? _____

_____

D / ugaarsiga Maroodiga

1 / miyaa lagu qabtaa ugaarsiga maroodiga aaga? _____

Hadday haa tahay, goorma? _____

Sidee hadda ku saabsan? _____

2 / goorma ayuu ahaa / diley maroodiga si daran?

_____

3 / maxay ahaayeen / sababaha sababay ugaarsiga maroodiga ba'an ee muddada kor ku xusan?

_____

4 / Meeye aagga lagu dhaqmo ugaarsiga maroodiga?

_____

5 / xaggeed ka yimaadeen ugaaratada? _____

6 / Maxaad ka ogtahay ugaarsiga isboorti ee lagu tababarayay aagaas ka hor 1992G.C?

_____

7 / Maxaad dareentaa markay dadku yimaadaan oo dilaan maroodiyaal?

_____

8 / Maxaad u maleyneysaa inay yihiin tillaabooyinka loo baahan yahay in la qaado si loo ilaaliyo inta hartay

Dadka Maroodiga ah ee deegaanka ku nool?

_____

Qaybta-II;

Colaadda bina-aadamnimada

 Kebele - _____

 Galmo - Lab / Dheddig,

 Da'da -Young / Qaangaar / Duug

Stat Xaaladda Bulshadeed - Reerka / Hogaamiyaha Deegaanka / Oday / Khabiir / Hogaamiyaha siyaasadeed

Qoyska xajmiga - _____ Xaasas ma lahayn _____ Shaqooyin _____

– Waxbarasho –Maqalin / rasmi / mid hoose / dhexe iyo wixii ka sareeya

 Mudo intee leeg ayaad joogtay aagga? (1- 3) (4 - 10) (10 - 15) (Inka badan 15) sano

 Cabbirka dhulka Beeraha _____ (hect -)

1 / maroodiyadu ma u soo dhowaadaan xeryaha aad ku nooshahay / dhul beereedkaaga? (Haa / Maya)

2 / Miyey dhibaato ku abuuraan gurigaaga? (Haa / Maya)

3 / Mudo intee le'eg ayay noloshaydu socotay? (1 - 3), (4 - 10), (10 - 15), (Kahor 15 sano kahor)

4 / Xilligee ayuu ku dhacayaa? (Qalalan / qoyan / xilli xilli aan la eegayn)_____

5 / Sidee loo badalaa burburka xayawaanku? (Hoos u dhaca / Kordhinta / Go'aan la'aanta /

6 /) Miyaad ugu warbixisaa dhacdooyinka noocaas ah hay'ad dawladeed? (Haa / Maya) ._____

Hadey haa tahay, yaa? _____

7 / Maxay yihiin talaabooyinka la-dagaallanka ee aad qaadataan?

1. _____
2. _____
3. _____
4. _____

8 / Tallaabooyinkan la-dagaallanka ma yihiin kuwo wax ku ool ah? Haa / Maya ._____

Hadday Maya tahay, maxaa diidaya?

_____

9 / maroodiyadu ma keenaan dhibaatooyin kale oo bulsho? (Haa / Maya)

_____

Hadday Haa tahay, waa maxay dhibaatooyinka waaweyn ee jira?

A/ _____

B/_____

C/_____

D/_____

10 / Adiga ama ehelkaaga soke ma dileen maroodiyaal? (Haa / Maya) Hadday Haa tahay, sababtu maxay tahay? _____

11 / Ma heshay wax faa iido ah ilaa hada maroodiga aaggan? (Haa / Maya) ._____

Hadey haa tahay, faa iidee? _____

_____

12 / Miyaad dareentaa inaad luntay sababtoo ah joogitaanka maroodiyaasha aaggan? (Haa / Maya) ._____ Hadey haa tahay, faa iidee? _____

_____

13 / Maxaad dareemeysaa haddii maroodiyaal aan halkaan joogin

A / Aad ugu faraxsan yahay B / Farxad C / aan ku faraxsanayn D / waxba

14 / Ma ogtahay sababta ay dowladdu u rabto inay ilaaliso maroodiyaasha? (Haa / Maya) ._____

Hadday haa tahay; maxaa? _____

_____

15 / Ma waxaad ka cabsi qabtaa ilaalinta maroodiyaasha aagga? (Haa Maya). _____

Hadday haa tahay, waa maxay sababtu? _____

_____

16. Ma u malaynaysaa inaad wax faa iido ah ka helayso maroodiyaasha mustaqbalka? (Haa / Maya) _____

i. Hadday haa tahay, faa idaa _____

17. Ma u maleyneysaa inaad leedahay door ka ciyaarista ilaalinta maroodiyaasha? (Haa / Maya) _____

Hadday haa tahay, waa maxay doorkaadu? _____

_____

APPENDIX-II

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-III

Dung decay rate

Starting date_____ ending date_____

Location_____ Habitat type_____

No.	Date of defecation	Canopy cover	Circumference	N^{th} day				N^{th} week										
				1	2	3	4	1	2	3	4	5	6	7	8	9	10	11
.																		
Number of remaining dung-piles																		

APPENDIX-IV

DRY SEASON DEFECATION RATE OF ELEPHANTS (Data collection sheet)

Date_____ Duration_____

Starting time_____ ending time_____

No.	Age & sex	Bolus circumference	1^{st}	2^{nd}	3^{th}	4^{th}	5^{th}	6^{th}	7^{th}	8^{th}	9^{th}	10^{th}	11^{th}