EXAMINING ACTIVITY PATTERNS, RANGING AND DIET OF BOUTOURLINI'S BLUE MONKEY (*Cercopithecus mitis Boutourlinii*) IN NATURAL FOREST AND SHADE COFFEE SYSTEM OF BELETE-GERA FOREST PRIORITY AREA, SOUTHWEST ETHIOPIA

M.Sc. Thesis

By:

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Examining activity patterns, ranging and diet of Boutourlini's blue monkey (*Cercopithecus mitis Boutourlinii*) in natural forest and shade coffee system of Belete-Gera forest priority area, Southwest Ethiopia

By Ahmed Mohammed Abachebsa

MSc Thesis Submitted to the Department of Natural Resource Management, College of Agriculture and Veterinary Medicine, Jimma University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Wildlife and Ecotourism Management

Major Advisor: **Behailu Etana (Asst. Prof., PhD Candidate)**

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DEDICATION

I am dedicating this thesis to beloved one who has meant and continue to mean so much to me. Although he is no longer of this world, his memories continue to regulate my life. He is my paternal grandfather Abachebsa Ababulgu whose love for me knew no bounds and, who taught me the value of hard work.

DECLARATION

I, Ahmed Mohammed, hereby declare to the school of graduate studies, Jimma University, College of Agriculture and Veterinary Medicine that this is my original work and all sources of materials used are duly acknowledged. This work had not been submitted to any other educational institutions for achieving any academic awards. I concede copyright of the thesis in favor of the Jimma University, College of Agriculture and Veterinary Medicine.

Name: - Ahmed Mohammed Abachebsa ____________ ______________

Signature Date of Submission

Place: Jimma University, College of Agriculture and Veterinary Medicine.

BIOGRAPHICAL SKETCH

Ahmed Mohammed was born in Shebe Sombo District, Jimma Zone of Oromia National Regional State in June 16, 1990 G.C. He started his elementary school education at Angecha Base and junior elementary school in 1998 and completed in 2005, and his Secondary School from 2006-2007 at Hawi Shabe high school. He continued his preparatory School at Jimma preparatory school in 2008, and completed in 2009. Then, He joined Adama Science and Technology University, in 2010, and graduated with B.Sc. Degree in Natural Resource Management (Forestry and Ecotourism) in 2012.

After graduation, He had been working at Shabe Sombo district, in Rural Land Administration and Environmental Protection Office since 2013 and joined Jimma University, College of Agriculture and Veterinary Medicine, School of Graduate Studies for the Degree of Master of Science in Wildlife and Ecotourism Management in 2016.

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LIST OF ACRONYMS

BGRFPA	Belete-Gera Regional Forest Priority Area
CG	Coffee Group
DBH	Diameter at Breast Height
FC	Forest Coffee
FG	Forest Group
GIS	Geographic Information System
GPS	Global Positioning System
GDRLEP	Gera District Rural Land and Environmental Protection
Ha	hectare
IUCN	International Union for Conservation of Nature
Km	Kilo meter
M	meter
m.a.s.l.	Meters above sea levels
NFG	Natural Forest Group
SEPGDR	Socio Economic Profile of Gera District Report
SEPShSD	Socio Economic Profile of Shebe Sombo District
SFC	Semi-Forest Coffee
ShSDRLEP	Shebe Sombo District Rural Land and Environmental Protection
SPSS	Statistical Package for Social Sciences

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ABSTRACT

Understanding activity pattern, home range and diets of primate species are fundamental for caring its behavioral ecology and vulnerability to disappearance. Boutourlini's blue monkey (Cercopithecus mitis Boutourlinii) is vulnerable sub-species, which is endemic to south western parts of Ethiopia. Their behavior with respect to natural forest and shade coffee systems is untried. Thus, this study was aimed to examine their behavior in natural forests and shade coffee habitats. Two different monkey groups were selected for the study in Belete-Gera forest priority area. Vegetation studies were done using quadrants of 20m X 20m throughout the home range of the two groups of monkeys. Instantaneous scan sampling method was used for the activity patterns of the monkeys using binocular/telescope and location points were recorded using GPS. Boutourlini's blue monkey of both group spent more time in feeding than moving and resting. The coffee group consumed a total of 27 plant species and natural forest group consumed 37 plant species. Both groups had shown strong preference for fruit (39.75%) and young leaves (33.65%). The average day ranges of the vulnerable blue monkey in shade coffee system was 697.50m and the natural forest group was 711.30m. Shade coffee group had larger ranging area (62ha) than natural forest group (34ha). The shade coffee group extremely prefer buffer zone area left in between shade coffee to perform much of their daily activities and spent much time in this area. Whereas forest groups equally use all parts of their home ranges. Thus, shade coffee systems should have to be supported with enormous amount of buffer zones to benefit the survival of the species.

Key words: Habitat, Conservation, Behavior, Endemic, Vulnerable

1. INTRODUCTION

1.1. Background and Justification of the Study

Ethiopia is among the countries with the highest rates of forest degradation due to extensive use of wood fuelling and intensive land clearing for agriculture to support the escalating human populations (Haileselassie, 2004). A number of forest-dwelling animals, including primates, are severely affected by the fragmentation of their habitat (Isabirye-Basuta and Lwanga, 2008). These fragmentations results in population declines in some primates and complete extirpation in others (Chapman *et al.* 2007). In Ethiopia the primary threat facing primates now is habitat destruction; these are taking place through reduction of forest size and quality that results in the reduction of food sources for forest-dwelling primates and in some cases threatens them with local extinction (Mekonnen, *et al*, 2010). The existing evidence suggested that fragmentation influences the lives of primates in many areas, including affecting their home range sizes, dietary compositions, physiological stress levels, daily path lengths, gastrointestinal parasite loads and opportunities for dispersal (Boyle *et al.*, 2009). On the other hand, other more complex systems such as agroforestry can support certain levels of biodiversity and serve as habitat, connecting corridors or stepping-stone for many species. For example shade coffee agricultural system in Ethiopia. Shade coffee is coffee produced under a tree canopy. shade coffee agricultural system can become key refuge areas for certain biodiversity, especially compared to more intensive agricultural practices (Guzmán *et al.*, 2016).

Blue monkeys (*Cercopithecus mitis*) are among the most widely dispersed of Africa's arboreal primate species and inhabit a variety of forest types such as tropical moist forest, tropical montane forest and coastal hill forest, including forest fragments across much of their range (Lawes, 2004). Among these, Boutourlini's blue monkey (*Cercopithecus mitis boutourlinii*) is one of vulnerable sub-species in International Union for Conservation of Nature (IUCN) list, which is endemic to southwestern parts of Ethiopia (Kingdon, *et al.*, 2008). Despite being labeled as a vulnerable species by IUCN, this mammal's habitat is slowly getting separated away from the forest edge and is now found deep in the forest. This may have been attributed to negative effects of human activities in the forest. It is also common to see Boutourlini's blue monkey in shade coffee system of Ethiopia. Therefore, there is a need to study the activity time budget of this monkey for the purposes of habitat modeling in future also there is need to create awareness among conservation biologist on the various daily activities of this mammal for the purpose of conservation of this unique primate species and its habitats.

Different studies revealed that primates often change their behavior when living in disturbed habitats, for example, by having lower-quality or less diverse diets, larger home ranges, smaller group sizes, and altered activity budgets (Limeira, 1997; Clarke *et al*., 2002). Thus, understanding of a species' home range, feeding and activity patterns is fundamental for caring its behavioral ecology and vulnerability to disappearance (Smith *et al*., 2013). Therefore, Comparisons of the behavior and ecology of primates living in intact and fragmented forest are critical to the development of conservation strategies threatened by habitat loss (Tesfaye *et al*, 2013). However, these behavior with respect to intact natural forest and shade coffee systems are untried.

To determine the extent to which the behavior and ecology of these monkeys are influenced by the habitat types, two focal groups were selected from relatively undisturbed continuous forest dwelling group (forest group) and a group occupying shaded coffee agricultural system (coffee group) and we compared their activity patterns, ranging behavior and diet of the species. This study aimed to examine activity patterns, daily path length, home range size and diets of Boutourlini's blue monkey in the natural forests habitat and shade coffee systems of southwestern Ethiopia.

1.2. Statements of the problem

In Ethiopia, very little effort is made to understand the primates association with the different kinds of habitat types including coffee management systems and this need to be addressed. How different species distribute their time among various activities is essential to characterization of their life styles, and lays a foundation for interrelating their ecology and behavior (Smith *et al*., 2013). Boutourlini's blue monkey *(Cercopithecus mitis boutourlinii*) is listed as a vulnerable sub-species, which is endemic to south western parts of Ethiopia (Kingdon, *et al.,* 2008). These species are known as arboreal. But, from time to time forests which they regularly use as habitat are declining through different anthropogenic activities including agricultural expansion, overexploitation, human encroachments and settlements, the expansion of large commercial farms in forest areas (especially through semi forest coffee and coffee farm system) (EPA, 2003; Hotel, 2008). However, the effects of this land use change (forest conversion) on Boutourlini's blue monkey's habitat preferences and resource availability in shade coffee system for this monkey are not well investigated. In addition to this, it is reported that Boutourlini's blue monkey showed variations in their activity pattern, ranging, feeding as well as conflict with human beings in natural forest and fragmented habitat. These behaviors with respect to natural forest and different shade coffee systems are not yet studied. So, the current study is proposed to examine activity patterns, daily path length, home range size and diets of Boutourlini's blue monkey in the natural forests habitat and shade coffee systems of southwestern Ethiopia.

1.3. Objectives of the study

1.3.1. General objective

The general objective of this study was to examine activity pattern, ranging and feedings of the vulnerable Boutourlini's blue monkey (*Cercopithecus mitis boutourlinii*) in natural forest and shade coffee system of Belete-Gera forest priority area, Southwestern Ethiopia.

1.3.2. Specific objectives

- ✓ To examine diurnal activity time budgets of the Boutourlini's blue monkey in natural forest and shade coffee system of Belete-Gera forest priority area.
- ✓ To identify day range lengths and home range size of the Boutourlini's blue monkeys in natural forest and shade coffee system.
- ✓ To compare diet and foraging behavior of the monkeys in natural forest and shade coffee systems of Belete-Gera forest priority area.

1.4. Research questions

This study was intended to address the following research questions:

- Do Boutourlini’s blue monkey have a preference for their natural forest or for shade coffee habitats?
- Are there behavioral differences in Boutourlini’s blue monkey when they are in their natural forest versus when they are in shade coffee systems?

1.5. Research hypothesis and prediction

Since the disturbance level, vegetation compositions and habitat sizes are different for the two habitat types considered in the study, the researcher hypothesized that Boutroulini’s blue monkeys in these two habitat types would differ markedly in their activity patterns, daily path length, home range size, and dietary composition. The home range size of Boutourlini’s blue monkey in the shade coffee system would be larger, movement patterns would be more linear, and they would have higher habitat selectivity than populations of natural forests.

1.6. Significance of the study

Conservation of primate and even other large mammals in shade coffee systems are not adequately studied in Ethiopia. Boutourlini’s blue monkey *(Cercopithecus mitis Boutourlinii*) being vulnerable species, and endemic to south western parts of Ethiopia, the knowledge of the activity pattern, ranging and feedings of the blue monkey in shade coffee habitats are not available. However, this knowledge is significant in designing appropriate conservation strategy. Thus, this study is important to address the ecological preferences of the vulnerable blue monkey to wildlife conservation sectors of government and other related stakeholders.

2. LITERATURE REVIEW

2.1. Definition and concepts of animal home range

In the route of its daily activities in its habitats, an animal travels through familiar places to obtain food, seek shelter, or find mates. The actual geographical area covered throughout these regular movements is said to be the animal's home range. An animal's familiarity with the features of its home range allows it to forage efficiently and escape predators when necessary (Emily, 2016). The size of an animal's home range is dependent on a variety of factors including seasonality, climatic and astronomical variables, food resource distribution and phenology, population density and group size, and body size and mass. Temporal and spatial variations in food sources particularly affect primate ranging and activity budget, and have an ultimate influence on home-range size and shape (Smith *et al*., 2013). For instance, data on primate feeding ecology can provide the level of dietary specialization of a species in addition to giving information on the individual food species necessary to their survival. The more specialized a primate's diet, the greater is its risk of extinction (Harcourt, 2002).

2.2. Shade coffee systems and primate conservation

There is growing evidence supporting the idea that agro-ecosystems can provide temporal habitat for migrating taxa (e.g., birds) and/or extend the available habitat and increase resource availability for native species (Perfecto and Vandermeer, 2008). However, recent studies have begun to assess the ability of primates to survive within agroecosystems (Estrada *et al.*, 2012).

Shade coffee system also provides several additional ecosystem services to local communities that may increase their annual yields and overall wellbeing (Jha *et al.,* 2011). Coffee management can oscillate from "rustic" coffee which has >90% of shade and thus resembles the traditional crops that were originally established under the forest's canopy, to "sun" coffee in which plantations can have no shade at all (Jha *et al.,* 2011). Several studies have highlighted the importance of shade coffee plantations as agroecosystems that favor biodiversity, by serving as buffer zones around protected areas and as dispersal corridors between forest patches (Dietsch *et al.,* 2004; Raman, 2006). In fact, some studies have demonstrated how primate species adapt to shade coffee and other agroecosystems (Bicca-

Marques, 2003; Estrada *et al.*,2012), using them in some cases as a new habitat (McCann *et al.,* 2003) or for dispersal purposes.

Researches had shown that several Neotropical primates use these transformed ecosystems as they offer connectivity between native forest patches (e.g., live fences) and increase habitat-wide resource availability (Estrada *et al.*, 2012). Several genera have been observed using agroecosystems in a permanent or temporal way, according to their biology and dietary flexibility. For example, the high ecological demands of spider monkeys and their reliance on ripe fruit in their diets (Di Fiore *et al.,* 2008), tend to use agroecosystems in a more temporal way than howler monkeys that can rely more heavily on leaves, which are more readily available in these habitats. These large ateline primates have been studied in some of the most widely distributed agroecosystems: shade coffee and cacao plantations (McCann *et al.,* 2003; Muñoz *et al.,* 2006; Zarate *et al.,* 2014).

2.3. Time budgeting and activity patterns of primates

The knowledge of the proportion of time that individuals spend on different activities during a day is important for the understanding of the ecology and life-cycle of a species. Time budgets indicate how individuals in a species interact with its environment and they show the investment in time that is necessary for activities that are important for the species survival and reproduction (Defler, *et al.,* 2010). The variation in time budgets between primate species has been shown to fit certain physical traits and environmental conditions; for example the proportion of the time spent foraging is positively correlated to body weight and negatively correlated to the proportion of foliage in the diet (Harrison *et al.,* 2005).

Primate species that inhabits in increasingly isolated, fragmented and marginal forests face a number of ecological restrictions: restricted home range, low tree density, low food availability and increased hunting pressure. These limitations affect the diet, mortality rate, reproduction rate and survival of the population (Wallace, 2008).Thus, how primate groups distribute their time can give clues about the species ability to survive under such restrictions and about their ecological limits of their tolerance. Time budgets are influenced by group size, habitat quality (Dunbar, 1992) and proximity to human settlements. Since primates appear to balance their time budget to suit environmental conditions (Harrison *et al.,* 2005) they can be used to compare different populations of the same species inhabiting different habitats.

Many primate species, have feeding peaks in the morning and afternoon, and a midday resting peak. For example, as many other primate species, woolly monkey (*Oreonax Flavicauda*) have more feeding time in the morning and afternoon, and they take resting time at the midday (Shanee and Shanee, 2011)

2.4. Habitat use and feeding activity of primates in fragmented area

Widely distributed species have natural geographic ranges extending over multiple biogeographic regions. Conservation strategies derived from different research carried out in a limited part of a species' range, then uniformly applied over multiple regions, brings risk of being ineffective for those species that occupy different habitat types and climatic zones across their range (Whittingham *et al*, 2007, McAlpine *et al*, 2008). Despite the potential importance of this problem for species' conservation, currently there is limited understanding of regional variation in species-habitat relationships within broad geographic ranges (Whittingham *et al*, 2007). For example, habitat selectivity of koala (*Phascolarctos cinereus)* in the semi-arid and arid landscapes of southwest Queensland, Australia, was highest at the more arid, western edge of the koala'srange with their occupancy restricted to riparian/drainage line habitats, while the more easterly koalas population displayed more variability in habitat use (Davies *et al.,* 2013).

Among primate species Blue monkeys can cope with a high variety of different habitats, types of forests and weather conditions (Twinomugisha *et al.,* 2006). They appear in various forest types from rain forests at up to 3000 m, forest patches on the savannah, to evergreen semi-deciduous forest (Mnason *et al.,* 2004). As their habitat the natural food sources of guenons also varies greatly (Kaplin & Moermond, 2000). *Cercopithecus mitis* monkeys are omnivores (Estes, 1992). Besides fruit they eat leaves, invertebrates, flowers, seed, bark and shoots (Fairgrieve & Muhumuza, 2003). They obtain liquids from food or from holes in trees (Estes, 1992).

Food is the abandoned most important factor of determining the animal's time budget that it spends with particular activities (Orams, 2002). Most studies on African forest guenons feeding ecology have come to the conclusion that these guenons spend a lot of time feeding on fruits and fibrous food and almost no invertebrates compared to food from plants (Chapman *et al.*, 2004; Tashiro, 2006). On the contrary, blue monkeys in the Kalinzu forest in Uganda (Tashiro, 2006) spend much more time feeding on invertebrates than shown in any other study. For example: Kaplin and Moermond (2000) and (Tashiro, 2006). It seems that the blue monkeys' diet is as varied as their habitat distribution.

2.5. Importance of buffer zone and agroecosystems

Despite the potential drawbacks of living in a human-modified habitat that include exposure to predators, modified or limited substrates for movement, increased hunting and disease transmission, the importance of shade coffee systems and buffer zone area to biodiversity is apparent. In shaded agroecosystems, such as cacao, coffee, mixed cacao/coffee, and cardamom, the complexity of the mid and upper canopy, including numerous epiphytes, vines, lianas, and other climbing plants offer many potential food resources, shelter, resting sites, and cover to primates using these habitats (Estrada *et al.*, 2006).

In Sub-Saharan Africa, the use of agroecosystems by primates is common, widespread, and important to their conservation. On Bioko Island, Equatorial Guinea, two threatened species, red-eared guenon (*Cercopithecu serythrotis*) and drill (*Mandrillus leucophaeus*), forage in banana (*Musa spp*.) plantations, and *C. erythrotis* also forages in shaded cacao and coffee plantations (Estrada *et al*., 2012). Some of the primate species used the plantations mainly for resting and to travel from one patch of native forest to another, but they also feed on leaves, fruits, and flowers of plants of all layers (Ganzhorn *et al.*, 2009).

2.6. Impacts of habitat fragmentation on forest dwellings animals

One of the major threats to wildlife and their habitats comes from the rapid loss of natural ecosystems as they are transformed into agricultural fields and pastures for livestock (Donald, 2004). The fragmentation of forests by the expansion of agriculture is recognized as an important factor contributing to worldwide decline of forest-dependent species. Thus, Species that are forest dependent may be especially vulnerable to fragmentation because they have specialized resource requirements and may exhibit lower mobility in an agricultural matrix (Henderson and Broders, 2008). Additionally, Primates in fragmented habitat are particularly vulnerable to the spread of parasitic infections because their sociality and group living facilitates parasite transmission (Chapman *et al.,* 2005). However, the ways of conceptualizing and measuring fragmentation effects have been highly variable. This has led to conflicting conclusions from different studies about fragmentation effects on the same primate species.

The significant role of matrix habitats in influencing edge effects, succession processes and dispersal between forests fragments has been increasingly recognized (Laurance *et al.,* 2002; Perfecto & Vandermeer, 2002). The future conservation of even well-protected species may depend on the ability of anthropogenic landscapes surrounding protected areas to support basic ecological processes (Perfecto & Vandermeer, 2002). In the tropics, agricultural areas vary considerably in management intensity, degree of planned and associated biodiversity, and hence in conservation value (Vandermeer *et al.,* 1998).

In contrast, traditional agroforestry systems like shade coffee can support diverse wildlife communities. However, little information exists on the extent to which agro-forests can support the foraging and reproduction of resident wildlife (Donald, 2004). Although a diverse canopy probably helps to prevent temporal gaps in food availability for arboreal taxa, the patterns of resource abundance affecting animals relying directly on shade trees for their foraging have received little attention (Carlo, *et al.,* 2004).

3. MATERIALS AND METHODS

3.1. Description of the study area

This study was conducted in Belete-Gera forest priority area located in Gera and Shabe Sombo Districts of Jimma Zone, Southwest Ethiopia. The area includes remaining tropical natural forest and large areas of shade coffee agricultural habitats. The total forest area is about 1,500 square kilometers (Todo and Takahashi, 2013).

Belete-Gera forest priority area is well-known in that it produces natural forest coffee as well as typical garden or plantation coffee. "Natural forest coffee" refers to coffee that grows spontaneously in the local forest, and which is genetically different from commercial varieties. In fact, the Belete-Gera forest can be divided into two types: the coffee forest area (including plantation coffee), and the intact natural forest area without coffee. In both types of forest, the residents are generally farmers, producing cereals, such as wheat, barley, and teff, vegetables, honey, and milk. In addition, farmers produce coffee in the coffee forest area. Plantation coffee is also one of the farmers' known activities in this forest.

Research done on estimation of the forest using satellite images indicates that the forest area in Gera and Shabe Sombo Districts decreased by 40 percent during the period 1985-2010 (Todo and Takahashi, 2013). Even though, the majority of the natural forests are under the government protection, it is presently under great threat because of resource over exploitation (Hundera, 2007). In the area, forests are mostly used by local communities, and although commercial logging is not present. Different researchers, the forest managers and experts raised three major reasons for the rapid declining of forest in the area: expansion of farmland including planting coffee in the forest; wood extraction for home consumption and commercial sales of firewood and timber; and illegal settlement from other parts of Ethiopia due to the country's growing population and different man-made/ natural hazards. Although wood extraction is illegal in the forest area, which is owned by the government, it is difficult to prevent, as there had been no active system or institution for forest management, either community or government-driven (Todo and Takahashi, 2013).

3.1.1. Gera

The coffee group of monkey was selected in the plantation coffee located in Gera district which found in Jimma zone of Oromia National Regional State, at about 435km south west of Addis Ababa and 93km from the zonal town Jimma. Geographically, Gera is located between $7^0$15'N - 8^0 45'N latitude and 35^0 30' E - 37^0 30' E longitudes (Hundera, 2007). The district is characterized as humid, subtropical climate, with a yearly rainfall ranging from1800mm to 2080mm per annum and a short dry season with relatively high cloud cover. A peak rainfall occurs from June to September, and extends to November with low rainfall in the district and short rainy season between February and April. The mean minimum and maximum annual temperature of Gera is 11.9 and 26.4°C respectively (GDRLEP office, 2017). The partial view of the shade coffee habitat of Gera districts had shown in figure 1 below.

Figure 1: Partial view of shade coffee systems in Gera (Photos by Ahmed, 2017)

Gera has area coverage of 133,010 ha and the most common land use types are; arable lands, cultivated land, grazing lands, wet lands, and natural forest mainly with forest coffee (FC) management practice (Table 1). Its administrative center is Chira town.

Table 1: Land use type and proportions in Gera district

Land use types	***Area in (ha)***	***%age***
Cultivated land	22,156.88	23.20
Grazing land	28,579.32	19.81
Forest land	80,830.40	56.00
Settlement land	707.22	0.49
Wet land	736.18	0.51
Total	**133,010**	**100**

Source: SEPGD Report 2016, GDRLEP office, 2017

3.1.2. Shabe Sombo

Forest group of the study subject represents parts of Belete-Gera forest which is situated in Shabe Sombo district, Jimma zone, Oromia National regional state. The district is located at 375 km south west of Addis Ababa and 52 km from the zonal town Jimma. It is part of the Belete Gera National Forest Priority Area and situated at longitudes between $36^0$15'E and $36^0$45' E and latitudes $7^0$30' N and $7^0$45'N and Altitude ranges between 1,300 to 3,000 m.a.s.l. The area receives an average annual rain fall ranging from 1800 mm to 2300 mm. The minimum and maximum daily temperatures of the area are 20°C and 28°C, respectively (Abazinab *et al.,* 2017). Shabe Sombo has area coverage of 119,100 ha and the most common land use types are; arable lands or cultivated land, grazing lands, wet lands, and forest lands mainly with FC management practice (Table 2). Its administrative center is Shabe town. The partial view of the natural forest of the study area had shown in figure 2 below.

Figure 2: Partial View of Natural forest in Shebe (Photos by: Ahmed, 2018)

Table 2: Land use types and proportions in Shabe Sombo district

Land use types	***Area in (ha)***	***%age***
Cultivated land	40,014	33.59
Grazing land	490	0.41
Forest land	51,000	42.82
Settlement land	8,696	7.30
Wet land	2,798	2.35
Others	16,102	13.52
Total	**119,100**	**100**

Source: SEPShSD Report 2016, ShSDRLEP office, 2017

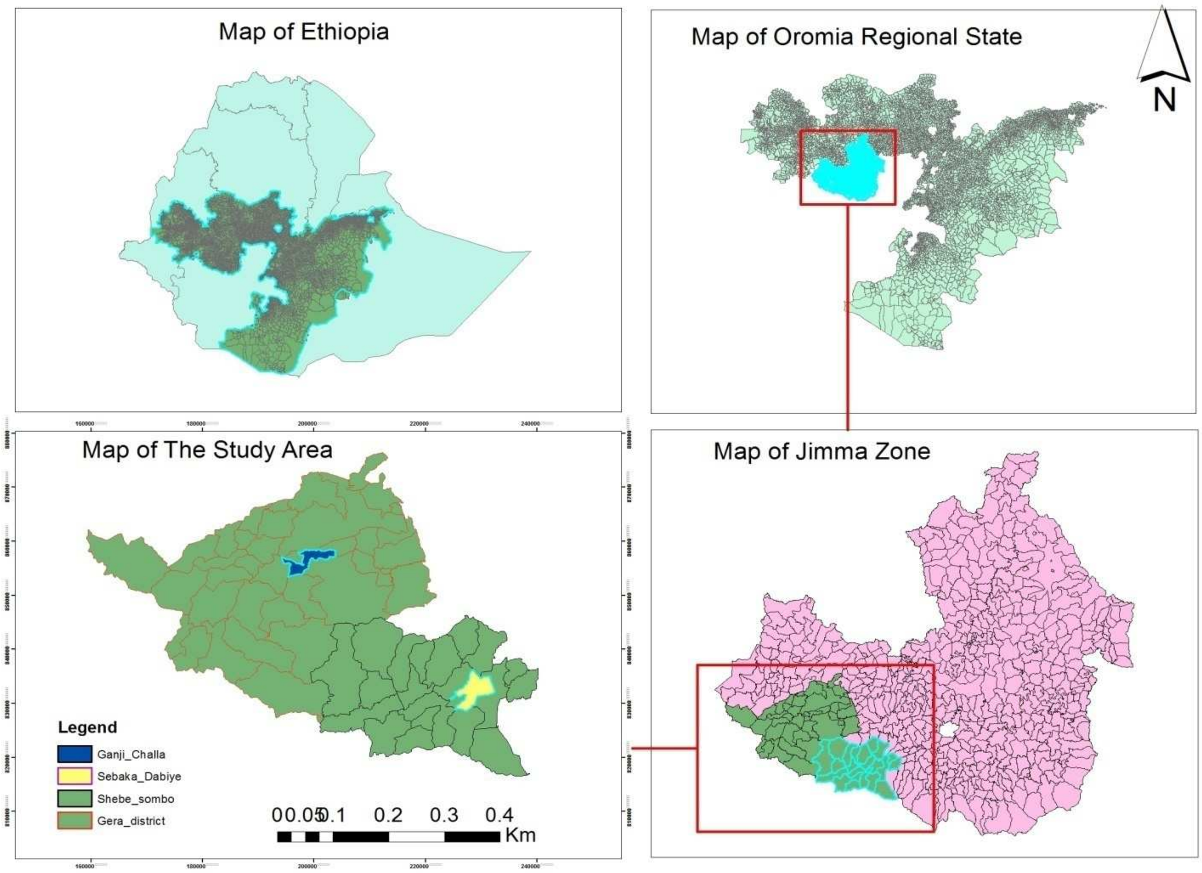

Figure 3: Map of the study area

3.2. Materials

Distance /range finder, Digital camera, Binder, Rain coat and sleeping bag, Binocular, Telescope, Caliper, GPS, plant press, Pen/pencil, papers and other stationary materials were used for this study.

3.3. Study design

At initial, a thorough search of the scientific literature was performed to determine what is known about the focus of the study. The search included current and past journal articles and textbooks, as well as information available via the internet. Then problem statement, objectives and hypotheses were devised and recognized. Then the appropriate method for sample acquisition and generation of the test data was selected consisting arrangement of procedures to test the hypothesis. Choosing and training of local field assistants and scouts of the forest as guards were done at this phase. So group follows were carried out by two pairs of trained observers each comprising one researcher and one local field assistant.

Reconnaissance survey, made during the initial phases of the research in August 2017, helps to determine the distribution of the study subject in the study area and two study sites were selected based on the availability of natural forest and shade coffee system purposively in order to compare variation among the different habitat types. Then two different groups of boutourlini's blue monkey were selected from the two identified sites.

To understand group distributions of Boutourlini's blue monkey in the study area, six transect lines 500m apart in each site were additionally used in the surrounding forest patches in the study area. However, no more than three in shade coffee habitat and four groups in natural forest of Boutourlini's blue monkey groups were detected during preliminary survey. Accordingly, the selected groups were identified from other groups by their total number of individuals that made the group and the unique natural markings of dominant individuals of group members.

After the groups were identified habituation practice to human observation was done for both groups especially the natural forest group. Instantaneous scan sampling method was used for the activity patterns using binocular and telescope. Data were collected from September, 2017 to April, 2018. Data interties and analysis were performed using Microsoft spread sheet and SPSS software from May to August, 2018. Then report writing, submission and defending of the thesis were decided to be in September and October 2018.

3.4. Study site selection

Two kebeles were identified from Gera and Shebe Sombo districts. The Ganji-cala kebele from Gera district for shade coffee group population due to availability of larger coffee farms in the area and Sebaka Dabiye kebele from Shabe Sombo district for forest population group due to the presence of dense natural forest were selected purposively for this study. Since the forest covers the two districts, the group selected at a distance about forty-one kilometers between the two study groups. This distance measured using arc map (GIS version 10.3) software.

3.5. Preliminary survey

A reconnaissance survey made at the two study site during the initial phase of the research in August, 2017 helps to assess the distribution of the study subject in the study area. When blue monkey population identified the total number of individuals, GPS coordinates for location, age and sex category were registered. In Gera, we identified three populations with different age and sex category whereas in Shebe forest we identified four groups of blue monkey population. This helped to identify the selected population of blue monkey from other population for further behavioral study.

Two different Boutourlini's blue monkey groups at two separate sites were selected for the study of their activity, ranging patterns and feeding ecology. Number of individuals in the population identified for these two-studied groups from other groups in the nearby area. In addition, age and sex composition of the groups are a key initial identification that we used to check other detail identification of the individuals in the groups. Furthermore, for each group's identification of individuals were observed by means of unique natural markings, facial appearance, fur colors and scars in different individual category. Different studies also conducted using these methods (Pozo-Montuy*et al.,* 2011 and Tesfaye*et al.,* 2013) for population identification.

The first group (Coffee Group) was located in shaded coffee dominated habitat type with 18 individuals of group members. These coffee group (CG) members include, two adult male, seven adult female, six juvenile and three infant individuals. At the meantime of this study, one adult male was separated from the group members. In addition to this study group there are also two groups of blue monkey in shade coffee habitat with member of eight and twenty-three individuals and which are not selected for this study.

The second group (Forest Group) inhabited natural forest habitat type with low human disturbance. In this area, there were four groups of blue monkeys with 13, 21, 16 and 24 individuals of groups' members. The selected FG monkey have 16 individuals throughout the study period with one adult male, six adult female, five juvenile and four infant members.

The habitat of coffee group is characterized by relatively high disturbances because of human labour in the coffee projects. Thus, this CG didn't require much time for habituation. The study groups specifically, forest group, was habituated to human observers through natural method and wearing non colorful clothes for a week by following the group throughout the day to approach the monkeys within 10-30 meters. Habituation is important in behavioral study to minimize record of disturbed behavior as it cannot represent the usual behavior of a species.

Figure 4: Photos taken during preliminary survey

3.6. Data collection and sampling methods

Data collection was carried out from September to November 2017 for the wet season and February to April of 2018 for the dry season for both groups. Direct observation method was used for the activity patterns using binocular/telescope and their location points were recorded using GPS. Sampling method for activities of the Boutourlini's blue monkey groups was through field observations using instantaneous scan samplings (Altmann, 1974) for five consecutive days per month.

3.7. Vegetation description

Vegetation studies were carried out by laying transects within the study sites. From the transects, 20m x 20m quadrants were placed at distance of 100m in which the distance between two line was 200m in the home range of each of the two study groups (CG and FG) (Hundera and Gadissa, 2008). The total of twenty eight quadrants were placed along transects and of these, 18 were sampled from shade coffee habitat and 10 from natural forests. This variation in quadrant number was resulted from the variation in home range sizes of the two study groups. In each quadrant, for all sampled plants, the species and number of individuals were recorded. The identified species belonging to tree that had ≥10cm circumference were measured then converted to DBH (i.e. DBH= circumference / pi) and the tree species diversity as well as evenness were computed (Hundera and Gadissa, 2008, Mekonnen *et al.*, 2018).

Figure 5: Photos taken during vegetation sampling

After vegetation data were collected, the density of tree plant species were calculated. In addition, plant species diversity was calculated using the Shannon-Wiener index, H' and plant species evenness was calculated using the evenness index, J (Krebs, 1989) to determine whether different species are evenly distributed or not in the study group's home ranges.

$$H' = -\sum_{i=1}^{S} Pi \ln Pi$$

H' = the Shannon diversity index
Pi is the proportion of plant species records of the overall species in sampled plots
S is the total number of species recorded in the sampled plots

Species evenness, J was calculated by

$$J = \frac{H'}{Hmax}$$

Where, J indicates the evenness of the different plant species represented in the home ranges of the study groups. H' is Shannon-Wiener index of diversity, H max is maximum diversity index

Values for J can range from 0.0 to 1.0, with 0 means most evenly represented and 1.0 indicating that less evenly represented (Krebs 1989).

In addition, all plant species being used by each group were recorded every 15min during the scan sampling. This was used for identification of what species of trees used by the subject repeatedly. Most of plant species in the study area were identified using expert method as well as different pictures and taxonomy books. For further identification, plant species in the quadrants were collected, pressed and identified at Jimma University Herbarium.

3.8. Activity pattern

To find out the various diurnal activities undertaken by the Boutourlini's blue monkey in the study areas, during activity scan sampling, the activities were recorded for 5 minutes scan periods. These scans were centered on the quarter hour intervals (i.e. at 0, 15, 30 and 45 minutes) from dawn to dusk (Fashing, 2001; Wong and Sicotte, 2007). The first scan was made from left to right then right to left for the second scan, and so on, to minimize bias of recording the same animal twice. Care was taken to avoid sampling the same individual more than once in a given scan. However, the same individual could be scanned in successive scans (Di Fiore, 2003). A stop watch was used to determine the time taken in each activity.

The group was scanned and the first activity sustained for at least five continuous seconds was recorded for each monkey clearly visible during the scan period. No individual was scored more than once during a given scan period. Data was collected for the first 1-5 visible adults and juveniles (ignoring infants) at the time of each scan. The identity of the scanned individual was recorded and assigned to one of the following age/sex classes: adult male, adult female, juvenile male or juvenile female by using binocular or telescope.

Each observable individual was recorded on the data sheet as performing one of the following behavioural activities: Feeding was recorded when an individual eating or foraging different types and parts of tree or other animal prey using their hands or mouth. This may include reaching for, licking, biting, chewing, picking, ingesting or placing food in the mouth or masticating a particular food item. Scanning was sitting or standing (stationary) with head in constant motion while apparently searching nearby vegetation for food or predator. Movement was recorded when the subject performed any directional movement, either alone or with other individuals, including walking, jumping, galloping, climbing, descending, or running, whether within a tree, across trees, or on the ground. Resting was recorded when monkeys are inactive, either sitting or lying down (body stationary and not involved in any activity). Playing includes chasing, hitting, and other vigorous activities involving exaggerated movements and gestures by a monkey interacting with others in a nonaggressive manner. Aggression was recorded when a monkey chase, bit, grab, displace, threat another monkey, or vocalize in an aggressive context. Grooming was recorded when a monkey uses its hands or mouth to examine or to clean the body of another monkey (both the groomer and groomee), including Self-cleaning. Sexual activities were recorded when an individual engage in copulatory behaviours. Drinking: when monkeys drink water from ground or tree groves. Others were recorded when a monkey performed activities such as vocalizing or defecating that did not fit into the main categories (Butynski, 1990, Fashing, 2001, Mekonen*et al.,* 2010).

Activity time budget was calculated by dividing the proportion of the number of behavioural records for each activity category by the total number of activity records each day (Vasey, 2005). Then it was summed within each month to construct monthly proportions of time budgets for each habitat types separately. The grand mean proportion of the monthly budgets provides the overall wet and dry season time budgets, as well as the overall time budgets during the entire study period (Di Fiore and Rodman, 2001; Di Fiore, 2003).

3.9. Ranging patterns: day range and home range

At the time of each activity scan sampling the location of the geographic center of the natural forest and shade coffee groups were recorded using a handheld GPS. The distance travelled each day by the group was determined based on the shortest point-to-point movements of the group center between consecutive GPS locations during full-day follows from 07:00 to 18:00 hours. Each day range was drawn on a GIS-system generated map (Arc Map version 10.3) by connecting the consecutive GPS location records and the total distances traveled per day. These values were calculated from the map by using measuring tools in the GIS software Arc GIS 10.3 (Di Fiore, 2003; Wong and Sicotte, 2007). Then mean day range lengths were calculated by averaging the wet and dry season day range lengths of the blue monkeys for both groups.

Arc Map version 10.3 software programs was used to estimate the home range size of the blue monkeys for natural forest and shade coffee groups by minimum convex polygon (MCP) method. This method is widely used by many researchers (Williams-Guille´n, 2003; Pombo *et al.*, 2004; Fashing*et al*., 2007; Wong and Sicotte, 2007) to determine the home ranges. The home ranges were calculated by constructing a polygon around the outermost GPS locations used by blue monkeys during both wet and dry seasons. The seasonal and overall home range areas used during the course of the study period was calculated by GIS Arc View 10.3. The wet and dry season home range areas were compared using Mann-Whitney U test.

3.10. Diets of Boutourlini's blue monkey

Diet data was collected through careful direct field observations. At the time of each activity scan sample, dietary data was collected on individuals scored as feeding. All plant and animal species that are consumed by the monkeys were identified and recorded. A certain score was given on the data sheet for the specific parts of a plant being consumed and the type of food item (young leaves, mature leaves, leaf buds, seeds, stems, flowers, fruits, flower buds, petioles, epiphytes, fungi or animal prey) as well as the species consumed (Fashing, 2001; Fairgrieve and Muhumuza, 2003; Di Fiore, 2004). From the plant parts, seed using behavior (spit, swallow, destroy) was carefully studied. The plant species used as food were identified in the field and collected for further confirmation at Jimma University Herbarium.

Diet composition was estimated by calculating the proportion of different food items and species consumed by the blue monkeys (Grassi, 2006). The daily food items and type of species consumed by the group were summed within each month to construct the monthly proportion of food items and food types consumed (Isbell, 1998; Di Fiore, 2003; Xiang *et al.*, 2007). The monthly proportion of each food item was also calculated as the total number of monthly individual scans for each food item divided by the total number of individual scans for all food item individual scans spent for the groups. The relative proportion of plant species used as food for blue monkeys was calculated from the monthly percentage contribution of different species (Fashing, 2001; Di Fiore, 2004).

Relative dietary preferences for different food species in the study groups' diet was calculated by dividing the percentage of total feeding time spent on species i by the percentage of the stem density that species i contributes to the total stem density in the study groups' home ranges (Fashing, 2001).

$$Dietarypreference = \frac{\%\ of\ total\ feeding\ time\ spent\ on\ species\ i}{\%\ of\ total\ stem\ density\ of\ species\ i}$$

Grand means of the monthly proportions of food items and food species consumed was used to calculate the overall diet of each study group for the entire study period.

The percentage contribution of food items and the species consumed by the combined study groups was compared between seasons using a Mann-Whitney U test and across months using a Kruskal-Wallis H test. The Mann-Whitney U test was used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed. The Kruskal-Wallis H test (sometimes also called the "one-way ANOVA on ranks") is a rank-based non parametric test that can be used to determine if there are statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable. It is considered the nonparametric alternative to the one-way ANOVA, and an extension of the Mann-Whitney U test to allow the comparison of more than two independent groups.

3.11. Data analysis

All statistics were carried out using SPSS version 23.0 evaluation software for windows. Statistical tests were two-tailed with 95% confidence intervals. Nonparametric Mann-Whitney U tests were used to compare seasonal differences as well as the behavioral difference of the study subject in the two study sites and Kruskal-Wallis H tests were used to compare monthly variation as the data were not normally distributed.

4. RESULTS AND DISCUSSION

4.1. Vegetation description

The total plant species recorded in the sampled plots (n=28) of the study area was 108. Among these 68 were recorded in shade coffee habitat and 64 recorded in natural forest habitat types (Appendix V and VI) having 24 species in common. From the coffee habitat species, 28 were herb and others were trees and shrubs (table 3). This site was covered with somewhat open canopy, thus species on the ground can get sunlight energy that can be a reason for these surplus amounts of herbaceous plant species in the site. According to Gole (2003), in shaded coffee habitats, the dense coffee shrubs form the second layer and the floor is covered by different species of herbs that are annually cleared to ease coffee harvesting.

However, in the natural forest the numbers of herb species were minimum, because of little to no human intervention that reduce forest canopy. In this close canopy area there must be fewer amounts of ground cover or herb species. The survey results showed that, total number of plant species was higher in shade coffee system with higher amounts of herbs than NF habitat with fewer herb species (Table 3). The tree species available in natural forest were denser than that of coffee habitat. The basal area of tree species in natural forest and shade coffee habitat was 418.83 m^2 /ha and 189.20 m^2 /ha respectively.

Shannon diversity index and evenness showed considerable variation among the forest stands of the two study areas. The natural forest habitat of the study subject exhibited the highest value of Shannon diversity and evenness (3.53 and 0.92) than that of shade coffee habitat (2.18 and 0.78). This indicates that the habitats of shade coffee group had slighter tree species composition and diversity as well as uneven distribution of dietary species. This result agreed with the study conducted by Wong and Sicotte, (2006) that revealed plant species composition and diversity is low in fragmented and disturbed forests, which in turn affects the availability of food for *Colobus vellerosus* species.

Table 3: Life forms with their corresponding number of plant species identified in the study area

Plant growth form	FG	CG
S	11	16
T	34	17
L	7	7
H	12	28
Total	**64**	**68**

S; shrub, T; tree, L; lianas, H; herbs

4.2. Activity time budgets

The overall activity time budgets of the two groups of Boutourlini's blue monkeys were 44.62 % of their time (n=10,793scan samples) spent in feeding, 28.33 % resting, 15.95 % moving and 8.02 % grooming. Forest groups spent higher proportion of their time on feeding (43.84%) and activities like resting, moving and grooming took 33.46%, 12.52% and 7.42% of their time respectively during wet season. Similarly, they spent (46.93%, 32.39%, 10.72% and 7.02%) of their time on feeding, resting, moving and grooming respectively during the dry season. This reveals that there were no much differences in the activity time budget among the seasons. This is probably because of even distribution of food items for Boutourlini's blue monkeys in the natural forest throughout both seasons here. Thus, this is an indicator why they prefer natural forest than disturbed area. Similarly, Kibebew and Abie (2017) found, Blue monkeys exhibited a tendency to spend more time in forest habitats, which may be associated to both fruit resource availability and structural characteristics such as larger fruit patches.

However, there was some variation between the two seasons in time budgets of the coffee group. This group spent higher proportion of their time in descending order as feeding (47.07%), moving (25.94%), resting (17.56%) and grooming (11.40%) during the wet season. However, during the dry season, this group has not followed this order. This became feeding (40.75%), resting (32.43%), moving (11.97%) and grooming (11.40%). As opposed to the natural forest group, the coffee group had shown higher movement during wet season than dry season. The probable cause for this might be the scarcity of fruit bearing trees during wet season in shade coffee habitat than during dry season. Therefore, they migrate to nearby home ranges that may increase the movement activity. There is a similarity with the fragment group studied by Tesfaye *et. al.,* (2013) that reported as they consume fruits as primary choice when present, they even partly shift their home ranges after 3-4 months to a nearby range in order to search and feed on fruiting plants. Table 4 below show the details of the time budgets of the Boutourlini's blue monkeys including the lower proportion of time budgets in both NF and shade coffee habitats during wet and dry season.

In general, the result of this study revealed that Boutourlini's blue monkey of both study sites spent more time in feeding than moving and resting whereas, the minimum time of the two groups were spent in drinking and other activities. This is common fashion as observed among most members of the genus (Appendix III). As observed in this study and other most cases, the activity time budget has direct correlation with the availability of frequent food resources and dietary diversity. This result is supported by Kaplin, (2001) and Tesfaye *et. al.,* (2013) who reported that blue monkeys showed high movement pattern to encounter fruit when there is fruit scarcity in the area.

The Boutourlini's blue monkey activities during rainy season and their resting time was mostly on large trees that different woody lianas and climber cover most parts of the trees (Appendix I). In the natural forest group, during dry season especially at the mid-day or when sun becomes overhead, they stay or perform their activity at lower strata in the forest. This is because of high sun heat at higher strata.

Table 4: Activity time budgets of the Boutourlini's blue monkeys in both NF and coffee habitats during wet and dry season

		Activity (%)								
Groups	**Season**	Feeding	Resting	Moving	Grooming	Playing	Aggression	Sexual activity	Drinking	Others
FG	Wet	43.84	33.46	12.52	7.42	1.88	0.60	0.17	0.00	0.09
FG	Dry	46.93	32.39	10.72	7.02	1.88	0.27	0.55	0.22	0.00

CG	Wet	47.07	17.59	25.94	6.31	1.73	0.64	0.67	0.00	0.04
CG	Dry	40.75	32.43	11.92	11.40	2.12	0.39	0.52	0.45	0.00

Mann-Whitney U test showed that there were no significant differences in aggression (U=40.00; P = 0.42), feeding (U=37.00; P = 0.33), playing (U=37.50; P = 0.34) and sexual activity (U=29.00; P = 0.09) between coffee group and forest group (P > 0.05). However, activities like resting (U=24.00; P = 0.04), grooming (U = 20.50; P = 0.03) and moving (U=55.0; P = 0.01) shows statistically significant different between the two groups and also between the dry and wet seasons of the coffee group.

As the result of this study showed, the variations in resting, grooming and moving are probably because of uneven distribution of food items in the areas. This consequent causes the group to move longer distance to search their food. This search of food might be resulted in wider home ranges for the study groups. When the times for movement of natural forest group minimized because of relatively enough food, then the time for resting has increased. During this time there is higher social life activity including grooming. Similarly, Brain (2015) in behavioural study of the same genus, *Cercopithecus aethiops*, stated that grooming is most often seen in the mid-morning, when the first feeding session is over and the satisfied monkeys are resting in the sun.

Boutroulini's blue monkeys spent much time in social life within a group especially the midday time. These include activities like grooming, playing and sexual activities, which accounted 10.673% of average daytime budgets. Most of the time the adult male (AM) move here and there around periphery of the group member and also sometimes it separates with one adult female (AF) to search food and perform other activities. For instance, it has been reported that adult male spider monkeys tend to have larger ranges and use peripheral areas of the home range more often than females (Chapman 1988; Stevenson, 2006). Sometimes, all group members become quiet as if they are not here around. This might be to escape from sun heat and some times during rainy times.

Boutroulini's blue monkeys also live social life with other primate species like colobus gureza and grivet monkey. They feed from a single tree even from the same branch at a time. When they sense there is problem in the environment or seen an enemy they all vocalize aggressively at the same time. This might be protection ways of the environment through social life. In contrast, sometimes conflicts might occur between blue monkey and colobus monkey, during this time the group member shows aggression with colobus and the other groups of colobus move here and there with voice of aggression.

There were two adult male in the CG, one stay in the group and the other stay another place during daytime. During our data collection, we observed that the separated adult male comes to the group at the end of the day. This time there was conflicts between the two adult male. Then the winner stays within the group and the lost one move some distance and stay around the group even sometimes live with groups of colobus gureza in the area.

4.3. Ranging patterns

The results of this study are consistent with the prediction set that home-range size of shade coffee group would be larger relative to that of natural forest group. However, the average day range lengths of the Boutourlini's blue monkeys among seasons in both the study areas were similar. In a similar way, there were no much variations of home ranges among seasons in both the study areas (table 5). This result is inline with the study conducted on the same species by Tesfaye *et. al*., (2013) at Jibat forest that revealed daily path lengths of Boutourlini's blue monkeys were relatively similar for forest group and fragment group and neither group exhibited much seasonal variation in this variable.

Table 5: Ranging patterns of Boutourlini's blue monkey in the study area

Groups	**Season**	**Day range (m)**	**Home range (ha)**
CG	Wet	684.33	26.01
CG	Dry	710.70	21.40
FG	Wet	728.90	26.76
FG	Dry	693.71	23.62

Mann-Whitney U test showed that there were no significant differences in day ranges as well as seasonal home ranges among the two seasons at both study sites of CG and NF groups ($P>0.05$).

4.3.1. Day range

The average daily range distances for shade coffee group and natural forest group during wet season in the study areas were 684.33 m and 728.90 m, respectively. Whereas the average day range distances during dry season were 710.70 m and 693.71 m in shade coffee system and natural forest habitats respectively. The combination of these two groups day range became averagely 702.20 m during the dry season. The combined mean daily range distance covered by the two study groups in wet season were found to be 706.61m. This result in line with the study conducted on the same species by Tesfaye *et. al*., (2013) at Jibat forest that exposed the average day range distance of the monkey to be 787.10 m.

In general, the average day ranges of Boutourlini's blue monkey in shade coffee system habitat was 697.50 m and the natural forest group was 711.30 m. This shows that the Boutourlini's blue monkey in shade coffee habitat type had compacted ranging patterns in their day range distances than natural forest group (Fig.6). This result agreed with the findings of Tutin (1999); Wong and Sicotte (2007) that demonstrated primates in fragmented habitat often have compressed ranging patterns, traveling shorter distances per day than species of the same group in contiguous forest. These implies there is some limitation on daily movements of shade coffee group in their larger home range than that of natural forest group. These limitations were shortness or absence of connection among corridors area and intervention of human labour as well as scouts for protection of coffee from olive baboon and other destructive animals in the coffee habitat. However, the natural forest group moves freely in their smaller home range.

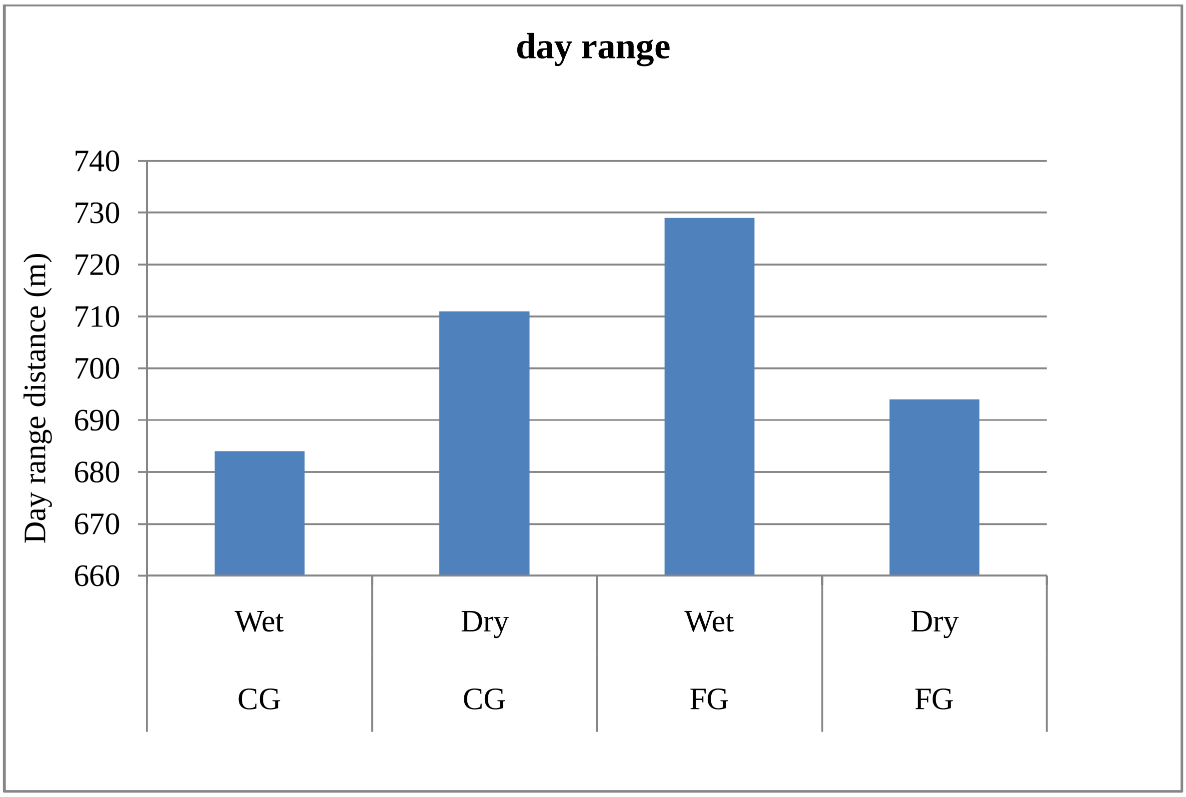

Figure 6: Day range length of Boutourlini's blue monkeys in Belete Gera Forest Priority Area

4.3.2. Home range

The NFG home range was 23.62 ha during dry season and the wet season home range was 26.76 ha. The total home range of the group was 34 ha during both seasons. In this case, there was higher use of the same ranging area in both seasons. In a similar way, the home range of the CG during the wet season was 26.01 ha, whereas the dry season was 21.40 ha (Fig.7). However, there was a considerable variation in the total home range sizes of both groups with CG having total home range of 62.12 ha (Fig.8). The dry season's low home range size is probably due to the coffee group spent much of their time in the small buffer zones in the coffee dominated habitat type. This may be due to uneven distribution of dietary resources in shade coffee habitat and to have better access of water during dry season. Meaning that rain-water collected in tree holes and leaves during rainy season are not available at the dry season. Thus, this result agreed with Wallace (2008) who indicated that there are months of the year where tree holes dry out and the only source of water for spider monkey is from ground streams and creeks.

In the natural forest, since there is similar resource availability throughout the home range, the group did not travel much out of their home ranges and also use the area in equal proportion to fulfill their requirements. Another reason for the smallness of the home range of NFG might be the presence of other groups around the studied group. This result supported by Pinto *et al.* (2003), that revealed the spatial use patterns of a group of primates may be influenced by food sources and the presence of other groups. Clarke *et al*. (2002) demonstrated an arrangement in the home range of one group of howler monkeys *(Alouatta palliata*) in Costa Rica. This group incorporated new stands of the fruit tree *Muntingia calabura (Elaeo carpacaeae)* when this source became available and was located close to their original home range.

A close relationship between home range size and food source availability has been demonstrated for Boutourlini's blue monkeys here. This study had shown that, the monkey group living in lesser dietary diversity environment occupied larger home range sizes. The study of Stoner (1996) on habitat selection by howler monkeys *(Alouatta palliata*) in Costa Rica clearly showed that the density of the major food resources was the most important factor driving habitat selection. The same species of howler monkeys *(Alouatta palliata*), studied in forest fragments of different sizes in Mexico showed a higher index of frugivory and travelling activities among the groups living in larger fragments that also contained the highest number of food sources (JUAN *et al.,* 2000).

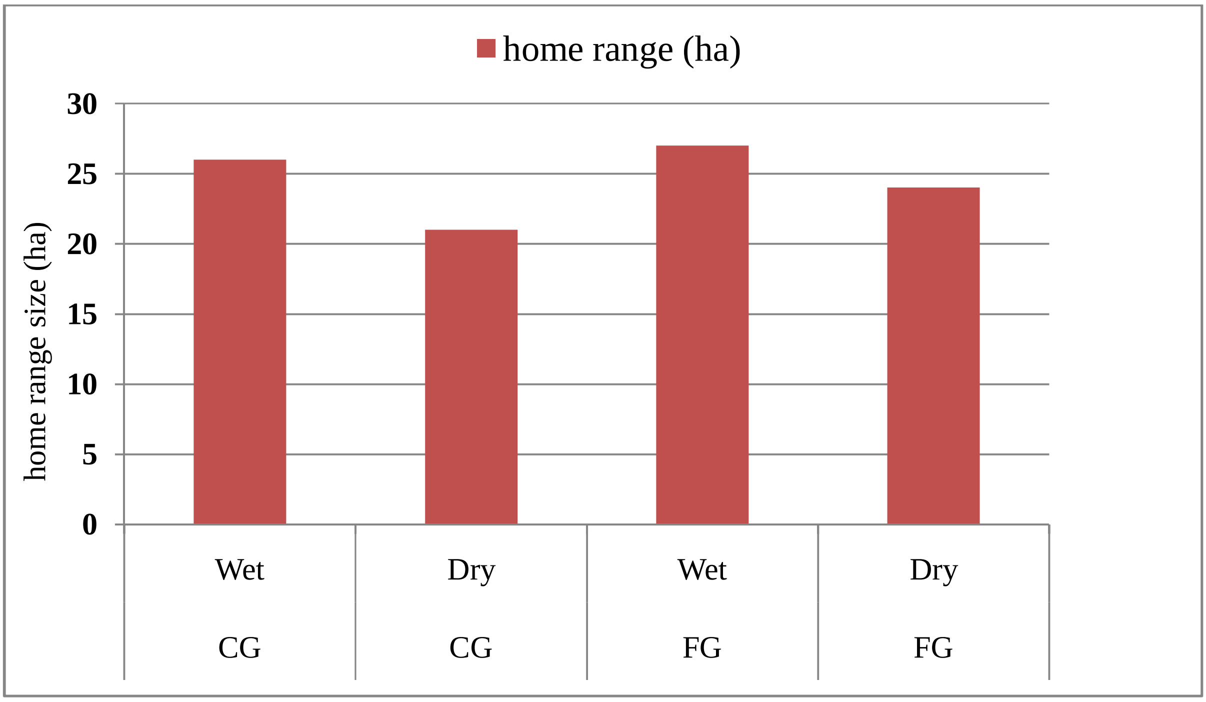

Figure 7: Home range sizes of Boutourlini's blue monkeys in Belete Gera Forest Priority Area

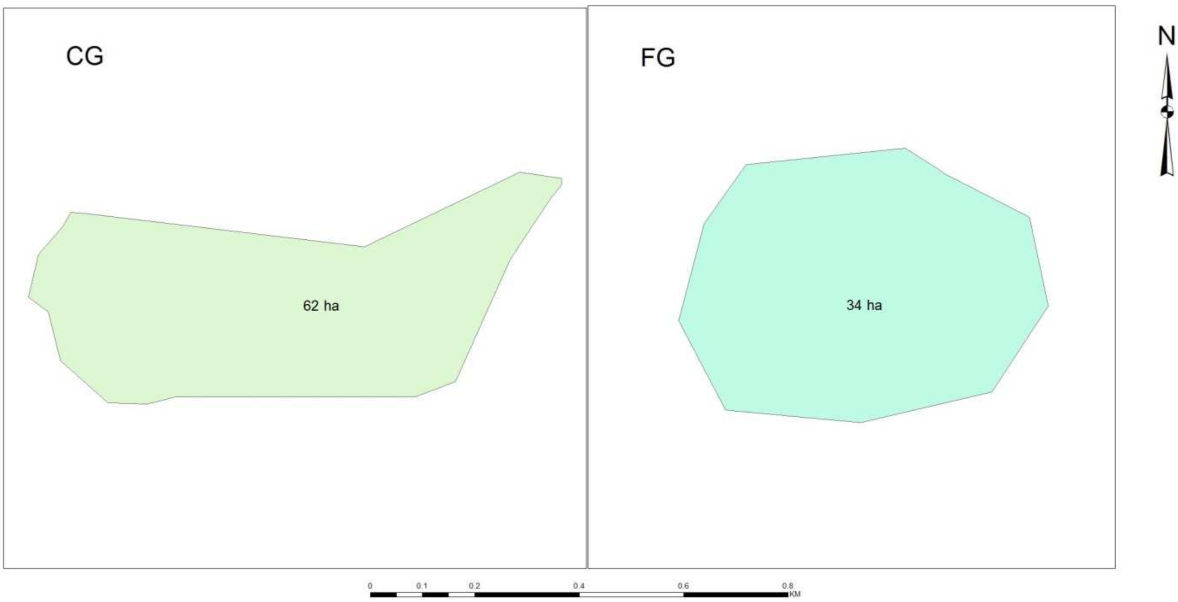

Figure 8: Maps of home range sizes of the Boutourlini's blue monkeys in the study area

4.4. Diets of Boutourlini's blue monkey

During the course of the study, Boutourlini's blue monkey of both group foraged at least on 44 different species of plants, which belonged to 30 families and accounted for 90.30% of their total feedings. This shows that their feeding items are highly dependent on plant species and in a very minimum amount (9.70%) feed on non-plant items. During the study period, Boutourlini's blue monkeys of coffee group consumed a total of 27 plant species and individuals of natural forest group consumed 37 plant species. Even though, the study results showed higher abundance of diet species in natural forest than shade coffee systems, the Boutourlini's blue monkeys are still surviving in shade coffee habitat types. This also showed that the availability of food species in shade coffee system of the study area to serve this species. The details of species eaten, percentage contribution and the preferred food items of the two study groups are presented in Table 6 and 7.

Among the 27 plant species that are consumed by Boutourlini's blue monkey of coffee group, the top five species accounted for 67.65% of the plant diet (Table, 7). Based on total percentage contribution of plant food items, *Olea welwitschii, Landolphia buchananni, Syzygium guineense*, *Tremao rientalis* and *Albizia gummifera* were the most consumed species accounting for 20.49%, 15.92%, 11.77%, 8.05% and 6.70% respectively. For the natural forest group, the following five plant species were highly consumed which accounted for 58.47% of their plant diets. These are: *Landolphia buchananni (*16.16%), *Croton macrostachyus (*15.27%), *Phoenix reclinata (*10.16%), *Celtis africana (*9.00%)and *Combretum paniculatum (*7.88%).

Table 6: Species eaten, percentage contribution and parts consumed by Boutourlini's blue monkeys in natural forest

No.	Scientific Name	Family	Local Name (Afan Oromo)	Parts used	Frequency	%age
1.	*Landolphia buchananni*	*Apocynaceae*	Yeeboo	FR YL	361	16.16
2.	*Croton macrostachyus*	*Euphorbiaceae*	Makanisa	ML FR S YL	341	15.27
3.	*Phoenix reclinata*	*Arecaceae*	Meexxii	FR	227	10.16
4.	*Celtis Africana*	*Ulmaceae*	Qayee/ Cayii	FR,YL,LB,FB	201	9.00

5.	*Combretum paniculatum*	*Menispermaceae*	Baggee	YL P LB	176	7.88
6.	*Polyscias fulva*	*Araliaceae*	Kayiyoo	ML YL FL	148	6.62
7.	*Schefflera abyssinica*	*Araliaceae*	Bottoo	YL ML	118	5.28
8.	*Olea welwitschii*	*Oleaceae*	Bayaa	FR YL FB	91	4.07
9.	*Ficus sur*	*Moraceae*	Harbuu	FR LB	62	2.77
10.	*Mellita ferruginea*	*Fabaceae*	Askiraa	YL ML	58	2.59
11.	*Diospyorus abysssinica*	*Ebenaceae*	Lookoo	YL FR ST	57	2.55
12.	*Albizia gummifera*	*Fabaceae*	Hambabesa	YL ML	52	2.32
13.	*Ficus vasta*	*Moraceae*	Qilxuu	FR	42	1.88
14.	*Cordia Africana*	*Boraginaceae*	Wodesa	FR YL ML FL	40	1.79
15.	*Mimusops kummel*	*Sapotaceae*	Kolaatii	YL	36	1.61
16.	*Apodytes dimidiata*	*Icacinaceae*	Wondabiyoo	YL FR	25	1.12
17.	*Carissa spinarum*	Apocynaceae	Agamsa	YL S FR LB	21	0.94
18.	*Dracaena afromontana*	*Dracaenaceae*	Emoo	FR YL	18	0.81
19.	*Grewia ferruginea*	*Tiliaceae*	Buruurii	FR	15	0.67
20.	*Tiliacora troupinii*	*Menispermaceae*	Liqixii	FL YL LB P	15	0.67
21.	*Fagaropsis angolensis*	*Rutaceae*	Sigiluu	LB YL	14	0.62
22.	*Rytigymia neglecta*	*Rubiaceae*	Mixoo	YL	13	0.58
23.	*Drynaria volkensii*	*Polypodiaceae*	Kaarollee	YL ML	13	0.58
24.	*Lepidotrichilia volkensii*	*Meliaceae*	Goraa	S YL	11	0.49
25.	*Vebris dainelli*	*Rutaceae*	Hadheessa	YL FR	11	0.49
26.	*Ilex mitis*	*Aquifoliaceae*	Mi'eessa	YL	10	0.44
27.	*Allophylus abyssinicus*	*Sapindaceae*	Se'oo	FL FR	9	0.40
28.	*Asplenium protensum*	*Aspleniaceae*	Gawoo/Qawo	ML FR YL	9	0.40
29.	*Sapium ellipticum*	*Euphorbiaceae*	Bosoqa	YL	8	0.35
30.	*Ficus thoningi*	*Moraceae*	Dambii	YL FR ML	6	0.26
31.	*Prunus Africana*	*Rosaceae*	Oomoo	FL YL	6	0.26
32.	*Syzygium guineense*	*Myrtaceae*	Baddeessaa	YL FR	5	0.22
33.	*Pouteria adolfi-friederici*	*Sapotaceae*	Qararoo	YL	4	0.17
34.	*Ekebergia capensis*	*Meliaceae*	Somboo	YL FR	4	0.17
35.	*Periploca linearifolia*	*Asclepiadaceae*	Hidda anano	FR FL	3	0.13

36. *Urerahypselodendron*	*Urticaceae*	Laanqessaa	YL	2	0.09
37. *Spathoda campanulata*	*Bignoniaceae*	Anuunnuu	YL	1	0.04

FR; fruit, YL; young leaf, LB; leaf bud, FB; flower bud, FL; flower, ML; mature leaf; S; seed, P; petiole, ST; stem

Table 7: Species eaten, percentage contribution and parts consumed by Boutourlini's blue monkeys in coffee dominated habitat

No.	**Scientific Name**	**Family**	**Local Name (Afan Oromo)**	**Parts used**	**Frequency**	**%age**
1.	*Olea welwitschii*	*Oleaceae*	Bayaa	FR YL FB	529	20.49
2.	*Landolphia buchananni*	*Apocynaceae*	Yeeboo	FR YL ML	411	15.92
3.	*Syzygium guineense*	*Myrtaceae*	Baddeessaa	YL FR LB FL	304	11.77
4.	*Celtis africana*	*Ulmaceae*	Qayee/ Cayii	FR YL ML	208	8.05
5.	*Albizia gummifera*	*Fabaceae*	Hambabbeessa	YL ML	173	6.70
6.	*Croton macrostachyus*	*Euphorbiaceae*	Makkanniisa	ML FR S YL	124	4.80
7.	*Ficus sur*	*Moraceae*	Harbuu	FR LB	105	4.06
8.	*Prunus africana*	*Rosaceae*	Oomoo	FL YL	101	3.91
9.	*Polyscias fulva*	*Araliaceae*	Kariyoo	ML YL FL	95	3.68
10.	*Apodytes dimidiata*	*Icacinaceae*	Wondabiyoo	YL FR	91	3.52
11.	*Millettia ferruginea*	*Fabaceae*	Askiraa	YL ML	65	2.51
12.	*Lagenaria siceraria*	*Cucurbitaceae*	Buqe shexana	FR YL	59	2.28
13.	*Schefflera abyssinica*	*Araliaceae*	Bottoo	YL ML	46	1.78
14.	*Ficus thonningii*	*Moraceae*	Dambii	YL FR ML	45	1.74
15.	*Ekebergia capensis*	*Meliaceae*	Somboo	YL FR	41	1.58
16.	*Sapium ellipticum*	*Euphorbiaceae*	Seddoo	FR YL	38	1.47
17.	*Drynaria volkensii*	*Polypodiaceae*	Kaarolle	YL ML	35	1.35
18.	*Macaranga capensis*	*Euphorbiaceae*	Wongoo	ML FR	28	1.08
19.	*Gouania longispicta*	*Rhamnaceae*	Hoomachiisa	YL FR	22	0.85
20.	*Vepris dainelli*	*Rutaceae*	Hadheessa	YL	18	0.69
21.	*Flacourtia indica*	*Flacourtiaceae*	Akuukkuu	ML	16	0.62
22.	*Lepidotrichilia volkensii*	*Meliaceae*	Goraa	FR	9	0.34

23. *Allophylus abyssinicus*	*Sapindaceae*	Se'oo	YL	8	0.31
24. *Diospyorus abysssinica*	*Ebenaceae*	Lookoo	YL	4	0.15
25. *Bersema abyssinica*	*Melianthaceae*	Lolchiisaa	YL	3	0.11
26. *Hippocrata africana*	*Celasteraceae*	Phiyoo/ Xiyoo	YL	3	0.11
27. *Ficus vasta*	*Moraceae*	Qilxuu	FR	1	0.04

FR; fruit, YL; young leaf, LB; leaf bud, FB; flower bud, FL; flower, ML; mature leaf; S; seed, P; petiole, ST; stem

Boutourlini's blue monkeys in Belete Gera Forest Priority Area have shown a strong preference for fruit (39.75 % of feeding scans) and young leaves (33.65% of feeding scans). The other preferred parts of species eaten by the blue monkeys are animal prey (9.70 % or n=467 of 4815 total feeding scans), flowers and seeds (3.87 % each of feeding scans), mature leaves (3.56 %), leaf buds (2.52%) and also flower buds, fungus, stems, epiphytes, petioles and green stems are eaten to some extent (Table 8). This implies that Boutourlini's blue monkeys can feed on the available resources. Blue monkeys are mainly frugivours but also consume leaves, insects and flowers based on availability (Cords, 2002; Fairgrieve and Muhumuza, 2003).

Table 8: The feeding preferences of the study subject in both different habitat types during the study period

Groups	Season	Parts used (%)												
		AN	E	FB	FL	FR	FU	GS	LB	ML	P	S	ST	YL
CG	Dry	14.89	0.85	0.00	2.04	31.08	0.00	0.00	0.21	2.25	0.32	11.01	0.86	47.37
CG	Wet	6.98	1.24	0.00	2.39	51.02	2.30	0.09	2.39	6.54	0.00	0.00	0.53	26.53
FG	Dry	12.48	0.12	3.77	7.65	37.81	0.00	0.12	5.89	2.71	0.94	0.00	1.53	26.97
FG	Wet	4.43	0.00	0.00	4.03	36.81	0.40	0.00	1.97	2.26	0.59	14.86	0.09	34.55

AN; animal prey, E; epiphytes, FB; flower buds, FL; flowers, FR; fruits, FU; fungi, GS; green stems, LB; leaf buds, ML; mature leaves, P; petioles, S; seeds, ST; stem, YL; young leaves

Mann-Whitney U test of Statistical analysis showed that there was no significant difference among the two groups for Animal prey (U=30.50; P=0.14), fruits (U=39.50; P=0.43), young leaves (U=42.00; P = 0.54), leaf bud (U=26.50; P = 0.07), stem (U= 48.50; P = 0.90) petioles (U=17.00; P = 0.07) and mature leaves (U=43.00; P = 0.59). However, there were significant different between the two groups of blue monkey in using seeds (U=5.50; P = 0.01), flowers (U=17.50; P = 0.01) and other food items.

As shown in table 8 above, among the most common food items of Boutourlini's blue monkey, coffee group monkeys mostly consumed young leaves (47.37%) and fruits (31.08%) during dry season. But they mostly consumed fruits (51.02%) and young leaves (26.53%) during wet season. This might be because of availability of fruit carrying species are less diverse during dry season in coffee dominated habitat. In contrast to this, Boutourlini's blue monkey of forest groups mostly consumed fruits (37.81%) than young leaves (26.97%) during dry season. This is in agreement with the result of the study conducted by Geleta and Bekele (2016) at Komto Protected Forest, Western Ethiopia that has shown fruits were consumed more during the dry season by Boutourlini's blue monkey.

In addition, the natural forest group consumed fruits (37.81% and 36.81%) during both dry and wet season respectively. This group had shown variation in consumption of young leaves (26.97% and 34.55%) during dry and wet season respectively. This shows higher consumption of young leaves during wet season than the dry season. This variation in consumption of young leaves and fruits may be because of the fact that the availability of food items varies with change of season. As stated by Kempe (2008), when fruits are less obtainable in the surroundings, blue monkeys change to feed on foliar foods. Additionally, the foliar diets of frugivours monkeys are an indicator of adaptive lifestyle and periodic fluctuations of food resources.

The result of this study showed that Boutourlini's blue monkeys do really consume various diets in natural forest and shade coffee habitats. However, there was no much variation in consumption of the major food items like fruits and young leaves in both the study sites. Forest group gets 37.31% and coffee group gets 41.05 % of its diet from fruits whereas, young leaves accounted for 36.95% of the diets for CG and 30.76% for natural FG. However, this result in of fruit consumption disagree with the study conducted by Tesfaye *et al.*(2013) at Jibat forest on the same species, which revealed that forest group obtained 53 % of its diet from fruit, whereas fragment group of bamboo dominated habitat type consumed fruit for only 17 % of the diet. The probable cause for this might be the difference of plant species composition among habitat types of bamboo and shade coffee systems.

The monthly proportion contribution of different food items from different plants species to the diet of Boutourlini's blue monkey of the two study sites are shown in Table 9. Fruits and young leaves were the top food item for most months ranging from 24.70–52.60% and 22.90-60.42 % throughout the study period respectively. Seeds (0.00–18.30%), and flower bud (0.00-6.31%) were consumed in significant amounts for a few months only. Leaf bud (0.00-8.80%), flowers (0.00-7.61%), stems (0.00-2.90%) and petioles (0.00-1.20%) were used by the study subject in most of months during the study period. However, epiphytes, fungus and green stems were used by Boutourlini's blue monkey to some extent in few months during the study period.

As shown by a kruskal-wallis H test animal prey, a fruit, mature leaves and young leaves were regularly used by Boutourlini's blue monkey of both groups over the study period with no significant variation among months ($P>0.05$). Whereas the other parts of plant species are used in non-regular manner from months to months through the study period.

From the monthly diet perspective of this study, Boutourlini's blue monkeys appear to have no profound difference in their feeding behavior, as the plenty of fruit and young leaves are major food resources in the two habitat type and both wet and dry season. Thus, in terms of the plant parts eaten, the major diets of the Boutourlini's blue monkeys not considerably varied over months and among the groups. For example, as shown in the study conducted by Twinomugisha, *et al.*, (2006) the diet frequency of blue monkey with which fruits, young leaves and animal prey were less variable over the study period.

Table 9: Monthly contribution of food items to Boutourlini's blue monkey

Months	% Parts used (by CG)												
	AN	**E**	**FB**	**FL**	**FR**	**FU**	**GS**	**LB**	**ML**	**P**	**S**	**ST**	**YL**
Sep	6.50	2.00	0.00	0.00	49.70	4.90	0.40	3.90	3.10	0.00	0.00	0.40	28.70
Oct	6.30	1.20	0.00	0.00	52.60	0.30	0.00	1.10	5.70	0.00	0.00	0.90	31.80
Nov	7.70	0.00	0.00	3.20	40.30	0.00	0.00	1.10	7.91	0.00	0.00	0.70	38.70
Feb	13.40	0.00	0.00	0.00	24.70	0.00	0.00	0.30	0.60	0.61	0.00	0.00	60.42
Mar	15.90	1.90	0.00	2.70	33.40	0.00	0.00	0.00	3.20	0.00	0.25	1.92	40.52
Apr	13.80	0.00	0.00	4.60	47.00	0.00	0.00	0.25	2.80	0.25	0.0	0.00	31.13
Months	**% Parts used (by FG)**												
	AN	**E**	**FB**	**FL**	**FR**	**FU**	**GS**	**LB**	**ML**	**P**	**S**	**ST**	**YL**
Sep	5.51	0.00	0.00	4.70	27.10	0.81	0.00	2.50	3.10	0.60	18.30	0.20	37.10
Oct	4.62	0.00	4.61	0.00	45.80	0.00	0.00	1.80	2.10	0.00	8.90	0.30	32.40
Nov	3.70	0.00	0.00	3.70	48.71	0.00	0.00	1.71	1.90	0.20	13.60	0.00	26.21
Feb	12.21	0.20	6.31	7.61	28.40	0.00	0.21	8.80	4.40	1.20	0.00	2.90	27.61
Mar	12.70	0.00	3.22	5.90	43.90	0.00	0.21	3.41	3.40	1.20	0.00	1.20	24.60
Apr	11.91	0.00	1.64	5.30	51.11	0.00	0.00	4.10	1.10	0.45	0.00	0.45	22.90

AN; animal prey, E; epiphytes, FB; flower buds, FL; flowers, FR; fruits, FU; fungi, GS; green stems, LB; leaf buds, ML; mature leaves, P; petioles, S; seeds, ST; stem, YL; young tree leaves

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

In general, the result of this study revealed that Boutourlini’s blue monkey of both study sites spent more time in feeding than resting and moving. Whereas the minimum time budgets of the two groups were spent in drinking and other activity.

Furthermore, this study showed the ecological variation among home range sizes of Boutourlini’s blue monkey living in different habitat types, meaning that natural forest and shade coffee systems. As we have predicted, the home ranges of coffee group was larger than that of the natural forest group. However, the average day range lengths of the two groups were similar.

Boutourlini’s blue monkeys of both studied groups in Belete Gera Forest Priority Area have shown a strong preference for fruit and young leaves as well as animal prey than other plant parts of their diets.

According to this study there was a variation in plant species diversity among the two study sites. The natural forest group had higher dietary species diversity and evenness than that of shade coffee habitats of Boutourlini’s blue monkey. However, still they can survive in shade coffee systems of larger area having a number of forest patches and connecting corridors.

Even though there are some variations in home range size and dietary diversity in the two study site, this study suggested that shade coffee systems may serve as complementary habitat for the conservation of Boutourlini’s blue monkey if the farm is suported with buffer zones.

The leftover forest patches and shade coffee systems of South Western Ethiopia can serve as a good shelter and give clue for the possibility of Boutourlini’s blue monkey conservation in coffee Agroforestry systems and in the buffer zones surrounding several shade coffee system as they extremely prefer buffer zone area to perform much of their activity in this area.

5.2. Recommendations

Based on the findings of this research the following recommendations were forwarded:

- To contribute to future conservation of Boutourlini's blue monkeys, conserving the remaining primary forest is crucial by habitat rehabilitation, enforcement of laws against deforestation of the natural habitats.
- Since shade coffee group blue monkeys spent majority of their time near the buffer zone in shade coffee habitats than the pure coffee farm, so to ensure their survival, coffee management should be supplemented with buffer areas.
- Shade plants selected for coffee farm should have to be mixed type with different fruit bearing tree species that serve as a food source for blue monkey than monoculture shade types. This may reduce the daily travel of the species and make them to invest their time more on productive activities.
- In order to prevent future decline of this species in the area, conservation practice involving local people as well as awareness creation about vulnerability and importance of the species is required.
- Habitat situations that these monkeys inhabit in, as they take part in these activities are facing alarming threat from anthropogenic factors; therefore mitigation actions to reverse this trend should be put in place by the relevant authorities' of the country i.e. Environmental Protection, Forest and Climate Change Authority as well as Wildlife Conservation Authority.

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APPENDICES

Appendix I: Photos taken during the study period

Appendix II: Percent of feeding records on different food items by *Cercopithecus mitis boutourlinii*

Country, site and Reference	**YL**	**ML**	**TL**	**FL**	**SH**	**FR**	**An**	**SD**	**BA**
Ethiopia, this study	33.65	3.56	37.21	3.87	__	39.75	9.39	3.87	0.805
Ethiopia, Komto Protected Forest, Geleta and Bekele. (2016)	27.40	20.30	47.7	11.775	17.69	15.38	3.37	4.98	6.86
Ethiopia, Jibat Forest, Tesfaye et al. (2013)	14.4	3.9	18.3	7.0	32.4	20.6	13.8	5.7	1.6

YL; young tree leaves, ML; mature leaves, TL, total leaves, FL; flowers, SH; shoots, FR; fruits, An; animal prey, SD; seeds, BA; barks

Appendix III: Comparison of percentage of time budget committed to different activities by members of the genus *Cercopithecus mitis* from studies in different parts of Africa.

Species	Site	Reference	% of time contribution				
			F	M	R	S	OS
Cercopithecus mitis boutourlinii	Belete Gera Forest, Ethiopia	This study	44.62	15.95	28.33	10.498	0.06
C. mitis boutourlinii	Jibat Forest, Ethiopia	Tesfaye et al. (2013)	48.4	17.9	21.7	12.0	0.0
C. mitis doggetti	Nyungwe Forest Reserve, Rwanda	Kaplin, (2001)	44.6	20.0	16.0	11.0	0.0
C. mitis stuhlmanni	Kekamega Forest, Kenya	Cords, (1987)	46.6	14.4	35.9	1.4	1.6
C. mitis stuhlmanni	Kibale Forest(Kanyawara), Uganda	Butynski, (1990)	60.3	19.7	9.9	8.3	1.8

F; feedings, M; moving, R; resting, S; social and OS; others

Appendix IV: Activity pattern data collection sheet

<u>Activity pattern data collection sheet</u> Time interval: <u>15 minutes</u>

Study Area_____________ Season ___________Month _________Date_____________ Observer ____________Group size_________

Time of observation	GPS Location		Altitude (m)	Age class/sex	Activity	Habitat type	If feeding					large mammals close to the study group	
	Loc X	Loc Y					Growth type	Species Eaten	Preferred parts	Distance from water	Group Spread	Species seen	Distance to the group (m)

Age class/sex: Adult male (**AM**); Adult Female (**AF**); Juvenile male (**J**); Juvenile female (JF)

Activity: Feeding (F), Moving (M), Resting (R), playing (P), Aggression (A), Grooming (G), sexual activity (SA), drinking (D)

Habitat type: Primary forest (PF) Secondary Forest (SF)**,** FC, SFC, GC, PC. Farm land (FL), grass land (GL), Other (Specify) ___

Food type or Preferred plant parts: young tree leaves (YL), mature leaves (ML), leaf buds (LB), seeds (S), green stems (GS), flowers (FL), fruits (FR), flower buds (FB), petioles (P), stem (St), epiphytes (E), fungi (FU) or animal prey(An) Others(**Os**)

Appendix V: Forest group vegetation

No.	Local Name	Scientific Name	Family	Life Form
1.	Aacoo /Beccoo	*Solanum tarderemotum*	*Solanaceae*	H
2.	Agamsa	*Carissa edulis*	*Apocyanaceae*	S
3.	Akuukkuu	*Flacourtia indica*	*Flacourtiaceae*	T
4.	Anuunuu	*Spathoda campanulata*	*Bignoniaceae*	T
5.	Askiraa	*Millettiaferruginea*	*Fabaceae*	T
6.	Baggee	*Combretumpaniculatum*	*Combretaceae*	L
7.	Bayaa	*Olea welwitschii*	*Oleaceae*	T
8.	Bosoqa	*Sapiumellipticum*	*Euphorbiaceae*	T
9.	Bottoo/gatamaa	*Schefflera abyssinica*	*Araliaceae*	T
10.	Buruurii	*Grewiaferruginea*	Tiliaceae	T

11.	Ceekaa	*Calpurina aurea*	*Fabaceae*	T
12.	Daannisa	*Domboya torrida*	*Sterculiaceae*	T
13.	Dambii	*Ficusthonningii*	Moraceae	T
14.	Dhummuugaa	*Justiciaschemperiana*	*Acantaceae*	S
15.	Emoo	*Dracaena afromontana*	*Dracaenaceae*	S
16.	Gajaa	*Olea hochstettri*	*Oleaceae*	T
17.	Geeshoo	*Rhamnusprinoides*	*Rhamnaceae*	S
18.	Goraa	*Lepidotrichilia volkensii*	*Meliaceae*	S
19.	Gubduu	*Cirsium dender*	*Asteraceae*	H
20.	Gubduu qamalee	*Girardina diversifolia*	*Urticaceae*	H
21.	Gursadii	*Lepidotrichilia volkensis*	Meliaceae	S
22.	Hadheessa	*Veprisdainelli*	*Rutaceae*	T
23.	Hambabbeessa	*Albiziagummifera*	*Fabaceae*	T
24.	Harbuu	*Ficussycomorus*	*Moraceae*	T
25.	Hidda anano	*Periploca linearifolia*	*Asclepiadaceae*	L
26.	Hidda gafarsaa	*Paullinia pinnate*	*Sapindaceae*	L
27.	Hidda simbiraa	*Cayratia ibuensis*	*Vitaceae*	H
28.	Kaarollee	*Drynaria volkensii*	*Polypodiaceae*	Ep
29.	Kariyoo	*Polysciasfulva*	*Araliaceae*	T
30.	Kolaatii	*Mimusops kummel*	*Sapotaceae*	T
31.	Kombolcha	*Maytenusgracilipes*	*Celastraceae*	S
32.	Liqixii	*Tiliacora troupinii*	Menispermaceae	L

33.	Lolchiisaa	*Bersemaabyssinica*	*Melianthaceae*	T
34.	Lookoo	*Diospyorusabysssinica*	*Ebenaceae*	T
35.	Makkanniisa	*Croton macrostachyus*	*Euphorbiaceae*	T
36.	Maxxannee	*Bidens biternata*	*Asteraceae*	H
37.	Meexxii	*Phoenixreclinata*	*Arecaceae*	T
38.	Mi’eessaa	*Euclea racimosa*	*Ebenaceae*	T
39.	Mixirii	*Tecleanobilis*	*Rutaceae*	T
40.	Mixoo	*Canthium oligocarpum*	*Rubiaceae*	T
41.	Ogiyoo namaa	*Aframomumcorrorima*	*Zingiberaceae*	H
42.	Oomoo	*Prunus Africana*	*Rosaceae*	T
43.	Phiyoo/ xiyoo	*Hippocrata africana*	Celasteraceae	L
44.	Qararoo	*Pouteriaadolfi-friederici*	*Sapotaceae*	T
45.	Qawoo/ Gawoo	*Aspleniumprotensum*	*Aspleniaceae*	L
46.	Qayee/ cayii	*Tremaorientalis*	*Ulmaceae*	T
47.	Qilxuu	*Ficusvasta*	*Moraceae*	T
48.	Qorasuma	*Premnaschimperi*	*Lamiceae*	S
49.	Raskimiri	*Leontis Africana*	*Lamiaceae*	H
50.	Saalmayee	*Oplismenushirtellus*	*Poaceae*	H
51.	Saaritii	*Thalictrumscimperianum*	*Ranunculaceae*	H
52.	Se'oo	*Allophylusabyssinicus*	*Sapindaceae*	T
53.	Simararuu	*Galinieriasaxifraga*	*Rubiaceae*	T
54.	Somboo	*Ekebergiacapensis*	*Meliaceae*	T

55.	Soolee	*Pittosporum viridiflorum*	*Pittosporaceae*	T
56.	Togoo	*Justiciadiclipteroides*	*Acanthaceae*	H
57.	Tunjoo	*Piper capense*	*Piperaceae*	H
58.	Ulaagaa	*Ehretiacymosa*	*Boraginaceae*	T
59.	Ulmaayee	*Clauseniaanisata*	*Rutaceae*	S
60.	Wantafullaasa	*Diospyroswelwitschii*	*Ebenaceae*	S
61.	Woddeessa	*Cordiaafricana Lam.*	*Boraginaceae*	T
62.	Yeeboo	*Landolphia buchananni*	*Apocynaceae*	L
63.	Yeeriyoo	*Plecranthus garckeanus*	*Lamiaceae*	H
64.	Yuddoo	*Crotolariamildbraedii*	*Fabaceae*	T

T; tree, S; shrub, L; liana, H; herb, C; climber, Ep; epiphytes

Appendix VI: Coffee group vegetation

No	Local Name	Scientific Name	Family	Life Form
1.	Aatoo Kuruphee	*Physalis peruviana*	*Solanaceae*	H
2.	Algee/ Yuddoo	*Dracaena steudneri*	*Dracaenaceae*	T
3.	Askiraa	*Millettia ferruginea*	*Fabaceae*	T
4.	Baddeessaa	*Syzygium guineense*	*Myrtaceae*	T
5.	Bayaa	*Olea welwitschii*	*Oleaceae*	T
6.	Bottoo/Gatamaa	*Schefflera abyssinica*	*Araliaceae*	T
7.	Buna	*Coffea arabica*	*Rubiaceae*	S
8.	Dambii	*Ficus thonningii*	*Moraceae*	T

9.	Darguu	*Hypoestes aristata*	*Acanthaceae*	H
10.	Dhummuugaa	*Justicia schemperiana*	*Acantaceae*	S
11.	Domborokkoo(Gutoo Hindaaqqoo)	*Solanecio gigas*	*Asteraceae*	S
12.	Qoraasuma/Urgessa	*Premnas chimperi*	*Verbenaceae*	S
13.	Ebicha	*Vernonia amygdalina*	*Asteraceae*	S
14.	Embirango Jaldesa	*Oxyanthus speciosus*	*Rubiaceae*	H
15.	Emoo	*Dracaena afromontana*	*Dracaenaceae*	S
16.	Gajaa/ Gagamaa	*Olea capensis*	*Oleaceae*	T
17.	Goraa	*Rubus steudneri*	*Rosaceae*	S
18.	Goraa Arbaa	*Rubus apetalus*	*Rosaceae*	S
19.	Graviliyaa	*Grevilla robusta*	*Proteaceae*	T
20.	Gurrantuutaa	*Falkia canescens*	*Convolvulaceae*	H
21.	Haanquu(Hidda)	*Embellia schimperio*	*Myrsinaceae*	L
22.	Hadheessa	*Vepris dainelli*	*Rutaceae*	T
23.	Halaalaa Jabbii,Caphoo	*Commlina diffusa*	*Commelinaceae*	H
24.	Hambabesa	*Albizia gummifera*	*Fabaceae*	T
25.	Hambabesa	*Albizia shympria*	*Fabaceae*	T
26.	Hanquu/ Heexoo	*Hagenia abyssinica*	*Rosaceae*	T
27.	Harmaguusa	*Diaphananthe adoxa*	*Orchidaceae*	Ep
28.	Hidda Fiitii	*Clematis hirsute*	*Ranunculaceae*	H
29.	Hiddii	*Solanium incanum*	*Solanaceae*	S
30.	Hoomachisa	*Gouania longispicta*	*Rhamnaceae*	L

31.	Ilchimmee	*Jasmium abyssinicum*	*Oleaceae*	L
32.	Jajjaba	*Setaria megaphylla*	*Poaceae*	H
33.	Kaasee	*Lantana salvifolia*	*Verbenaceae*	H
34.	Gohaa	*Oryla latifolia*	*Poacaeae*	H
35.	Kalaalaa	*Commelina kotschyi*	*Commelinaceae*	H
36.	Kariyoo	*Polyscias fulva*	*Araliaceae*	T
37.	Keelloo	*Cymbopogoncaesius*	*Poaceae*	H
38.	Kombolcha	*Maytenus gracilipes*	*Celastraceae*	S
39.	Marfeeshexana/Anfarii	*Buddleja polystachya*	*Loganiaceae*	H
40.	Marga Gogorrii	*Panicum monticola*	*Poaceae*	H
41.	Maxxannee	*Bidens biternata*	*Asteraceae*	H
42.	Maxxannee	*Rubia cordifolia*	*Rubiaceae*	H
43.	Maxxannee Fiti	*Clematsis mensis*	*Ranunculaceae*	H
44.	Minaan Durbaa	*Lantana trifolia*	*Verbenaceae*	S
45.	Mixirii	*Teclea nobilis*	*Rutaceae*	T
46.	Phiyoo	*Hippocrata africana*	*Celasteraceae*	L
47.	*Oomoo*	*Prunus Africana*	*Rosaceae*	T
48.	Qawoo	*Asplenium protensum*	*Aspleniaceae*	L
49.	Qayee	*Tremao rientalis*	*Ulmaceae*	T
50.	Qomanyoo	*Brucea antidysenterica*	*Simaroubiaceae*	T
51.	Qoricha Hadhaa	*Alysicarpus quartinianus*	*Fabaceae*	H
52.	Qoricha Ilkaanii	*Fadogia cienkowski*	*Rubiaceae*	S

53.	Qoricha Shanqillaa/Budaa	*Withania somnifera*	*Solanaceae*	H
54.	Qunnii	*Cyperus bulbosus*	*Cyperaceae*	H
55.	Raaskimmir(Amharic Word)	*Leontis Africana*	*Lamiaceae*	H
56.	Reejjii	*Vernonia auriculifera*	*Asteraceae*	S
57.	Saalmayee	*Oplismenus hirtellus*	*Poacaeae*	H
58.	Simbiree(Hidda)	*Cayratia ibuensis*	*Vitaceae*	H
59.	Sokorruu	*Acanthus eminence*	*Acanthaceae*	S
60.	Sooyyama	*Vernonia hymenolepis*	*Asteraceae*	S
61.	Timbaatimboo	*Nicotiana glauca*	*Solanaceae*	S
62.	Togoo/ Xobbee	*Justicia diclipteroides*	*Acanthaceae*	H
63.	Tunjoo	*Peponium vogelli*	*Cucurbitaceae*	C
64.	Dhoqonu	*Grewia ferruginea*	*Tiliaceae*	H
65.	Coqorsa	*Cynodondactylon*	*Poaceae*	H
66.	Wongoo	*Macaranga capensis*	*Euphorbiaceae*	T
67.	Xosinyi/Awxii	*Calamintha paradoxa*	*Labiatae*	H
68.	Yeeboo	*Landolphia buchananni*	*Apocynaceae*	L

T; tree, S; shrub, L; liana, H; herb, C; climber, Ep; epiphyte