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SCHOOL OF GRADUATE STUDIES
COLLEGE OF NATURAL SCIENCES
DEPARTMENT OF BIOLOGY



Distribution, feeding ecology and habitat association of De Brazza's monkey (*Cercopithecus neglectus*) in Mettu district, Illubabor Zone, Southwestern Ethiopia

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A Thesis

Submitted to the Department of Biology, College of Natural Sciences, in partial fulfillment of the requirement for the Master's degree of Science in Ecological and Systematic Zoology

Jimma, Ethiopia

October 2014

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Acknowledgements

First of all, I would like to express special thanks to my advisors Dr. Tsegaye Gadisa and A / Prof. Tariku Mekonnen for their unlimited commitment in giving me professional guidance, assistance and advices in addition to providing me with relevant material support for the writing and completion of this thesis. Above all, their tolerance, politeness and giving timely response along with thoughtful criticisms are among their best qualities that encouraged me to complete this work in time. I am highly grateful to Dr. Delenasaw Yehualaw and Gelaye G/Michael for their professional guidance and comments.

I also thank the Department of Biology and the College of Natural Sciences, Jimma University for creating appropriate schedule and provision of suitable condition for the accomplishment of this thesis.

It is also my pleasure to thank Mettu College of Teachers' Education, the administrative office of Mettu district, the officials in the three study Kebeles in the study area, the recruited household heads, focus group discussants, research assistant and local guides for their cooperation and contribution in providing me with the required information and assisting in collecting data.

My special thanks also go to Seifu Befekadu, Takele Ayalew, Takele Lemma, Berhanu Gezahegn, Zinab A / Oli and Amare Ademe for their encouragement in addition to sharing professional experiences.

I am very grateful to Akililu Yihun without whom data collection through field survey could have become impossible for helping me in preparing suitable work schedule at my work place. My thanks also go to Ketema Addisu and Abubekir Ahmed for accessing Garmin GPS during the period of field survey.

Finally, I present my deepest appreciation and thanks to my children for their contribution to my success and my wife Gete Kechema, who made significant contribution in the writing and completion of this thesis through moral and financial support besides carrying all the burdens of my family.

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Acronyms

AF- Adult female

AM- Adult male

CP- Coffee plantation

CRF- Continuous riverine forest

CTDF- Continuous tree dominated forest

FRF- Fragmented riverine forest

FTDF- Fragmented tree dominated forest

HHHs- Household heads

HHs- Households

J- Juvenile

YBR- Yayo Biosphere Reserve

Abstract

*The study was conducted between September 2013 and February 2014 to determine the distribution, feeding ecology and habitat preference of De Brazza's monkeys in Mettu district, southwestern Ethiopia. The study was designed to cover both wet and dry seasons and both Kola and Woynadega agro-climatic zones. Questionnaire, field survey and focus group discussion were used to gather primary data (qualitative and quantitative data) from the study area. Line transect survey technique was used to study distribution pattern of the monkey. The survey on feeding ecology of the monkey was carried out by direct observation. Average group encounter rate per km was calculated to determine habitat preference of the monkey. The monkey occurred from lowland with altitude of 1312 m up to 1640 m asl in the sampling area. A distance of 16.5 km was surveyed and a total of 49 De Brazza's monkeys (dry season) and 46 De Brazza's monkeys (wet season) were counted in 8 localities. Eight groups were identified moving along seven transects. Group size ranged from 1 to 8 with mean 5.8 individuals per group. The average group density of De Brazza's monkey in the study area was 3.9 per km². The total population of De Brazza's monkeys in Mettu district was estimated to be 4939. Riverine forests were the most preferred habitats of the monkey. Fruits, leaves, animal preys and flowers constituted the monkey's diet listed from the most consumed to the least consumed. The average time spent by De Brazza's monkeys feeding on fruits was 74.1% (dry) and 54.8% (wet); leaves 8.3% (wet) and 5.5% (dry); animal preys 7.3% (dry) and 4.9% (wet); flowers 1.7% (wet) and 0.7% (dry) and they spent 12.4% and 30.3% of their time feeding on other unidentified items during the dry and wet season, respectively. Thirteen tree species provided the diets of De Brazza's monkeys, the top five of which were *Cordia africana*, *Albezia gummifera*, *Sapium ellipticum*, *Ficus sur* and *Trichilla dregeana*. The population of De Brazza's monkey is declining and threatened with local extinction due to habitat destruction by anthropogenic activities of the local communities. Urgent governmental and communal conservation measures should be taken.*

1. Introduction

1.1 Background

De Brazza's monkeys (*Cercopithecus neglectus*) belong to the non human Primates. They are locally known as swamp monkeys in Kenya (Thomas, 1991; Campbell *et al.*, 2011). De Brazza's monkey is one of the most unusual species in the group of old world monkeys commonly known as guenons. Their forest dwelling members include *Cercopithecus cephus*, *C. pagonias*, *C. nictitans*, *C. talopolin* and *C. neglectus*. Guenons are endemic to Sub-Saharan Africa (Cole *et al.*, 1994; Enstam and Isbell, 2007). They are thought to be in the active stages of speciation (Gautier-Hion *et al.*, 1988). The group is regularly reviewed and there is some disagreement on the taxonomy. Thirty years prior to 2002, they were described containing 1, 2, 4 or 5 genera (Glenn and Cords, 2002).

De Brazza's monkeys are mostly covered with "grizzled" grey fur with black extremities and tail. The shape of the head is round, with a long white beard, white muzzle, and an orange crown. The thighs and rumps have white stripes. Legs are long and the tail is non prehensile. Body length ranges from 40 to 63.5 cm (Mac Donald, 2001). A conspicuous orange crown is displayed above the eyes. This monkey shows marked sexual dimorphism in a number of features (Leutenegger and Lubach, 1987; Fleagle, 1988; Nowak, 1999). Markings on males are more prominent than those on females (Oregon Zoo, 2011). Male De Brazza's monkey weighs up to 7 kg, exceeding the average female by 3. Males possess a blue scrotum.

Throughout much of its range, this species lives in polygamous groups of between eight and ten individuals, but in certain regions, such as Gabon, De Brazza's monkeys can be found in small monogamous family groups, comprising a male-female pair and their offspring (Fleagle, 1999; Macdonald, 2001). This monkey is the only guenon species that forms these strong breeding pair bonds (Burnie, 2001). Groups often comprise one resident male, at least 3 adult females and some juveniles (Muriuki, 1989). In most guenons, females remain in their natal group throughout their lives, whereas males disperse around the time they reach sexual maturity. Males typically compete to control access to a group of females (Nowak, 1999). Although groups maintain small territories that they mark out with saliva and scent, they do not appear to show any aggression towards other groups of De Brazza's monkeys that enter these areas (Burnie, 2001; Woodland

Park Zoo, 2009). In contrast, when encroachment is made by a different species of monkeys, De Brazza's may become extremely hostile, with the entire group becoming involved in forcibly ejecting the intruder (Woodland Park Zoo, 2009).

Females reach reproductive maturity at around four and half years while males at around 7 years of age. Females give birth to only one offspring per year and have a gestation period of 6 months. When born, the young weigh 260 g and are weaned after approximately 395 days by which time they weigh 1.6 kg (De Magalhaes and Costa, 2009). In captivity, De Brazza's monkeys live up to 31 years of age (Weigl, 2005); however, longevity of the species in the wild is not documented.

The feet of De Brazza's monkeys are considered more robust than those of other Guenons (Wolfheim, 1983; Como Zoo and Conservatory, 2003; Oregon Zoo, 2005; 2011), which makes them well adapted to life on the forest floor rather than on the trees. They also have large cheek pouches for temporary food storage, and large incisors to better eat fruit from the trees (Oregon Zoo, 2005; King, 2008). De Brazza's monkeys are diurnal mammals spending the majority of their time at the lower canopy or on the forest floor feeding. They are omnivorous primarily feeding on fruits. They also feed on flowers, mushrooms, beetles, termites and worms (Nowak, 1999; Como Zoo and Conservatory, 2003; Oregon Zoo, 2005).

De Brazza's monkeys agricultural pests in Kenya, where they raid crops of maize and potatoes (Mugambi *et al.*, 1997). This monkey is endangered in Kenya due to rapid habitat loss (Kingdon, 1997), but much of its ecology and conservation status remain unknown due to its cryptic nature. Only limited studies have been carried out locally. Because of superior hiding tactics, population counts are difficult in the wild (Wolfheim, 1983). De Brazza's monkeys are listed as least concern by IUCN red list category (Struhsaker *et al.*, 2008). The species is classed as a 'serious' threat under the Vertebrate Pest Committee's list of exotic animals (Vertebrate Pest Committee, 2007).

De Brazza's monkeys are generally restricted to dense swamp bamboo and dry mountain forests associated with streams, rivers and dense vegetation, and occur from lowland areas to sub-montane forests at an elevation of up to 2100 m (Institute of Primate Research Kenya, 2008). Unlike some other species of guenons, De Brazza's monkeys are rarely found associated with

other monkeys. They are found in tropical riverine forests widely distributed in Central Africa, from the Atlantic coast of Southern Cameroon, through Equatorial Guinea down to Northern Gabon, Kenya, and extend to isolated populations in Eastern Africa including South Sudan, Uganda, Kenya and Southwestern Ethiopia (Blon *et al.*, 1992; McGraw, 1994; Diamond, 2011). Currently, the presence of this monkey was recorded in Illubabor Zone, Yayo Biosphere Reserve (Alemneh Amare, 2012). Though its presence was recorded in this zone, its distribution, feeding ecology, population status, habitat association, the degree of conflicts with human and its conservation were not assessed in many areas of the zone. Hence, the present study aimed at assessing distribution, feeding ecology and habitat association of De Brazza's monkeys in Mettu district, one of the districts known to harbor the monkey in Illubabor Zone, Southwestern Ethiopia.

1.2 Statement of the problem

De Brazza's monkeys are rare, threatened and occur in isolated populations in Eastern Africa including Uganda, South Sudan, Kenya and Southwestern Ethiopia (Yalden *et al.*, 1977; Cole *et al.*, 1993; Wallace, 2006). Fragmented populations of De Brazza's monkeys are also found in Western Ethiopia, extreme Southern Sudan and Eastern Kenya (IUCN Red List (2009)). The species was generally common and widespread, even though locally threatened by hunting and habitat loss in parts of its range (Baranga, 2004).

De Brazza's monkeys are threatened with local extinction as a result of deforestation for agricultural expansion and hunting due to their crop raiding behavior in Kenya (Decker, 1995; Chism and Cords, 1998) and also in Southwestern Ethiopia. The Southwestern Ethiopia De Brazza's monkeys are rare and the least studied isolated populations in Africa facing high threat with local extinction (Alemneh Amare, 2012). Habitat destruction resulting from deforestation through removal of trees for timber production, firewood and agricultural expansion are some of the activities undertaken by local people creating big challenges affecting the distribution of Primates including De Brazza's monkeys in the study area (Appendix VII). Although Alemneh Amare (2012) studied De Brazza's monkey ecology in Yayo Biosphere Reserve, in Illubabor Zone, most parts of the Zone within Southwestern Ethiopia, are not assessed. Feeding behavior among others limits the distribution of the species affecting their choice of habitat. It was found

important to carry out the survey on the distribution, feeding ecology and habitat association of De Brazza's monkeys to fill the existing gap of knowledge.

1.3 Objectives

1.3.1 General objective

The general objective of this study is to assess the distribution, feeding ecology and habitat association of De Brazza's monkey (*Cercopithecus neglectus*) in Mettu district, Illubabor Zone, Southwestern Ethiopia.

1.3.2 Specific objectives

- To identify the distribution pattern of the De Brazza's monkeys
- To describe the diets of the De Brazza's monkeys
- To examine habitat association of the De Brazza's monkeys
- To describe crop raiding behavior of the De Brazza's monkeys

1.4 Research Questions

- What does the distribution pattern of the De Brazza's monkeys look like?
- On what food types do De Brazza's monkeys feed?
- What types of habitats are preferred by De Brazza's monkeys?
- What possible ways are there for protecting the De Brazza's monkeys and their habitats in the study area?

2. Literature Review

2.1 Distribution

The range of De Brazza's monkey is a large triangle bordered by southern Ethiopia to the northeast, Cameroon to the northwest and northern Angola to the South. This monkey is more common in Eastern Africa and less regularly observed on the continent's western side (Como Zoo and Conservatory, 2003; Oregon Zoo, 2005; Wolfheim, 1983). The known range of the De Brazza's monkey continues to expand with the discovery of new populations in Kenya, Gabon and Congo (Maisels *et al.*, 2007; Mwenja, 2007).

In Africa, most De Brazza's monkeys live along rivers. They are rarely found in non-riverine habitats (Wahome *et al.*, 1993; Mugambi *et al.*, 1997). These monkeys occur in forests, swamps and seasonally flooded areas. They exist predominantly in the closed canopy preferring dense vegetation, and are generally found within 1 km of rivers in humid forests (Wolfheim, 1983; Oregon Zoo, 2005). The natural distribution of the species is closely linked to tropical riverine forests and swamps in Central Africa with areas of flooded forests being heavily utilized by the species (Wahome *et al.*, 1993; King, 2008). De Brazza's monkeys are generally restricted to dense swamp bamboo and dry mountain forests associated with streams, rivers and dense vegetation, and occur from lowland areas to sub-montane forests at an elevation of up to 2100 m (Institute of Primate Research Kenya, 2008). They are occasionally found in dense vegetation away from water. However, groups found in such areas may have a water source within a day's travel (Decker, 1995). Wahome *et al.* (1993) observed that De Brazza's monkeys (in Kenya) spent more time in the swampy parts of their habitats, even though the swamp represented a relatively small part of their total home range. Typical home range of these monkeys is about 5 hectares (Wolfheim, 1983; Wahome *et al.*, 1993). These monkeys generally are low dwelling arboreal monkeys, spending relatively little time high in the canopy, and can move along the ground successfully (Manaster, 1979). In Kenya, De Brazza's monkeys were observed moving a little more than 300 m per day (less during the dry season). They also move up and down within the canopy depending on time of day and location of food (Wahome *et al.*, 1993).

2.2 Behavior

De Brazza's monkeys are diurnal mammals that live in small group consisting of four to ten monkeys though groups have been found with up to 35 members. Larger groups of 16-35 individuals may be observed and solitary males are often sighted (Mugambi *et al.*, 1997; Maisels *et al.*, 2007; King, 2008). Lone males of the species are often sighted outside the territories of local troops (Muriuki, 1989). Unlike some other species of Guenons, De Brazza's monkeys are rarely found associating with other monkeys. Observations of captive De Brazza's monkeys show that the social structure is based on small groups that maintain some distance from other groups to avoid confrontation (Oswald and Lockard, 1980). Monthly home ranges of this monkey in small isolated and unprotected areas of forest in Kenya range from 0.20 to 0.85 ha (Karere, 2000). De Brazza's monkey is considerably less conspicuous than other Guenons. The species rarely uses group calls and generally avoids living in multi species troops (Gautier – Hion and Gautier, 1978), although they have been sighted in the company of Red tailed monkeys (*Cercopithecus ascanius schmidtii*) and Black and white Colobus monkeys (Decker,1995).

De Brazza's monkeys are arboreal, territorial, and terrestrial. They take shelter on trees and freeze when alarmed. They are diurnal hand gatherers foraging in the early morning and evening. They are omnivorous but primarily eat fruit. It was reported that the species spends about 47% of its time feeding on fruit and 32% feeding on leaves (Karere, 2000). Other items in their diet include berries, flowers, mushrooms, beetles, termites and worms (Wahome *et al.*, 1993; Nowak, 1999; Como Zoo and Conservatory, 2003; Oregon Zoo, 2005). In the wild, De Brazza's monkeys have been reported to feed on one or two fruit trees until most of the fruit was consumed. They also feed regularly on herbs and climbers. When consuming invertebrates, these monkeys were meticulous in their method of capture often carefully uncurling the leaves in which the invertebrates were living and using their hands when eating (Wahome *et al.*, 1993). As foraging usually takes place in exposed areas, food is stored in cheek pouches, and only eaten when the monkeys return to a safe location (Wood land Park Zoo, 2009). According to Alemneh Amare (2012), De Brazza's monkeys were very active during November feeding on berries of *Coffea arabica* and in April, they showed least feeding activity compared with other months.

2.3 Natural predators and disease

In their natural habitat, species that feed on De Brazza's monkeys include Rock Pythons (*Python sebae*), Crown Eagle (*Stephanoetus coronatus*), Leopards (*Panthera pardus*), Golden Cats (*Felis aurata*), other Primates and humans (Wahome *et al.*, 1993; King, 2008). In Tasmania, potential predators include the Tasmanian devil (*Sarcophilus harrisi*), spotted-tailed quoll (*Dasyurus maculates*), large raptors such as Wedge-tailed Eagles (*Aquila audax*) and, should it become established, the introduced European Red Fox (*Vulpes vulpus*) (DPIPWE, 2011).

Wild populations of De Brazza's monkeys are vulnerable to a variety of diseases, including Simian immuno-deficiency viruses (SIVs), herpes B virus, and multiple gastro intestinal parasites (Thompson *et al.*, 2000; Karere and Munene, 2002; Bibollet-Ruche *et al.*, 2004). Individuals may also be prone to ectoparasites such as ticks and mites. It is likely that some symptoms of pre-existing infectious diseases may appear when the species is subject to stress in captivity or experimental manipulations (DPIPWE, 2011).

2.4 Primates as pests and effects on populations

One key issue of "Primates" as "pests" is increasing competition between non human Primates and humans with the spread of agriculture and human activity into areas that previously sustained non human Primates alone. Primates damage crops, particularly around African and Asian reserves being responsible for over 70% of the damage events and 50% of the area of farms damaged (Naughton-Treves, 1998). The human and non-human primate niches overlap extensively making competition higher and posing significant management problems (Strum, 1987). Planting and growing patterns may make foods accessible to primates specifically at those times when there is little for non-humans to eat. When natural foods are limited, high quality, easily digested human foods provide an alternative source of nutrition for primates and crop raiding may intensify (Horrocks and Baulu, 1994). Crop raiding is integral to the ecology of primates inhabiting areas of human animal interface (Naughton-Treves, 1998). Rain fall, season, crop-variety and characteristics, wild food availability, distance from forest, nearest farm or village, and farm protection methods have an impact on raiding (Mohnot, 1971; Maples *et al.*, 1976; Musau and Strum, 1984; Gautier-Hion *et al.*, 1985; Biquand *et al.*, 1992; Hill, 1999).

In most primate range countries the major threats to populations are extensive conversion of Primate habitat into areas of human use (agriculture, forestry, plantations), trapping for the biomedical trade, bush meat trade and disease (Lee *et al.*, 1986., Walsh *et al.*, 2003). However, historical declines, even when associated with other pressures, were marked in those areas where Primates and humans were in potential conflict over crops. For example, although the major decline in the population of rhesus monkeys in India in the 1960s was due to trade in live animals for experimentation, the population decrease was most marked in agricultural areas. Southwick *et al.* (1983) reported 89% decrease in village populations of rhesus macaques and 76% in canal bank groups, both of which were frequent crop raiders. They attributed the distribution of the loss to changing human attitudes and agricultural expansion, which placed the rhesus into closer contact and conflict with humans. Where people increase stocking rates in relation to natural vegetation availability, to enhance returns of meat, milk and other animal products, Primates may be squeezed out or suffer reduced reproductive rates by the far more effective off take of human-managed livestock movements through the area. While the human herders may not have a perception of monkeys as pests, the indirect competition can drive monkeys into habitats, such as forests or plantations (Ciani *et al.*, 2001), where they then cause significant damage and become “pests”.

3. Study area and Methods

3.1 The Study area

The study was carried out in the forests of Mettu district which is located in Illubabor Zone of Oromia Regional State, Southwestern Ethiopia. Mettu district is one of the 24 districts of Illubabor Zone. The district has an area of 1452 km² and lies between 8° 6′-8° 31′N latitude and 35° 10′-35°50′E longitude. The administrative center of the district, Mettu town, is situated about 600 km southwest of Addis Ababa, the capital city of the country. The district is bordered by Bilo Nopa district in the northeast, Alle and Halu districts in the south, Hurumu district in the east, Bure district in the west and Darimu district in the north. Its northwestern and southeastern parts are bordered by West Wollega Zone and Southern Peoples’ Regional State (Fig. 1).

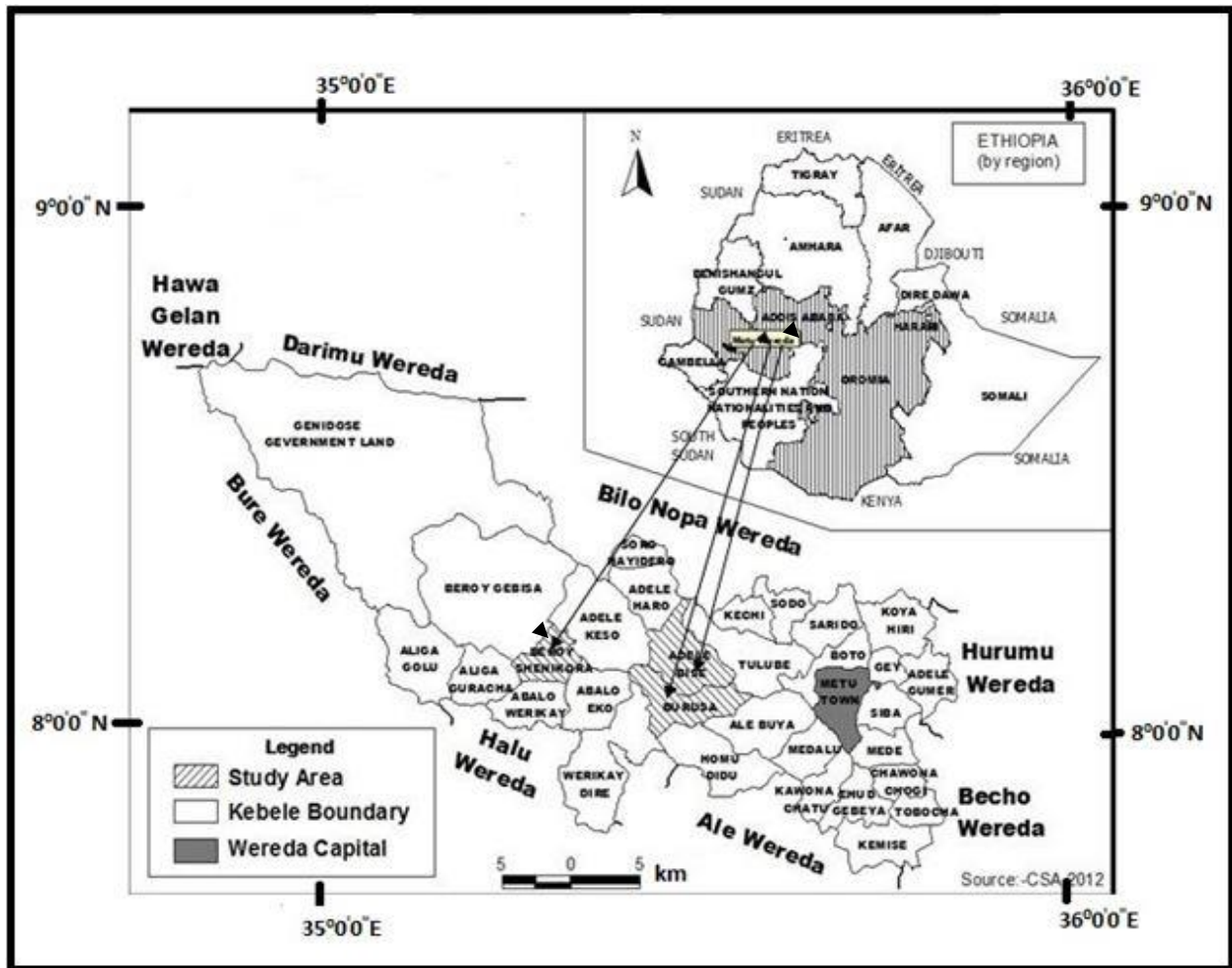


Figure 1: Map of the study area

Lower plateaus dominate the relief features of the district. The altitude of the district ranges from 1000 to 2027 m asl. However, the elevation of the localities from which data were collected for this study using field survey ranged from 1312 to 1640 m asl.

The major rivers that cross the district include: Geba, Sor, Qeber, Konor and Gumero (Fig. 2).



Figure 2: Partial view of Konor River, in the study area

The district also comprised two settings of agro-climatic zones out of which Woynadega covers 83% and Kola covers 17% of the total area of the district. Red, black and brown soils are the major soils in the district covering 80%, 15% and 5%, respectively. Cheetahs (*Acinonyx jubatus*), buffalos (*Syncerus caffer*), lions (*Panthera leo*), waterbuck (*Kobus ellipsiprymnus*), leopards (*Panthera pardus*), bushbucks (*Tragelaphus scriptus*), Civet cats (*Civettictis civetta*), hares (*Lepus fagani*) and monkeys including the De Brazza's, blue monkeys (*Cercopithecus mitis*) and Colobus monkeys (*Colobus guereza*) are some of the wild animals found in the district. The district has no parks, or sanctuaries for wildlife conservation. However, there are interesting tourist attraction sites such as Sor Fall in the district.

According to the 2007 statistical abstract, the total human population of Mettu district is 60,646 with 30,309 (49.98%) males and 30,337 (50.02%) females (CSA, 2007). The average household size of the district was 4.4 (for both urban and rural).

The district has 29 farmer associations. The livelihood activities of people in the district are highly dependent on agriculture. Maize and sorghum (*Sorghum bicolor*) are the major annual crops cultivated in the district. Coffee, vegetables and fruits are major cash crops grown in the district. About 67.5% of the district was arable land, of which 38.6 % was under annual and perennial crops. Grazing land accounts for 6.8% of the district, while forests and shrubs cover 14.6%. The degraded land and others cover 11.1% of the district.

Tree forests, riverine forests, bushes and shrubs, woodlands and savannah grasses are the types of vegetation in the district (Mettu Woreda Profile, 2011).

3.1.1 Climate

Ten years (2005-2014) Meteorological data shows that the study area received between 993.2 and 1839 mm annual rainfall (Mettu Meteorological Station, 2014). Mettu district has a unimodal pattern of rainfall. The annual rainfall of the district over 10 latest years (including the first eight months of the year 2014) is given in Figure 3.

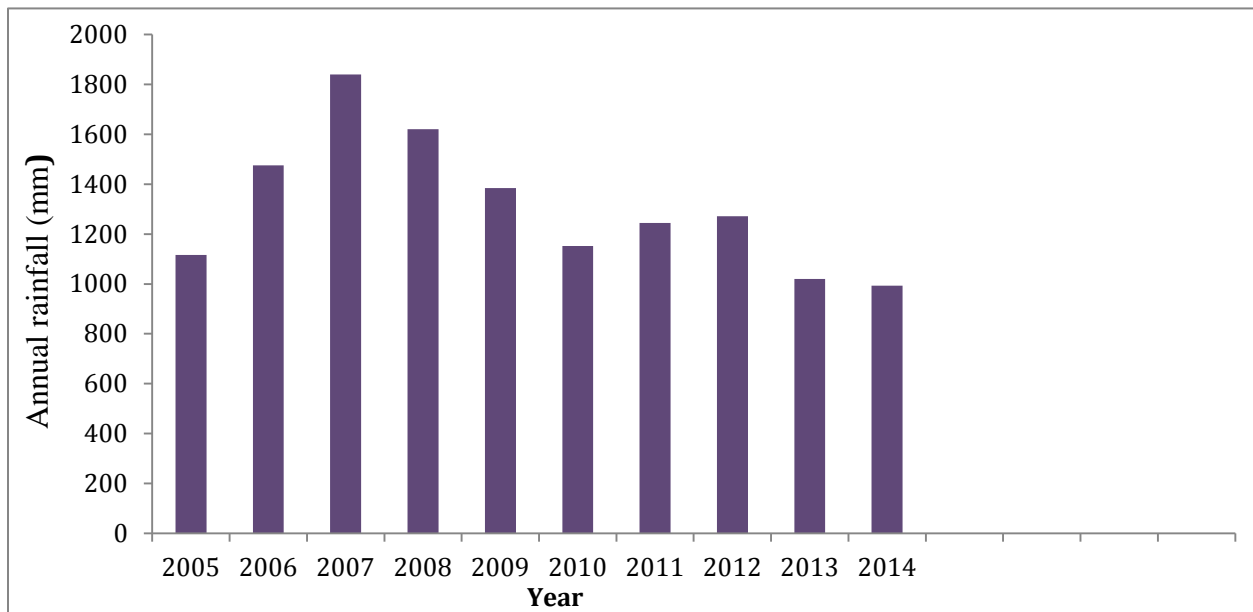


Figure 3: Annual rainfall trend of Mettu district (2005-2014).

Ten years (2005-2014) Meteorological data also shows that the mean minimum temperature of the study area oscillated between 9.1 and 12.4 °C and the mean maximum temperature between 26.7

and 28 °C (Metu Meteorological Station, 2014). The overall average annual temperature for the district over the ten years was 19.1 °C (Appendix VIII).

The data collection for this study took place from mid September to November 2013 for the wet season and from early December 2013 to late February 2014 for the dry season. Data collection was preceded by a preliminary survey which was conducted for one week.

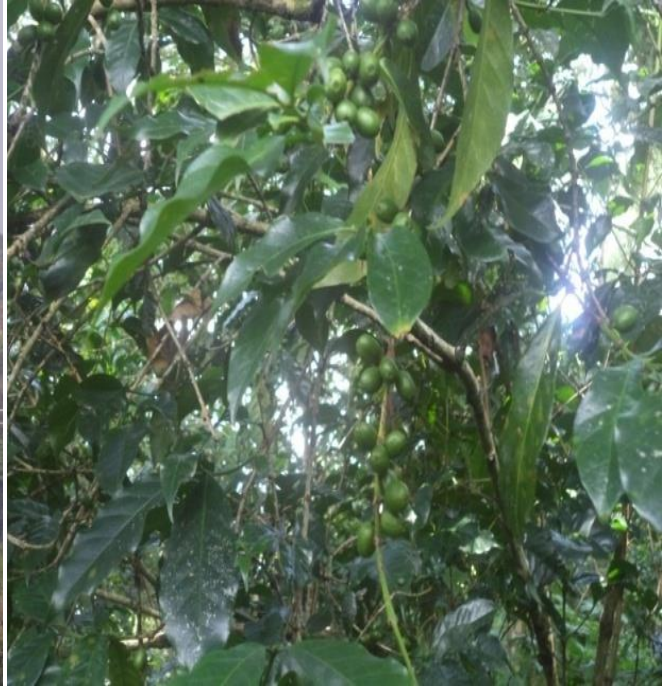
3.2 Materials and Methods

Digital camera, Garmin Global Positioning System (GPS 60 and GPS 72H), Data sheets, First aid kit, bags and printed photographs of De Brazza's monkey and blue monkeys (*Cercopithecus mitis*), stationeries (writing pad, pen and pencil) were used during data collection period.

The methods of data collection techniques for this survey were designed to cover both wet and dry seasons (Anderson *et al.*, 2007; Buckland *et al.*, 2010). Both lowland (Kola) and highland areas (Woynadega) within the De Brazza's monkey range of the study area were sampled. The sampling sites were selected based on the presence of the monkeys, possibility of getting appropriate information from the respondents and accessibility of transportation. The habitat types in the study area were determined based on the dominant vegetation (Irwin *et al.*, 2005). Accordingly, the study area was classified as a continuous and fragmented riverine forest, continuous and fragmented tree dominated forest, and coffee plantation (Plate 1). The forests which were divided into smaller pieces by the presence of roads / streets, farmlands and human settlements were considered as fragmented those which were not divided into smaller pieces were considered as continuous forests.



A



B



C



D



E

Plate 1: Partial view of fragmented tree dominated forest (A), Coffee plantation (B), Continuous riverine forest (C), Continuous tree dominated forest (D) and Fragmented riverine forest (Laku stream) (E)

Primary data were collected from the communities residing in three Kebeles selected from the study area through questionnaire and from community elders and local development agents through focus group discussion. Primary data were also collected from forests through direct observation. The study used both qualitative and quantitative data. The qualitative data were collected from the local community and the forests (fragmented and continuous forests of the De Brazza's monkey habitats) in the study area with the help of questionnaire, field surveys and focus group discussion where as quantitative data were gathered from the forests in the study area using field surveys (direct observations).

The informants were selected among households of the local community by focusing on those people who had experience of going into the forest and so had seen the De Brazza's monkeys. Hence, non probability (purposive) sampling technique was employed for selecting and recruiting the respondents and sampling sites from the selected villages in each Kebele.

Three Kebeles (2 from Woynadega and 1 from Kola) were selected purposively among existing 29 kebeles in Mettu district based on the criteria mentioned earlier. Next, the villages which are

located near forests were selected purposively from each selected Kebele. Finally, a total of 105 households were purposively selected for the questionnaire survey as a sample size from the households of the selected villages. Among 105 selected households 90 household heads (respondents) were considered from Woynadega (highland) and the remaining 15 were from Kola (lowland) agro-climatic zone.

Questionnaire technique was employed by focusing on the local people who had experience of going into the forest (De Brazza's monkey habitat) and so had seen the De Brazza's monkeys, who reside in the vicinity of the forest and whose livelihood is highly dependent on the forest and agriculture. Structured and semi structured questionnaire of closed and open ended questions were employed (Appendix I). The questionnaires were dispatched among a total of 105 households selected from the three Kebeles to collect responses. Three enumerators were hired and were trained as to how to go through filling the responses of respondents on the questionnaire. The information collected through questionnaire include background information about the respondents (sex, age, family size, educational status); socio-economic aspect (duration of stay, occupation); acquaintance with De Brazza's monkey, local name of the monkey, presence / absence of water source near De Brazza's monkey habitat, distance between De Brazza's monkey habitat and the nearest river / stream, diet variations in different seasons and tree preferences of the monkey.

In addition, information on whether or not De Brazza's monkeys feed on cultivated crops, crops damaged by De Brazza's monkey, season when more damage to crops occurs by the monkey and presence or absence of forest reserves (Gonedele Bi *et al.*, 2009; Addisu Mekonnen *et al.*, 2012). While collecting the information, the respondents were shown the photograph of De Braazza's monkey to ensure the animal about which information was being collected.

Field survey was used to confirm and complement the information collected from the local communities through questionnaire.

The survey on distribution pattern of De Brazza's monkey was carried out using line transect (sample count) census techniques (Anderson *et al.*, 1979; Peres, 1999). A line transect of 1 - 3 km long with width ranging from 0.02 - 0.1 km (20 - 100 m) was used in assessing the different habitat types (Continuous and Fragmented riverine forest, Continuous and Fragmented tree

dominated forest, and Coffee plantation). The surveys were conducted using direct field observation by walking along existing paths and newly cut trails at an average speed of 1 km/hr in the forest (Wallace *et al.*, 1998; Peres, 1999; Chapman *et al.*, 2000). All distances were estimated visually by the experienced observers both horizontally and vertically. The search took place in the morning from 8:00 - 11:00 a.m. and in the afternoon from 3:00–5:00 p.m. when the De Brazza's monkeys were active (Struhsaker, 1981). At each survey area when De Brazza's monkeys were encountered, the date, name of the location, habitat type, tree species they used, number of group(s) and group size with sex and age composition, distance surveyed, area occupied by each group and estimate of group (population) density were recorded (Appendix II).

Population count of De Brazza's monkeys in each locality was carried out by the investigator and research assistant with unaided eye. Each habitat was assessed during both wet and dry seasons (Anderson *et al.*, 2007; Buckland *et al.*, 2010) to check if there was change in group number and population size.

Group density was calculated as the total number of groups sighted within the fall off sighting distance divided by the total length of transect sampled times both sides of its width (Fashing and Cords, 2000). Sightings of solitary individuals were excluded from the analysis to calculate group density estimates and encounter rates (Whitesides *et al.*, 1988; Fashing and Cords, 2000; Worman and Chapman, 2006).

$$D = \frac{\text{Sum of groups sighted}}{2 (L \times \text{width of one side of transect in km})}$$

Where,

D = the density of individuals or groups per km²

L = Total transect length (the sum of the lengths of all trials walked in each habitat in km)

The total population was estimated by multiplying the average group density estimates by the total area of suitable habitat in the study site (Lawes, 1992; Chiarello, 2000; Addisu Mekonnen *et al.*, 2010).

In addition, the association with other Primates, altitude and GPS location were recorded with a Garmin GPS 60 and GPS 72H.

Age and sex composition of De Brazza's monkey in all habitats were categorized as adult male (AM), adult female (AF), Juvenile (J), and Infant (I). The sex of juveniles and infants was not identified since the monkeys were sighted from a distant place with naked eye and also due to the small size and invisibility of sex organ. Whenever infants were encountered, the monkeys found carrying infants were recorded as adult females since female De Brazza's monkeys are responsible for caring for the infants (parental care). Adult females were also identified using their size which is larger than juveniles and smaller than adult males. The adult males were easily identified by their large size and possession of prominent blue scrotum. Therefore, identification of sex and age groups was carried out in the field by using relative body size and external genitalia (Agtsuma, 2001).

When De Brazza's monkeys were encountered, habitat type was recorded. Encounter rates of groups per km were calculated by habitat type (Wallace *et al.*, 1998; Bobadilla and Ferrari, 2000), and sightings were summarized as the total number of groups and individuals observed in each habitat type (Buckland *et al.*, 1993; Anderson *et al.*, 2007) (Appendix III). Therefore, habitat preference of the study groups was analyzed by the proportion of the number of scans where the groups spent in different habitats in the home range during the study period (Vie *et al.*, 2001; Wallace, 2006).

The diet types of the monkey were recorded by using the proportion of time spent feeding on each item during each month of the study period in the study area (Appendix IV). The types of diets consumed in the sampling area were identified through direct observation and were recorded on a standardized data sheet (Fashing, 2001; Fairgrieve and Muhumuza, 2003; Di Fiore, 2004). Feeding activity was recorded within 15 minutes intervals by focusing on the identified study group a single age and/or sex group at a time. Local name and scientific name were used in identifying the plants that were used as diets of De Brazza's monkey during the study period (Appendix V). Plant diet identification was performed at field. Animal prey was recorded when a monkey was searching for animal prey by scratching tree bark, exposing curled leaves and when it was found performing the activity of masticating and ingesting or directly seen eating on insect (Dietz *et al.*, 1997).

Focus group discussion was employed to complement the data collected through questionnaire and field survey. Open ended questions were used to collect information from six community

elders and three individuals who were development agents in the three Kebeles selected for this study. The information gathered using this technique include forest use by the local communities, tree species most frequently removed for various purposes, methods used by the local people to protect crop damage by wild Primates like De Brazza's monkeys, population trend of De Brazza's monkey and their suggestions regarding measures to be taken by the local communities and the government to conserve De Brazza's monkeys and their habitats in the study area (Appendix VI).

All quantitative data gathered from the field were analyzed using statistical package for social sciences (SPSS), version- 17. Descriptive statistics in the form of mean, percentages, tables, bar and pie charts were used for presenting the results of the study.

Two tailed student t-test, with 95% confidence interval and appropriate degree of freedom was used to analyze seasonal variation in the number, sex and age distribution of De Brazza's monkey in the study area. The same test was employed to see seasonal variation of each item consumed by the monkey.

Chi-squared test with 95% confidence interval and appropriate degree of freedom was used to test the number of sex ratio.

Finally, the qualitative information gathered from the focus group discussants were organized, analyzed and presented.

4. Results

4.1 Questionnaire Survey

According to data gathered on demographic information of the sample household heads (HHs), 12.38% of the study respondents were unable to read and write. The others 29.52%, 40%, 13.33% and 4.8% attended adult, primary, secondary education and diploma and above level, respectively (Table 1).

As indicated in Table 1, 46.7% of the study respondents have 4-6 family members, 28.57% have 7-9, 12.39% have 1-3, and the other 12.39% have more than 9 family members. 46.7% of them lived in the local area at least for 25 years where as 30.4% and 22.8% of them resided for 15-24 and 5-14 years, respectively. The livelihood activity for 49.5% of the sampled HHs is crop cultivation and livestock keeping while 43.8% practice cultivating crop alone. The rest, 5.7% and 0.95% lead their lives by trading and livestock keeping, respectively.

Table 1: Socio-demographic characteristics of the participants

Characteristics		Kebele of the study area						Total	
		Burrussa		Adele Bisse		Baroy – shonkora			
		No	%	No	%	No	%	No	%
1	Educational status								
	Illiterate	2	4.4	10	22.2	1	7.1	13	12.38
	Adult education	19	42.2	11	24.4	1	7.1	31	29.52
	Primary education	20	44.4	15	33.3	7	46.7	42	40
	Sec. education	2	4.4	7	15.6	5	33.3	14	13.33
	Diploma and above	2	4.4	2	4.4	1	7.1	5	4.8
	Total	45	100	45	100	15	100	105	100
2	Family size of HHs								
	1 - 3	1	2.2	7	15.6	5	33.3	13	12.39
	4 – 6	25	55.6	22	48.9	2	13.3	49	46.7
	7 – 9	19	42.2	5	11.1	6	40	30	28.57
	More than 9	0	0	11	24.4	2	13.3	13	12.39

	Total	45	100	45	100	15	100	105	100
3	Duration of stay (years)								
	5 – 9	1	2.2	13	28.9	0	0	14	13.3
	10 – 14	0	0	9	20	1	6.7	10	9.5
	15 – 19	1	2.2	8	17.8	1	6.7	10	9.5
	20 – 24	10	22.2	7	15.6	5	33.3	22	20.9
	> 25	33	73.3	8	17.8	8	53.3	49	46.7
	Total	45	100	45	100	15	100	105	100
4	Occupation								
	Crop cultivation	6	13.3	38	84.4	2	13.3	46	43.8
	Livestock keeping	0	0	0	0	1	6.7	1	0.95
	Crop cultivation and livestock keeping	39	86.7	3	6.7	10	66.7	52	49.5
	Trading	0	0	4	8.9	2	13.3	6	5.7
	Total	45	100	45	100	15	100	105	100

All HHHs assessed in the study area were found to be familiar with De Brazza’s monkey. The study HHHs also confirmed that they invariably call the animal “wonna” locally.

The responses of the study participants indicated that 62% confirmed the presence of river / stream near De Brazza’s monkey’s habitat in Burrussa while 38% witnessed its absence near the monkey’s habitat. Similarly, in Adele-Bisse 89% confirmed the presence of river / stream while 11% assured its absence near the monkey’s habitat. In Baroy-Shonkora all respondents agreed that the habitat of De Brazza’s monkey is located always near river / stream (Fig. 4).

Overall, 79% of the respondents replied that De Brazza’s monkey habitats are found in association with river / stream in the local area. 21% of the respondents in the three Kebeles responded the absence of river or stream near the habitats of De Brazza’s monkey.

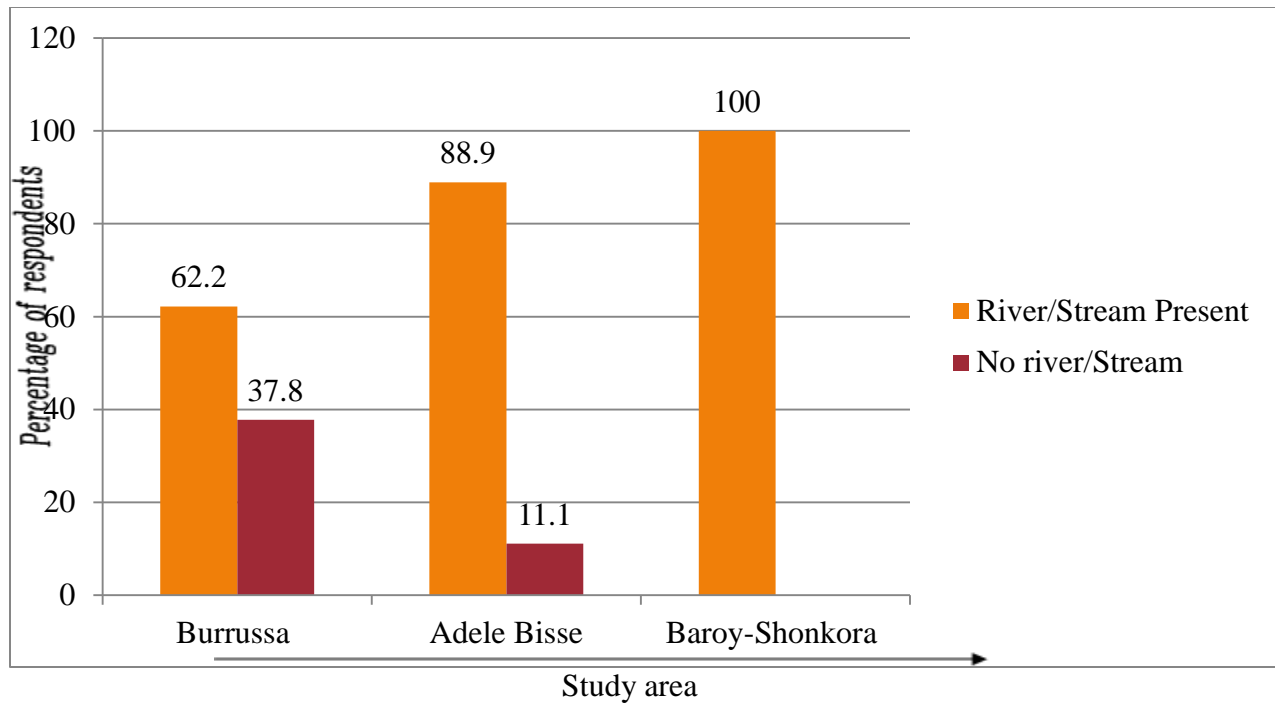


Figure 4: Percentage of responses on presence / absence of river or stream near De Brazza’s monkey habitat in each study Kebele

The data gathered on the estimated mean distance between De Brazza’s monkey habitat and the nearest river / stream in the study area is presented in Table 2.

As to most of the respondents (58%), De Brazza’s monkey habitats are located on average only up to 200 m away from the nearest river/stream in their local area. About 36.2% of them estimated the distance to be between 200 and 500 m while 5.7% of the respondents estimated the distance as ranging from 501-1000 m.

Table 2: Responses of study HHHs on the estimated average distance between the nearest River / stream and De Brazza’s monkey habitat

Distance (meter)	Kebele of study area						Total	
	Burrussa		Adele Bisse		Baroy- Shonkora		No.	%
	No.	%	No.	%	No.	%		
< 200	25	55.6	28	62.2	8	53.3	61	58.09
200-500	18	40	14	31.1	6	40	38	36.2
501-1000	2	4.4	3	6.7	1	6.7	6	5.7
> 1000	0	0	0	0	0	0	0	0
Total	45	100	45	100	15	100	105	100

All respondents (100%) responded the variation in the diets of De Brazza’s monkey during wet and dry season in all the sampling villages.

According to the responses of open ended question, De Brazza’s monkeys feed on corn (*Zea mays*), cereals and berries of coffee during the wet season in the study area and they feed on fruits and leaves of different plants in the wild and small animals like worms during dry season in the study villages.

According to the responses of most study participants for the open ended questions, the top 5 tree species preferred by De Brazza’s monkey in their local area were listed by most respondents as *Cordia africana*, *Albezia gummifera*, *Sapium ellipticum*, *Ficus sur* and *Trichilla dregeana*. A few others listed as *Ficus sur*, *Albezia gummifera*, *Cordia africana*, *Prunus africana* and *Ficus vasta* as the 5 tree species constituting the most preferred diet of De Brazza’s monkeys. Still very few of them listed a combination of other tree species.

The information gathered on whether or not the monkeys feed on cultivated crops indicated that in all areas sampled (100%), there was crop raiding by De Brazza's monkey.

As analyzed from the responses of the study respondents to open ended question, 35.6% of the study respondents in Burrussa faced more damage to their crops by De Brazza's monkeys in July and August, 40% of them in July, August and September and 24.4% in August and September.

In Adele-Bisse, 44.4% faced more damage to their crops in July and August, 40% in July, August and September and 15.6% in August and September.

In Baroy-Shonkora, 53.3% faced more crop damage by the monkeys in July and August, 33.3% in July, August and September and the rest 13.3% in August and September. All respondents indicated that all crop raiding was performed during the wet season.

As to responses to presence/absence of forest reserve in each Kebele surveyed, all (100%) study respondents in Burrussa and 60% of the respondents in Adele-Bisse confirmed that there is forest reserve in their village. Overall, 81.9% of the respondents, confirmed the presence of forest reserves in each of the Kebeles surveyed although they were absent in some villages as responded by 18.09% of the sampled HHHs

4.2 Field survey

Five continuous and three fragmented habitats were assessed. A total of 46 De Brazza's monkeys (wet seasons) and 49 De Brazza's monkeys (dry seasons) were counted in 8 localities. Eight groups were identified moving along 7 transects of different habitats identified in the study area during the period of field survey. Group size ranged from 1 to 8 individuals with average 5.8 individuals per group. The average number of individuals per group was 5.8 during the wet season and 6.1 during the dry season. The mean population density of De Brazza's monkey was 23.3 individuals per km² and the mean group density of De Brazza's monkeys in the study area was 3.9 per km². The estimated total population size of De Brazza's monkey in Mettu district was 4939.

De Brazza's monkeys were found associated with both Colobus monkeys & Blue monkeys in 25% of the habitats surveyed and they occurred with only Colobus monkeys in 62.5% of the

habitats assessed. De Brazza's monkeys occurred rarely without association with other Primates (only in 12.5%) in the habitats sampled (Table 3).

Table 3: Distribution of De Brazza's monkey population in different types of habitats

Name of the location	Elevation (m)	Group No.	Area (km ²)	No. of individuals						Total		Habitat type
				AM	AF		J		I	wet	dry	
					W	D	W	D				
Laku forest	1570	1	0.5	1	2	3	2	2	1	6	7	CRF, CP
Aba Alga forest	1613	1	0.4	1	3	3	1	1	1	6	6	CTDF
Aba Konchi forest	1583	1	0.26	1	5	5	1	1	1	8	8	CRF
Kallo forest	1636	2	0.6	2	6	7	4	5	2	14	16	CRF
Konor	1595	1	0.06	1	1	1	0	0	1	3	3	FRF, CP
Doba	1640	1	0.16	1	1	1	1	1	0	3	3	CTDF, CP
Kollo Jawe	1620	-	0.06	1	0	0	0	0	0	1	1	FTDF
Shonkora	1312	1	0.12	1	2	2	1	1	1	5	5	FRF, TDF
Total		8	2.1	9	20	22	10	11	7	46	49	
Mean				1.1	2.9	3.1	1.4	1.6	1	5.8	6.1	

AM: Adult male; AF: Adult female; J: Juvenile; I: Infant; CRF: Continuous riverine forest; CTDF: Continuous tree dominated forest; FRF: Fragmented riverine forest; FTDF: Fragmented tree dominated forest; CP: Coffee plantation; W: Wet season; D: Dry season

Two tailed student t-test with 95% confidence interval and 1 df showed that there was no significant variation ($P > 0.05$) in total number of De Brazza's monkeys between dry and wet seasons.

During the field survey period, 9 adult males (AM) with standard deviation (SD) ± 0.1 during both wet and dry seasons, 20 adult females (AF) with SD ± 2 during the wet season and 22 AF with SD ± 2.2 during the dry season, 10 Juveniles (J) with SD ± 1.3 during the wet season and 11 Juveniles with SD ± 1.6 during the dry season, 7 Infants with SD ± 0.69 were counted (Table 4).

Table 4: Seasonal variation of age and sex distribution of De Brazza's monkeys

Age category	Wet season	Dry season	Mean
Adult males	9	9	9 \pm 0.1 SD
Adult females	20	22	21 \pm 2.1 SD
Juveniles	10	11	10.5 \pm 1.45 SD
Infants	7	7	7 \pm 0.67 SD
Total	46	49	47.5

The adult males constituted 19.6% (wet season) and 18.4% (dry season), adult females 43.5% (wet season) and 44.9% (dry season), juveniles 21.7% (wet season) and 22.4% (dry season) and infants 15.2% (wet season) and 14.3% (dry season) of the total sample count in the study area (Fig. 5).

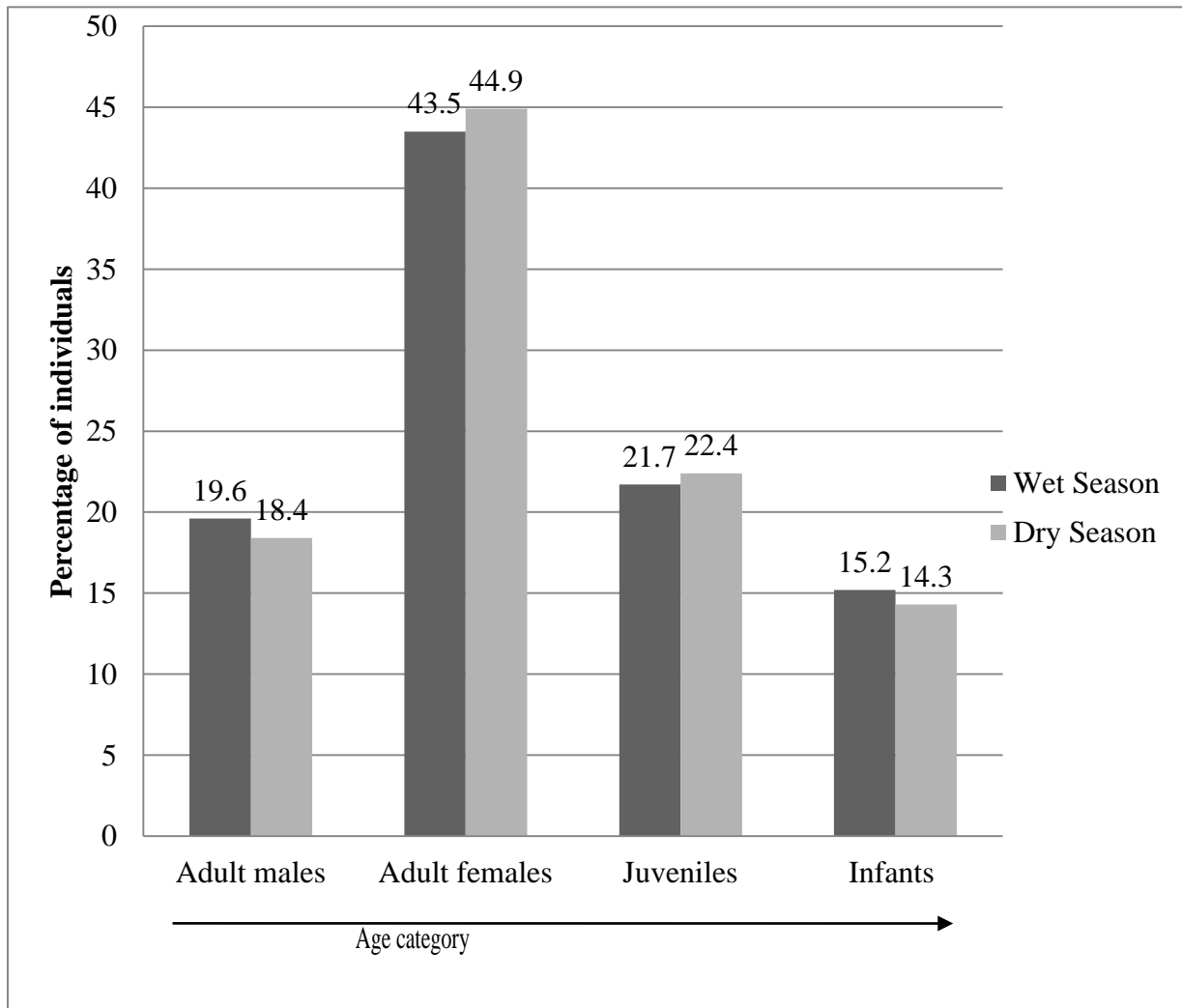


Figure 5: Mean percentage of seasonal variation of age and sex composition of De Brazza's monkeys

Although the number of adult females and juveniles appeared to show difference between the two seasons, two tailed t-test with 95% confidence interval and 1 df indicated that the difference is not statistically significant ($P > 0.05$).

On average, adult males constituted 18.95%, adult females 44.21%, juveniles 22.1% and infant constituted 14.74% of the total population of the sample count of De Brazza's monkeys in the study area.

Chi-squared test with 95% confidence interval indicated that there was no deviation of sex ratio from 1:1 ($P > 0.05$) for the average number of adult male and female De Brazza's monkey in the study area (Table 5).

Table 5: Chi-squared test for significance of change in sex ratio of De Brazza's monkeys in the study area

Sex	Observed mean value	Expected mean value	Calculated value of Chi-squared	Threshold value of Chi-squared for 1df	P-value
AM	1	2	1	3.84	> 0.05
AF	3	2			
Total	4	4			

df: degree of freedom

The most preferred habitats of De Brazza's monkey were riverine forests (RF) with encounter rate of 0.52 groups per km. Tree dominated forests and Coffee plantation (CP) constituted the second and third preferences of De Brazza's monkey habitats each with encounter rates of 0.50 groups per km in the study area. The overall average encounter rate of groups per km was 0.51 in the study area during the study period (Table 6).

Table 6: Encounter rates of De Brazza's monkeys in different types of habitats in the study area

Types of Habitats	Distance Surveyed (km)	No. of Group(s)	Encounter rate of group(s)/km	Mean encounter rate
CRF	8	4	0.50	0.52
FRF	3.5	2	0.57	
CTDF	4	2	0.50	0.50
FTDF	2	1	0.50	
CP	6	3	0.50	0.50
Average encounter rate of groups per km				0.51

Diet composition of the monkeys in the study area during the field survey period included fruits, leaves, flowers and animal preys. Overall, the highest proportion of De Brazza's monkeys' diet was fruit which on average took 64.5% with SD \pm 11.8% of their time of feeding during the study period. The average time spent feeding on leaves, animal prey, flowers and other unidentified items (like seeds, mushrooms, corns, cereals, etc.) was 6.9% with SD \pm 2.4%, 6.1% with SD \pm 11.7%, 1.2% with SD \pm 0.8% and 21.4% with SD \pm 11.7%, respectively during the field survey period (Table 7, Fig. 6).

Table 7: Average percentage of time spent by De Brazza's monkeys consuming different diets in different months in the study area

Months	Diets (%)				
	Leaves	Fruits	Flowers	Animal prey	Other unidentified items
September	9.92	59.39	2.58	3.97	24.14
October	9.01	57.19	1.53	6.35	25.92
November	5.95	47.91	0.85	4.38	40.91
December	7.95	71.8	1.66	9.29	9.3
January	3.99	80.45	0.02	3.98	11.57
February	4.53	70.02	0.52	8.68	16.25
Sum	41.35	386.76	7.14	36.65	128.09
Mean	6.89	64.46	1.19	6.11	21.35

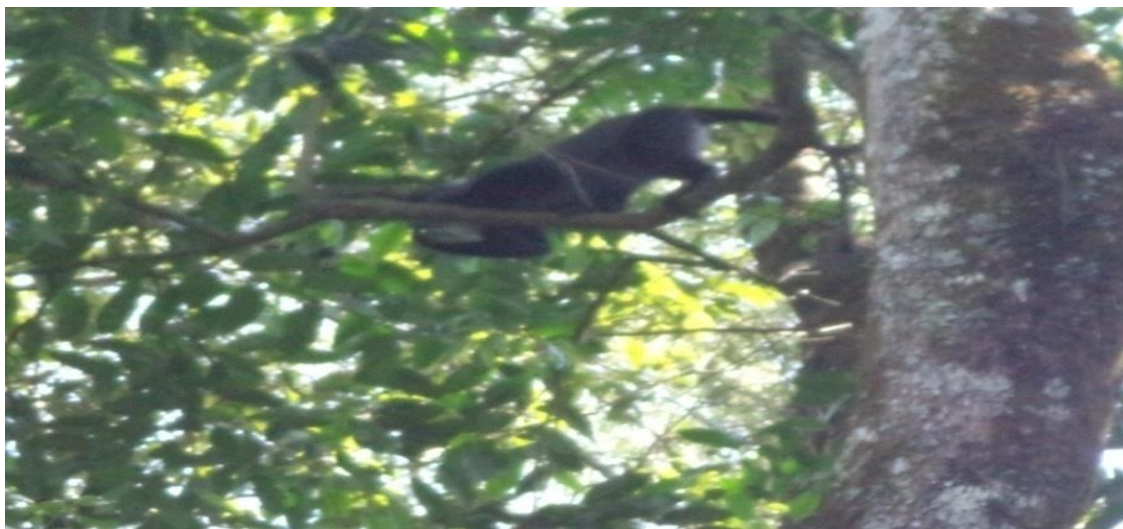
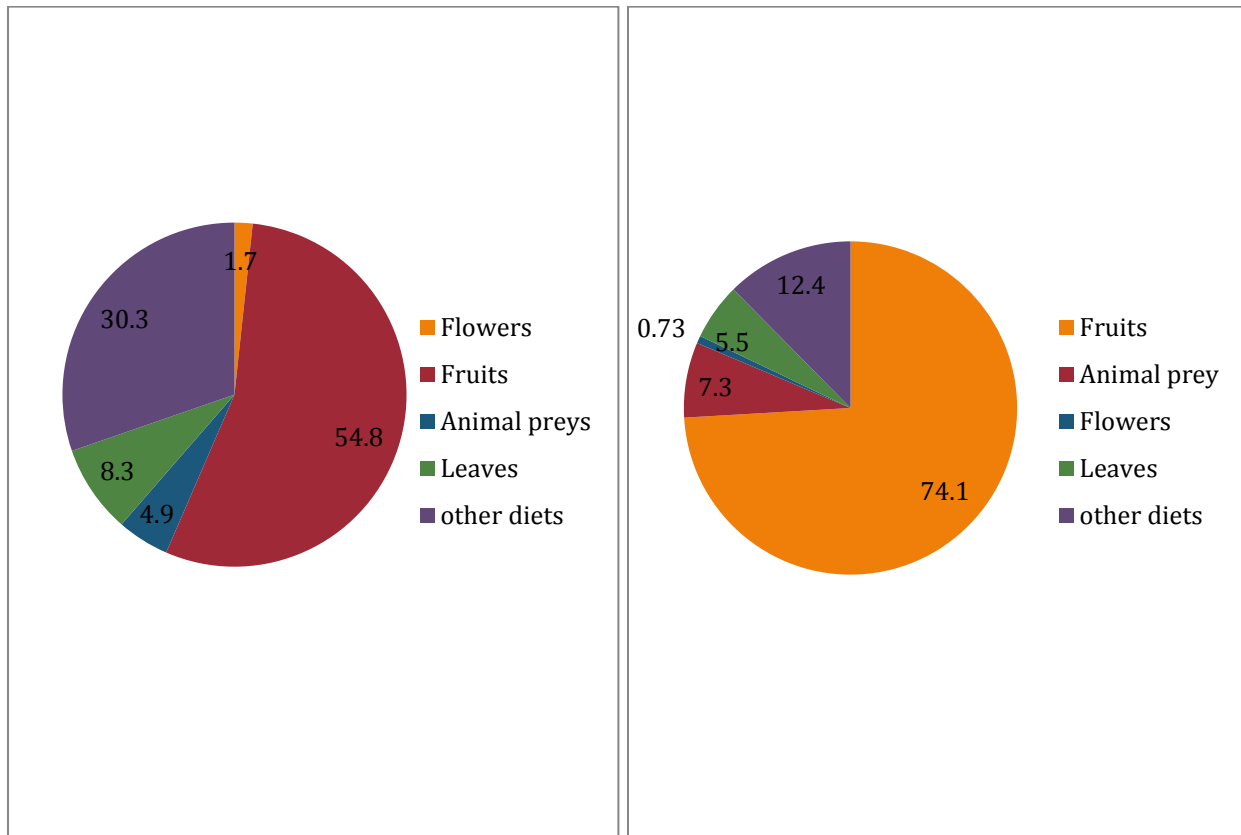


Figure 6: De Brazza's monkey searching for animal prey in the study area

The average time spent by De Brazza's monkey feeding on fruits was 74.1% with $SD \pm 5.6\%$ and 54.8% with $SD \pm 6.1\%$ during the dry and wet seasons, respectively. The average time taken by the monkeys feeding on leaves was 8.3% with $SD \pm 2.1\%$ during the wet seasons and 5.5% with $SD \pm 2.1\%$ during the dry season. Similarly, the time spent feeding on flowers was 1.7% with $SD \pm 0.9\%$ during the wet seasons and 0.7% with $SD \pm 0.8\%$ during the dry seasons and it was 7.3% with $SD \pm 2.5\%$ during the dry seasons and 4.9% with $SD \pm 1.3\%$ during the wet seasons for feeding on animal preys and 12.4% with $SD \pm 3.5\%$ during the dry seasons and 30.3% with $SD \pm 9.2\%$ during the wet seasons for feeding on other unidentified items during the study period. The percentage of time devoted to feeding on different items (diets) by De Brazza's monkeys during different seasons is shown in Figure 7 (A) and (B).



A

B

Figure 7: Percentage of time spent feeding on different items by De Brazza's monkeys during wet (A) and dry (B) season

Even though the time spent in different season for feeding on the same item varied numerically, two tailed student t- test with 95% confidence interval showed that there was no significant variation ($P > 0.05$) in percentage of time spent feeding on leaves, flowers and animal preys between seasons. However, the test showed that there was significant difference ($P < 0.05$) in percentage of time devoted to feeding on fruits and other unidentified items between wet and dry seasons (Table 8).

Table 8: t- test for variations of diets of De Brazza’s monkeys between different seasons

Diet	Season	% of time spent			Mean	$t_{\text{calculated}}$	t_{critical}	P-value
Fruit	Wet	59.39	57.19	47.91	54.8	4.02	2.776	< 0.05
	Dry	71.8	80.45	70.02	74.1			
Leaves	Wet	9.92	9.01	5.95	8.3	1.6	2.776	> 0.05
	Dry	7.95	3.99	4.53	5.5			
Flowers	Wet	2.58	1.53	0.85	1.7	1.43	2.776	> 0.05
	Dry	0.02	0.52	1.66	0.7			
Animal preys	Wet	3.97	6.35	4.38	4.9	1.5	2.776	> 0.05
	Dry	9.29	3.98	8.68	7.3			
Other unidentified items	Wet	24.14	25.92	40.91	30.3	3.14	2.776	< 0.05
	Dry	9.3	11.57	16.25	12.37			

De Brazza’s monkeys were observed feeding on thirteen different species of trees in the present study area (Table 9, Plate 2).

Table 9: Tree species used by De Brazza's monkeys in the study area

Scientific name	Local name	Growth form	Plant part(s) consumed
<i>Cordia africana</i>	Wodessa	Tree	L, Fr, Fl
<i>Ficus sur</i>	Harbu	Tree	Fr, L
<i>Albezia gummifera</i>	Ambabessa	Tree	L
<i>Sapium ellipticum</i>	Bosoka	Tree	L, Fr
<i>Ficus thonningii</i>	Dembi	Tree	L
<i>Podocarpus falcatus</i>	Birbirsa	Tree	L
<i>Prunus africana</i>	Homi	Tree	L
<i>Trichilla dregeana</i>	Luya	Tree	Fr, L
<i>Albezia grandibracteata</i>	Alele	Tree	L
<i>Coffea arabica</i>	Buna	Tree	Fr
<i>Ficus vasta</i>	Ogda	Tree	Fl, Fr
<i>Olea welwitschi</i>	Baha	Tree	L
<i>Diospyros abyssinica</i>	Loko	Tree	L, Fr

Fr: fruits; L: leaves; Fl: flowers



A

B

Plate 2: De Brazza's monkey on *Sapium ellipticum* in CRF (A) and on *Albezia gummifera* tree in FTDF (B) in the study area

4.3 Focus group discussion

The focus group discussants forwarded that the dwellers of the local area use forests for such purposes as agriculture, timber production, construction and firewood. They also listed the trees frequently removed from the forests in their local environment for the different purposes as *Ficus sur*, *Albezia grandibracteata*, *Prunus africana* and *Cordia africana* among which the removal of *Cordia africana* tree is made possible only with permission from the concerned Kebele officials. The local people protect their cultivated crops against De Brazza's monkeys by chasing the monkeys using domestic dogs (*Canis familiaris*) rather than hunting / killing as any act of killing them is forbidden by the local Government. According to the discussion conducted with the discussants, from the time of their arrival, the population of De Brazza's monkey was declining from time to time in the local area. The discussants also forwarded that they should be sensitized on the benefits of the monkey by concerned bodies, so that they take part in the protection of the De Brazza's monkey population. Finally, they suggested that the government has to take action which will allow the co-existence of De Brazza's monkeys and the human communities in the local area without causing any harm or only little harm to each other as, for example, already began such as having forest reserves and limited use of some tree species only through permission from concerned (local government) bodies, especially for those tree species which have survival value for the De Brazza's monkeys.

5. Discussion

The result obtained from the present survey on the demographic information of De Brazza's monkeys (group size, age and sex composition, and density) might not be exact or it might be under-estimated because of the difficulty of population count in the wild owing to the monkey's superior hiding tactic (Wolfheim, 1983), and also due to the difficulty of sighting all in the deep forests (Shah, 2003).

According to the present survey, all households sampled were found to be familiar with De Brazza's monkey. This is high compared with the case in Kenya, where 75% of people interviewed around Mathews Range Forest Reserve were found unfamiliar with the monkey (Mwenja, 2007). The reason for the difference might be that the respondents in the current study area (Mettu district) visit forests for their livelihood activities more frequently than those interviewed in Kenya or the difference might result from more habitat fragmentation or destruction that kept the respondents in touch with the forest and hence the De Brazza's monkey.

Riverine forests were found to be the most preferred habitats of De Brazza's monkey for this survey with 0.52 group encounter rate per km followed by tree dominated and coffee plantation habitats. This result coincides with Wahome *et al.* (1993), Mugambi *et al.* (1997) in Kenya and Alemneh Amare (2012) in Yayo Biosphere Reserve (Ethiopia) who reported that most De Brazza's monkeys occur along rivers. The higher encounter rate in the riverine forests of the study area might be attributed to the availability of more food items relative to the other habitats in the study area. It was also seen that the estimated maximum distance between De Brazza's monkey habitats and the nearest river / stream was 1 km with majority of the habitats occurring only within distance of up to 200 m. This confirmed the previous finding which reported that De Brazza's monkeys are generally found within 1 km distance to the rivers in humid forests (Wolfheim, 1983; Oregon Zoo, 2005) and keep close to water ranging not further than 200 m away (Wahome, 1989).

De Brazza's monkeys were found to occur from lowlands with elevation of 1312 m up to high lands with elevation of 1640 m asl in the sampling area of Mettu rural district. This finding supports the Institute of Primate Research Kenya (2008) reports that this monkey occurs from lowland areas to an elevation of up to 2100 m asl in Kenya and from 1380 to 1702 m asl near

river and streams in YBR (Alemneh Amare, 2012). However, it is in contrast to Mwenja (2007) who reported that 75% of the population was known to occur between the elevation of 900 m and 1300 m asl in Kenya.

The sex ratio was found to be 1:1 ($P > 0.05$) for the average number of adult male and adult female De Brazza's monkey in the current sampling area. This confirmed De Brazza's monkeys live mostly in polygamous groups (Mwenja, 2007) although monogamous groups were known to occur in Gabon (Fleagle, 1999; Mac Donald, 2001). It also supports Muriuki (1989) who reported that lone males of De Brazza's monkeys are often sighted outside the territories of local troops. The two monogamous groups sighted in the current study area might not be natural groups, but probably resulted either from dispersal of a male De Brazza's monkey to another habitat to live solitarily as a result of which the group size is reduced from four to three or it might result from habitat fragmentation. The group size of De Brazza's monkey varied between 1 and 8 with average 5.8 in the sampling area of this survey which is quite different from those recorded by Wahome (1993) and Mwenja (2007), the group size of which varied between 1 and 18 and 1 and 16, respectively in Kenya. The relatively smaller group size in this survey is perhaps due to reduced area of the De Brazza's monkey habitats which in effect brought limitation in the diets and hence reduced its reproduction in the study area. The average group density of De Brazza's monkeys recorded in this particular study (3.9 groups per km²) is high compared to that of Alemneh Amare's (2012) study which reported the monkey's average group density as 0.73 per km² in YBR. The higher group density in the current survey might be either due to the difference in methods used to estimate transects width in both study sites or due to the smaller area of the De Brazza's monkey habitats sampled in this survey.

There was no significant variation in number of De Brazza's monkeys of similar age and/or sex category between seasons in the sampling sites of Mettu district although the sample count was greater for the dry season than the wet season. The difference arose perhaps because of sighting problem owing to abundance of leaves of trees during the wet season which became conducive for hiding the monkeys.

The result of the present survey indicates that there were lower number of juveniles and infants to grow and substitute their parents to ensure the survival of the species. This is due to lack or

shortage of suitable habitats. Hence, it seems from the trend that the population is declining threatening the existence of the species in the study area.

It was observed that De Brazza's monkeys occurred in association with *Colobus guereza* and *Cercopithecus mitis* in the habitats assessed in the current survey. This supports the study of Decker (1995) and Mwenja (2007) who observed association with other Primates including *Colobus guereza*, *Cercopithecus ascanius schmidtii* and the vervet monkeys in Uganda and Kenya, but contrasts with Gautier-Hion and Gautier (1978) and Wahome (1989) who reported that the species is known to avoid poly-specific association. The reason for the co-occurrence of these monkeys in the same habitat in the current study area, even sometimes on a single tree, is probably because either the part of the tree they feed on vary (little/no niche overlap) or because of the presence of diet in excess in the local area of study, and hence no competition. It might also be for mutual benefit to avoid intruders/predators.

De Brazza's monkeys were found to consume fruits, leaves, flowers and animal preys in the current study area with fruits constituting the highest and flowers the least proportion of the monkeys' diets (Table 7). This agrees with the study of Alemneh Amare (2012) in YBR and Staaden (1996) report in Kenya who added mushrooms to the list. The reason why fruits became the first (top) preference of De Brazza's monkey could probably be because they were nutritious. Flowers were least consumed perhaps because of their poor nutritional value. Fruits and animal preys were more consumed during the dry season than the wet season whereas leaves and flowers were more consumed during the wet season (Table 8) similar to the study of Alemneh Amare (2012). The time devoted to feeding on fruits significantly varied ($P < 0.05$) between seasons as opposed to Alemneh Amare's (2012) study ($P > 0.05$) in YBR. It was also observed that there was no significant variation ($P > 0.05$) in time devoted to feeding on flowers and animal preys between seasons (Table 8) confirming Alemneh Amare's (2012) study in YBR. Fruits were eaten more during the dry season than the wet season to compensate for the high energy used by De Brazza's monkey for reproduction.

Although only two of the 13 tree species (Table 9), namely, *Ficus thonningii* and *Prunus africana* used by De Brazza's monkeys in this survey were found among the ten most preferred plants reported in Kisere forest in Kenya (Wahome, 1989), and only *Ficus thonningii* constituted one of the ten top preferred plant species of the monkey in Mathews Range Forest Reserve

(Kenya) as reported by Mwenja (2007), all the 13 species are among the 20 tree species used by De Brazza's monkey in YBR (Alemneh Amare, 2012). *Cordia africana* and *Ficus sur* were among the five top tree species preferred by De Brazza's monkey during the present survey (household questionnaire survey), this was also reported by Alemneh Amare (2012) in YBR (Ethiopia). However, only *Ficus sur* was recorded among the ten top tree species in Kisere forest (Wahome, 1989) and Mathews Range Forest Reserve in Kenya (Mwenja, 2007). The similarity might be attributed to the presence of similar habitats and similar tree species composition of the two study areas and the difference probably arose due to either the absence of a particular tree species or due to shorter duration of stay during the field survey in the current sampling area.

De Brazza's monkeys were found to raid crops including maize, coffee berries and cereals in the study area and the damage being higher in wet season than dry season. This is similar to Mugambi *et al.* (1997) who reported this monkey as agricultural pest in Kenya raiding crops of maize and potato. The reason why damage to crops by De Brazza's monkey becomes greater during the wet season than dry season is perhaps because wet season is the season during which these monkeys run short of their favorite food (fruit) in the wild. Thus, the present survey also confirmed the previous study that when natural foods are limited, high quality, easily digested foods provide an alternative source of nutrition for Primates and crop raiding may intensify (Horrocks and Baulu, 1994).

It was also observed that the people in the current local area of study remove trees like *Ficus sur*, *Albezia grandibracteata*, *Prunus africana* and *Cordia africana* for timber production, firewood and other purposes although the removal of one species (*Cordia africana*) requires permission from concerned Kebele officials (Focus group discussion). All of these trees were found to constitute the diets of De Brazza's monkeys in the study area (Table 9).

Despite the absence of legal hunting in the current study area, due to the action of the local government, the De Brazza's monkey population is declining from time to time (focus group discussion). In general, large family size and agriculture (crop cultivation and livestock keeping) as the main livelihood activities of most of the households led to extensive destruction of forests which gradually resulted in the decline of De Brazza's monkey population in the study area as a consequence of which the De Brazza's monkey population became locally threatened. According to Lee *et al.* (1986) and Walsh *et al.* (2003), the major threats to populations in most Primate

range countries are extensive conversion of Primates' habitat into areas of human use. This must be curtailed to save the species.

6. Conclusion and Recommendations

The forests currently surveyed in Mettu district are characterized by the presence of many indigenous tree species and wild animals containing varieties of arboreal animals. Moreover, the presence of river and a number of small streams across which the De Brazza's monkey population occurs are some of the features which describe the sampling area. The habitats of wild animals in the local area are continually destroyed through conversion of land to agriculture owing to large family size and type of livelihood activity of the human communities residing in the area. Although continuous habitats are found in the study area, there are also some habitats which are fragmented by human settlements and human built wide paths across which both humans and live-stock move. In addition, the local communities use the forests surrounding them for generating income, construction and firewood among other purposes. These and other related anthropogenic activities in the local area involve the removal of trees inevitably resulting in the reduction of De Brazza's monkeys and their habitats to a narrow range. As a consequence, human wildlife conflict and crop raiding by wild Primates become evident. The habitat destruction might also result in out breeding depression. Hence, these anthropogenic activities seem to endanger the existence of the locally threatened Primate, De Brazza's monkey. It can be predicted that the growing human population and the nature of livelihood activity of the local communities (crop cultivation and livestock keeping) will affect more of the remaining habitats of De Brazza's monkeys. This situation intensifies the conflict and crop raiding as it brings the monkey close to human residence area and might gradually over years end up with local extinction of the species. Therefore, based on the findings of this survey, the following actions which may directly or indirectly affect the De Brazza's monkey population and its habitats are recommended:

- ❖ The local government should strengthen the protection of the existing forest reserves along with their associations. Enforcing laws against the removal of trees in the reserve for firewood, timber production, construction and other purposes should be practiced.
- ❖ Maintaining, expanding and protecting fragmentation of De Brazza's monkey preferred habitats, particularly riverine forests in the study area is desirable.
- ❖ Alternative livelihood activities other than agriculture should be sought if possible for the communities of the local area by the local government.

- ❖ The use of crop rotation, adjustment of harvest or sowing times to favor crop rather than pests (De Brazza's monkeys) may help to minimize human-De Brazza's monkey conflict in the local area allowing them to co-exist peacefully.
- ❖ In addition to encouraging involvement of the local community, educating them (awareness creation of the local community) on the importance of conserving natural resources, like forests and wild animals such as De Brazza's monkey, may help to change their attitude and make them take care of their surroundings by actively participating in the process in their local area.
- ❖ Continuous monitoring of De Brazza's monkey population size and the trends for planning a timely and appropriate management options, such as the establishment of wildlife corridor, for example, by wildlife biologists is necessary.
- ❖ Family planning education for the local communities in the study area is also essential to reduce the unusual increment in number.

7. References

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8. Appendices

Appendix I: Household Questionnaire Survey

General direction

This research is being carried out for partial fulfillment of master's degree in Ecological and Systematic Zoology.

The purpose of this questionnaire is to gather information on distribution, feeding ecology and habitat association of De Brazza's monkey in the forests of Mettu district.

All information (response) you provide will be kept confidential and you are not required to write your name.

Therefore, I kindly request you to give your genuine and honest response to each of the following questions.

I thank in advance for your co-operation.

Direction for the enumerator/ respondent: put “√” inside the box for your choice for closed ended questions, and write responses on the space provided for open ended questions or rank as 1st, 2nd, 3rd,etc, when required.

1. Information gathered on Personal background information of households

1.1 Household head code number _____

1.2 Kebele of the household head _____

1.3 Name of village or “Got” _____

1.4 Educational status: Illiterate Primary education

Adult education Secondary Diploma and above

2. Information gathered on socio-economic conditions of households

2.1 Duration of stay (years)

5-9 10-14 15-19 20-24 25 and above

2.2 Livelihood activity/occupation

- Crop cultivation
- Livestock keeping
- Crop cultivation and livestock keeping
- Merchant /trader
- If any other, specify_____

3. Information gathered on the distribution of De Brazza's monkeys

3.1 Have you ever seen this monkey (De Brazza's monkey) in your environment? (Showing its photograph)

Yes No

3.2 If your answer to question number 3 is yes, what do you call it locally? _____

4. Information gathered on habitat association of De Brazza's monkeys

4.1 Is there river/stream around the De Brazza's monkey's habitat in your local environment?

Yes No

4.2 If your answer to question 4.1 is yes, what is the estimated average distance between the nearest river/stream and any group of De Brazza's monkey sighted? (m)

< 200 200-500 501-1000 greater than 1000

5. Information gathered on the feeding ecology of De Brazza's monkeys

5.1 Do the diet types of De Brazza's monkey vary seasonally?

Yes No

If your response to the above question is "Yes", please list as:

Diets during the wet season_____

Diets during the dry season_____

5.2 From your experience, what are the most preferred tree species of De Brazza's monkeys in your local area?

Please list only top 5 of them, in priority.

1. _____

2. _____

3. _____

4. _____

5. _____

5.3 Do De Brazza's monkeys feed on your cultivated crops?

Yes

No

5.4 In which season do they harm more your crop(s)?

Wet season

Dry season

Please, specify crop types and the month(s) of damage _____

5.5 Is there forest reserve in your Kebele / village?

Yes

No

Thank you!

Gaaffilee Qorannoo

Kallattii Waliigalaa

Qorannoon kun kan gaggeeffamu ulaagaa eebbaa digirii 2^{ffaa} (digirii maastarii) gosa barumsa Baayoloojii (Ecological and Systematic Zoology) guutuufii dha.

Kaayyoon gaaffiilee dhiyaataniis odeeffannoo mata-duree “facaatii, akkaataa soorannaa fi bakka jireenyaa “wonaa”n filatu” gandoota muraasa aanaa Mattuu irraa guuruu dha.

Deebiin isin kennitanu hundi iccitiin kan qabamu ta’ee maqaa ofii barreessuun hin barbaachisu.

Kanaafuu, deebii sirrii fi haqa qabeessa ta’e akka kennitanu kabajaan isin gaafadha.

Ajaja: Gaaffilee filannoo qabanuuf mallattoo “√” saanduuqichaa keessa kaa’aa.

Kanneen deebii gabaabaa barbaadanuuf deebii gabaabaa kaa’aa; bakka barbaachisutti immoo sadarkaan kaa’aa.

1. Odeeffannoo waa’ee nama mana bulchuu

1.1 Lakk. Koodii kennameef _____

1.2 Ganda _____

1.3 Maqaa gooxii _____

1.4 Sadarkaa barumsaa: hin baranne sadarkaa 1^{ffaa}

barumsa ga’eessotaa sadarkaa 2^{ffaa} Dippiloomaa fi ol

2. Odeeffannoo waa’ee diinagdee hawaasaa nama mana bulchuu

a. Yeroo hammam (woggaa meeqaaf) bakka kana jiraattan? _____

5-9 10-14 15-19 20-24 25 fi ol

b. Gosa hojii hojjattanii jiraattanuu

• Midhaan oomishuu

• Horii horsiisuu

• Midhaan oomishuu fi horii horsiisuu

• Daldala

• Kan biraa yoo ta’e haa ibsamu _____

3. Odeeffannoo waa'ee facaatii "wonaa" ilaalchisee

a. "Bineensa kana" naannoo keessanitti takkaa argitanii beektuu? (footoo "isaa" itti agarsiisaa)

Eeyyee lakkii

b. Yoo "eeyyee" jettan maqaa isaa maal jettanii waamtu?

4. Odeeffannoo waa'ee bidoollee (bakka jireenyaa)"wonaan" jaallatu ilaalchisee

4.1 Ganda keessanitti naannaa bakka jireenyaa wonaa, bishaan ni jiraa?

Eeyyee lakkii

4.2 Yoo "eeyyee" jettan, fageenyi bakka jireenyaa wonaa fi bishaan gidduu tilmaamaan meetira meeqa ta'a?

< 200 200-500 501-1000 >1000

5. Odeeffannoo akkaataa soorannaa "**wonaa**" irratti:

5.1 Gosti nyaataa "Wonaa" bonaa fi ganna keessa adda addummaa ni qabaa?

Eeyyee Lakkii

Eeyyee yoo jettan gosa nyaataa maqaa dhayaa.

Gosa nyaataa ganna keessa_____

Gosa nyaataa bonakeessa_____

5.2 Muuxannoo keessan irraa, mukkeen "wonaan" filataman kam fa'i? warra hunda caalaa wonaan filatamanu 5 qofa maqaa isaanii tarreessaa.

1_____

2_____

3_____

4_____

5_____

5.3 “Wonaan” midhaan keessan ni nyaataa?

Eeyyee lakkii

5.4 Ji’oota (waqitiilee) kam keessa irra caalaa midhaan keessan miidha?

Ganna keessa Bona keessa

- Gosa midhaanii fi ji’oota maqaa dhayaa _____

5.5 Ganda keessan keessa bosonni daanga’aan ni jiraa? Eeyyee lakkii

Galatoomaa!

Appendix II: Distribution of De Brazza’s monkeys

Name of the location	GPS Location		Altitude (m)	No. of Gr.	Area (km ²)	No. seen				Total		Habitat type	Other Primates
	X	Y				AM	AF	J	I	Wet	Dry		

Appendix III: Habitat preference of De Brazza’s monkeys

Type of Habitat	Distance Surveyed (km)	No. of Group(s)	Encounter rates of groups per km

Appendix IV: Feeding ecology of De Brazza's monkeys

Date _____

Starting time _____

End time _____

Time interval: 15 minutes

Months	Diets (%)				
	Leaves	Fruits	Flowers	Animal preys	Other un identified items

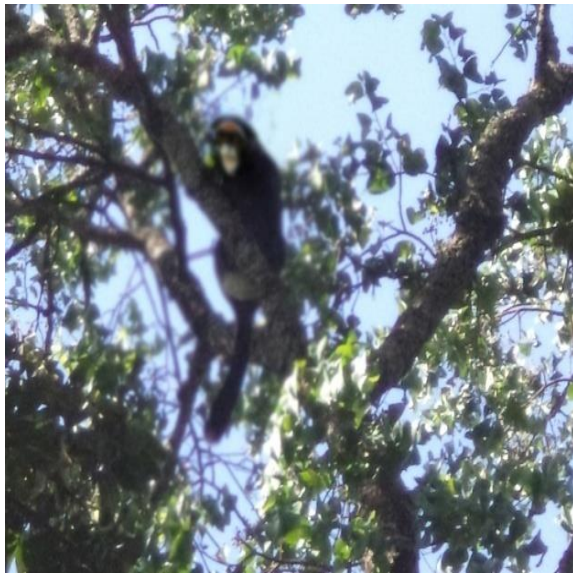
Appendix V: Tree species constituting the diets of De Brazza's monkey

Scientific name of the plant	Local name	Growth form	Plant part(s) consumed

Appendix VI: Focus group discussion questions

1. For what purposes do the local people use forest resources?
2. Which tree species are frequently removed from forests in your local area for different purposes?
3. What methods do the local people use to protect crop damage by wild Primates (e .g. De Brazza's monkey)?
4. From the time of your arrival in the local environment what is happening to De Brazza's monkey populations?
5. What measures do you think should be taken to conserve De Brazza's monkey and its habitats both by the local communities and the government?

Appendix VII: Plates showing different photos of De Brazza's in different habitats and habitat destruction in the study area



A



B



C



D

Adult male (A), Adult female (B), Juvenile (C) and Infant (D) De Brazza's monkeys in the study area



Hiding tactic of De Brazza's monkey (Adult male) in the study area



A

B

Habitat destruction (A and B) in the study area

Appendix VIII: The Rainfall and Temperature Trend of Mettu district (2005-2014)

Year	Minimum temperature (°C)	Maximum temperature (°C)	Average (°C)	Annual rainfall (mm)
	Mean	Mean		
2005	12.2	27.9	20.1	1116.5
2006	12.4	28	20.2	1475.8
2007	12.2	26.6	19.4	1839.5
2008	9.9	26.5	18.2	1620
2009	9.1	27.9	18.5	1384.8
2010	11.7	27.6	19.7	1151.8
2011	10.1	27.8	18.95	1244.2
2012	10.7	27.8	19.3	1271.6
2013	9.4	27.3	18.4	1020.6
2014	9.2	26.7	17.95	993.2 (8 months)

Source: Mettu Meteorological Station, 2014