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Population Status and Feeding Ecology of Menelik's bushbuck (*Tragelaphus scriptus meneliki*, Neumann, 1902) in Wof Washa natural forest, North Shoa, Amhara regional State, Ethiopia

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DECLARATION

I declare that the thesis entitled "Population status and feeding ecology of Menelik's bushbuck (*Tragelaphus scriptus meneliki*, Neumann, 1902) in Wof Washa natural forest, North Shoa, Amhara Regional State, Ethiopia" comprises research work done by me under the supervision of my advisor Dr. Tsegaye Gadisa and co-advisor Dr. K.K. Subhash Babu. This thesis is my original work and that it has not been submitted for any degree or examination in any other University and not been done earlier by anyone else in the study area. Sources used for the thesis have been properly acknowledged.

Brnesh Hailemariam

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LIST OF ABBREVIATIONS

AMWCDO: Agricultural Minstery of Wildlife Conservation and Development Organization

a. s. l.: above sea level

b. s. l.: below sea level

EWNHS: Ethiopian Wildlife and Natural History Society

IUCN: International Union for Conservation of Nature and Natural Resources

SUNARMA: Sustainable Use of Natural Resources and Management

T. s. meneliki: Tragelaphus scriptus meneliki

WWNF: Wof Washa Natural Forest

ABSTRACT

A study on the population status and feeding ecology of Menelik's bushbuck (Traglaphus scriptus meneliki) was conducted in the Wof Washa Natural Forest (WWNF) during April-August 2013 including dry and wet seasons. Line-transect counting method was used to estimate total population size of Menelik's bushbuck in the study area and diet of Menelik's bushbuck was studied using direct observation method. A total of 64 and 72 Menelik's bushbucks were recorded during the dry and wet seasons, respectively. The population structure of Menelik's bushbuck was adult male 27.94%, adult female 36.76%, sub-adult males 11.03%, sub-adult females 15.45% and young 8.82%. The male to female sex ratio was 1.00:1.34, while ratio of young to all adult individuals was 1.00:10.33 both during dry and wet seasons. The seasonal differences in the population size was statistically not significant (P>0.05). Menelik's bushbuck in the study area prefers natural forest habitat than plantation and Erica woodland habitats. 64% of Menelik's bushbuck diet comes from leaves, 20% from shoots and 7% from stems, and fruits and flowers contributed for only 6% and 3%, respectively. Menelik's bushbuck consumed 28 plant species, of these the three top species were Maytenus arbutifolia (13.45%), Cynodon dactilon (11.50%) and Myrsine africana (9.90%) accounted for 34.85% of their overall diet. The main threats of the Menelik's bushbuck in the study area were deforestation, fire wood and grass collection, livestock grazing, and other related human activities. Long term studies, conservation program and involvement of local communities for the conservation of Menelik's bushbuck in the area are recommended.

Keywords: Feeding ecology, Habitat prefrence, Menelik's bushbuck, Population status, Threat, Wof Washa Natural Forest.

1. INTRODUCTION

1.1. Background of the study

Ethiopia is one of the most physically and biologically diverse countries with sizeable endemism in the world (Abune, 2000). The main reason for the presence of diverse living organism and large number of endemic species is the variation in climate, attitude and rugged topography (Tefera, 2011). The altitudinal variation within Ethiopia produces a range of climate regimes, which affects every aspect of life in the country such as animal and plant distribution (Yalden and Largen, 1992). The country is endowed with extensive and unique environmental conditions (IBC, 2009). It contains various wildlife and wildlife habitats created by differing combination of elevation, rainfall, soil surface and ground water ranging from alpine moorlands to lowland savannas and arid lands, and extensive wetlands (Yalden, 1983; IBC, 2009).

The Ethiopian region, which includes sub-Saharan Africa is diverse with animal biodiversity and possesses 26% of all genera and 23% of all described endemic species (Cole *et al*., 1994). Such high level of endemicity in the fauna of Ethiopia is probably related to the proportion of highland ground in the country as compared to the rest of Africa (Yalden and Largen, 1992). Many of the endemic animals are specifically associated with the high altitude moorland and grassland habitats. Others belong to the highland and lowland forests of south west Ethiopia. Though, the endemic mammals of the country, 17 species are highland altitude moorland or grassland species whose altitudinal range is confined above 2000 m (Yazezew *et al.*, 2011). For instance, the endemic mammals of the country such as Mountain nyala, Walia ibex, Gelada baboon and Ethiopian wolf is associated to the highlands of Bale, Simien, and Menz (Yalden and Largen, 1992). The endemic Menelik's bushbuck (*Tragelaphus scriptus meneliki)* is confined to the

highland forests of Bale, Menagesha Suba, Denkoro and other highland areas (Yazezew *et al*., 2011) and East and West of the Omo River and South of the Blue Nile (Wronski *et al*., 2006b).

Menelik's bushbuck (*Tragelaphus scriptus meneliki)* is an even-toed ungulate (Artiodactyla) belonging to the family- Bovidae, Subfamily-Tragelaphus, Genus –*Tregalaphus*, species – *scriptus* and subspecies- *meneliki* (Wronski *et al*., 2006b). *Tragelaphus scriptus meneliki* also called Arussi bushbuck or black bushbuck named after Emperor Menelik II (1844 –-1913) of Ethiopia. It was described from the Managasha forest West of Shoa by Matschie, in 1912 (Moodley *et al*., 2008).

Menelik's bushbuck is an attractive, medium-sized bushbuck with a rather long coat of dark brown hair. Usually, there are contrasting white patches on the throat, base of neck and inside of legs, and a few white spots on the thighs. The head is reddish brown with a black nose stripe and imperfect white chevron between the eyes (Yazezew *et al*., 2011). Male of Menelik's bushbuck has a dark grey-brown pelage that is pretty and longer than other bushbucks, with virtual absence of pale dorsal markings (AMWCDO, 1981; Yalden *et al*., 1984). The female is bright rufous, with a dark suffusion on neck and saddle (Moodley *et al*., 2008).

Menelik's bushbucks are mixed feeders. They feed on leaves, shoots, fruits, flowers and dig up various tubers and roots (AMWCDO, 1981; Yazezew *et al*., 2011). The most common habitat of Menelik's bushbuck is the dense bushes in the highland forests up to the tree-line of 4000 m (AMWCDO, 1981). The major threats of Menelik's bushbuck are habitat destruction and poaching, disease (e.g rinderpest) (Wronski *et al*., 2006a).

Menelik's bushbuck is classified as least concern by the IUCN (IUCN, 2012). The actual population size of Menelik's bushbuck has been unknown (Tefera, 2011), and little is known

about the distribution, habitat association, food preferences and behaviour of this ungulate in (Yazezew *et al*., 2011). Based on this research problem, the present study was aimed to assess the population status and feeding ecology of Menelik's bushbuck in Wof Washa Natural Forest, North Shoa, Amhara Regional State, Ethiopia.

1.2. Statement of the problem

A reliable estimation of population size, information on habitat requirements and assessment of threats are in the center of population biology and ecology for management of wildlife species (Matrai *et al*., 1998; Fernando *et al*., 2005). Menelik's bushbuck has not been subjected to scientific studies and it's accurate estimate of the total population size has not been made in Ethiopia because of their furtive behaviour (Tefera, 2011; Yazezew *et al.,* 2011). Therefore, information available on its ecology and biological details are far from complete and patchy as well.

Wof Washa Natural Forest (WWNF) is facing a number of anthropogenic threats. The main threats of the area are heavy grazing, cutting of trees for construction and utensil materials, farm tools and fuel, fire, and expansion of cultivated land. These human activities have tremendous impacts on the wildlife including the Menelik's bushbuck (EWNHS, 1996).

Due to increasing human population, agricultural expansion and deforestation, the Menelik's bushbuck often run into frequent conflict with people (Wronski *et al*., 2006a; Yazezew *et al.,* 2011). Monitoring of its population abundance, feeding behaviours and threats are important to design appropriate management strategies of this animal. To this end the present study was conducted to get preliminary information on the Menelik's bushbuck population status and feeding ecology in the study area.

1. 3. Objectives of the study

1. 3.1. General objective

The general objective of the present study was to make a preliminary survey on with the population status and feeding ecology of the Menelik's bushbuck (*T. s. meneliki*) in Wof Washa Natural Forest.

1.3.2. Specific objectives

- To estimate the population size of Menelik's bushbuck in the study area
- To describe habitat preferences of Menelik's bushbuck
- To state the potential factors pertinent in determining the distribution of Menelik's bushbuck in Wof Washa natural forest
- To identify the diet of the study species

1.4. Significance of the study

It is expected that, the results of the study would offer a good data base for various organizations and private investors who need to invest and protect their resources in the study area. It will also revel the population status of Menelik's bushbuck and anthropogenic threats to develop management strategies for conservation of this species in the area. This study is also expected to form the basis for other researchers who will be interested in related investigations to establish management strategies in the study area.

1.5. Limitation of the study

This particular study has faced serious time and financial constraints to collect enough data on Menelik's bushbuck since its sighting is limited. The study would have been more important if the study was of a long term, and comparisons of the population density of the study area with other forests in the country are included. Detailed published information on Menelik's bushbuck was scarce. Consequently, this study has limitation for discussion and to compare the result to other information.

2. LITERATURE REVIEW

2.1. Taxonomy and distribution of Common Bushbuck *(Tragelaphus scriptus)*

The Bushbuck (*Tragelaphus scriptus*) was first described by Pallas in 1766 (Wronski, 2004). It is a medium sized sexually dimorphic antelope (Wronski, *et al*., 2006d; Apio, 2003*)*. Females are hornless and smaller than males. Bushbucks are comparatively easy to recognize by differences in the pattern of individual coats (Estes, 1991). This is valid for males and females, where this type of pattern is sufficiently widespread in the population to allow large number of individuals to be recognized. The colour of bushbuck is fawn (a pale yellowish brown colour), "harnessed" with straps on the body. Male bushbucks have a darker colouration than the females, resulting in a more striking differentiation between their white stripes and spots. As males age, their coats become darker and they look even more striking. All have white under parts and white markings on the face and ears. They have an arched back posture and the rear legs are a little longer and more muscular than the forelegs (Wronski, 2004).

Bushbuck *(Tragelaphus scriptus)* is an even-toed ungulate (Artiodactyla) belonging to the family- Bovidae, Subfamily- Tragelaphus, Genus –*Tregalaphus,* species –*scriptus* (Dankwa *et al*., 2002). *Tragelaphus scriptus* is one of the most widespread antelopes in Africa; occurring from as far West as southern Mauritania and Senegal, East across the Sahel to Ethiopia and Somalia and South in all countries to South Africa (Apio and Wronski, 2005).

The families of Bushbuck occur widely in sub-Saharan Africa, wherever there is cover to conceal it, from sea level to 4,000 m, from rainforest edge to patches of gallery forest and bushes near water in the sub desert. Bushbucks are predominantly browsers and inhabit dense bush-land, riverine forests and similar habitats (Estes, 1991; MacLeod *et al*., 1996). It is naturally absent in

dry and semi-arid regions and in extensive areas of closed-canopy forest. Its ability to survive in human-dominated landscapes and withstand heavy hunting pressure has enabled it to persist over much of its former ranges (East, 1999; Dankwa and Euler, 2002).

Tragelaphus scriptus is a generalist and herbivore that has kept pace with environmental changes by local adaptation to changing habitats, since this sedentary species appears to require water, cover and the availability of grazing or browse (Kingdon, 1997). As a consequence, *T. scriptus* is the most widespread and ecologically and taxonomically diverse of all spiral-horned antelopes, occurring in approximately 73% of the total land area of sub-Saharan Africa (Moodley and Bruford, 2007; Moodley, *et al*., 2008). Local adaptation across this vast and heterogeneous range has resulted in marked geographic variation in body and horn size, coat length and pattern, colouration and sexual dimorphism. Dorsal stripes and patterning are stronger in bushbuck populations from African forest block (harnessed type) and weaker in the bushbuck from the southern and eastern half of the continent (sylvan type). Montane populations are often darker with more hairs than those living in the surrounding lowlands (Wronski, 2004). Over 40 subspecies of bushbucks are known, which vary in both colouration and type of habitats they frequent (Moodley and Bruford, 2007).

According to Grubb (1985), geographical variations of *Tragelaphus scriptus* can be interpreted by recognition of four most distributed groups of subspecies in Africa. These are *T. s. scriptus*, the western type subspecies, *T. s. sylvaticus*, the south African type and two small localized populations, one in the mountains of Ethiopia (*T. s. meneliki*) and another along the coastal areas of Kenya (*T. s. fasciatus)*. Both Menelik's bushbuck and Common bushbuck are found in different parts of Ethiopia. The Ethiopian highlands East and West of the Omo River and South of the Blue Nile are inhabited by the endemic Menelik's bushbuck (Wronski *et al*., 2006b).

2.2. Unique features of Menelik's bushbuck

The Menelik's bushbuck is somewhat similar in appearance to the mountain races of the East African bushbuck in Kenya and the Cape bushbuck in South Africa (Dankwa and Euler, 2002). Both males and females have geometrically shaped white patches or spots on the most mobile parts of their body, such as ears, chin, tail, legs and neck as well as a band of white at the base of the neck (Hillman, 1986). Females and young are mainly reddish, and males become progressively darker with sexual maturity and age. Both sexes and all age groups have a white underside on the broad woolly tail and white flashes above their black hooves (Kingdon, 1997).

Menelik's bushbucks have large broad ears and when they stop to regard an intruder the ears with their tufts of white are conspicuous. Spinal crests of long whitish or black hairs run down the centre of the back. The tail is bushy and long, reaching up to just above the hocks, white underneath and black- tipped in appearance, and they displays a unique and beautiful coat colour (Dankwa and Euler, 2002).

2.3. Population status and distribution of Menelik's bushbuck

A total population estimation of Menelik's bushbuck has not been made because of their furtive habits (Yazezew *et al.*, 2011; Tefera, 2011). In Ethiopia, bushbuck is locally common in areas such as the Bale Mountains, Nech-sar National Park and Omo-Mago Murule region with largest concentration in Mago National Park, where its population is 735 individuals (Wilhelmi *et al*., 2006). They also occur in Simien Mountain National Park in association with Gelada baboon, Walia ibex, Duiker and Klipspringer at an altitude of 3300 m a.s.l. (Dunbar, 1978). Menelik's bushbuck is also fairly widespread in the Cedar forests in Menagesha and the Eucalyptus groves of

the Entoto range. Nevertheless, their most common habitat is the dense bush in the highland forests up to the tree-line of 4000 m (AMWCDO, 1981).

Most authors considered that, the Menelik's bushbuck inhabits montane grass land areas. Moreover, records indicate that, throughout historical times, Menelik's bushbucks have occupied a limited and disjunct range in the Chercher, Arsi and Bale Mountains, the mountains of western Shoa and areas of high ground in the province of Illubabor (Yalden *et al*., 1984). They are usually found near water sources (ETC, 1982; Wronski *et al*., 2006c). Menelik's bushbuck is a forest-dwelling antelope. It makes its home in a wide array of forest types. Rainforests, savanna-forest mosaics, light woodlands, and savanna bush forests are among its preferred habitats (Yalden and Largen, 1992).

According to Yalden *et al.* (1984), in some of the more arid parts of its range, such as the Awash Valley, bushbuck is largely restricted to riverine vegetation, but dissemination into dry area is limited because the species does not tolerate prolonged drought. This indicates why bushbuck is scarce in water deficient areas of northern and southern Ethiopia, and is totally excluded from the Dankil desert and most parts of the Ogaden region (Wronski *et al*., 2006a).

2.4. Threat of Menelik's bushbuck

The major threats of bushbuck are habitat destruction, poaching and disease (e.g rinderpest) (Wronski *et al*., 2006a; Yazezew *et al.*, 2011). Predictably, the main threats to the species come from humans, largely in the form of land-use pattern changes that have resulted in degraded or loss of habitat over the last century. Much of the montane forest has been cut and replaced by agriculture and deforestation tends to be on the increment (Dankwa *et al*., 2002). Menelik's bushbuck have disappeared from some areas in the drier parts of its former range because of

habitat destruction and increasing aridity, but it is expanding its distribution within the equatorial forest zone as this is unlocked up by human activities (Yazezew *et al.,* 2011).

The predators of Menelik's bushbuck include the leopard, lions, hyenas, cheetahs, hunting dogs and crocodiles (Wronski *et al.,* 2006a). The young are also caught by servals, golden cats, eagles and pythons (Yazezew *et al.,* 2011). Bushbucks do not tolerate oxpeckers or other birds that help control insect pests (Brashares and Arcese, 2002). As a result, they often have numerous ticks on their head and neck. They also suffer from common ungulate diseases, including rinderpest, which diminished their numbers (Apio, 2003; Wronski *et al.,* 2006a).

2.5 Behaviour and feeding ecology

Bushbuck are semi-solitary animals that occur either singly, in pairs, or in small groups consisting of one dominant mature ram, 2-3 adults and 1-2 sub-adult youngsters (Magliocca *et al.,* 2002). The dominant ram stays with a family group throughout the year. Both male and female bushbucks are sedentary and occupy well-defined home ranges (Wronski, 2005; Wronski and Apio, 2006; Wronski *et al*., 2006c). Adult males defend the inner core of their home ranges against other males, indicating that the males at least are territorial (Wronski, 2005; Wronski *et al*., 2006d). After natal dispersal, young-adult males join loose bachelor pools, from which they will later challenge territory holders, so as to take over an existing territory (Wronski, 2005). Females are philopatric and form matrilines, which means that the home ranges of related females strongly overlap while those of non-related females show little or no overlap (Wronski and Apio, 2006). Family bonding of Menelik's bushbuck is weak and individuals constantly exchange between adjacent groups. Groups usually avoid each other where home ranges overlap

but for a short period of time it may occur on communal feeding grounds. Sub-adult rams are solitary and keep to the fringes of family groups (Seymour, 2002).

Menelik's bushbuck is usually most active during early morning and in the late afternoon hours (Dankwa and Euler, 2002). They become almost entirely nocturnal in areas where they are disturbed frequently during the day (Wronski *et al.*, 2006c). When alarmed, individuals react in a variety of ways. If they are in forest or thick bushes, they may "freeze" in one position and remain very still, their coloring camouflaging them. Sometimes they will sink to the ground and lie flat, or they may bind away, making a series of hoarse barks. When surprised in the open, they sometimes stand still or slowly walk to the nearest cover. They spend the heat of the day lying up in dense bushes where there is no hope of spotting them (Apio and Wronski, 2005).

Bushbucks feed on various species of trees, shrubs, perennial woody and annual non-woody herbs, and sometimes on grass (MacLeod, *et al*., 1996; Haschick and Kerley, 1997). Bushbucks are primarily browsers; in some areas, they enter agricultural fields to eat crops and may be considered as a pest. They do need water, although are able to obtain by licking dew from plants and grasses in the morning (Estes, 1991). However, Menelik's bushbucks are mixed feeders. They use both plant species and plant specific material, especially young growth from actively growing shoot ends. Menelik's bushbuck feeds on leaves, tender shoots, and dig up various tubers and roots and depend on grasses only when they are young (AMWCDO, 1981; Yazezew *et al.*, 2011). A versatile diet and ability to subsist on both grass and browse contribute to the success of them (Kingdon, 1997).

According to Estes (1991), reproduction appears to be seasonal in most bushbuck populations with two peak birth periods a year. After a gestation period of around six months, one offspring

is born. The young is kept hidden in thickets or long grasses for the first four months of its life. The mother returns to her young to allow it to suckle and she eats its faeces. This may be done to prevent detection of the young by predators with a keen sense of smell and to keep the area clean, as the mother does not move her young from its safe retreat regularly, as other antelope species are seen to do. Offspring reach maturity at around one year; however males do not reach physical maturity until they are three years. By this time, the horns would grow to adult size, and colouration and behavior of the animal changes.

3. THE STUDY AREA AND METHODS

3. 1. Description of the study area

3.1.1. Geographical location and topography

The present study was conducted in Wof Washa Natural Forest found in North Shoa Zonal Administration of Amhara National Regional State, situated approximately between 9º44′32″-9º46′26″N and 39º 44′00″- 39º 47′19″E. Wof Washa Natural Forest is one of the central highlands and oldest natural state forests in Ethiopia. It is located at about 190 km from Addis Ababa and 60 km from the zone capital (Debre Birhan) in the North. Currently, this forest covers 8200 ha which has shrunken from 9200ha since 1994 (Schürmann, 2008).

The study area is bordered by three districts namely: Tarmaber in the North-east, Ankober in the South and South-west and Basona Worena in the North and North-west (Fig. 1). The forest under study lies to the right of the road from Addis Ababa to Dessie via Debre Sina specifically Wof washa is located at three to four hours foot walk from Debrse Sina towards the South. The topography of the area is steep and dissected by ravines and gorges through which rivers and streams tumble down the eastern escarpment of the Great Ethiopa Rift Valley. The forest is on steep slopes in narrow valleys mostly facing to the East.

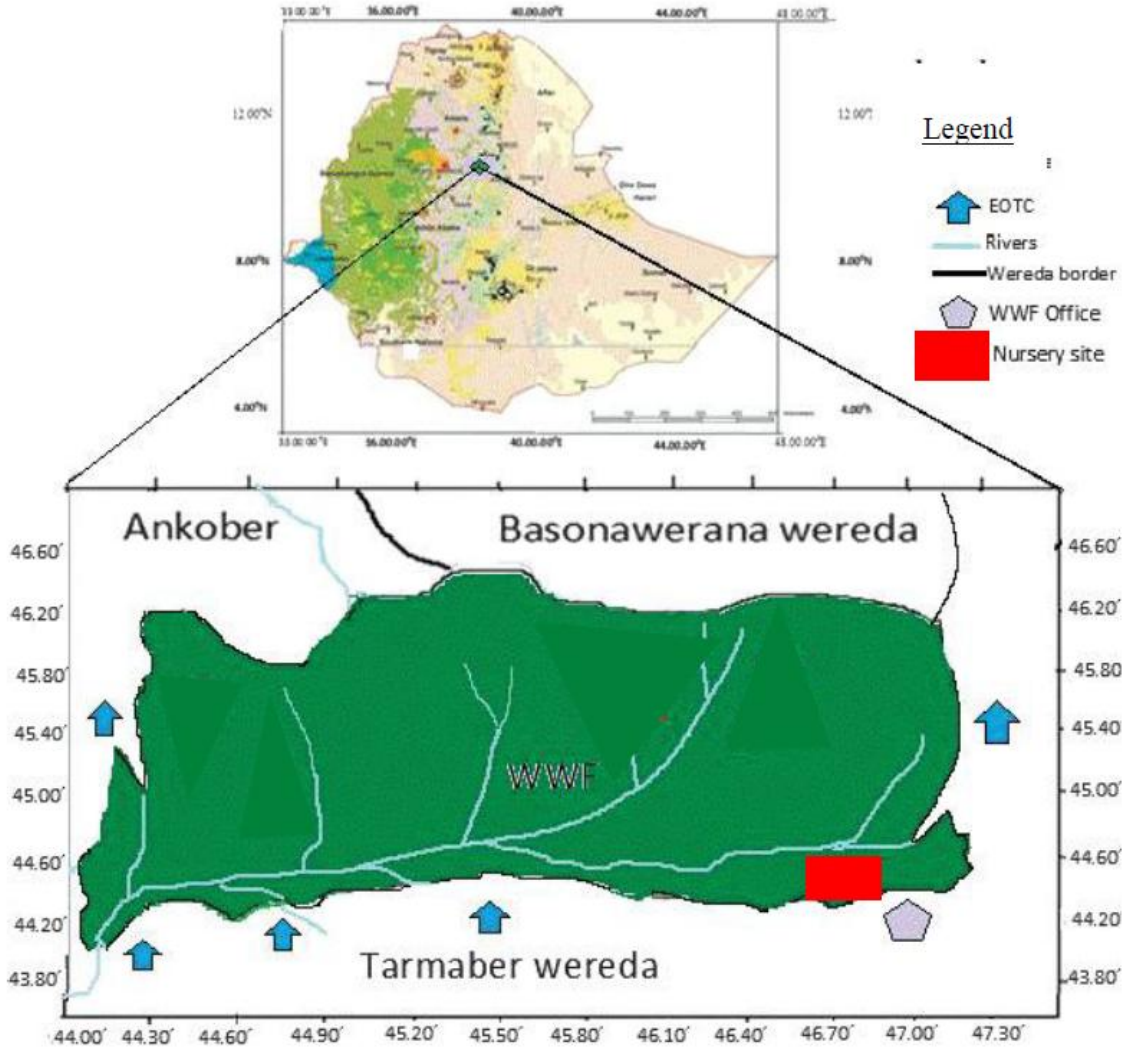


Figure 1: Map of the study area (Source: Fisaha *et al.*, 2013)

3.1.2. Climate

The distribution of rainfall in the area is bimodal, characterized by a prolonged wet season from July to September long rainy season and short rains, from March to May with a peak in April. The short rainy season is unpredictable and highly variable. As in many tropical rain forests, there was considerable month-to-month variation in the rainfall at WWNF during the study period. The actual rainy season is from June to September and varies in intensity in the study

area. The highest amount of rainfall was recorded in July, followed in August. The area receives a rainfall of approximately 1400mm per annum coupled with the low evapo-transpiration (Fisaha *et al*., 2013).

The study area and its surrounding areas fall into different climatic zones locally called as Weina Dega, Dega and Wurch. But Wof Washa forest is a highland forest characterized by cold temperature. Temperatures range from a mean minimum of -8°C to 4°C to a mean maximum of 18°C to 35°C. The mean annual minimum temperature was 10^0C where as the mean annual maximum temperature was 20^0C (Fisaha *et al*., 2013; Schürmann, 2008). There was often persistent fog over the area and drying winds during the day and frosts may occur at night (Fig. 2).

Figure **2**: View of the foggy cover of WWNF (Photo: Brnesh H/Mariam, 2013).

3.1.3. Flora

The vegetation of Wof washa forest is moist to dry Afro-alpine mixed with both broadleaved and conifers. There are both indigenous and exotic tree species in WWNF (SUNARMA, 2005). The main characteristic plant species are *Hagenia abyssinica, Olea europaea* subsp. *cuspidata* and *Juniperus procera, Podocarpus falcatus, Allophylus abyssinicus, Haleria lucida, Euphorbia abyssinica, Polyscias fulva, Olinia rochetiana, Ilex mitis* and *Galiniera saxifra* are common in the middle of the forest areas. At and above 3,000 m.a.s.l, *Erica arborea, Hypericum revolutum* and giant *Lobelia* spp. are the most dominant species with few *Hagenia abyssinica* and *Pittosporium viridiflorum* below inaccessibly cliffy and steep slope areas. In the open areas, over rocks and on the cliffs, there are also extensive patches of the endemic *Kniphofia foliosa*, clumps of *Helichrysum* spp. and *Festuca* grass, which adapt to the extreme climate. *Dovyalis abyssinica* and *Maytenus arbutifolia* are the most dominant shrubby trees under the canopy of *Juniperus*

procera and *podocarpus falcatus* in most parts of the forest (Schürmann, 2008; Fisaha *et al*., 2013)

3.1.4. Fauna

In addition to Menelik's bushbuck, the study area also supports a variety of wildlife populations. The black and white colobus monkey (*Colobus guereza*), large troops of *Theropithecus gelada,* Grivet monkey (*Cercopithecus aethiops*), Klipspringer (*Oreotragus oreotragus*), Common duiker (*Sylvicapra grimmia*), Crested porcupine (*Hystrix cristata*), Abyssinian hare (*Lepus habessinicus*), Bush hyrax (*Hetrohyrax brucei*) and Rock hyrax (*Procavia capensis*) are among the commonest. The area also harbours many species of rodents and birds including endemic and rare Ankober serin (*Serinus ankoberensis)*. Carnivorous mammals in the area include leopard (*Panthera pardus*), hyena (*Crocuta crocuta*), common jackal (*Canis aureus*), Serval (*Felis serval*) and Abyssinian genete (G*enetta abyssinica*) (Schürmann, 2008). The endemic Menelik's bushbuck found more populated on the lower and central part of the forest in association with Colobus guereza for vigilance.

3.2. Methods of data collection

Population status and feeding ecology of the Menelik's bushbuck were investigated along randomly selected sampling units in the study area. preliminary survey was done before the actual data collection. The actual data collection included counting of Menelik's bushbuck population, observation of its feeding behaviours and threats and questionnaire survey to assess anthropogenic threats. Data collection was done during April - August 2013. April - May 2013 which covered the dry season whereas, June - August 2013 covered the wet season.

3.2.1. Preliminary Survey

A reconnaissance survey was carried out in collaboration with the scouts of the study area during the first five days of the study period prior to the actual data collection process. During this period, all available and relevant information were gathered regarding accessibility, climatic conditions, vegetation types, fauna, topography, infrastructure and water sources in the area. In addition, permanent transect lines were also demarcated by paints, natural markings such as streams, rivers, big trees and stones/rocks. Knowledge and experience of the local people were used to locate sampling sites.

3.2.2 Sampling design

According to the preliminary survey disclosure of the vegetation cover and topography of the study area, sampling sites were randomly selected in WWNF. The study area had a heterogeneous vegetation type and topography. It is categorized in to Plantation, Natural forest and *Erica* woodland (EWL) vegetation zones based on the dominant vegetation they contained. Each vegetation zone had distinguishing features of vegetation type and topography. Census Zones were established in all the three vegetation types.

A total of nine transects (T1-T9) ranged 30-50m width and 500-2000m in length (based on the type of habitat) was designed based on straight lines to yield sufficient information to conduct proper statistical analysis and to avoid systematic error or bias (Anderson *et al*., 1978). Among these, two (T1 and T2) were in the plantation habitat, five (T3 - T7) were in the Natural forest and two (T8 and T9) were in the *Erica* woodland habitat. Transects were placed by stratified random sampling approach in which transect placement was proportional to the area of the habitat type. Adjacent transects were at least 200m apart from each other to avoid double count.

3.2.3. Population count and habitat preference

Total count method was carried out through walking along transects while recording the number of individuals obseved on each side. Each transect was censused twice a month and conducted at an equal rate in the morning (06:00-10:30h) and in the late afternoon (15:00-17:30h), when the animals were very active (Dankwa and Euler, 2002). Total population, sex and age composition of the species along each transect were recorded by counting animals in both sides of the observer while cutting the transect. The age categories identified were young, sub-adult and adult. Sex and age determination were made based on body size, presence or absence of horns, horn size (for males only), and coat colour (Yazezew et al., 2011).

Distribution and habitat association of Menelik's bushbuck in the study area were determined from the size of population observed in different habitat types during the wet and dry seasons were used to compare the habitat preference (Yazezew *et al*., 2011).

3.2.4. Feeding ecology

For observing the feeding ecology, binoculars was used to further determination of the plant species and parts of plants consumed by the animals after the animals left the spotted area. During the feeding observation plant species and the plant parts consumed were recorded. Moreover, detailed observations of groups on feeding was made, while the animal eating a particular plant species by selecting suitable vantage points which provide a broader view than low landscape positions (Yazezew *et al*., 2011). Immediately, after the animals left the spotted area, plants were identified (if the common name of the plant is known) and recorded in the diet data sheet or samples were collected, pressed and brought to the nearby Debre Berihan

University botanical science laboratory for specimen identification by referring the book Flora of Ethiopia and Eretria volume 1 up to 7.

3.2.5. Anthropogenic threats

Anthropogenic impacts of the local people to the animal were determined by using physical observations of the area and interviewing the local people to assess their attitude towards the study species. An interview survey was conducted around the WWNF focusing on the local people, who are familiar with and reside near the vicinity of the study blocks, purposely to achieve good information from those respondents on a random basis while considering households for sex and age. The questionnaire had 14 questions related to socio demographic information on respondents (age, sex, and family size), livestock type and numbers grazing in the study area, socioeconomic activities that performed in the forest and conservation status of Menelik's bushbuck in this forest (Appendix I). The questionnaire contained both open and close-ended questions. These questions were translated in to Amharic language, printed and then asked to respondents in the form of a structured interview questions.

3.3. Data analysis

Statistical package software SPSS version 16.0 was used to analyze the data. Data collected from each transect and the Menelik's bushbuck population was analyzed using descriptive statistics. One way ANOVA was used to compare population size of the animal in different seasons. Using the t-test, the population structure and the mean number of individuals in each habitat type was compared to determine population composition and distribution in habitats. Questionnaire was analyzed using chi-square test to determine and compare the significant differences between respondents. Comparisons were made at 0.05 level of significance for all tests.

4. RESULTS

4.1. Population structure

During the dry season, a total of 64 Menelik's bushbucks were counted. Among these, 19 (29.69%) were adult males, 23 (35.94%) were adult females, 7 (10.94%) were sub-adult males, 10 (15.63%) were sub adult females and 5 (7.81%) were young individuals (Table 1). The number of adult females was higher than adult males, sub- adult males, sub-adult females and young during dry season. Next to adult females, the largest proportion was adult males. The population structure of Menelik's bushbuck had significant difference (t=3.66, df=4, p=0.022). Out of the total population, 18.75% was from plantation habitat, 67.19% was from natural forest habitat and 14.06% was from *Erica* woodland habitat. However, number of individuals counted in each three habitat types had significant difference (t=1.96, df=2, P=0.189).

Table 1. Population structure of the Menelik's bushbuck during the dry season

Sites	Transect No.	Adult male	Adult female	Sub-adult male	Sub-adult female	Young	Mean(±SE)
Plantation	1	1	2	0	0	0	0.60±0.400
	2	3	4	1	0	1	1.80±0.735
Natural	3	2	1	1	2	0	1.20±0.374
forest	4	2	4	2	2	0	2.00±0.632
	5	4	4	1	1	1	2.20±0.735
	6	2	2	1	2	1	1.60±0.245
	7	3	2	0	2	1	1.60±0.510
Erica	8	1	2	1	1	0	1.00±0.316
woodland	9	1	2	0	0	1	0.80±0.374
Total		19	23	7	10	5	12.80±4.321

During the wet season, a total of 72 Menelik's bushbucks consisting of 19 (26.39%) adult males, 27 (37.50%) adult females, 8 (11.11%) sub-adult males, 11 (15.28%) sub adult females and 7 (9.72%) young were counted (Table 2). The number of adult female was higher than adult males, sub- adult males, sub-adult females and young during the wet season. Next to adult females, the largest proportion was adult males, followed by sub- adult females. There was significance different between population composition of Menelik's bushbuck in wet season (t=3.80, df= 4, P=0.019). Out of the total population counted during the wet season, 22.22% was from plantation habitat, 62.50% from forest habitat and 15.28% was from *Erica* wood land habitat. However, there was significant difference in Menelik's bushbuck population between habitats at t=2.26, df=2, P=0.152 level of significant.

Table 2. Population structure of the Menelik's bushbuck during the wet season

Sites	Transect No.	Adult male	Adult female	Sub-adult male	Sub-adult female	Young	Mean (±SE)
Plantation	1	1	2	1	1	1	1.20±0.200
	2	3	4	1	1	1	2.00±0.632
Natural	3	3	4	0	2	0	1.80±0.800
forest	4	2	3	1	2	1	1.80±0.374
	5	2	3	1	1	2	1.80±0.374
	6	3	4	1	1	1	2.00±0.632
	7	2	3	1	1	1	1.60±0.400
Erica	8	2	3	1	1	0	1.40±0.510
woodland	9	1	1	1	1	0	0.80±0.200
Total		19	27	8	11	7	14.40±4.122

The population structure and the proportion of various age-sex categories of the observed Menelik's bushbucks in the WWNF are given in Figure 3. Out of 136 individuals of Menelik's bushbuck counted in both dry and wet seasons the mean percentage composition of 27.94% adult males, 36.76% adult females, 11.03% sub-adult males, 15.44% sub-adult females and the remaining 8.82% were young. The male to female ratio was 1.00:1.34. During the study period, more adult individuals were counted than sub-adults and young ones. The age ratio of young to all other individuals was 1.00:10.33 and young to mature or adult aged ratio was 1.00:7.33 during both wet and dry seasons (Table 3). The ratio of sub-adults to adults were 1.00:2.47 and 1.00:2.42, sub adult males to sub-adult females was 1.00: 1.43 and 1.00:1.38, sub-adult male to adult males was 1.00:2.71 and 1:2.38 during wet and dry seasons, respectively. Here also, the ratio of sub-adult female to adult female was 1.00:2.30 and 1.00:2.45 and young to adult female was 1.00:4.60 and 1.00:3.86 during wet and dry seasons, respectively (Table 3).

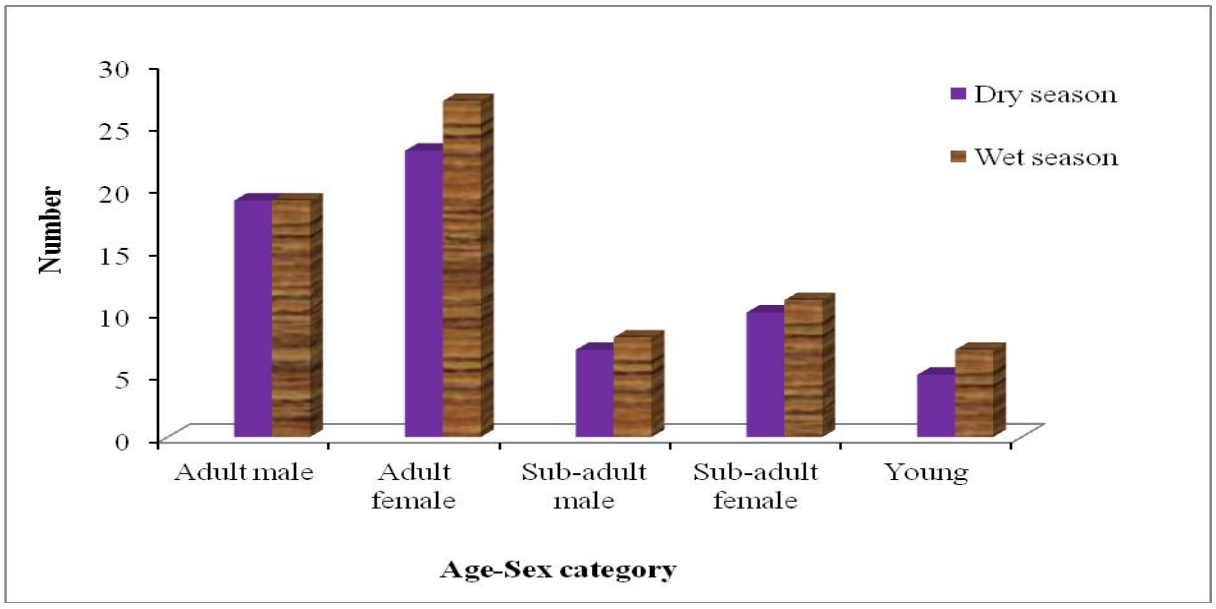


Figure 3: Age and sex categories of the Menelik's bushbuck observed during dry and wet seasons.

Table 3. Proportions of different age and sex categories of the Menelik's bushbuck recorded during the dry and wet seasons.

Season	Sex and Age categories					Ratio		
Season	Sex		Age			Sex	Age	
	AM	AF	SAM	SAF	Y	M : F	Yg: Others	Yg: Ad
Dry	19	23	7	10	5	1.00:1.27	1.00:11.8	1.00:8.40
Wet	19	27	8	11	7	1.00:1.41	1.00:9.29	1.00:6.57
Total	38	50	15	21	12	1.00:1.34	1.00:10.33	1.00:7.33

(AM = Adult male, AF = Adult female, SAM = Sub-adult male, SAF = Sub-adult female, Y = Young)

The mean number of the Menelik's bushbuck population per transect was 12.80±4.321 and 14.4±4.122 during the dry and wet seasons, respectively (see Table 1 and 2). The results of both the dry and wet season revealed there was no significance difference in the number of the Menelik's bushbuck population per transect ($F=17$, $df=8$, $P=0.185$ and $F=3.00$, $df=8$, $P=0.197$) respectively. The population of Menelik's bushbuck in the wet season was higher than dry season, but the difference was not significant ($t=1.512$, $df=8$, $P=0.169$). The highest number of Menelik's bushbucks were counted at transects number five in dry season and at transect six and

two in the wet season. The total population of Menelik's bushbucks were the same in the dry and the wet seasons in transect nine and recorded the least number of animals compared to other transects (Fig. 4).

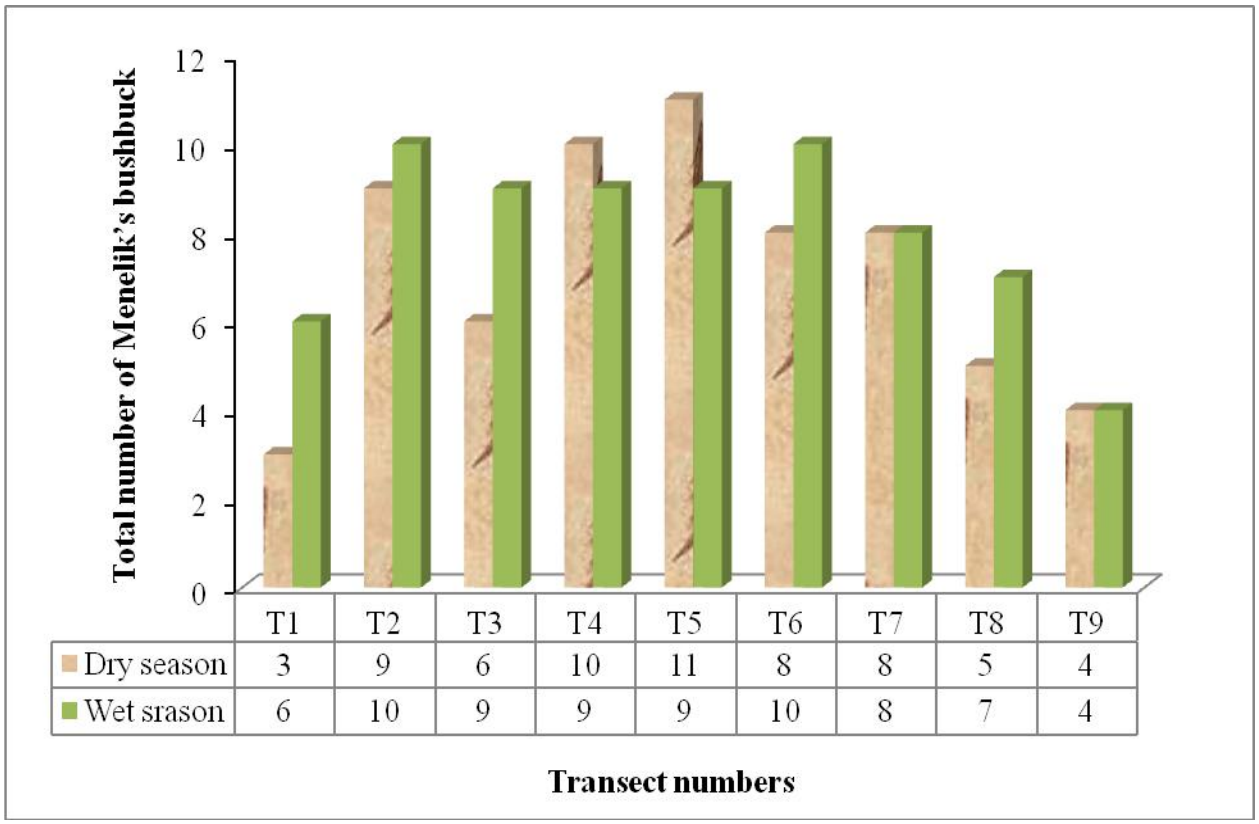


Figure 4: Total number of Menelik's bushbuck per transect both in dry and wet season

More Menelik's bushbucks were counted in the natural forest than plantation, followed by *Erica* woodland for both the dry and wet seasons (Fig. 5). The difference was significantly between natural forest and plantation (t=4.382, df=4, P=0.012), and between natural forest and *Erica* woodland (t=4.165, df=4, P=0.014), while between plantation and *Erica* woodland habitats had no significant difference (t=1.725, df=4, P=0.160).

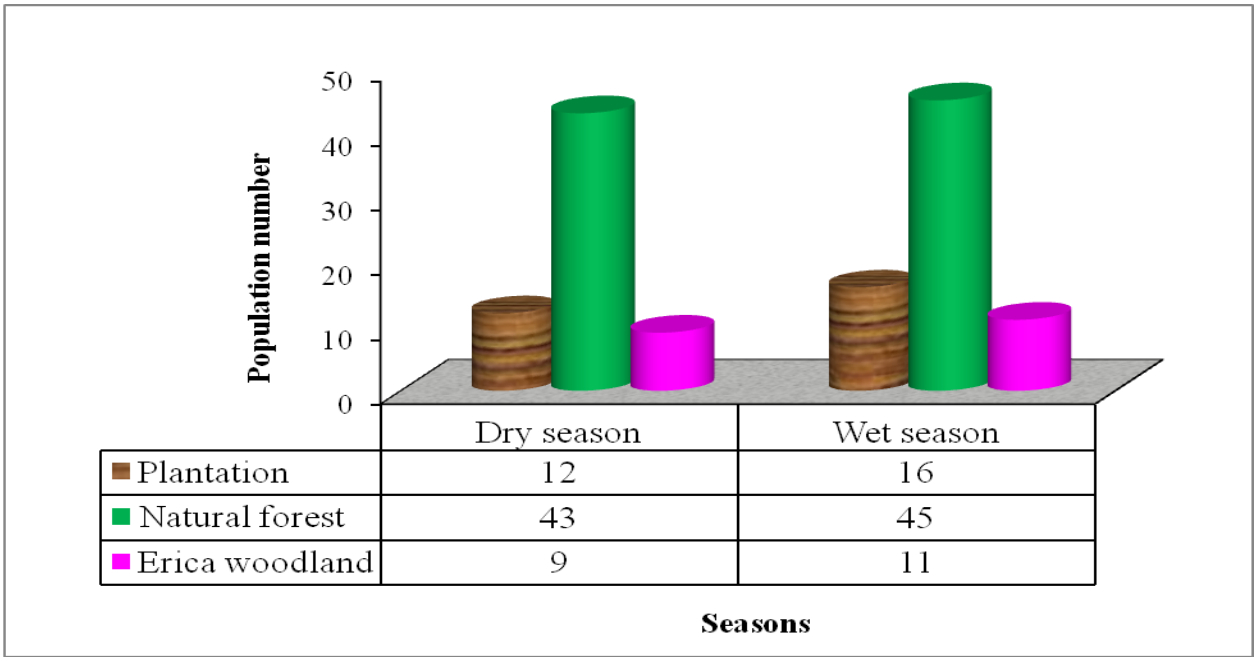


Figure 5: Menelik's bushbuck population recorded in the three habitat types both in dry and wet seasons.

4.2. Feeding Ecology

A total of 1148 feeding activity observations were recorded from scan sampling of Menelik's bushbuck. The various food types that made up the Menelik's bushbuck diet in the present study area are given in Table 4. A total of 28 species of plants species belongs in 22 families were consumed by Menelik's bushbuck. From these plant species, 39.29% were tree, 32.14% were herbs and 28.57% were shrubs. The different parts of plant preferred by Menelik's bushbuck are shown in Figure 6.

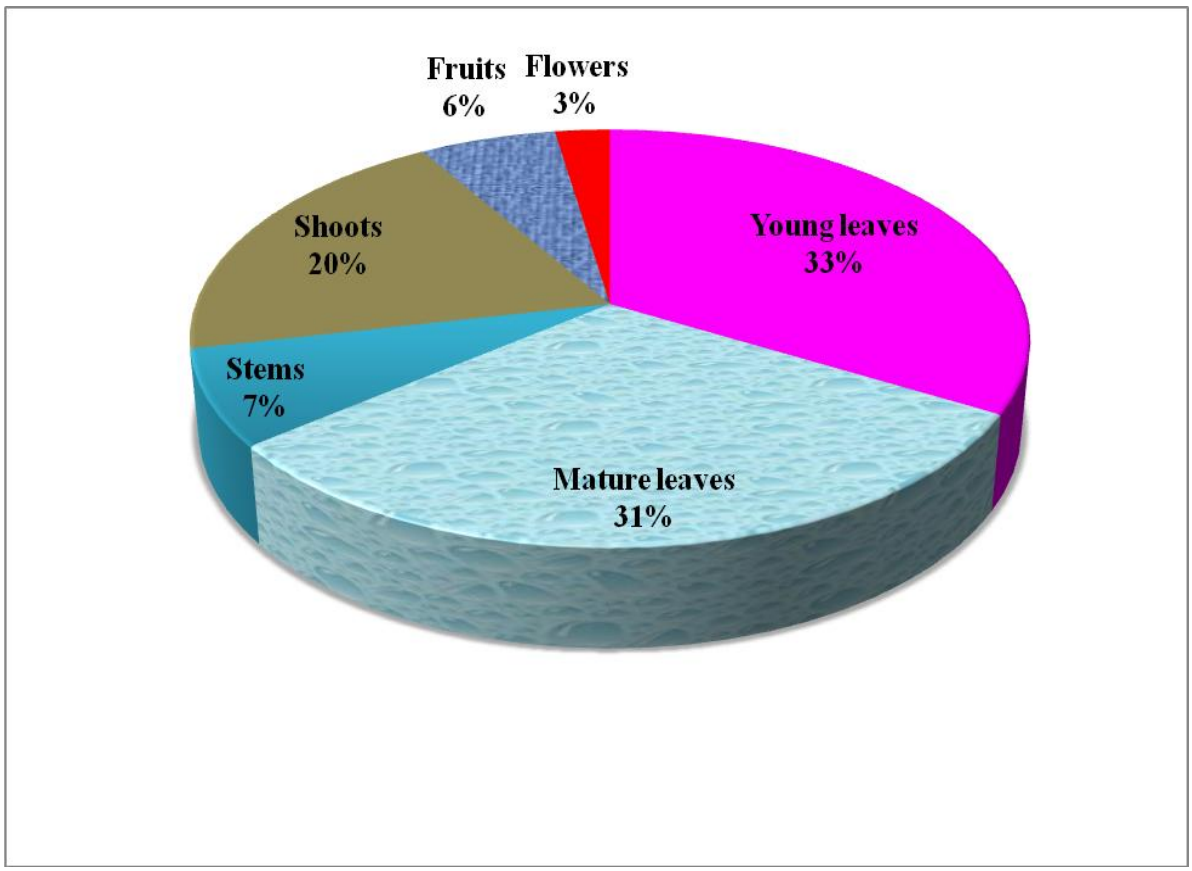


Figure 6: Plant parts preferred by Menelik's bushbuck and their percentage frequency of consumption.

The major food components of plant species for Menelik's bushbuck in the study area were *Maytenus arbutifolia* (13.45%), *Cynodon dactilon* (11.50%), *Myrsine africana* (9.90%), *Cyperus fischerianus*, *Eleusine floccifolia* and *Carissa spinarum* (8.04%, for each) and *Ilex mitis* (6.01%), while *Lobelia rhyncopetala* (0.17%), *Hagenia abyssinica* (0.25%), *Erica arborea* (0.42%), *Thymus schimperi* (0.51%) and *Cupressus pllcitanica* (0.59%) were contributed the least percentage in their diet (Table 4).

Table 4. List of plant species, food items, consumed frequency and percentage composition of the diet of Menelik's bushbuck.

Common name	Family name	Species name	Life forms	Food items	**Percentage** %
Agam	Apocynaceae	*Carissa spinarum*	T	Yl,Ml,Fr	8.04
Meser genfo	Aquifoliaceae	*Ilex mitis*	T	Yl,Ml,Sh,St,	6.01
Atat	Celastraceae	*Maytenus arbutifolia*	S	Yl,Ml,Sh,Fr	13.45
Abesha tid	Cupressaceae	*Junipers procera*	T	Yl,	1.01
Ferenge tid	Cupressaceae	*Cupressus pllcitanica*	T	Yl	0.59
Engicha	Cyperaceae	*Cyperus fischerianus*	H	Yl,Ml.Sh	8.04
Aseta	Ericaceae	*Erica arborea*	S	Yl,Ml	0.42
Wajima	Fabaceae	*Medicago polymorpha*	H	Yl,Ml,St,Sh, Fl	4.82
Tree Lucerine	Fabaceae	*Chamaecytisus proliferus*	S	Yl,Ml,Sh,	0.59
Koshim	Flacourtiaceae	*Dovyalis abyssinica*	S	Yl,Ml,Fr	0.59
Amija	Hypericaceae	*Hypericun revolutum*	S	Yl,Ml,Sh	1.78
Tosegne	Lamiaceae	*Thymus schimperi*	H	Yl,Ml,Sh	0.51
Jibra	Lobeliaceae	*Lobelia rhyncopetala*	H	Yl	0.17
Kelewa	Myricaceae	*Mtrica salicifolia*	T	Yl,Ml,Sh	0.93

Kechemo	Myrsinaceae	*Myrsine Africana*	S	Yl,Ml,Sh	9.9
Weira	Oleaceae	*Olea europaea* subsp. *Cuspidate*	T	Yl,Ml	1.1
Wertub	Plantaginaceae	*Plantago lanceolata*	H	Yl,Ml,Sh,St	1.44
Senbelet	Poaceae	*Hyperrhenia hirta*	H	Yl ,Ml,Sh	1.78
Serdo sar	Poaceae	*Cynodon dactilon*	H	Yl,Ml,St,Sh	11.5
Akerma	Poaceae	*Eleusine floccifolia*	H	Yl,Ml,Sh,St	8.04
Embacho	Polygonaceae	*Rumex nervosvs vahl.*	T	Yl,Ml,Sh	2.62
Kega	Rosaceae	*Rossa abyssinica*	S	Yl,Ml,Sh,Fr	2.28
Tikur Enchet	Rosaceae	*Prunus Africana*	T	Yl,Ml	0.59
Koso	Rosaceae	*Hagenia abyssinica*	T	Ml	0.25
Tota kula	Rubiaceae	*Galineria saxifrasa*	T	Yl,Ml	2.96
Akenchira	Scrophulariaae	*Striga craterostigma*	H	Yl,Ml,St,Sh	1.94
Ketkita	Spaindaceae	*Dodonaea viscose*	S	Yl,Ml,	3.3
Lenquatie	Tiliaceae	*Grewia ferruginea*	T	Yl,Ml,Fr,Fl	5.5
Total					100%

(T=Tree, H=Herb, S=Shrub, Yl=Young leaves, Ml=Mature leaves, St=Stem, Sh=Shoot, Fl=Flower, Fr=Fruit).

In addition to the plant species found in the forest, eight species of crops, gesho (*Rhomus prinoides),* chilly (*Capsicum annum),* wheat (*Criticum satvium),* barely (*Hordeum vulgare),* beans (*Vicia faba),* peas (*Pisum sativum),* maize (*Zea mays)* and cabbage (*Brassica carinata)* were consumed by the Menelik's bushbuck outside the forest boundary and also the local communities reported that these crops were eaten by the Menelik's bushbuck.

4.3. Direct observation of anthropogenic threats

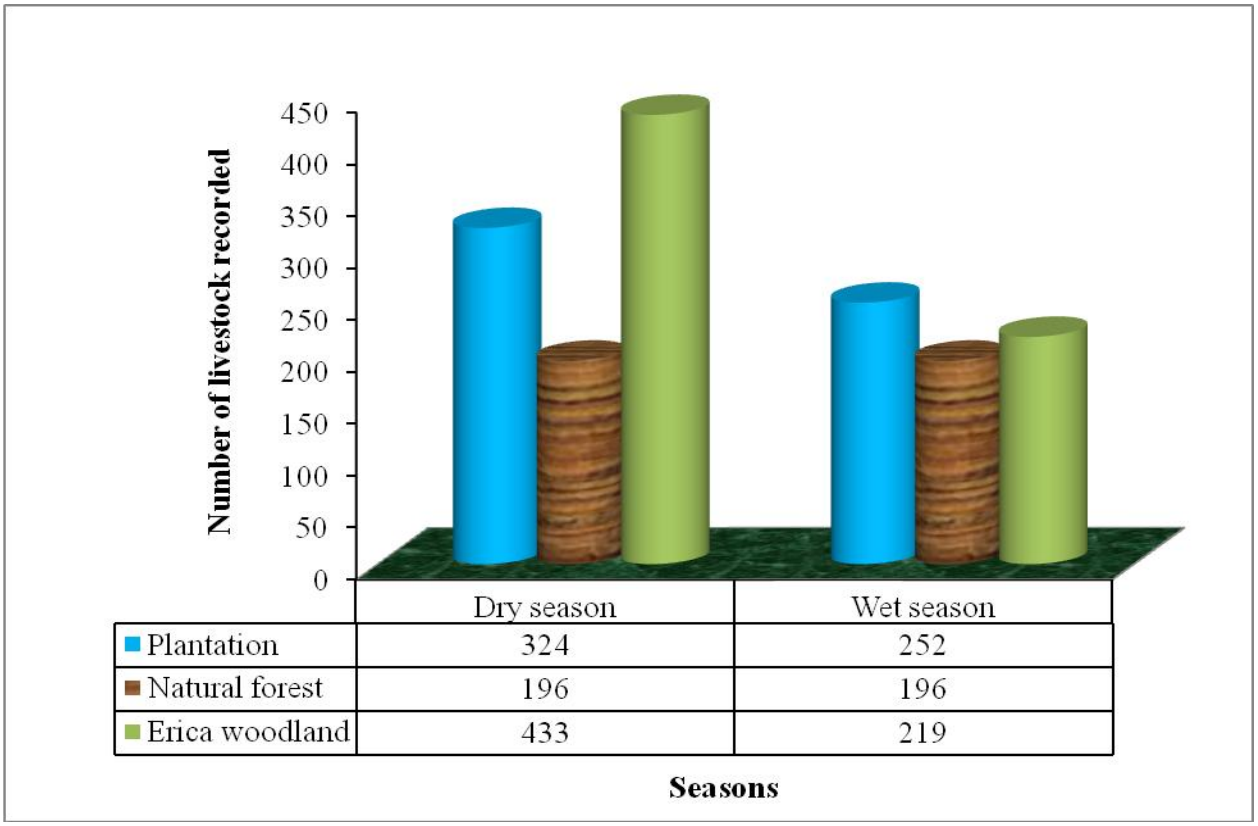
During the study period, 1620 numbers of livestock were observed grazing in the three Menelik's bushbuck habitats both in dry and wet seasons (Table 5). Overgrazing increased competition for pastures especially during the dry seasons. The number of sheep was the highest, followed by cattle, goat, donkey and horse both in dry and wet seasons, which constituted for 570, 476, 404, 123 and 47 individuals, respectively.

Table 5. Types and number of livestock grazed in the Menelik's bushbuck habitats during dry and wet season

Season	Type and number of livestock recorded					Total
	Sheep	Cattle	Goat	Donkey	Horse	
Dry season	366	285	212	60	30	953
Wet season	204	191	192	63	17	667
Average	285	238	202	61.5	23.5	1620

During the dry and wet seasons a mean of 105.89 ± 27.718 and 74.11 ± 15.291 livestock respectively per transect foraged in Menelik's bushbuck habitats. During the dry season more livestock were sighted per transects than during the wet season. There was a significant difference (t = 3.820, df=8, P=0.005) in the number of livestock grazed per transect in the dry season. Similarly, during the wet season, there was a statistical difference (t=4.846, df= 8, P=0.001) in the number of livestock grazed per transect.

The highest number of livestock was recorded in *Erica* woodland habitat of Menelik's bushbuck, followed by plantation in the dry season, while in the wet season the highest number of livestock recorded was in the plantation followed by *Erica* woodland habitat (Fig. 7). In natural forest habitat of Menelik's bushbuck, livestock were foraged similarly in both dry and wet seasons.



	Dry season	Wet season
Plantation	324	252
Natural forest	196	196
Erica woodland	433	219

Figure 7: Total number of livestock recorded in Menelik's bushbuck habitat types during dry and wet seasons

The mean number of people seen performing different activities in Menelik's bushbuck habitats per transect during the dry and wet seasons was 29.89 ±2.19 and 17.33 ± 1.33, respectively. Recorded human activities were herding livestock, collecting firewood, cutting trees for construction, farm tools and timbers and collecting grasses, which have disturbed the Menelik's bushbuck and/or cause threat to the habitat. High number of people who performed such activities was recorded in the dry season (Fig. 8). The number of people observed per transect during the dry season showed significant difference (t=13.617, df= 8, P =0.000). There was also significant difference in the wet season (t=13.00, df=8, P =0.000) in the number of people performed different activities in Menelik's bushbuck habitats.

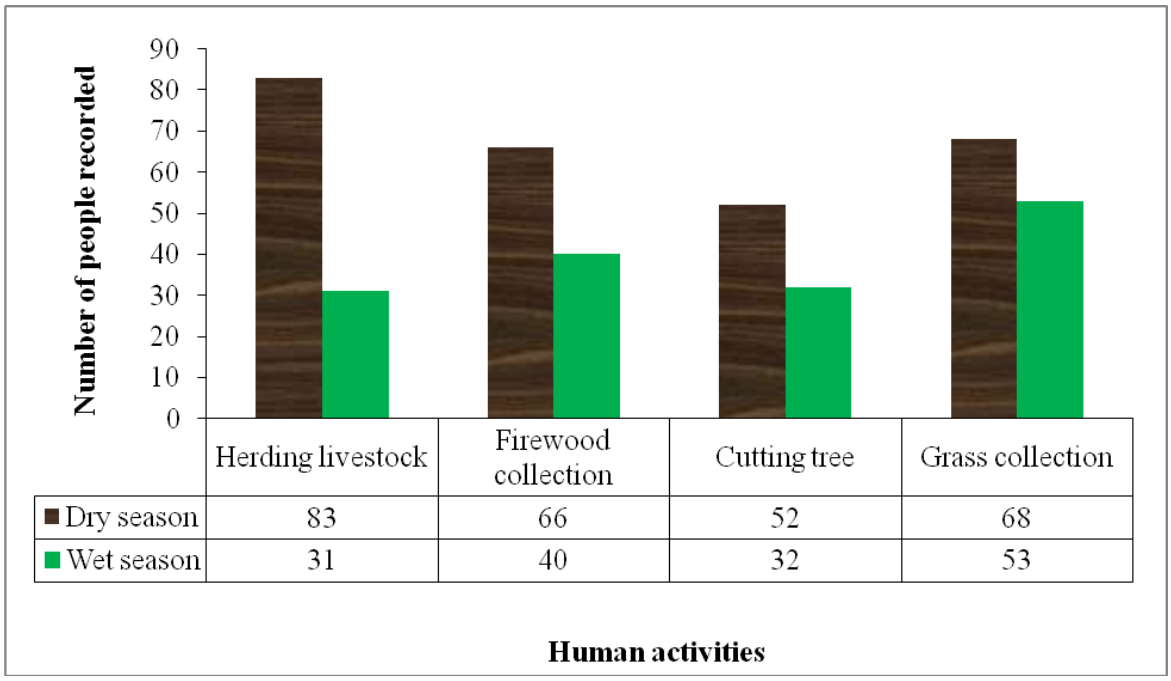


Figure 8: Number of people performing different activities in Menelik's bushbuck habitats in the study area during dry and wet seasons

The mean number of individuals observed herding livestock per transect during the dry and wet seasons were 9.22 ± 2.23 and 3.44 ± 0.67, respectively. There were a significant difference in the dry season (t=4.14, df= 8, P= 0.003) in the number of people kept livestock per transect. Likewise, the result of the wet season observation also showed there was a statistical difference (t=5.15, df=8, P=0.001) in the number of people kept livestock per transect.

The mean number of individuals observed collecting firewood per transect during the dry and wet seasons was 7.33± 1.47 and 4.44 ± 0.67, respectively. There was a statistical difference in the number of individuals collected firewood per transect during the dry season (t=4.98, df =8, P=0.001) and wet season (t=5.43, df =8, P = 0.001), respectively.

Mean number of individuals, who perform **t**imbering by cutting big trees from the study area per transect during the dry and wet seasons was 5.78± 2.01 and 3.56 ± 1.58, respectively. Tree cutting from each transect during the dry season differed significantly (t=2.87, df= 8, P=0.021). Similarly, during the wet season, there was a significance variation in the number of individuals involved in tree cutting per transect (t=2.25, df= 8, P=0.055). Timber extraction for construction work and to make utensil material was mostly observed in and at the border of natural forest habitat of Menelik's bushbuck (Fig. 9).

Figure 9: Processing logged tree by local people (Photo: Brnesh H/Mariam, 2013)

Mean number of individuals who collected grass from the study areas per transect during the dry and wet seasons was 7.56 ± 2.26 and 5.89 ± 0.86, respectively. Grass collection from each transect during dry and wet seasons differed significantly ($t=3.34$, $df= 8$, $P=0.010$ and $t=6.87$, $df =8$, $p=0.000$, respectively).

4.4. Questionnaire data

Out of the 54 respondents involved in the questionnaire survey, 37 (68.5%) were males, and 17 (31.5%) were females. Majority (75.90%) of the respondents' age ranged from 21 to 50 years old, while 11.10% and 13.00% of the respondents' were less than 20 years and older than 50 years, respectively. In terms of education, 38.9% of respondents had informal education, who

can read and write, while 18.5% were illiterate, 25.9% had primary education, 16.7% had secondary and beyond secondary level of education. With regard to family size, 64.8% of respondents had 4-7 family size, while 16.7% of the respondents had 1-3 and 8-10 family size for each. On the other hand 1.9% of respondents had more than 10 member families.

Most of the respondents (29.6%) have lived 21-30 years in the study area concerned, while 16.7%, 22.2%, 20.4%, and 11.1% of the respondents lived in the area for 11-20, 31-40, 41-50 and more than 51 years, respectively. According to their response, majority of the heads of households were born in the areas concerned.

The major livelihood activity of the people living adjacent to the WWNF was subsistence agriculture, which include both crop farming and livestock rearing. As shown in Figure 10, the land holding size of the surveyed households ranged from 0 to 1.5 hectares. From the total respondents interviewed, 90.70% of respondents had crop lands around the forest. However, farmers cultivated maize (*Zea mays)*, peas (*Pisum sativum*), beans (*Vicia faba*), barely (*Hordeum vulgare*), wheat (*Criticum satvium*) and chilly (*Capsicum annum*).

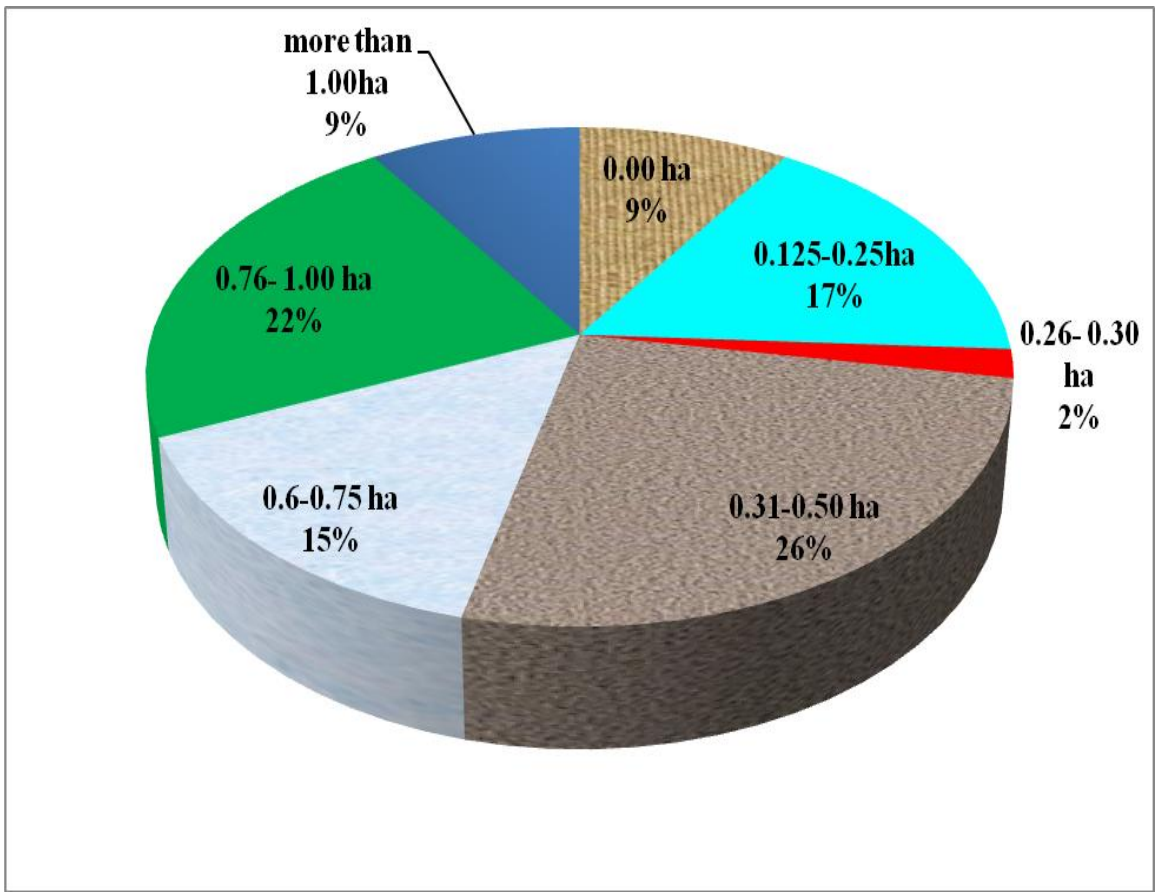


Figure 10: Size of the crop land owned by households around the study area

Out of the respondents, 39 (72.2%) were involved in livestock grazing in the study area for different time length. Among them, 28 (71.8%) respondents used grass for their livestock throughout the year, while 11 (28.2%) of respondents used the forest only for 5-9 months. The major livestock reared by the local communities were cattle, sheep, goat and pack animals which include donkey and horse (Fig. 11). The mean number of livestock in the study area per household was 9.05±0.609.

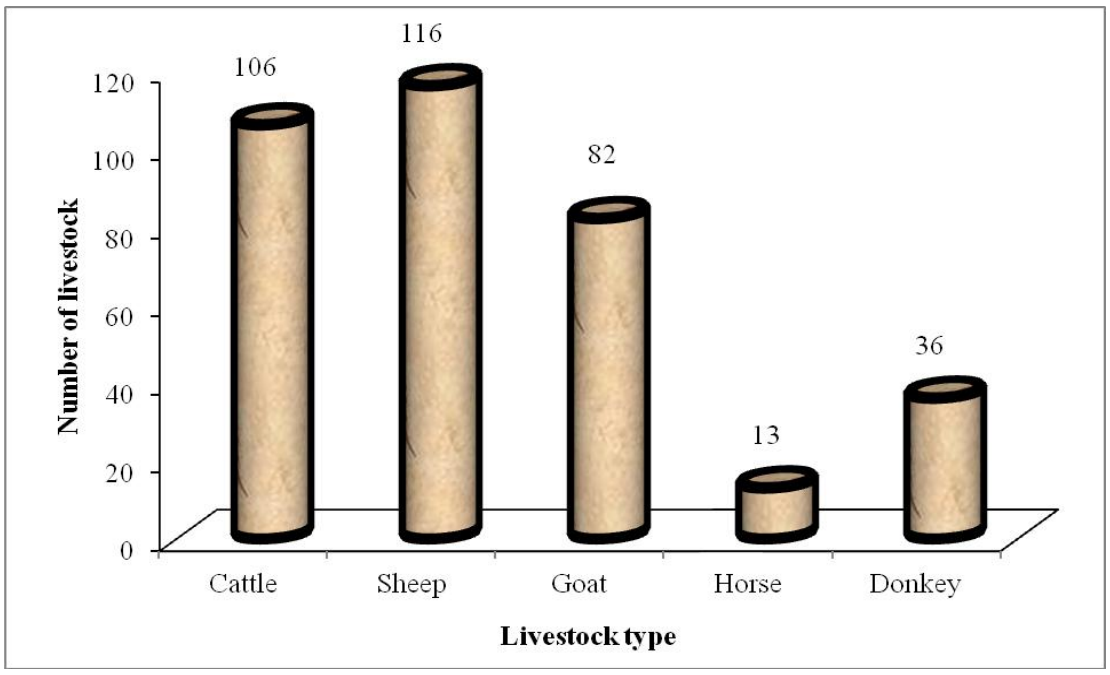


Figure 11: Number and types of livestock from respondent information

The community living adjacent to WWNF used the area for cutting grass, firewood collection and cutting trees for construction materials and furniture making in addition to grazing their livestock. Out of the total respondents, 35 (64.8%) were accounted for cutting grass. Among the respondents, 49 (90.7%) were using the forest for firewood collection. On the other hand, 16 (29.6%) of respondents were cutting the trees for house construction and for making furniture.

Regarding to the attitude of respondents to Menelik's bushbuck, most (35 (64.8%)) of respondents had positive attitude towards the conservation of this animal. But, 14 (25.9%) and 5 (9.5%) of the respondents had negative and neutral attitude, respectively. There were no significant difference in the attitude of respondents and sex ($\chi 2$ =0.422, df=2, P= 0.810), between attitude of respondents and age ($\chi 2$ = 3.865, df= 8, P=0.869), and between attitude and educational status ($\chi 2$ = 8.542, df=6, P=0.201).

Most (77.8%) of respondents wanted to participate in Menelik's bushbuck management in the area, but 12 (22.2%) were not given attention to protect Menelik's bushbuck. There were no significant difference between sex of the respondents in Menelik's bushbuck conservation ($\chi 2$ =0.742, df= 1, P= 0.485), age groups ($\chi 2$ =3.619, df=4, P=0.46), and educational status ($\chi 2$ =3.279, df= 3, P=0.351). Male respondents expressed more interest in conservation of Menelik's bushbuck than female respondents. Most of respondents (54.76%) were aged between 21-40 years expressed the need to conserve Menelik's bushbuck, while the age group between 11 - 20, and more than 41 years accounted for 14.29% and 30.95%, respectively, need to conserve Menelik's bushbuck.

Educated respondents (45.24%) expressed interest for conservation of Menelik's bushbuck than less educated (only read and write) 38.105% and illiterate respondents 16.67%. According to the respondents, the values of Menelik's bushbuck for local community were accounted 58.97% for source of revenue from tourists and 41.03% for source of meat and traditional hide productions. However, in household questionnaire allocation surveys, a total of 19 Menelik's bushbuck's hides or leather (Fig. 12) was observed in respondent's house.

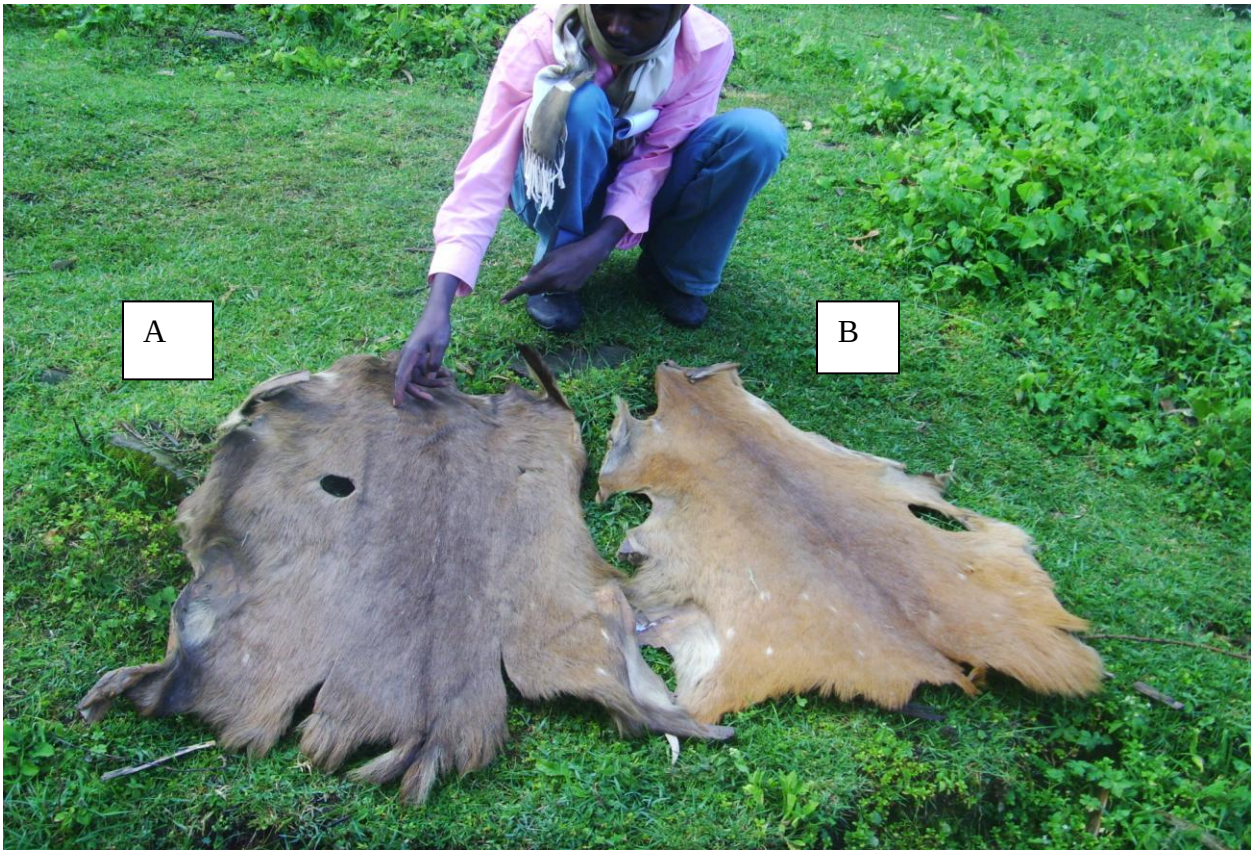


Figure 12: The hides of Menelik's bushbuck (A male B female) (Photo: Brnesh H/Mariam, 2013)

5. DISCUSSION

The result of the present study revealed that the populations of Menelik's bushbuck structured with 27.94% adult males, 36.76% adult females, 11.03% sub-adult males, 15.44% sub-adult females and 8.82% young individuals. Females were predominant than males and young in the populations of Menelik's bushbuck both in dry and wet periods, which indicates that the population have a potential to increase in number. The male to female ratio of this result (1.00:1.34) is not deviated much from studies in Denkoro forest (Yazezew *et al.*, 2011).

Possible reasons for unequal postnatal sex ratio may be due to the increased mortality of males because they were more exposed to predation than females as they are less vigilant during feeding. The solitary nature of males forming small groups enhances the vulnerability of males towards predation (Dasmann and Mossman, 1962). This is because males leave their mother after maturity while females remain to form a mother clan (Wronski *et a*l., 2006c). The explanation for male mortality is also that bachelor males are distributed often in less favorable habitats as the central core area is inhabited by territorial adult males (Wronski, 2004 and 2005).

The number of young Menelik's bushbuck accounted 8.82% of the total recorded individuals. The ratio of young to other individuals (1.00:10.33) in the present study may show a declining trend of the animal. The possible reasons for the low proportion of young in the population may be higher percentage of young mortality or predation. Mostly, young individuals are prone to predators than others, because they are unable to escape from predators at this stage. The young have a tendency to be kept hidden under bushes or other shaded areas and they could have been underestimated during the survey (Wronski, 2004). Young to other individual ratio of the present study was also comparable to the earlier study of Yazezew *et al.* (2011).

Distribution and habitat association of animals are determined based on the availability of water, food, shelter and breeding site changes on a seasonal basis (Balakrishinan and Easa, 1986). In the present study, more Menelik's bushbucks were counted during the wet season than during the dry season. This finding agrees with the result of Yazezew *et al.* (2011). The dry season in the present study area coincides with the availability of less food, water and shelter. This reduced the foraging efficiency of the animal and they hide themselves during hot weather in the dense bush forests and under thick vegetation cover (Yalden and Largen, 1992; Wronski *et al*., 2006c). On the other hand, human activities and livestock were more in the dry season leading to disturbance and resource competition. As a result, Menelik's bushbucks were less accounted in dry season.

Population counts of Menelik's bushbucks were not significantly different between dry and wet seasons ($p > 0.05$). This indicates that the relative abundance of Menelik's bushbuck is naturally associated with preference towards a given habitat in each season. This could depend on what the habitat provides in terms of shelter, food, water source, security from human disturbances and free space for essential activities (Dankwa and Euler, 2002). The differences in the counts of Menelik's bushbucks in some of the transects might resulted in the tendency of Menelik's bushbucks to seek habitats with good supply of food from season to season.

Out of the nine transects, Menelik's bushbucks were more frequently counted in transect 5, which is a dense forest and included rivers. This is supporting the views of Yalden and Largen (1992) and Chane (2010), who described that Menelik's bushbucks are associated to dense forest and water sources. Lowest numbers of Menelik's bushbucks were counted in transects 1 and 9. Because these transects were mostly open, near to human settlements, exposed to human activities, and lack water sources. This also supports the findings of Yalden *et al.* (1984) and

Yazezew *et al.* (2011), who confirmed that Menelik's bushbuck is limited the dissemination in water deficient and threaten areas with less resources.

Counts of Menelik's bushbuck revealed significant differences between natural forest and plantation and between natural forest and *Erica* woodland habitats ($P< 0.05$), while there was no significant difference between plantation and *Erica* woodland habitat type. Most individuals were found at natural forest, followed by plantation and *Erica* woodland, respectively both during dry and wet seasons. Thus, Menelik's bushbucks prefer the middle part of the forest since human impact is minimized due to its inaccessibility and seems to be more ecologically intact than plantation and *Erica* woodland habitats. Plantation and *Erica* woodland sites are highly affected by human activities and have relatively poor habitat quality because of intense livestock grazing. Therefore, least number of Menelik's bushbucks was recorded in these two habitats types. Chane (2010) also described that Menelik's bushbucks are not favored in open and disturbed habitat.

The diet of Menelik's bushbucks consisted of 28 plant species during the study period. This corresponds with the bushbuck's ability to utilize a wide range of plant species as already reported by several workers (MacLeod *et al*., 1996; Haschick and Kerley, 1997). From this recorded diet of Menelik's bushbuck, 13 species of plants are in accordance with previous studies of Yazezew *et al*. (2011) in Denkoro forest. The top three plant species, *Maytenus arbutifolia* (13.45%), *Cynodon dactilon* (11.50%) and *Myrsine africana* (9.90%) accounted for 34.85% of their overall diet in the present study. Menelik's bushbucks prefer to eat leaves, shoots, stems, fruits and flowers (Kingdon, 1997; Wronski, 2004). The present study and Yazezew *et al.* (2011) investigation also agreed with these food items eaten by the Menelik's bushbuck.

Even though, Menelik's bushbucks consumed all food items listed in the present study, leaves accounted for 64% of their overall diet. Menelik's bushbucks preferred younger leaves to mature leaves. This is in line with the findings of Yazezew *et al*. (2011), which indicated that Menelik's bushbucks are mostly browsers as they spend most of their time feeding on leaves. In addition, they also spend a small portion of their time feeding on shoots and stems. However, flower and fruits were seasonal food items and were not available throughout the year. The present study showed that Menelik's bushbucks are miscellaneous feeders, which rely on 39.29% tree, 32.14% herbs and 28.57% were shrubs. These life forms of plants consumed by this animal are similar to the findings of Wronski (2006b) for bushbuck in general and AMWCDO (1981) and Yazezew *et al*. (2011) for Menelik's bushbuck, in particular.

It is difficult to discuss the population trend of Menelik's bushbuck in the present study area as population census of the species has not been made for a continuous period. Due to the increasing human population, encroachment into the wildlife areas increases and more lands adjacent to the wildlife area are used for livestock grazing, farmland and other human activities, this creates pressure on wildlife population in WWNF (Schürmann, 2008). This might make significant effects on the Menelik's bushbuck population in the study area in the coming years.

During the dry and wet seasons 105.89 ± 27.718 and 74.11 ± 15.291, respectively, mean number of livestock per transect foraged in Menelik's bushbuck habitats. Overgrazing increased competition for pastures especially during the dry season due to the incidence of grass and other food items in the forest better than outside the forest and lack of alternative grasslands for local community out of the forest. High number of sheep and other domestic animals grazed in the forest. These have caused deterioration of vegetation that might influence the distribution of wildlife including Menelik's bushbuck in the forest.

According to Newmark *et al*. (1994), the major problem protected areas facing today in Africa is human settlements in adjacent lands and the unauthorized harvesting of resources within the protected areas in Africa. During physical observation periods the mean 29.89 ±2.19 and 17.33 ± 1.33 number of people have seen during the dry and wet seasons, respectively which performing herding livestock, collecting firewood, cutting trees for construction, farm tools and timbers and collecting grasses in Menelik's bushbuck habitats per transect. These might cause scarcity of food for Menelik's bushbuck and disturb the natural behaviour of this animal in their habitat. Forest exploitation and farming activities inside or close to the forest boundary might cause strong impacts on this animal. Wild animals are highly restricted in some parts of the forest because of human and livestock encroachment (Sillero-Zubiri, 2004). Menelik's bushbucks have been disturbed in their habitat because of their furtive behaviour (Yazezew *et al.,* 2011).

Monitoring the concern of local communities related to conservation around wildlife resources can provide a foundation for effective decision making that mitigates impact of human beings on wildlife habitat. Local opinions can also influence conservation efforts and conflict tolerance (Beresfored and Phillipins, 2000). Data collected through the questionnaire survey in this study pointed out that the local community use resources from the forest. According to their response, 64.8%, 90.7% and 29.6% of respondents were accounted for cutting of grasses, firewood collection and cutting the trees, respectively.

Conservation attitude of communities living adjacent to protected areas is highly influenced by the problems associated with wildlife (Balakrishnan and Ndhlovu, 1992). Small losses of community economy caused by wildlife can generate negative attitude towards wildlife in communities with subsistence economy (Oli *et al.,* 1994). Despite the conflicts and problems encountered by Menelik's bushbuck, most (64.8%) of the respondents had positive attitude

towards conservation of Menelik's bushbuck, whereas some (25.9%) of the respondents had negative attitudes due to frequently crop raiding of Menelik's bushbuck. This crop raiding behaviour and human conflict extent of Menelik's bushbuck also reported by Adem (2009) in Denkoro forest.

The positive attitude of local communities towards Menelik's bushbuck is because of no agricultural land near to the forest boundary and no crop damage by this animal. The local communities are advantageous from the source of meat and tourism value of Menelik's bushbuck, and has this value of Menelik's bushbuck might create positive attitude among the local community. According to the respondents, the values of Menelik's bushbuck were 58.97% and 41.03% for tourism and for source of meat and traditional hide productions, respectively. Due to such have values, 77.8% of respondents need to participate in Menelik's bushbuck conservation in the area by controlling hunters and deforestation. As the crop loss by Menelik's bushbuck increases, the attitude towards the animal becomes negative. Generally, the direct conflict over livelihoods produces negative perceptions towards Menelik's bushbuck, while the reverse is true for positive perceptions.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The population structures of Menelik's bushbuck were adult male and adult female biased. The high percentages of adult individuals showed that Menelik's bushbuck population will be decreased in WWNF in the near future. The distribution of the Menelik's bushbuck is related to the availability of the resource across the WWNF. Data related to feeding habit and habitat preferences of Menelik's bushbuck showed that they are mixed feeder herbivore and appears to require availability of food plants, water and covers. The Menelik's bushbuck mostly preferred natural forest habitat in the study area due to availability of food and water sources and due to less anthropogenic effects. This study also revealed that young and matured leaves with various food items and species of plants are the principal diet of Menelik's bushbuck.

Even though, Menelik's bushbucks do not appear to be in immediate threat in the study area, there are many conservation problems that could affect the species in the future. These threats are the results from increasing human population, settlement encroachments to Menelik's bushbuck ranges and increase in subsistence agriculture, overgrazing and overexploitation of natural resources and deforestation in WWNF. As a result, the quality of the Menelik's bushbuck habitat is disturbed and deteriorated. The scarcity of food in this degraded habitat will have profound negative effects on different aspects of the ecology of the animal. Although there is crop damage, the attitude of most of the local people towards Menelik's bushbuck is positive.

6.2 Recommendations

The results of the present study have several conservation and management implications to mitigate the threats that could be faced on the Menelik's bushbucks and their habitat.

Based on the findings of the present study, the following points are recommended

- Local residents should receive awareness education on the values of forest and wildlife conservation.
- Local people should minimize deforestation, grass collection, livestock grazing and encroachment to redevelop degraded areas in WWNF.
- In order to conserve Menelik's bushbuck or other wildlife and prevent future decline, conservation practices involving local people should be incorporated.
- The illegal activities like poaching of Menelik's bushbucks and timber logging of trees should be strictly controlled.
- The topography of Wof Washa forest and the surrounding areas is very attractive and interesting and thus they have great potential for tourism. But, facilities such as roads, experienced wildlife experts for that area and field guides are lacking. If such and other facilities are fulfilled, tourists can visit the area and the local people will improve their economic status through hotels, lodges, restaurants and selling local products. This, in turn will develop positive attitude among the local people towards forest and wildlife conservations.
- Conservation program for endemic Menelik's bushbuck in the WWNF should be established.
- Long term research should be carried out on other aspects of this endemic animal.

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LIST OF APPENDICES

Appendix **I**. Interview sheet

1. Sex _____ Age _____ Family size _____

2. Educational status_____

3. Time living in the area _____years.

4. Do you have livestock? A. Yes B. No

If "yes" mention the type and numbers?

5. Does your livestock graze in the Wof Washa Forest? A. Yes B. No

If "yes" How long do you use for grazing in Wof Washa Forest? _____

6. Do you have farm land inside or around the study area? A. Yes B. No

If "yes" What is the size of your farming land? _____

7. Do you produce charcoal from the study area? A. Yes. B. No

8. Do you collect grass from the study area? A. Yes. B. No

9. Do you collect firewood from the study area? A. Yes. B. No

10. Do you cut tree from the study area? A. Yes. B. No

11. Is there any Menelik's bushbuck hunter in Wof Washa Forest? Yes □ No □

12. What is your attitude towards the Menelik's bushbuck?

A. positive B. negative C. neutral

13. What do you obtain from Menelik's bushbuck in the study area? _____

14. Do you have an interest in management of the Menelik's bushbuck? Yes □ No □

Appendix **II**. Data collection sheet for population census of Menelik's bushbuck

Date_____

Transect No.	Adult male	Adult female	Sub-adult male	Sub- adult female	Young
1					
2					
3					
4					
5					
6					
7					
8					
9					
Total					

Appendix **III**. Data collection sheet for direct observation of anthropogenic threats of Menelik's bushbuck

1. Study site _____

2. Date _____ starting time _____ending time _____

3. Number of Menelik's bushbuck observed in the transect _____

4. Number of livestock disturbing Menelik's bushbuck during observation

A. Sheep _____ B. Goat _____ C. Cattle _____ D. Horse _____

F. Donkey _____

5. Number of people seen performing different activities in the area

A. collecting grass _____ B. collecting firewood _____

C. herding livestock _____ D. cutting tree _____