




**Madda Walabu University**

**School of Graduate Studies**

**Department of Ecotourism and Biodiversity Conservation**

**Ecosystem and Biodiversity Conservation Program**

# Population Status, Trends and Habitat Use Type of Mountain Nyala *(Tragelaphus buxtoni)* In Bale Mountains National Park Southeastern Ethiopia

**By; Shamil Kedir**

**Advisor: Habte Telila (PhD)**

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**APPROVAL SHEET ONE**

**To**: Ecotourism and Biodiversity Conservation Department

**Subjec**t: Thesis Submission

This is to certify that the thesis entitled "**Population Status, Trends and Habitat Use Type of Mountain Nyala *(Tragelaphus buxtoni) in Bale Mountains National Park South eastern Ethiopia."***Submitted in partial fulfillment of the requirements for the degree of Master's of science in Ecosystem and Biodiversity Conservation, the Graduate program of the department of Ecotourism and Biodiversity Conservation, and has been carried out by Shamil Kedir, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence here by he can submit the thesis to the department.

Name of major Advisor/supervisor: HabteTelila (PhD)

Signature:

Date:

**APPROVAL SHEET TWO**

This is to certify that the thesis prepared by Shamil Kedir, entitled "**Population Status, Trends and Habitat Use Type of Mountain Nyala** *(Tragelaphus buxtoni)* **In Bale Mountains National Park Southeastern Ethiopia."** It is submitted in partial fulfillment of the requirements for the Degree of Master of Science in Ecosystem and Biodiversity Conservation complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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| _____ | _____ | _____ |
|---|---|---|
| **Name of student** | **Signature** | **Date** |

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Name of Advisor

1._____ _____ _____

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1._____ _____ _____

Name of Internal Examiners:

2._____ _____ _____

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**DEDICATION**

This thesis is dedicated to my father Ato Kedir Kelil from whom I gained a lot of experiences in my life.

**STATEMENT OF THE AUTHOR**

By my signature below, I declare and affirm that this Thesis is my own work. I have followed all ethical and technical principles in the preparation, data collection, data analysis and compilation of this Thesis. Any reference that is included in the Thesis has been given recognition through citation. Likewise, brief quotations from this Thesis may be used without any special permission provided that accurate and complete acknowledgement of the source is made. However, in all other instances, permission must be obtained from the author of the Thesis.

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**ABBREVIATIONS**

BMNP Bale Mountains National Park

EWCA Ethiopian Wildlife Conservation Authority

EWCP Ethiopian Wildlife Conservation Program

FZS Frankfurt Zoological Society

GPS Geographical Positioning System

GTZ Germen Technical Zusmmenarbet

HQ Headquarter

IBC International Biodiversity Conservation

IUCN International Union for Conservation of Nature and Natural Resource

**ABSTRACT**

*This study was carried out in Bale Mountains National Park Southeastern Ethiopia. The objective of the study was to investigate the population structure, trends and habitat use of Mountain Nyala in three major habitat types (Gesse grassland, Woodland (Head quarter), Afro-alpine habitats) which were identified by and sampled. Population counts of Mountain Nyala was carried out using stratified systematic transect line sampling method in the study area 25 transect line ranged from 0.2-3.5 km was made. In the study area about 2156 Mountain Nayala were counted in the wet season and 2032 individual Mountain Nyala were counted during the dry season. A total of 199 groups of Mountain Nyala were found in wet season and also 190 groups of this animal were counted in dry season in the study area. Of which, 142 groups observed in Gesse grassland, 39 groups observed in head quarter and 9 groups were observed in Afro-alpine during wet season. About 77.87% Mountain Nyala were observed in Gesse grassland and the rest 16.04% and 6.09% were observed in head quarter and Afro-alpine respectively. Likewise, in dry season about 80.31%, 17.03% and 2.66 were seen in Gesse, head quarter and Afro-alpine habitat respectively. Moreover, the study identified that the total number of Female juvenile groups was higher than the total group number of each groups. As the study show from the total wet season counted Mountain Nyala about 28.64 % were Female juvenile groups and about 31.05% of total count in dry season was also Female juvenile groups. Regarding to the trend of the population of Mountain Nyala it is irregular in each particular period of time. For instance in Gesse and Afro alpine sites the population were increased from 2013 to 2014, whereas, the number of this animal were decreased from 2014 to 2016 and since 2016 the number of Mountain Nyala is increasing. Regarding to the distribution and habitat preference of Mountain Nyala from the total counted Mountain Nyala about77.87% populations were found in Gesse grass land and the other 16.04% and 6.09% found in Afro alpine and Head Quarter respectively. Again Mountain Nyala prefer mostly Gesse open grassland habitat type and also Gesse forest and Gesse Bush land habitat types. To this end, regular assessment, monitoring and evaluation of Mountain Nyala and other wildlife population and conservation threats are essential for better conservation measures.*

*Key words: Mountain Nyala, Wildlife, Habits, Conservation Measures*

# 1. Introduction

## 1.1 Background of the Study

Globally, a total of about 5416 species of mammals exist, out of which 1150 species of mammals are recorded in Africa (Evangelista, *et al*. 2006). Ethiopia is one of African countries which is home to a highly diversified faunal species composition. The country has a land area of 1.12 million square kilometers and wide variety of topography and climate. There is a great variation in altitude ranging from 116m bsl in the Danakil depression of Afar region to 4620m above sea level at the top of Mountain Rasdashen of Semen Mountains (EWCA, 2017).

Ethiopia currently possesses more than 320 species of mammals of which 55 are endemic. Out of this 12 of them are endemic large mammals including Mountain Nyala (*Tragelaphus buxtoni*). The high level endemicity of mammals in Ethiopia is attributed to the large extent of highlands isolated from the rest part of Africa and the variability of climatic factors among different habitats. Many protected areas in Ethiopia are becoming isolated and the reasons for the isolation include growing human population in areas adjacent to protected areas and land use change towards agriculture, infrastructure and settlement in areas that were previously unpopulated. Bale Mountains National Park is the most threatened national park (Evangelista, *et al*. 2006).

The tendency of establishing human settlements in protected areas is becoming common and endangering the future life of wildlife species. Wildlife species are affected due to habitat destruction from increased human activities such as urbanization, cultivation, overgrazing, bushfire, and deforestation. Such activities increase hand in hand with the increase in population growth and poverty (Refera and Bekele, 2004). Increased human population pressure and its negative impact on habitat loss in African countries is a common phenomenon (Evangelista, et al., 2006). Habitat loss, fragmentation, and degradation pose direct threats to wildlife species worldwide. Driven by human population growth, unsustainable consumption of natural resources and policies that do not fully value biodiversity, habitat destruction is widely accepted as the leading cause of wildlife extinction rates in recent decades (Kinahan, 2013).

In many cases, the absence of adequate survey data to monitor wildlife populations and distributions prevents timely management and conservation decisions that could ultimately save

a species or population. This is especially true with rare and endangered species in developing countries, where wildlife managers have limited resources and information to formulate effective conservation strategies. Given the urgency with man at-risk species, wildlife managers are increasingly looking for new approaches to assess a population's range and distribution, identify critical habitats, and guide conservation priorities (Hillman, 1986). These challenges associated with wildlife management and conservation may best be demonstrated in Ethiopia, where 83% of its 90 million people live in rural areas. Most Ethiopians have subsistence livelihoods relying on small-scale farming, livestock, and natural resources which have resulted in alarming reductions of both wildlife and habitat (Stephens *et al.,* 2001).

According to Asefa (2005), Mountain Nyala is a Bovidae family found in highlands of south Eastern Ethiopia. It was the last large antelope to be discovered in Africa (Kinahan, 2010). The males are typically 120-135 cm tall while females stand 90-100 cm at the shoulder. Males weight 180_300Kg and female's weight 150_200Kg.The coast is grey to brown, marked with two to five poorly defined White strips extending from the back to the underside, a row of six to ten White spots. White markings are present on the face; throat and legs as well. Males have a short dark erect Crest, about 10 cm high, running along the middle of the back. Only males possess horns; whose maximum recorded length is 188 cm .The horn start growing at six months and the spiral pattern reaching full growth by two years. The Horns have only one to two spirals.

Population estimates for the Mountain Nyala have been extremely variable over the years. Brown (1969) estimated a total population of between 7000-8000 in 1969 and Hillman (1987) estimated a global population of 3000 Mountain Nyala, with a total of 1500 occurring in the BMNP. More recently, Refera and Bekele (2004) reported a total Mountain Nyala population of 1,000 occurring globally with 95 % of the population found at BMNP headquarters and Gesse Valley. However, in 2007, a total count of the Gesse valley and the HQs estimated a total of 957 ± 56 individuals (BMNP, 2010).

It is clear that true population estimates of Mountain Nyala are vague and uncertain. Given that it is generally agreed that about 95% of the global population occurs in the BMNP, estimating accurate and precise density estimates of Mountain Nyala (*Tragelaphus buxtoni*) within the BMNP is not only important for the park but also for the entire global population. Thus this

study aimed to investigate the current population status of Mountain Nyala and the environmental factors that affect the population of Mountain Nyala.

## 1.2 **Problem of the statement**

The Mountain Nyala is a spiral-horned antelope endemic to Ethiopia (Brown, 1969; Yalden *et al*., 1984). This species has been declining considerably both in number and distribution (Stephens et al., 2001; Befekadu and Afework, 2004; OARDB, 2007; Evangelista et al., 2008; Malcolm and Evangelista, 2011; Yosef, 2010). It inhabits three discrete mountain ranges in Ethiopia's south-eastern highlands (Ahmar, Arsi and Bale Mountains); with the majority of the population (80% of the total) being persisting in the Bale Mountains, it has an estimated global total population of 3,500-4,000 animals (Evangelista *et al.,* 2008; Malcolm and Evangelista, 2011; Yosef, 2010). These recent reports show the substantial population decline of Mountain Nyala has been observed.For instance estimated the total population of Mountain Nyala was ranging between 1720 and 2035 individuals; when compared with earlier report of 7000-8000 animals by Brown (1969). It is currently listed as an endangered species by IUCN which has been primarily attributed to uncontrolled hunting and habitat loss and degradation (IUCN, 2013). Thus, given its national and global conservation significances and the ever increasing threats facing it through direct and indirect human-induced activities (Malcolm and Evangelista, 2011; IUCN, 2013), having detailed information regarding the biological and ecological aspects of the species has been identified as one of the top management-oriented priority research topics by the Bale Mountains National Park (BMNP) management (OBARD, 2007). Previous studies on Mountain Nyala have been primarily focusing on its distribution, activity patterns, population status and structure (Yosef, 2010). Detailed information on aspects of their current population status, and trends of Mountain Nyala as well as their habitat preference in Bale mountains National Park south eastern Ethiopia. Hence, this research was proposed to conduct on the title population status, trends and habitat use of Mountain Nyala in Bale mountains national park to fill the above gap.

## 1.3. Objective of the Study

### 1.3.1. General Objective

The general objective of the study was to investigate the population status, trends and habitat use of Mountain Nyala, Bale Mountains National Park south eastern Ethiopia.

### 1.3.2. Specific Objectives

The specific objectives of this study were**:**

- To determine population status and trends of Mountain Nyala*;*
- To identify habitats use of Mountain Nyala; and
- To investigate the distribution and habitat preferences of Mountain Nyala.

## 1.4. Significance of the study

The significance of this study is to help policy makers and local actors to update with current population status, and trends as well as their habitat use of Mountain Nyala to take care of them and understand to take action to protect them.

Therefore, in this respect the study has a significant contribution to the literatures and can be used as an input for different stakeholders, policy purposes and also references for further studies.

## 1.5. Scope and limitation of the research

This study was conducted Bale Mountains National Park Head Quarter, Gesse grassland and Afro alpine. The major concern of this study was to estimate population status, density or size, rate of population change and as well as habitat of Mountain Nyala and local communities around the study area of Bale mountains national park.

## 2. Literature Review

### 2.1. Distribution of Mountain Nyala

#### 2.1.1. The Bale Mountains

The Bale Mountain highlands of south eastern Ethiopia are unique in Africa and are known as center of endemism. They encompass Africa's largest alpine plateau and contain the largest populations of Africa's most charismatic species like Mountain Nyala, which is the species of present study (Nelson, 2017). They also harbor an exceptionally high number of other species endemic to Ethiopia. Mountain Nyala is African Artiodactyls of the family Bovidae antelope species found only in Ethiopia. Their abundances are drastically declining mainly due to the impact of rapid human population growth. It is the most important trophy species in Ethiopia as well as in the current study site. Even though, the Mountain Nyala is currently categorized as an endangered species by IUCN.

The Bale Mountains cover a large expanse of Ethiopia's southern highlands with nearly 3,500 $km^2$ of Afro-alpine and sub-alpine ecosystems. The Harenna Forest, part of a dense band of wet montane forest between 1,500 and 3,200 m, covers almost 5,000 km2 on the southern and western slopes. Mountain Nyala are known to occur in five partially disjunction populations but are also suspected to inhabit unexplored areas on the southern slopes of the massif. In 1970, BMNP was created to protect Mountain Nyala and Ethiopian wolf populations and their critical habitats (Hillman, 1993). The park is centrally situated in the Bale Mountains and covers approximately 2,150 km2, The grasslands and shrub lands of the Gesse Valley (including those at the Park's headquarters), in the northern tip of BMNP, now support the highest density of Mountain Nyala and the best studied over the years. This area was not mentioned by Brown (1969), and the species was rare in the area in the 1970s and early 1980s (Refera and Bekele, 2004).

The Gesse Valley is situated near the Park's headquarters and has been regularly visited by tourists. As a result, wildlife and habitat in the area have been well protected over the years and Mountain Nyala populations grew rapidly. By 1987, it was possible to see herds of up to 500

Mountain Nyala on the Gesse grasslands in the evening. Transect data from Gesse initiated by the park in 1985 showed rates of 20-26 Mountain Nyala per kilometer of transect (Stephens et al. 2001). During the change of government in 1991, civil unrest in the Bale region resulted in the illegal killing of many wildlife species and the movement of people into the park (Wolde gebriel 1997). Some of these areas have never been reclaimed by the park and the level of protection has been greatly reduced. Transects conducted in the 1990s averaged four Mountain Nyala per kilometer (Stephens et al. 2001); however, Refera and Bekele (2004) counted between 682 and 731 animals in four surveys in the Gesse Valley and adjacent BMNP headquarters. These numbers provide the best current estimates. The Hanto hunting block lies just north of the park and still supports a number of Mountain Nyala. A census team from the EWCP estimated 375 Mountain Nyala within the hunting block in 1998. The area was visited in 2002 and the number of Mountain Nyala appeared to be noticeably lower than the previous EWCP estimates (Malcolm p). Despite a 5 km buffer between BMNP and the hunting block, it is likely that Mountain Nyala move between the two areas (Alastair, 2017).

An extensive East-West ridge that runs approximately 30 km east of Goba supports a large and stable population of Mountain Nyala. The northern slopes of the ridge are moderately inhabited by people and livestock, while the southern slopes have large tracts of intact forests. Mountain Nyala are mostly found between 1,800 and 3,000 m, but are sometimes found as low as 1,600 m in acacia woodlands (Evangelista persobs). Two contiguous hunting blocks (OdoBulu/Besemena and Abasha/Demero) were established in 2002 and 2003 and have since been surveyed by the EWCP several times. Overall, the eastern ridge of the Bale Mountains may have over 600 $km^2$ of Mountain Nyala habitat and a population of 1,500-2,000 is probable. Outside these two main centers of population (Gesse Valley and the eastern ridge), Mountain Nyala population densities are low or unknown elsewhere in the Bale Mountains. The species is still seen occasionally on the Sanetti Plateau, and the EWCP has reported Mountain Nyala in the high forests to the east of Sanetti in an area called Sheddem. In 2003, Mountain Nyala were reported from a new area just outside the extreme southwest corner of BMNP close to the town of Angetu. They were reported to be on steep bamboo slopes where there were few cattle.

A wildlife department expedition counted three Mountain Nyala; however, the area has considerably dense vegetation that would inhibit most survey methods. Local people report large numbers of Mountain Nyala west of Angetu, but this area has not yet been thoroughly explored or surveyed. Some Mountain Nyala remain in the western extension of the Bale Mountains south of the towns of Dodola and Adaba(BMNP*,* 2017*).*

The Ethiopian Forestry Department in cooperation with German Technical Aid (GTZ) has established a horse trekking business in the area. The opportunity to see Mountain Nyala is an important incentive for tourists. A biologist was employed for three months in 2001 to count the species (Asefa, 2005). He estimated 50 Mountain Nyala, which seems reasonable on the basis of a visit made in January 2011 (Malcolm persobs). Over most of their range in the Bale Mountains, Mountain Nyala have declined substantially since Brown's surveys in the 1960s. For instance, Brown (1966) reported seeing 35 Mountain Nyala in a day in the woodlands and moorlands above Goba. Most of the trees in this area have now been cut, and Mountain Nyala are only rarely seen Transect counts across the Sanetti by car have dropped from one Mountain Nyala per 12.5 km in the 1970s and early 1980s to one per 50 km in the 1990s (Stephens *et al.* 2001). Similar declines have been noticed over much of the park's interior, where human and livestock encroachment has become more prevalent. Other than the populations that reside in the Gesse Valley, the eastern ridge of the Bale Massif, and explored highlands of the Harenna Forest, it is possible that only 150 to 200 Mountain Nyala persist in other areas of the BMNP. Summing the totals for the different parts of the Bale Mountains, a population of between 2,500 and 3,000 seems probable for the areas where Mountain Nyala are currently known to occur.

### 2.1.2. Arsi Mountains

The Arsi Mountains are situated in the central highlands of the east Rift Valley. Largely defined by the Galama Ridge and several isolated volcanic cones, the highlands are mostly covered by giant heath and Afro-alpine ecosystems with small pockets of montane forest at lower elevations. The first record of Mountain Nyala came from this area (Lydekker 1910), and several early collecting and hunting expeditions visited the Galama ridge in the 1920s (Refera, and Bekele, 2004). Leslie Brown visited the Arsi Mountains in 1966 finding Mountain Nyala throughout. He estimated the regional population to be about 700 despite the fact that almost all

the flanking forests had disappeared. He stated that Mountain Nyala are now a scarce and beleaguered species existing in a fraction of its previous habitat (Brown, 1966).

In the 1970s and 1980s, the Arsi Mountains contained several open hunting blocks available to licensed professional hunters and their clients; Mountain Nyala were plentiful, and most of the record trophy Mountain Nyala were taken from this area. All hunting was closed in Ethiopia between 1993 and 1995. During this time, the Arsi Mountains were heavily exploited for wood and wildlife by the local people. Uncontrolled burning, cultivation, livestock pressure, and poaching greatly reduced the region's natural resources and disrupted ecosystem processes (Kubsa, 1999; Evangelista, 2007). When controlled hunting blocks were established in 1995 under the new hunting system, the Galama Ridge, Mt. Chilalo, and Mt Kaka had little remaining wildlife. Between 1996 and 1998, only seven Mountain Nyala were harvested from the Galama Ridge and Mt. Chilalo. The operator of the hunting concession voluntarily ceased all hunting activities, but continued to pay fees and maintained guards in an effort to let the wildlife populations and habitat recover.

In 2000 and 2001, Evangelista and a research team conducted a ten-week ecological assessment of the area. The team estimated that about 90% of the Galama Ridge had been burned in the previous seven years, and agriculture was observed as high as 3,410 m (Evangelista persobs). Tentatively, the team concluded a total population of 125-150, with 80-100 along the Galama Ridge, 10-20 around Mt. Chilalo and 30-40 on Mt. Kaka. Kubsa to the west of Mt. Kaka was not included and may still harbor Mountain Nyala as it did in Leslie Brown's time. Munessa is a district and town in the Arsi region that lies on the eastern slopes of the Rift Valley. A ridge of woodlands runs in a north-south orientation to the east of the town of Munessa at an elevation of about 2,400 m. The forest is situated between Lake Langano, which is as close as 10 km to the west, and Mt. Kaka, about 25 km to the east. The forest once stretched for more than 60 km, extending south toward Wondo Genet. Continuous tree felling over the past 40 years has reduced the forest coverage in the south, and the wooded area now extends about 40 km varying in width from 4 to 8 km.

The area was first gazette as forest reserve in 1969. In 1987 it was named the Munessa Shashemane Integrated State Forestry Development and Utilization Project. Mountain Nyala

occur almost exclusively in the Munessa part of the project, which covers 111 km2 and ranges from 1,900 to 2,500 m in elevation. Approximately 85 $km^2$ are covered in Afro-montane forest with *Podocarpus falcatus, Croton macrostachyus* and *Schefflera abyssinca* dominant. The remaining 26 $km^2$ are covered by a plantation forest comprised mostly of *Cupressus lusitanicsa* with some *Pinus* and *Eucalyptus* spp. Mountain Nyala were not known to exist in Munessa when Brown did his surveys in the 1960s; however, they appear to have flourished within the plantations. The plantation is intensively managed for timber and is also a controlled hunting block. In 2002, Malcolm visited the area and, working with two experienced trackers, conducted four searches for Mountain Nyala. Mountain Nyala were seen during three of the four surveys, including a herd of 13 females with a single male and a herd of four females and two males. Droppings and footprints were common. The Mountain Nyala frequented the native forests and areas of regrowth following the harvest of *Cupressus*(J. Malcolm persobs). During the trip, the entire area of the forest was not surveyed, so the full range of Mountain Nyala within the natural forest and plantation was not determined. Mountain Nyala have been able to flourish in this area largely because of the absence of domestic livestock and farming. Because of the low elevations of Munessa, we can speculate that the species may have occupied large forested areas at lower elevations in the past. The forest administration encourages the conservation of Mountain Nyala and habitat through sustainable harvest strategies. They receive some direct compensation from the hunting fees and employ several game scouts to work with hunters and tourists. Despite the guards and intensive management of Munessa, livestock grazing and poaching still occur. The 2002 visit coincided with an annual holiday for the Oromo people, traditionally celebrated by a group hunt. Twenty people from the plantation's work force were mobilized in case of incursions, but the day passed quietly. However, the next morning two men were riding through the forest with spears, and the guard was sure that they were after Mountain Nyala (Malcolm persobs). Trophy hunting brings important revenues to the plantation and local community, indicating the potential economic value of wildlife resources. In addition, Munessa is very close to the most popular resort destination for people living in Addis Ababa, namely Lake Langano. An expensive safari lodge (Bishangari) has recently been built on the Munessa side of the lake and further utilization of wildlife resources, such as wildlife viewing and photo safaris, seem plausible.

The EWCP estimated the Mountain Nyala population in Munessa using a transect method in 1995 and 1999. Their figures were 95 and 81 animals, respectively. Based on the 2002 observations by J. Malcolm, the Mountain Nyala population is likely to have increased to 200 animals.

### 2.1.3. The Ahmar (Chercher) Mountains

The mountains flanking the east side of the Rift Valley subside above Arsi and re-emerge 50 km farther north as a steep ridge rising to 3,000 m. This mountain range is known as the Ahmar or Chercher Mountains. A population of Mountain Nyala was reported for the first time in 2005 in an area called Worga Bula. Located east of the town of Ashmira and close to the larger town of Teferi Birhan. The area is defined by steep-sided gorges and ranges from 1,800 to 2,800 m in elevation. The forests are dominated by *Juniperus procera, Podocarpus gracilior* and *Schefflera abyssinica*; however, much of the area has been degraded by various land-use activities. In an effort to inhibit further degradation of the landscape, there was an immediate call for the establishment of a controlled hunting block that would encompass over 78 $km^2$. Preliminary surveys by the EWCP suggest that the Mountain Nyala population is at 150. Further surveys and research are expected, and it is suspected that Mountain Nyala may migrate to and from Arba Gugu in response to seasonal variability (Refera, B. &Bekele, A., 2004).

To the north of Worga Bulu are two controlled hunting blocks called ArbaGugu and DinDin. Although the two blocks are relatively close to each other and similar in elevation, they are separated by a plateau and cultivated land at lower elevations (Malcolm persobs). ArbaGugu covers approximately 225 $km^2$ and ranges in elevation from 2,000 to 3,600 m. In 2002, J. Malcolm talked to the professional hunter that held the concession. It was reported that Mountain Nyala mostly inhabit the steep, shrub land slopes as well as the mature montane forest above 2,800 m (Evangelista. *et al.,* 2007). Because of the steep terrain, most of the remaining habitat is inaccessible to humans and livestock, and provides a sanctuary for the Mountain Nyala. Recent population estimates for ArbaGugu were unavailable for this study. In 1995, the EWCP estimated 445 Mountain Nyala and permitted an annual harvest quota of three for 1996. The Mountain Nyala population, as seen in other areas, appears to have increased since the early 1990s, and it is possible to see as many as 20 animals in a day (Evangelista. *et al.,* 2007).

The DinDin hunting block occupies about 25 $km^2$ of the ridge and shares area portion with a Forest Priority Area. Mountain Nyala have been hunted in the region since at least the mid-1960s (IUCN, 2013), but the locality was not mentioned by Brown in his survey. OARDB (2007), the professional hunter for the hunting block, has visited the area since the 1970s. He reports that the population declined in the era of the Derg (1974-1991) when laws regulating the use of wildlife and natural resources were largely ignored. Mountain Nyala populations never recovered to the levels of the 1970s (OARDB, 2007). The EWCP hunting census groups have visited DinDin three times, once in 1995 and twice in 1999. The population estimate for 1995 was 100. The first group that visited in 1999 saw seven Mountain Nyala and estimated a population of 116. Later in the same year a biologist from the EWCP visited the area but failed to see any Mountain Nyala and concluded the population was in decline. A review of 2001 Land satellite images suggests that there is probably less than 150 $km^2$ of available habitat, including the high forests and the shrub covered slopes. During the time of our survey, there appeared to be little human or livestock presence at the DinDin hunting block, nor was there any apparent evidence of tree cutting in recent years (Malcolm, 2002)). This situation exists because the concession holder retains a force of 12 game guards to protect the remaining habitat. Uncontrolled burning of vegetation still occurs regularly at lower elevations, and it is presumed that low levels of poaching still occur. With the help of local scouts and a guide from the Harerghe Department of Natural Resources, we made four attempts (mornings and evenings) to locate Mountain Nyala. No Mountain Nyala were observed; however, we did find fresh tracks and scat (Malcolm 2002 persobs). Other scouts in our party reported seeing Mountain Nyala in the vicinity, citing a dozen locations where they can be seen on a regular basis. The maximum potential population could be 150; however, 100 may be more reasonable (Malcolm persobs).

North of the ArbaGugu and DinDin hunting blocks, the Ahmar Mountains drop in elevation and curl eastward. The entire ridge used to be extensively wooded and supported two significant populations of Mountain Nyala: AsbeTeferi with Kuni-Muktar (recorded together as AsebeTeferi by Brown in 1966) and, further to the north, GaraMuletta. The species now only survives in KuniMuktar, which was designated a wildlife reserve in 1990. It is remarkable that the population of Mountain Nyala has persisted so long in this pocket of habitat. In Grim wood, the consultant head of Ethiopian Wildlife in 1963, considered the population doomed at that time

(Brown 1966). It is typical in this area that forage for livestock is cut by hand and carried back to the homestead. This reduces the disturbance to Mountain Nyala from livestock and other domestic animals.

The Kuni-Muktar Wildlife Reserve consists of two small forested areas that lie above the village of Kuni. The Muktar Forest lies east of the village and the Sobaly-Jelo Forest lies to the west. The two upper Afro-montane forests have elevation ranges from 2,300 to 3,075 m and sustain the northernmost population of Mountain Nyala ever recorded. Collectively, the forests cover less than 25 km2. The forests have historically supported stable populations of Mountain Nyala despite their small area (Brown, 1969a). By 1996, poaching, deforestation and agricultural development had severely degraded the habitat, and reports indicated that the Mountain Nyalawere no longer present (East, 1999). In 2001 and 2002, however, a team of biologists from the EWCP and Harerghe Department of Natural Resources conducted a survey of Mountain Nyala confirming their persistence. They used survey questionnaires and counted Mountain Nyala in the evening when they emerged from cover. For the first two surveys, they concentrated on MuktarTerara counting 25 and 28 Mountain Nyala, respectively.

In the second two surveys they concentrated in the Jelo area and counted 24 and 27 Mountain Nyala (Yosef, 2010). In 2005, Kuni-Muktar was visited by P. Evangelista and associates from Colorado State University for a vegetation and habitat assessment. The team not only reported Mountain Nyalapersisting in the fragmented forests, but also found two ambitious efforts to restore native forests and critical habitat being facilitated by the Oromia regional authority. The frst was a relocation program that moved approximately 30,000 people from the area between 2001 and 2004. The human population around Kuni is now estimated to be about 7,500 households. The second was a reforestation program begun in 2004 when 77 ha of *Juniperus procera* were planted in the vacated agricultural felds on MuktarTerara, and 980 ha of *Juniperus procera*, *Casuarina equisetifliumlia, Hagenia abyssinica, Grevillea robusta* and *Olea Africana* were planted on Sobaly-JeloTerara. Additional reforestation efforts were planned for 2007 (Evangelista. *et al.,* 2006)). Given these efforts, it is possible that a population of 200 Mountain Nyala persist in the Kuni-Muktar Wildlife Reserve with the potential to increase provided restoration trends continue.

## 2.2. Historic and Potential Habitat of Mountain Nyala

At least one Mountain Nyala population has been extirpated in the recent past. This population occurred on Mt. Abaro and the neighboring forests around Wondo Genet approximately 40 km east of Lake Awassa. Trophy specimens were shot in the 1950s (Gebrekidan.W 1997); however there have been no reliable reports of Mountain Nyala after 1975. At Wondo Genet, Guides are still promise to show visitors Mountain Nyala, but it is unlikely that they still survive in the area. North of Kuni-Muktar, Mountain Nyala once was thought to occupy the GaraMuletta Mountains, but this population has not been adequately confirmed. Leslie Brown (1966) visited the area and reported seeing one spiral horned antelope which could have been a Mountain Nyala or a greater kudu. An expedition from the Ethiopian Wolf Conservation Programme (EWCP) visited the area in 2001 for two weeks and concluded that no Mountain Nyala were present (EWCP report).

There are persistent reports of other Mountain Nyala populations that may be worth investigating., Mountain Nyala are reported to occur in Adola (KebreMengist), Agere Maryam and Sheik Hussein (90 km east of the Bale Mountains). Mountain Nyala horns were reportedly found in the Adola area in the 1970s (OARDB, 2007). Extensive forest still exists, but it is now densely populated with people and there were no reports of Mountain Nyala (Malcolm persobs). Agere Maryam is another potential area for Mountain Nyala. The forested area is about 80 km southwest of Adola. Although the area is isolated from human activities, it is still unknown whether or not Mountain Nyala inhabit the forests OARDB (2007) thought that Mountain Nyala might occur in the forests 15 km south of Sheik Hussein. Although we cannot present any conclusive evidence on the Mountain Nyala populations in these areas, we do recommend that the areas be surveyed for Mountain Nyala in the immediate future.

## 2.3. Populations of Mountain Nyala

It is difficult to census any wildlife species that prefers dense montane habitats and steep terrain Furthermore, it is highly likely that Mountain Nyala exist beyond the areas included in this report. The EWCP conducts regular surveys of the controlled hunting blocks, but the latest data were not available for this report. Based on the information we gathered (mostly between 2000 and 2003), the total Mountain Nyala population for the areas surveyed would be

approximately 3,680. This estimate is slightly higher than two other recent estimates by East (1999) and Sillero Zubiri (in press). These authors estimated about 2,000 but were not aware of the populations east of Goba around OdoBulu or increasing population trends observed in protected areas. Despite the recovery of many regional populations and the possibility of additional undocumented populations, there is little doubt that the species has gradually declined since Brown's expeditions in the 1960s and has struggled to rebound following the civil unrest between 1991 and 1995.

The Mountain Nyala has been considered, most particularly by Brown (1969), an ecological specialist largely restricted to the heath and moorland zones. Similar reports by early hunters also support Brown's observations (Sillero-Zubiri and Macdonald, 1997)). However, we now know that Mountain Nyala prefer the dense cover and plant rich high montane forests. These forests provide protection from climatic extremes, concealment from predators and offer a diverse array of forage to maintain dietary requirements throughout the year. Generally, Mountain Nyala inhabit mesic habitats between 1,800 and 3,500 m, but are often observed in the higher Afro-alpine and sometimes in the lower acacia woodlands. As habitat becomes fragmented and forage diminishes, Mountain Nyala are known to frequent agricultural lands at night, feeding on barley, beans and maize. Forest plantations may also prove to be important habitat, especially for cover and routes of travel. Although the Mountain Nyala is, with little doubt, a specialist species to Ethiopia's highlands, the species is also adaptable and has a remarkable ability to survive in adverse environmental conditions. This has been demonstrated in Kuni-Muktar, where the species was thought to be extinct in 1998 (East 1999); in the Galama Mountains, where the species has managed to persist despite widespread burning of the landscape, poaching and other human activities; and at Gesse and BMNP headquarters, where they share a small area of habitat with people and livestock from the town of Dinsho. Although these circumstances still pose significant threats to local populations, the adaptive characteristics of the species give wildlife managers critical time to implement improved management and conservation strategies.

### 2.4. Population Trends

The Mountain Nyala is endemic, known only to occur on the east side of the Rift Valley in Ethiopia, by the Chercher Mountains in the north and the Bale Mountains in the south. However,

much of the Mountain Nyala's habitat in the northern and central mountains of its range has become highly fragmented by human settlement and agriculture (Alastair 2017). The most prominent population of Mountain Nyala is found in the BMNP, which was first proposed in the late 1960s to protect the Afro-alpine habitat and the rare and endemic species of the Mountain Nyala(*Tragelaphus buxtoni*) and the Ethiopian wolf (*Canis simensis*), although never formally gazette the park was established in 1971. For these reasons, Mountain Nyala were identified as Principal Ecosystem Components in the BMNP GMNP 2007 and subsequently ranked high in priorities for monitoring (BMNP, 2017).

While the Mountain Nyala range covers pockets in the Harenna forest escarpment between 2,200 m and 3,000 m (Evangelista, 2006), the Sanetti Plateau and the Web valley, more than 95% of the BMNP population occurs in the northern woodlands and grasslands of the park Headquarters in Dinsho and the Gesse valley(BMNP, 2017).

Population estimates for the Mountain Nyala have been extremely variable over the years. Brown (1969) estimated a total population of between 7000-8000 in 1969 and Hillman (1987) estimated a global population of 3000 Mountain Nyala in 1987, with a total of 1500 occurring in the BMNP. More recently, Refera and Bekele (2004) reported a total Mountain Nyala population of 1,000 occurring globally with 95 % of the population found at BMNP headquarters and Gesse Valley. However, in 2007, a total count of the Gesse valley and the HQs estimated a total of 957 ± 56 individuals. It is clear that true population estimates of Mountain Nyala are vague and uncertain. Given that it is generally agreed that about 95% of the global population occurs in the BMNP, estimating accurate and precise density estimates of Mountain Nyala within the BMNP is not only important for the park but also for the entire global population. In 2007 a pilot survey was developed for carrying out distance transects for nyala monitoring in the Gesse valley (Randall unpublished). These transects were repeated three times in the wet season in 2007 and once in 2008. Total counts were also conducted in the same seasons for comparison. These pilot surveys were then used to examine accuracy and precision in methods as well as efficiency in resource use in order to design survey protocols for the long term monitoring of the BMNP Mountain Nyala(Gottelli and Sillero-Zubiri, 1992).

## 2.5. Threats to Mountain Nyala

Predictably, the main threats to the species come from humans; largely in the form of land-use practices that have resulted in degraded or loss of habitat over the last century. Much of the montane forest has been cut and has been replaced by agriculture. Deforestation tends to be incremental. Over the last 30 years, the closed-canopy montane forest south of Goba has been slowly removed so that only a few large trees of scattered *Hypericum* remain (Malcolm persobs). This is the area where Brown counted 30 Mountain Nyala in a day, but now there are few signs of Mountain Nyala. Preliminary satellite analysis of the vegetation in the Bale Mountains suggests about 10% reduction in Mountain Nyala habitat in the last 10 years (Malcolm persobs), while even higher losses can be observed in the Galama Mountains (Evangelista *et al*. 2007).

As agriculture expands to higher elevations, livestock grazing is pushed to sub-alpine and Afro-alpine ecosystems. To promote the growth of grasses and forbs, local people will burn the montane shrubs and heath lands that provide vital thermal cover for wildlife. As livestock populations move into Mountain Nyala habitat, there is a decrease in available forage, increased interaction with domestic dogs and greater opportunity for poaching. Chris Hillman (1987 perscomm) was the first to note that Mountain Nyala seem to avoid any area with cattle. Almost all of the extant Mountain Nyala populations occupy areas that have few cattle. This is especially evident in Munessa where the species has congregated in an area of unusually low elevation but one which is kept clear of cattle by the foresters. Another example can be found above Dodola, where Mountain Nyala occupy very steep slopes with cattle both above and below them. Illegal hunting of Mountain Nyala seems to be limited in most areas where they occur. Woldegabriel (1997) reported that two sets of horns on average were found around BMNP each year until the civil unrest began in 1991.

Today, only a small area of BMNP (i.e. Dinsho and GesseValley) is patrolled regularly. Evidence of poaching on Sanetti, the eastern escarpment of the Bale Mountains, and Harenna Forest has been observed and documented in recent years (Evangelista persobs; Evangelista *et al.* 2007). Perhaps the most effective deterrent to illegal hunting is the establishment of controlled

hunting blocks. Some professional hunters (but not all) maintain permanent camps in the concessions, employing guards and game scouts to patrol for illegal hunting and deforestation activities. As local communities receive revenue and employment opportunities from the establishment of controlled hunting blocks, they tend to become more proactive in conserving wildlife and habitat. In a recent case, community members reported poachers within a controlled hunting block to local authorities resulting in the arrest of three individuals. With a staff of less than 30 up until recently, it has been impossible for the EWCA alone to effectively enforce Ethiopia's wildlife laws and regulations. There has been no record of disease or parasites affecting or regulating Mountain Nyala populations. However, bovid are known to be susceptible to a number of pathogens, and it is likely that Mountain Nyala are vulnerable to a number of diseases or parasites that can be transferred by other wildlife species or livestock. Several studies are currently being conducted. Several predator species are known to prey on Mountain Nyala. Perhaps the most common are the leopard (*Pantherapardus*) and hyena (*Crocutacrocuta*), which share much of the Mountain Nyala's range. On the eastern and southern slopes of the Bale Mountains, lions (*Pantheraleo*) are known to prey on Mountain Nyala and influence local movement and distribution of herds (Evangelista persobs). Other incidents of predation or killing of Mountain Nyala calves have involved jackals (*Canisme somelas*), warthogs (*Phacochoerus africanus*), and domestic dogs (Kinahan, 2013).

### 2.6. Conservation of Mountain Nyala

Effective conservation strategies for the Mountain Nyala are needed if the species is to survive. Although there are many approaches to conservation, several key milestones must be met before success can be achieved. The first is that policy and regulations regarding Mountain Nyala, habitat, and management must be clearly defend and enforced. New wildlife policy has been in development for nearly five years and urgently needs completion and implementation. Furthermore, legislation that addresses illegal hunting and habitat destruction need to be formulated and enforced. This should coincide with restoration efforts of critical habitat (Kinaha, A.A., 2010). Specifically, reforestation programs (as seen in Kuni-Muktar) must be immediately implemented. Many of Ethiopia's highland tree species are slow growing and may take as long as 30 to 60 years before providing adequate habitat. In particular need are DinDin, the Galama

Mountains and BMNP headquarters. Perhaps the best approach to conservation is through sustainable management that includes economic development and benefits to local communities.

The Munessa Shashemane Integrated State Forestry Development and Utilization Project serves as a strong working model of sustainable management. A limited number of Mountain Nyala are legally hunted each year providing important revenue to the company, federal and regional governments, and local communities. Likewise, timber is commercially harvested at a sustainable rate which allows a fixed annual off-take and time for replanting and tree growth. The system works because Mountain Nyala and habitat are: (1) intensively managed and monitored, (2) protected from exploitation, (3) recognized for their economic benefits, and (4) harvested at sustainable levels. Legal hunting is seen as a quandary by some. If overseen and managed properly, it could provide one of the most effective means of conservation. Professional hunters that have rights to controlled hunting blocks regularly employ game scouts and guards to protect wildlife populations and habitat (EWCA, 2012).

In DinDin, for example, the professional hunter employed 12 game scouts to keep the area free of cattle and humans (despite the fact that he was not allowed to shoot any animals). In the Soba hunting block by BMNP, the professional hunter had persuaded people to relocate from prime Mountain Nyala habitat. In OduBulu, the professional hunter developed a water-supply system to the town of Buko. Many people in the Arsi Region were unhappy when controlled hunting ceased, as it provided an important source of employment and revenue. At the same time, removing any animals from a species that numbers less than 4,000 is risky and wildlife managers must be vigilant in monitoring populations and meeting management objectives. Today, about 1% of mountain nyal populations within hunting blocks are allowed to be hunted (Mamo and Pinard, 2011). All hunting activities are under the direction of a licensed professional hunter, a game scout from EWCA, and an observer from the oromia regional authority. Since 1943, there are no records of Mountain Nyala in captivity, although all the other spiral horn antelope have been kept and bred in zoos. A genetically sustainable *ex situ* breeding program would be extremely expensive and has been opposed by the Ethiopian wildlife authorities. Modern cryogenic methods (frozen eggs and sperm) have not been tried. These methods are usually a last

resort for imperiled wildlife. A proactive conservation strategy for the Mountain Nyala, however, can still insure the survival of the species.

## 3. Methodology

### 3.1. Description of the study area

The study was carriedout in Bale Mountains National Park geographically located between 06°29'-07°10'N, 39°28"; - 39°57' E in southeastern Ethiopia 400 km of Addis Ababa the capital city of Ethiopia (Fig. 1), The Park encompasses 2,150 km$^2$ of mountains and forests. Bale Mountains National Park contains the largest continuous area (over 1,000 km$^2$) of afro-alpine habitat in Africa (Aseffa, 2005). It covers an altitudinal range from 1,500 to 4,377 m asl. Tulu Dimtu (at 4,377 m asl) in the Bale Mountains which is the highest peak in southern Ethiopia and the second highest in the country (BMNP, 2010).

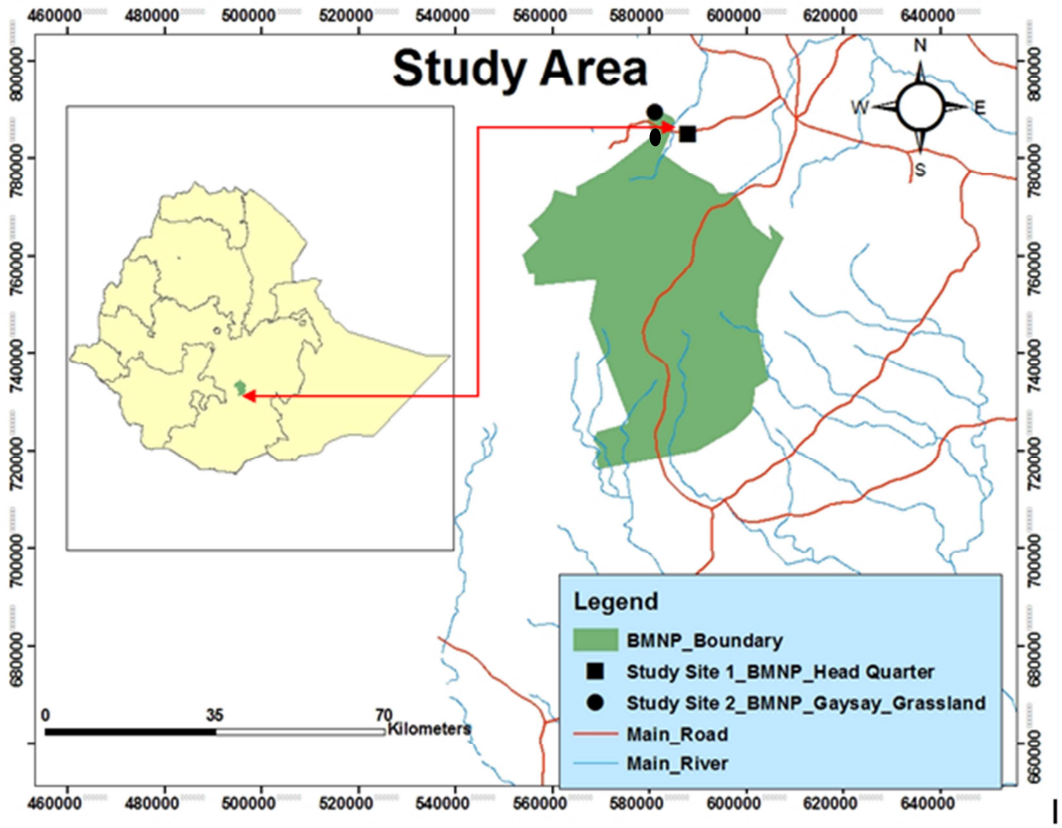



Figure 1 Map of study area

### 3.1.1. Climate, Vegetation and specie compositions

Temperature of the area is variable, particularly in areas of the highest altitudes during the dry season and more or less the same pattern of temperature during the wet season. The highest temperature is 12.6$^{o}$C in March and the lowest is 5$^{o}$C in December (Hillman, 1986). However, the temperature of the Park normally ranges between 5$^{o}$C and 20$^{o}$C. The warmest period of the year is between March and April. The coldest period is between November and December, and it can reaches up to 1.5$^{o}$C. Rainfall in BMNP is bimodal, with heavy rain during July–October and short rain during March–June. The annual rainfall ranges from 1000 to 1400 mm. Over 60% of the annual rainfall occurs between April-September (wet season). The dry season, from October to March is characterized by extremely cold nights and warm days (Hillman, 1986 and 1996).

BMNP possesses one of the highest incidences of animal and plant endemicity of any terrestrial habitat in the world. In BMNP, there are at least 1600 species of flowering plants, of which 163 are endemic (23 to Bale alone) to Ethiopia. In Bale Mountains National Park-afro alpine areas of altitude >3400 m asl have a vegetation composition of *Erica arborea*, *Helichrysum* spp., *Alchemilla* spp., and giant Lobelia (*Lobelia rhyncopetalum*). The mountains are one of the centers of faunal diversity and endemicity, which generate numerous natural processes vital to human existence and support an important reservoir of genetic resources (BMNP, 2010).

Bale Mountains National Park is the home of diversity and endemism of fauna (Hillman, 1986). The Park supports mammal species (Fishpool and Evans, 2001). The Park is home to the largest populations of boththe endemic and endangered Ethiopian wolf (*Canis simensis*) and Mountain Nyala, as well as the endemic Bale Monkey (*Chlorocebus djamdjamensis*) and the Giant mole rat (*Tachyoryctes macrocephalus*). Over 310 bird species have been recorded in BMNP to date, about 20% of the species recorded for Ethiopia. Among the endemic birds of Ethiopia, 57% are found in Bale Mountains (Hillman, 1986; IBC, 2007). Due to its unique diversity and density of rodent community (400 kg/ha), it is also very important for many rare large eagles, vultures and raptors (BMNP, 2010).

The Mountain Nyala are shy and elusive towards human beings. They are primarily a browser; the Mountain Nyala may switch to grazing occasionally. Females start mating at two years of

age, and males to become sexually mature by that time. Gestation lasts for eight to nine months, after which a single calf is born. The lifespan of a Mountain Nyala is around 15to 20 years (Bornfree, 2002).

The typical habitat for the Mountain Nyala is composed of montane woodland at an altitude of 3000_3400m.Human settlements and large livestock population have forced the animal to occupy Heath forests at an altitude of above 3400m.Mountain Nyala is endemic to the Ethiopian high lands east of the Rift valley. About half of the total population of the Mountain Nyala occurs in the Gesse in the northern parts of the Bale Mountains National Park (Ogutu*et al.,* 2012). The Mountain Nyala has been classified under the endangered category of IUCN.The typical habitat for the Mountain Nyala is composed of montane woodlands at an altitude of 3000_3400m.The vegetation generally includes Juniper, *Haegenia, Hypericum* and etc.They often visit the edges of montane grasslands at 2800_3100m which is covered with *Artemisia afra, Kniphofia* and evergreen *Hypericum* species.

Major threats to the survival of the Mountain Nyala include illegal hunting, habitat destruction encroachment by livestock, predation of calves by dogs, expansion of montane cultivation and construction at high altitudes (Brown, 1969).

### 3.1.2. Hydrological System

The Bale massif plays a crucial role in climate control in the region, attracting large amounts of orographic rainfall. Rainfall can occur in any month of the year, although peak rainfall occurs between March and October, peaking in August and March. Some 600-1000mm falls annually in the lower altitude areas, and 1000-1400mm in the higher areas. The watershed of the plateau is characterized by flat, swampy areas and many small shallow lakes that are crucial for flow regulation. Overall a total of 40 rivers rise in BMNP area, contributing to five major rivers the Web, Wabe Shebelle, Welmel, Dumal and Ganale. Some rivers were stocked with brown and rainbow trout in the 1960s and 70s and good fishing under license is still available in some areas (Alastair, 2017).

### 3.2. Material and methods

#### 3.2.1. Materials

Binoculars, Digital camera, compass, 100m tape, BMNP map, GPS, and note books was used during data collection.

#### 3.2.2. Sampling sites

The Headquarter, Gesse and Afro alpine sites were taken as the habitat is almost similar and Gesse was divided in to three blocks as woodland, open grassland and Erica shrub. The sampling sites are classified based on landscape and heterogeneity of the area. Based on these 12, 25 and10 transects were set in Headquarter Gesse and Afro alpine area respectively.

##### 3.2.2.1. Sampling at Gesse

A total of 25 transects having the distance of 500m apart was placed in grassland and woodland habitats in the Gesse Valley following a systematic parallel lines with transects at a 10° bearing north to south of the road across the area. These 25 transects ranged from 0.65 to 3.5Km. Transects were set in *Erica* escarpments on the southern end of the study area was placed in a east-west (90° bearing) direction due to a steep ridge on the northern and Southern edges of the *Erica z*one, which prevents transects from the woodland zone extending easily into the *Erica* zone.

Each transect was walked on the same day and the protocol was repeated for a second time on the following day. Thus, Gesse population counts were having two replicates. In order to further avoid double counting, teams were to record individuals only within the designated strata or stratum where their transect lies. All Mountain Nyala seen was recorded and the time and their GPS location taken. In addition, the habitat in which they located, their total number and group composition was also recorded map showing the division of study area in to three ecosystem.

A total of six zig-zag transects was placed across 25 clearly defined vegetation blocks in the Gesse valley. Zigzag transects allowed for shorter distances in between transects while covering the desired area to count all individuals, compared to parallel straight line transects increasing travel distances between transects. The Vegetation blocks choose by considering the natural

changes in vegetation type, for example from shrub land to woodland and where natural features such as Rivers occurred.

### 3.2.2.2. Sampling at Head Quarter

For a distance sampling in Head Quarter because of its small size compared to Gesse a total of 12 transects having the distance of 100m apart was placed following a systematic parallel grid with a bearing(s) north to south. Moreover a total count data collection was used for both the Head Quarter and Gesse area to compare both techniques. In population estimates comparison was between distance sampling and total counts in order to minimize errors.

As for Gesse counts, Head Quarter (HQ) transect was started by all teams at the same time (10:00). Teams comprised one individual and transects was walked in a South direction initially. Once all individuals have finished their count through line (transect) and they wait at the end point until 11:00 and all individuals were re-walk the same transect in a North direction (Fig 2).

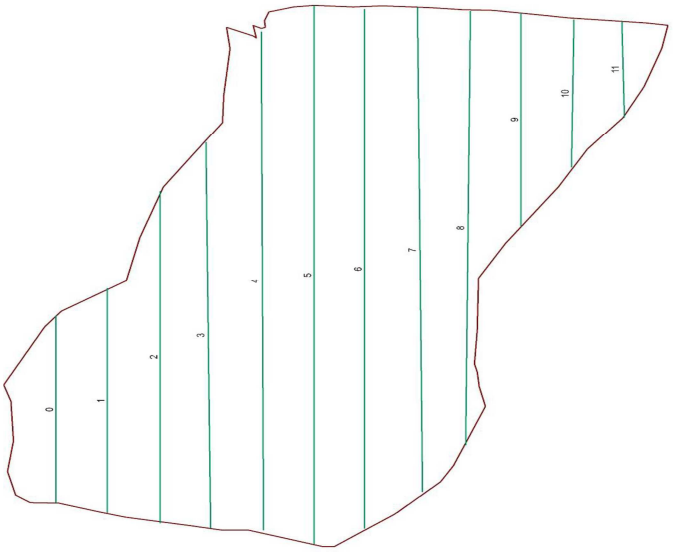



Figure 2 Transect line of Head Quarter site

Data was only being collected within 50m of the line to avoid double counting. As for Gesse population counts, all Mountain Nyala was recorded and the time, GPS, habitat, number and group composition noted. This protocol was repeated on two consecutive days, thus provided four replicates of the counts observation.

### 3.2.2.3. Sampling at Afro Alpine

Afro Alpine or Erica vegetation zone was the one of BMNP habitat of the study area. In this habitat a total of 10 transect with 7.5 km length and 500 m strip width each (250 m on each side of the transect line) were marked. Each of this transect-line was located randomly in the study area using GPS. All transects were laid roughly parallel to each other and the same transects were used for both wet and dry seasons survey. Each transects in a given habitat were surveyed at the same time twice per day. The transect lines were demarcated using natural boundaries like rivers, streams, rocks big trees etc.

### 3. 2.3. Population Estimate of Mountain Nyala

The entire study area was divided into four blocks under three ecosystems (habitats) with natural and artificial boundaries. These ecosystems are grasslands, woodlands and afro alpine habitats. This can be easily identified on map as well as on the field. The difference between consecutive transects varied depending of the vegetation covers. For instance the distance between consecutive transects of grassland woodland and afro alpine is 500 meters since it is very easy to identify on 500meter distance (Fig.3).

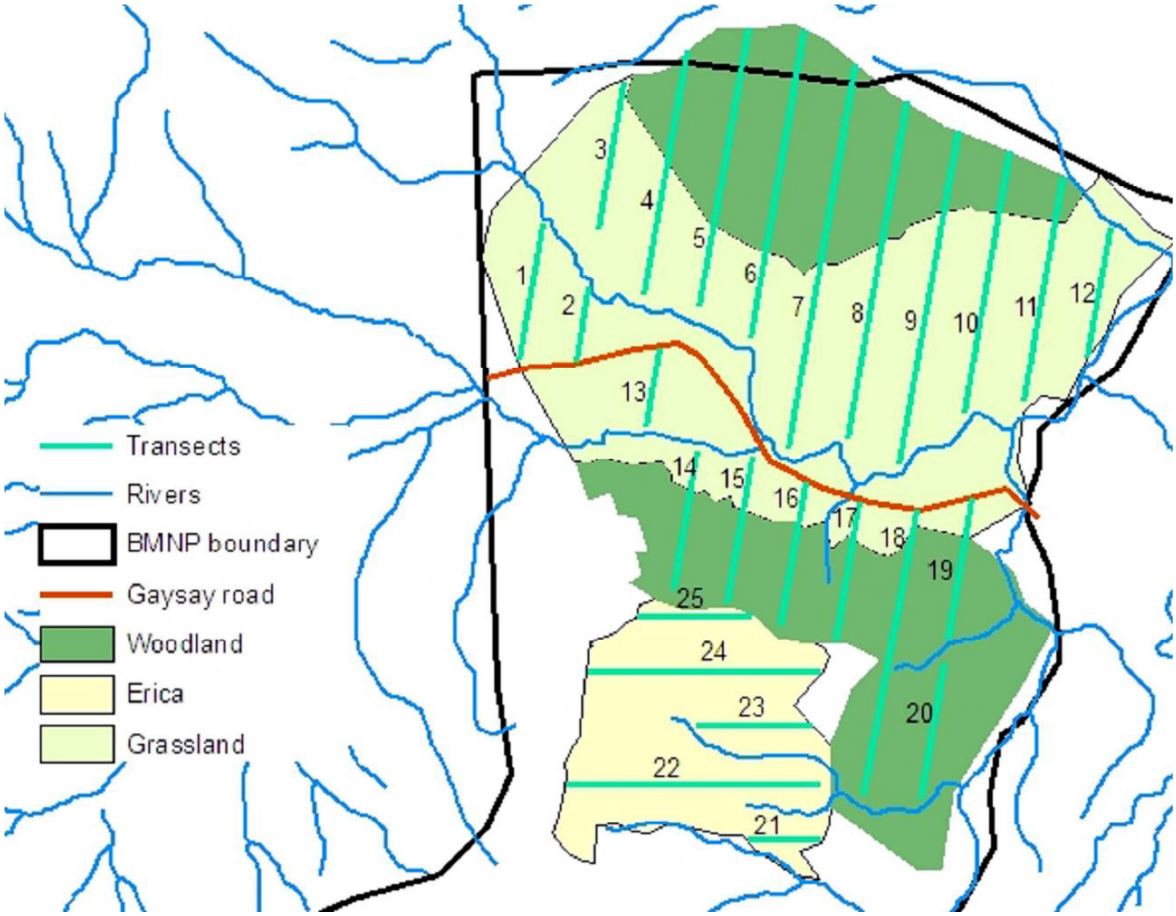



Figure 3 Map of distance sampling in Gesse Grassland

To collect data counting was carried out using Binoculars, Range finders and compasses for three times during wet season and three times during dry seasons in all selected habitats. Census was conducted when the Mountain Nyala were most active and with good visibility in the morning (10:00 -12:30 am) and in the afternoon (2:00 -4:30 pm).each transect was completed within 1-2 ½ hours by two well experienced and responsible Para-ecologists of from the park.



Figure 3 Counting of Mountain Nyala Population at Gesse grassland

### 3.4. Data analysis

Data from the three sites counting over the study area were combined due to small sample sizes to analyze them separately. Social group types of the Mountain Nyala were identified based on each recorded group's composition of the five different age/sex categories; thus, records with similar composition were classified as one of the possible social group types. Differences in relative frequencies of occurrences of the whole Mountain Nyala groups and occurrences of each social group type between habitat types and in frequencies of occurrences of each pair of the social group types within and across habitats were identified using SPSS software. SPSS were also used to test differences in the proportions of animals recorded across and between each pair of group types. To see how patterns of group size distributions differ across the social group types, all groups recorded for each group type were classified into five group size categories (Rafera and Afework, 2004): all-male group type, all female group type, Male-female group, Female juvenile groups and Male-female-juvenile group and percentage relative frequencies of the number of groups recorded in each group size category for each group type were graphically illustrated. All these analyses were conducted in SPSS version 20.

## 4. RESULTS

### 4.1. Mountain Nyala Population

The number of Mountain Nyala individuals and groups in both wet and dry seasons were higher in Gesse grassland followed by Head Quarter and Afro alpine. Moreover the total number of Mountain Nyala individuals and groups were higher during the wet season than the dry season (Table 1). **Table 1 Number of Mountain Nyala in tree sites**

| Study sites | | | | | | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gesse | | | | | Head Quarter | | | Afro alpine | | | | | |
| Animal | Season | Individual | Group | percentage | Individual | Group | percentage | Individual | Group | percentage | Individual | Group | percentage |
| Mountain Nyala | Wet | 1679 | 138 | 77.88 | 346 | 43 | 16.05 | 131 | 19 | 6.07 | 2156 | 199 | 100 |
| | Dry | 1631 | 142 | 80.31 | 329 | 39 | 16.19 | 71 | 9 | 3.5 | 2032 | 190 | 100 |

### 4.1.1. Age and sex structure of Mountain Nyala

Of the total population of Mountain Nyala at three sites in BMNP majority of the population were adult females followed by sub- adult females, adult males and sub-adult males (Table 2)

**Table 2 Age structure and sex ratio of Mountain Nyala**

| Habitat | Total | | Adult Male | | Adult female | | Su-adult male | | Sub-adult female | | Juvenile | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | | % | No | % | No | % | No | % | No | % | No | % |
| Headquarter | 346 | 100 | 67 | 19.36 | 138 | 39.88 | 47 | 13.58 | 81 | 23.41 | 13 | 3.75 |
| Gesse | 1679 | 100 | 338 | 20.13 | 682 | 40.62 | 235 | 14 | 417 | 28.84 | 109 | 6.5 |
| Afro-alpine | 131 | 100 | 5 | 3.8 | 17 | 12.98 | 1 | 0.76 | 17 | 12.98 | 1 | 0.76 |
| Total | 2156 | 100 | 407 | 18.88 | 835 | 38.73 | 280 | 13 | 512 | 24.75 | 120 | 5.57 |

### 4.1.2. Social Group Types

Based on the composition of different age/sex of Mountain Nyala, majority of the individuals were in Female juvenile groups followed by all-male type, all female group type, Male-female group and Male-female-juvenile group (Table 3).

Table 3 Number of social group in the study area

| Habitat | Number of Groups | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Group | | **All-male group type** | | **All female group** | | **Male-female group** | | **Female juvenile groups** | | Male-female-juvenile | |
| | Wet | Dry | Wet | Dry | Wet | Dry | Wet | Dry | Wet | Dry | Wet | Dry |
| Headquarter | 43 | 39 | 6 | 5 | 14 | 13 | 9 | 8 | 12 | 10 | 2 | 1 |
| Gesse | 138 | 142 | 36 | 30 | 20 | 21 | 18 | 22 | 42 | 47 | 20 | 24 |
| Afro-alpine | 19 | 9 | 4 | 2 | 7 | 3 | 2 | 1 | 3 | 2 | 3 | 1 |
| Total | 199 | 190 | 46 | 37 | 38 | 37 | 30 | 31 | 57 | 59 | 25 | 26 |

### 4.1.3. Group size

As the result of the study shows during the wet season, the group size ranged from 7 to 21 in Gesse grassland, 4 to 11 in Afro alpine and 6 to 15 in head quarter and during the dry season, it ranged from 5 to 17 in Gesse grassland, 4 to 9 in Afro alpine and 5 to 12 in Head Quarter (Table 4).

Table 4 Group size of Mountain Nyala in the Study area

| No | Sites | Lowest group size (individuals) | | Highest group Size (Individuals) | |
|---|---|---|---|---|---|
| | | Wet | Dry | Wet | Dry |
| 1 | Gesse Grassland | 7 | 5 | 21 | 17 |
| 2 | Head Quarter | 4 | 4 | 11 | 9 |
| 3 | Afro alpine | 6 | 5 | 15 | 12 |



A B

Figure 4 Group of Mountain Nyala with the Largest (21 Individual of Mountain Nyala) (A) and Lowest (4 Individual of Mountain Nyala) Population

### 4.2. Trends of Mountain Nyala Population

The population of Mountain Nyala counted in different consecutive five years in Gesse grassland Head Quarter was decreased in 2016 and increasing since 2017 whereas the population at Afro alpine showed slight difference (Figure 5).

Table 5 Mountain Nyala Population Trend

| year | Gesse grassland | Headquarter | Afro-alpine | Total Population |
|---|---|---|---|---|
| 2013 | 1453 | 211 | 23 | 1687 |
| 2014 | 1568 | 214 | 74 | 1856 |
| 2015 | 1483 | 221 | 49 | 1753 |
| 2016 | 1270 | 234 | 38 | 1542 |
| 2017 | 1581 | 232 | 98 | 1911 |
| 2018 | 1679 | 346 | 131 | 2156 |

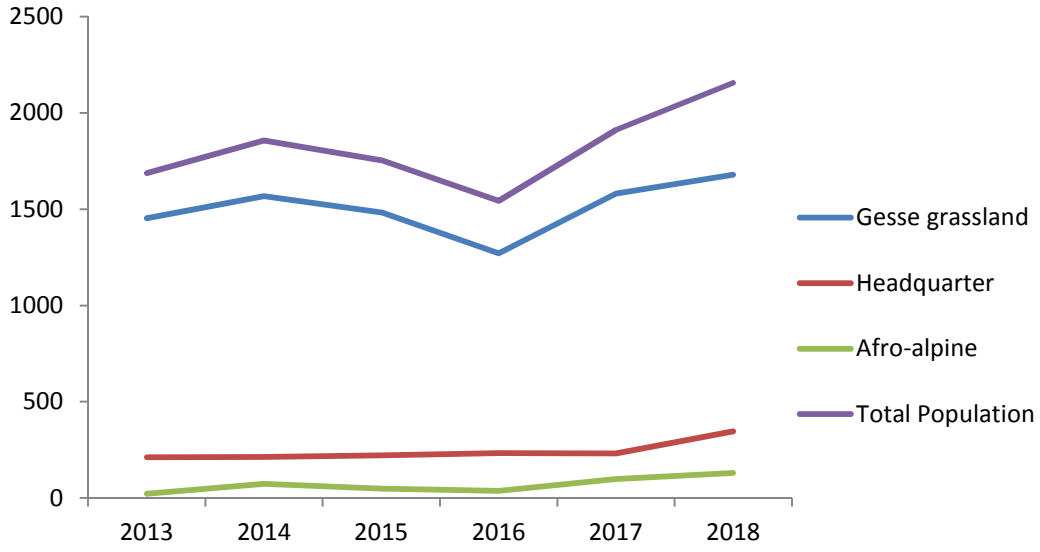



**Figure 5 Population trends of Mountain Nyala**

### 4.3. Distribution and Habitat preference

The Mountain Nyala was distributed into three common habitats (Table 5).There where commonly observed in Gesse grassland, Northern woodland (Head quarter) and Afro-alpine habitats (Table5)

Table 6 Population estimates and density in the three sites

| Estimate | Habitat type | | | Total |
|---|---|---|---|---|
| | Grass land(Gesse) | Woodland(HQ) | Afro-alpine | |
| Population estimate | 1679 | 346 | 131 | 2156 |
| Density | 60.2 | 301.9 | 0.04 | 1.9 |

On the other hand in the present study the three common habitats were classified in to seven sub-habitats as shown on table 6. The result shows that from the total counted in wet season Mountain Nyala, about 1679 number of Mountain Nyala prefer Gesse sites and also from those 1679 mountain nyala about 865 found in Gesse open grassland. From dry total counts about 1632 of Mountain Nyala also found in Gesse site. Of these 1632 about 798 number of Mountain Nyala found in Gesse open grassland.

Table 7 Classification of habitat types in the study area with their area and Mountain Nyala preference

| No | Habitats | Sub-habitats | No of Group | | No of individuals | |
|---|---|---|---|---|---|---|
| | | | **Wet** | **Dry** | **Wet** | **Dry** |
| 1 | Gesse | Gesse open grassland | 71 | 69 | 865 | 798 |
| | | Gesse Forest | 29 | 25 | 345 | 272 |
| | | GesseBushland | 38 | 48 | 469 | 562 |
| | | Sub-total | 138 | 142 | 1679 | 1632 |
| 2 | Afro alpine | Afro alpine open land | 11 | 6 | 83 | 52 |
| | | Afro alpine bush land | 8 | 3 | 48 | 19 |
| | | Sub-total | 19 | 9 | 131 | 71 |
| 3 | Head Quarter | Head Quarter Grassland | 28 | 22 | 262 | 173 |
| | | Head Quarter forest | 15 | 17 | 84 | 176 |
| | | Sub-total | 43 | 39 | 346 | 329 |
| Total | | | 199 | 190 | 2156 | 2032 |

## 5. DISCUSSIONS

### 5.1. Population of Mountain Nyala

The study focused on the BMNP head quarter, Gesse grassland and Afro alpine. Mountain Nyala had wide distribution, occupying three to all of the five habitats of BMNP (BMNP, 2017). This small but important zone at the north of the park comprises almost flat land, with swampy areas. The area is particularly important for Mountain Nyala, although good populations of other antelope such as Menelik's bushbuck (*T.sriptus meneliki*), Bohor reedbuck (*Redunca redunce*), and Red duiker (*Cephalophus natelensis)* are found in large numbers on these grasslands, particularly in areas where human disturbance is slight, or at night. Grazing pressure is high in this area. These zone covers 29.6Km2/1.38% of whole national park (BMNP, 2017). This study relatively presented data concerning on the population of Mountain Nyala, patterns of social organization mainly, focusing on frequencies of occurrences, group sizes and compositions of the different social group types, as well as the influence of habitat type on these attributes.

By this study a total of 47 transect were located in the study sites following a systematic parallel grid with transect at a 10° bearing north and south of the road that traverses the area. Transects were spaced 500m apart and placed avoiding river crossings. The 47 transects ranged from 0.65 to 3.5 km Surveys occurred in the middle of the wet season (August) where Nyala typically spend more time in the grasslands during the day compared to the woodlands where they spend much of their day in the dry season. This allowed for greater visibility and more sightings. The maximum number of mountain Nyala counted was 1679 during the wet season and the lowest number was 71 during dry season. During each census season, fluctuation in number of mountain Nyalas in each counting block was observed.

A total of 2156 Mountain Nyalas were counted using these 47 transect lines. And also the study identified the number of Mountain Nyala population and number of group in both wet and dry season. As a result, the study shows that in the study area in the wet season the number of Mountain Nyala population and group number was 2156 and 199 respectively.

In dry season the number of Mountain Nyala population was 2032 and group number was 190. The number of Mountain Nyala individuals and groups in both wet and dry season were higher in Gesse grassland followed by Head Quarter and Afro alpine. Similar study of Hillman (1987), shows that particularly, in the case of mean group sizes, contrast with the general presumption that ungulates form larger group sizes in open habitats than in dense habitats, which is mainly attributed to a defensive mechanism against higher predation pressure in open habitats. Moreover the total number of Mountain Nyala individuals and groups were higher during the wet season than the dry season.

Population fluctuations in ungulate species due to natural and/or unnatural factors results in changes in patterns of their social grouping (IUCN,2013), suggesting that monitoring of such behavior could indicate the population status or the presence of some sort of threatening factors operating against them. Frequency of group size distribution presented here for Mountain Nyala shows the pattern existing among the different group types at present and thus constitutes important base-line data for managers of the species.

### 5.1.1. Age and sex structure

As the study result indicates that group types containing female juveniles generally occur most frequently than group types without juveniles, which is consistent with the results reported for similar larger antelopes, such as the common eland (Hillman, 1987). The data also showed that all the five age/sex categories attained their wet and dry numbers and proportions in these group types. Although the reason why such large congregations occurred in groups of Mountain Nyala containing juveniles is unclear, several factors such as the presence of tendencies for juveniles to associate with their peers, predation and/or human-induced disturbances could be among the major causes of such aggregations (Hillman, 1987). As observed in other ungulates (Hillman, 1987), if there is a tendency for juveniles of Mountain Nyala to associate with their peers, to which adult females are attracted, this would result in the formation of large groups in the female-juvenile group in the female-juvenile group type.

In conclusion, the cumulative results obtained from the frequency of occurrences of the different social group types, as well from their group sizes and compositions, can provide

important information for managers of a number of endangered wildlife species, including the Mountain nyala, as changes in these patterns over time would make these managers to investigate the causes and take appropriate conservation measures. However, it has been noted that social organization in ungulates is often in state of flux lasting from a few hours to several days in response to different environmental factors (Hillman, 1987 and Kinahan, 2013).Therefore, long-term observations on individually known animals of mountain nyala are required to elucidate the durability/stability of the social associations reported here.

### 5.1.2. Group size

According to BMNP (2017), Mountain Nyalas are normally composed of adult and sub-adult females and May or may not have adult or sub-adult males. The group is matriarchal. An adult (alpha) female leads the group members. The age and size of females determine the dominance hierarchy. Male Mountain Nyalas live with the herds until they become adult males. Old males are usually solitary and young adults may form small groups. Size, age and heavy horn tussling determined their dominance hierarchy and the group size of Mountain Nyala is between3 to 25.Similarly, the study result shows that, during the wet season the group size ranged from 7 to 21 in Gesse grassland, 4 to 11 in Afro alpine and 6 to 15 in head quarter and during the dry season, it ranged from 5 to 17 in Gesse grassland, 4 to 9 in Afro alpine and 5 to 12 in Head Quarter.

Similarly the report of BMNP (2017) shows that Cow and calf groups were consistently larger than bull groups. Small groups containing between 4 and 10 animals were most common throughout the BMNP. Likewise, as observed from the study sites, there was a difference in grouping characteristics between groups containing cows and calves and those containing only bulls. The wet season total count average (2156) was grouped in 199 forming the mean group size of 12.5. The dry season total count (2032) was grouped into 190 with the mean group size of 10.5. The most frequently observed group size was 9 animals (wet season) and 7 animals (dry season). A group of more than14 animal is rare.



Figure 6 Sub-Adult Female Mountain Nyala Population at Gesse Grassland

### 5.2. Trends of population

In Gesse grass land and Afro alpine sites the population of Mountain Nyala increased from 2013 to 2014, whereas, the number of this animal decreased from 2014 to 2016 and since 2016 the number of Mountain Nyala is increasing (Fig 5). This study agreed with the study of Aseffa (2005) reported that the population trend of Mountain Nyala shows irregular based on the park's management effectiveness made during each particular period of time.

Whereas in Head Quarter the number of Mountain Nyala is stable which shows the management of this site was good because the head office of Bale Mountains National Park is there and this site is fenced. Generally, in the present study, the total number of Mountain Nyalas in the Bale Mountains National Park is between 2032 and 2156. This shows that the population of Mountain Nyala is high in this year when compared with other periods in park history. For example population estimates for the Mountain Nyala have been extremely variable over the years. Brown (1969) estimated a total population of between 7000-8000 and Hillman (1987) estimated global population of 3000 mountain Nyala, with a total of 1500 occurring in the BMNP. More recently, Refera and Bekele (2004) reported a total mountain Nyala population of 2850 occurring globally with 95 % of the population found at BMNP headquarters and Gesse Valley.

### 5.3. Distribution and habitat preferences

According to Hillman, (1987), although habitat type had a significant effect on the frequency of occurrence of overall Mountain Nyala groups in the study area. Furthermore, no significant effects of habitat type on mean group sizes of overall groups and each group type were revealed. These results, particularly, in the case of mean group sizes, contrast with the general presumption that ungulates form larger group sizes in open habitats than in dense habitats, which is mainly attributed to a defensive mechanism against higher predation pressure in open habitats (Kinahan, 2013). Thus, this lack of differences between open grassland and woodland habitats in the present study may be due to the similarities existing between the two habitats in the stimuli (e.g. resource availability, competition, predation and/or disturbances) in response to which the formation of social organization of

the species was necessitated. Similarly, this study shows that from the total counted Mountain Nyala that is 2156 (100%), about1679 (77.87%) populations were found in Gesse grass land and the other 16.04% and 6.09% found in Afro alpine and Head Quarter respectively.

The term vegetation type, which is the major plant species composition within a given habitat type (Hilman, 1987), was used in the present study to denote habitats of the Mountain Nyala. Accordingly, they classified the Gesse grassland habitat in to three vegetation types (forest land, Open grassland and Bush land), Head Quarter in to two (Forest land and grassland) and Afro alpine in to two (Bush land and open montane grassland). In the present study, this habitat classification system was used without a slight modification. Accordingly, 7 habitat types were defined and used in the present study (see Table 6 for their descriptions). Similarly, this study shows the Mountain Nyala prefer most of the time Gesse open grassland habitat type and also Gesse forest and Gesse Bush land habitat types are the second and the third most preferred habitat by Mountain Nyala from Gesse site in the study area followed by Grassland and forest habitat type of Head Quarter site (Table 6).

## 6. Conclusion and Recommendations

### 6.1. Conclusion

The present investigation provides valuable information on the population status, trends and habitat use of Mountain Nyala in Bale Mountains National Park.

Overall, 2156 individuals of Mountain Nyala were recorded during wet season for three sites (Gesse, head quarter and Afro-alpine). But, 2032 individuals of Mountain Nyala were recorded during dry season. The mean numbers of individuals observed during all seasons of the study were 2094. On the other hand in wet season a total of 199 Group and in dry season about 190 Group of Mountain Nyala was observed. In wet season from a total of 2156 Mountain Nyala, about 78.90% was observed in Gesse grassland and the left 16.04% and 6.09% were seen in head quarter and Afro-alpine respectively and in dry season about 80.3`% and 17.03% and 2.67were seen in head quarter and Afro-alpine respectively.

The highest number of Mountain Nyala recorded in the latest five years was 1679 during dry season of 2018 and the lowest 23 during wet season of 2013. The number of Mountain Nyala in both wet and dry season in 2018 in increased from 1663 in 2017 in wet season to 1679 and from 1270 in 2016 to 1679 in 2018.

The population of Mountain Nyala increased by 27.68 % within the last five years period and the total populations of the three sites in the study area in wet season were 2156 and 2032 individuals in dry season. The total number of juvenile female group is larger than the other groups. 199 groups of Mountain Nyala were counted in the wet season and 190 groups are counted in dry season. The Mountain Nyala was distributed into three habitats (Gesse grassland, Northern woodland (Head quarter) and Afro-alpine habitats) of these three habitats Gesse grassland is the most preferred habitat in the study area.

### 6.2. Recommendation

Based on the findings of the study, the following recommendations are forwarded to overcome the challenges of the Mountain Nyala conservation in BMNP.

1. Take action in regular monitoring of Mountain Nyala in order to secure the availability of Mountain Nyala and proper attentions should be given on effective protected area management.
2. Implement conservation initiative program, aims at supporting community-based natural resource management around the park is very important.
3. Control human settlements and livestock number around protected area; create awareness towards the significance of conservation of Mountain Nyala.
4. Unmanageable spread of fire has adverse effects, especially on afro alpine and Gesse grassland sites of Mountain Nyala and others. Therefore, awareness creation should be practiced the effects of fire on wildlife as well as on their future life.
5. Finally, Regular assessment, monitoring and evaluation of Mountain Nyala and other wildlife population and conservation threats are essential for better conservation measures.

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