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Distribution pattern, population estimate and habitat suitability map of the endangered mountain nyala (*Tragelaphus buxtoni*) in Arsi and Ahmar Mountains, Ethiopia

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1. INTRODUCTION

Antelope species are declining across the globe. Out of the 91 species of antelopes existing in the world, 25 species are threatened with Extinction (ASG 2009). The charismatic mountain nyala (*Tragelaphus buxtoni*) is among those endangered antelopes that is an endemic and keystone species to the Ethiopian highlands (Hillman, 1986; Hillman, 1988; Yalden et al., 1996). It inhabits Afroalpine and dense montane habitats of the Bale, Arsi and Ahmar Mountains (Malcolm and Evangelista, 2011). Habitat loss due to expanding human settlements, agriculture and increasing livestock grazing pressure contributed to the decline of mountain nyala across its range (Yalden *et al.*, 1984; Woldegebriel Gebre Kidan, 1996). As a result of its restricted range and small population size, mountain nyala are listed as Endangered by the IUCN Red List of Endangered Species (Sillero-Zubiri, 2008).

The Arsi Mountains has the second largest mountain nyala population next to Bale Mountains. The mountain nyala population found in the Arsi Mountains is genetically differentiated from the larger population found in the Bale Mountains (Atickem et al., 2013). This makes the need of conservation of the mountain nyala in Arsi particularly critical. The Ahmar Mountains support the least number of mountain nyala population. Widespread deforestation, annual fire and agricultural expansion to the cliffs of the mountains further threaten the species in Arsi and Ahmar Mountains.

The distribution pattern, population status and habitat requirements of mountain nyala is relatively documented in the Bale Mountains with recent studies (Atickem & Loe, 2013). On the other hand, the distribution pattern and population status of the species in Arsi and Ahmar Mountains were known from short term observations and trophy hunters (Evangelista et al., 2007). The population was estimated to be 7000 to 8000 in the 1960's and confined to fragmented patches of the Bale and Arsi Mountains (Hillman, 1986). Currently, about 3800 individuals are estimated in the Bale Mountains (Atickem et al., 2011) although Sillero-Zubiri (2012) had put the population in between 1500-2000 individuals. The population status in Arsi and Ahmar Mountains is poorly documented. Lack of information on the distribution pattern, population status and remaining potential habitat further complicates the conservation effort to save the remaining mountain nyala population. Thus the study aimed to determine the distribution pattern and population status of mountain nyala (*Tragelaphus buxtoni*) in the Arsi and Ahmar Mountains of Ethiopia. Modelling the currently available habitats in the study area will assist the conservation of the endangered species.

2. STUDY AREA

The Arsi and Ahamar Mountains are considered part of the central highlands of Ethiopia, east of the Rift Valley (Brown, 1969). Mountain nyala are known to inhabit the northern highlands include Arsi Mountains National Park, Munnesa-Shashemene State Forest, and the Werganbula and Arbagugu Controlled Hunting Areas (CHAs) (Figure 1). The Ahmar Mountains are also the northern most range of mountain nyala and includes the Dindin and Sororo-Torgam CHA, and the Muktar Mountain.

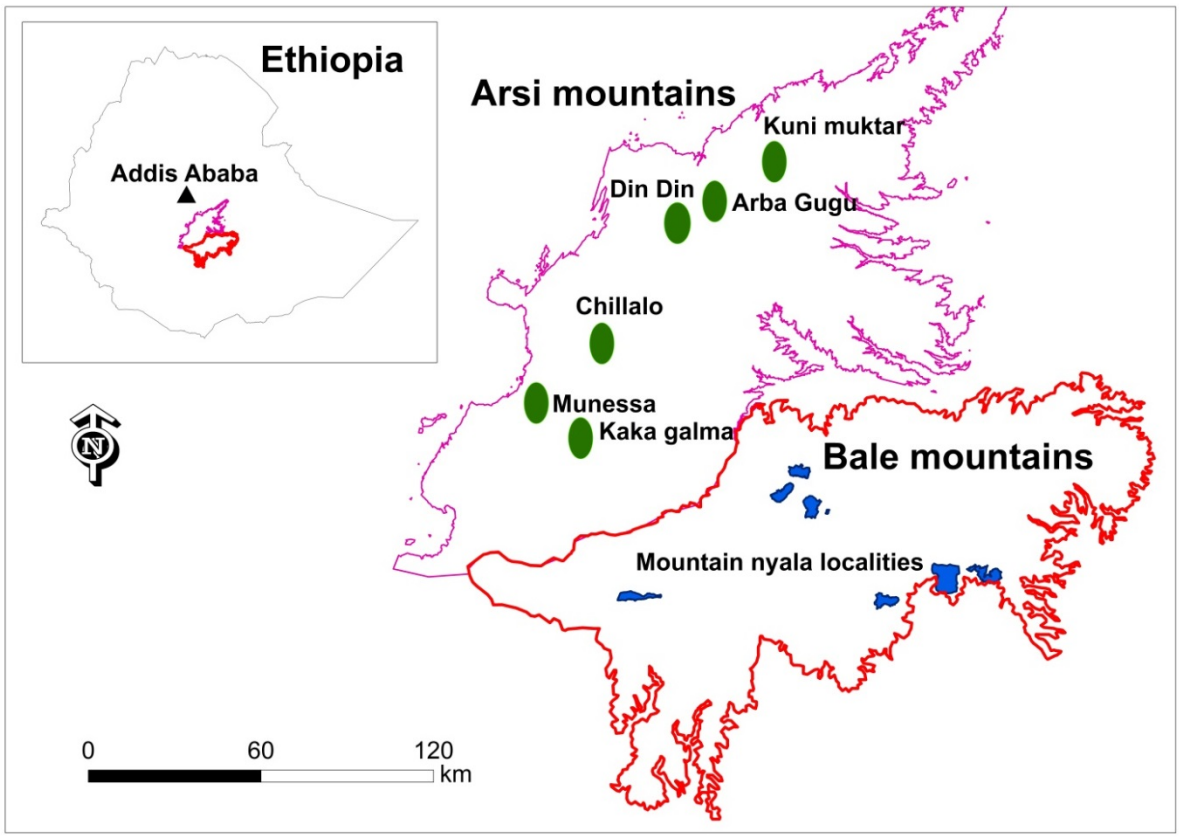

Figure1: Distribution of mountain nyala (*Tragelaphus buxtoni*) in Arsi and Ahmar Mountains, Ethiopia

3. METHODS

3.1. Distribution and Population status of mountain nyala in Arsi and Ahmar Mountains

The study sites are selected from the preliminary survey and historical records. Interviews with the local people following methods by Thompson and Bleich (1993) were also employed for obtaining demographic information. Population estimates were conducted using pellet counts using methods outlined by Wanyama et al. (2009). Counting of pellet groups has been used as indirect (Huapeng et al., 1997) and accepted method of estimating and monitoring ungulate population density (Hibert et al., 2010). Systematic line transects that are parallel to each other were designed and random points were generated in ArcGis 10. Systematic transects and random points were surveyed with the help of experienced scouts and trained field assistants. Twenty five representative fresh pellet groups were used to estimate the pellet degradation rate across study sites for the wet season. Estimation of defecation rate was not possible in the present study area. The defectaion rate of mountain nyala in the the Bale Mountains (i.e., 22.3 pellet-group per day per animal; Atickem et al., 2011) was used for the present study area. From the pellet count studies, density of animals will be calculated as

$$Da = \frac{Ds}{Pi * I}$$

where Da= Density of the animal,
Ds= Total number of fecal pellets,
Pi= Mean time to decay of the pellets and
I= Rate of production of pellets (Homyack et al., 2009).

3.2.Habitat suitability map of mountain nyala

The core area in the patches including buffer areas with no human settlement was identified and the actual distribution of the species will be determined in the Arsi and Ahmar Mountains.

The habitat suitability model will be developed by presence absence data. Sample sites were selected for presence/absence surveys based on prior knowledge of the areas, information from previous surveys and altitudinal range.

4. PRELIMINARY RESULTS

The whole data on this project is in the processes of data entry and comprehensive analysis will be carried out soon. The final manuscripts will be submitted to Rufford with in short period of time. I presented here only the preliminary results.

4.1. Distribution of mountain nyala in Arsi and Ahmar Mountains

The Arsi and Ahmar Mountains are the northern-most range of mountain nyala. These mountains include Arsi Mountains National Park (Chilalo-Galama and Kakka block), Munessa-Shashemene state forest (Munessa-Kuke CHA), Worganbula CHA, Arbagugu CHA, Dindin forest, Sororo-Torgam CHA and Muktar Mountain.

Arsi Mountains National Park, established in 2011, found in Arsi and western Arsi zones, Oromia Regional State of Ethiopia. The Park is subdivided into four blocks; Dera-Dilfekar, Chilalo-Galama, Kakka and Hunkolo. Mountain nyala are found only in Chilalo-Galama and Kakka blocks. Both blocks are characterized by Afroalpine vegetation at the higher elevation, ericaceous vegetation at the middle and a few remnant Afromontane forests at the lower elevations. Galama Mountains constitute the largest portion of the park, located between 7º48' to 7º88' N latitude and 39º27' to 39º51' E longitude with altitudes ranging from 2700m to more than 4000 m asl (Girma et al., 2015). Mountain nyala are widely distributed in the southern part of the mountain where they are getting better protection and relatively no livestock interference. Kakka Mountain is located between 7°15' and 7°30' N latitudes and 39°0' to 39°15' E longitudes with a total area of 103 Km^2. The altitude ranges from 3146 to 4217 m asl. Livestock grazing and uncontrolled annual fire is severe in both mountains. As a result the species is found at the tip part of the mountains (the case in Kakka) and marginal areas that provide better protection and/or cover (the case in Galama).

Munnesa-Shashemene state forest covers 111 km^2 of natural dry Afromontane forest and artificial plantation (Evangelista et al., 2007) and extends over an elevation range from 2100 to 2700 m asl exhibiting undulated topography. The state forest supports the second largest mountain nyala population in Arsi Mountains. The state forest consists of both dry Afromontane forest and artificial plantation (Evangelista et al., 2007). Mountain nyala is widely distributed in the natural plantation and the dense artificial plantation provides cover and corridor during movement between the forest patches. Livestock grazing and human encroachment has become increasing in recent years and the natural forest is under severe pressure from illegal logging.

Werganbula CHA is a highly rugged and undulated landscape with deep gorge mainly characterized by a heavily threatened Afrotropical forest. This patch supports the smallest mountain nyala population in Arsi Mountains. The area served as a controlled hunting area and now abandoned due to the decline of mountain nyala population and other administrative

problems of the region. Hence, such type of consumptive utilization of wildlife has to be practiced with comprehensive assessment and management. Agricultural expansion is still a serious problem though undulated topography of the area helps the remnant mountain nyala population to survive.

Arbagugu CHA supports the largest mountain nyala population in Arsi and Ahmar Mountains and the area is characterized by steep hills of mixed open woodland and ericaceous habitat interspersed with rivers and streams. The species is naturally protected by deep and rugged landscape of the area. Human encroachment is the most serious problem. If the human encroachment continues unchecked, the survival of mountain nyala face local extinction and the Afrotropical forest will be fragmented. The mountain nyala population are only found in the deep gorges and hills, areas inaccessible to human.

The Ahmar Mountains are the northern most range of mountain nyala and includes the Dindin and Sororo-Torgam CHAs, and the Muktar Mountain. The Dindin CHA covers 130 km^2 of natural and plantation forests, ranging from 2000 to 3070 asl in elevation. The site exhibits a diverse topography mainly consisting of mountains and valleys. Sororo-Torgam CHA covers 78 km^2 ranging from 2000 to 3000 meters asl in elevation. The site exhibits a diverse topography mainly consisting of mountains and valleys. Muktar Mountain has a total area of 36 km^2 is a dry evergreen montane forest and elevation ranges from 2000-3010 m asl.

Dindin CHA exhibits vegetation cover that includes both natural forest and plantation. The area served as a controlled hunting area and now abandoned due to the decline of mountain nyala population. Agricultural expansion in the south west and livestock grazing throughout all parts of the forest needs serious attention. As a result the mountain nyala population is declined and is at the brink of extermination.

Sororo-Torgam CHA covers 78 km^2 ranging from 2000 to 3000 meters above sea level in altitude. The controlled hunting area exhibits vegetation cover that includes wooded valleys, hilly forest lands, open forest edges, and thicket bush lands. The participatory forest management (PFM) associations are being contributing a lot to the hunting area protection through the ongoing reforestation activities.

Muktar Mountain, a dry evergreen montane forest, currently exists as an island surrounded by human settlement and agricultural fields. As a result the mountain nyala population is found in ¾ of the area. This is the smallest patch both in Arsi and Ahmar Mountains.

4.2. Mountain nyala Population status in Arsi and Ahamar Mountains

Population status is estimated by combining transect methods in open areas and pellet counts in dense forests and bush where visibility is too poor for transect sampling. The total population size of mountain nyala estimated here is based on the pellet count study. The average pellet degradation rate was 46.5 days for Muktar and Soroto-Torgam controlled hunting area and 45.5 days for the remaining study sites.

Table 1: Population estimate (PE) of mountain nyala (*Tragelaphus buxtoni*) in Arsi and Ahmar Mountains, Ethiopia (using pellet count study)

Mountains	**Study sites**	**CA**	**NP**	**PAI**	**PE**
Arsi	Galama	45	270	0.001	66
	Kakka	32	192	0.001	42
	Munnessa	54	324	0.004	220
	Arbagugu	66	396	0.003	253
	Worgnabula	18	108	0.001	42
Ahmar	Muktar	12	72	0.002	25
	Sororo-Torgam	30	180	0.002	55
	Dindin	28	168	0.001	33
	Total	285			721

Key, **CA**= Core areas of mountain nyala in Km^2, **NP**=Number of plots used for the study, **PAI**=pellet abundance index, **PE**= population estimate

Malcolm and Evangelista (2005) estimated the total population of Muktar and Sororo-Torgam CHA (previously known as Kuni-Muktar) 50 individuals in 2004. At present these two areas are separated by human settlement and the population is estimated separately. The total mountain nyala population of Muktar Mountain and Sororo-Torgam CHA was 23 and 55 respectively. This is by far smaller than Ethiopian Wildlife Conservation (EWCA) (2003) assessment which was 200 for both localities.

Mountain nyala population in the Dindin CHA was estimated to be 33. Malcolm and Evangelista (2005) estimated the population to be 100. The Arbagugu CHA supports the highest number of mountain nyala population in Arsi and Ahmar Mountains with 253 individuals. Munnesa-Shashemene state forest supports the second largest mountain nyala population and estimated to be 220. Arsi Mountains National Park supports a total of 112 individuals (75 mountain nyala in Galama and 37 in Kakka).

4.3. Habitat suitability of mountain nyala in Arsi and Ahmar Mountains

The potential area of mountain nyala habitat in Arsi and Ahmar Mountains is approximately 1030 km^2 area. Livestock grazing, uncontrolled burning, wood collection, and new established settlements along with expansion for agriculture pose the most significant threats to mountain nyala and other wildlife in the area. As a result, the core area of mountain nyala is diminished to 285 km^2 area (Table 1). The habitat suitability map is under development and will be submitted to Rufford in the near future.

5. CONSERVATION IMPLICATIONS

Mountain nyala populations in Arsi and Ahmar Mountains have been displaced from most of their previous range and only persist in isolated patches. These patches currently exist as an island surrounded by human settlement and agricultural fields. These patches are also heavily grazed, frequently burned and fragmented that reduces habitat quality and critical wildlife corridors. Currently, there is no habitat connectivity between most habitat patches that could serve as a wildlife corridor for the exchange of individuals between the populations.

Uncontrolled burning in the study area is a common occurrence. It has had a number of negative impacts on the local environment including degradation of the Afroalpine vegetation. The situation is now severe and degrading the fully grown *erica* vegetation which provides important cover for mountain nyala. Wildlife conservation awareness program should be launched with other stakeholders so as to get the support of the local community. The sustainability of conservation areas depends on the full hearted support of the local community that also helps for the sustainable utilization of the wildlife resource. As a result, local communities and administrators will be aware of the ecological importance of Afroalpine and Erica habitats and will participate in conservation of mountain nyala in the area.

Figure 2: Burnt *erica* habitat in Galama Mountain.

Figure 3: Burnt *erica* habitat in Kakka Mountain

Livestock grazing is widely spread as an increasing conservation challenge in Arsi and Ahmar Mountains. "Godantu" (traditional livestock keepers) are severely affecting the Arsi Mountains National Park and CHAs. The CHAs are potential sites to practice sustainable utilization of the wildlife resources, but livestock grazing and human encroachment has become increasing in recent years and the natural forest is under severe pressure from illegal logging. Hence, the local administrative bodies, concessionaire and other stake holders should work best to mitigate the encroachment activities and agricultural expansion in the area.

Figure 4: Livestock grzing in Arbagugu Controlled hunting area

Figure 5: Human encroachemnt in Arbagugu Controlled hunting area

Excessive grass harvesting for animal feed and fire wood collection by local communities are also threats to the mountains. In collaboration with the local officials and the concerned community members, the concessionaires and park management should make their best effort

to alleviate the problem. There should be awareness creation campaign and a program aimed at integrating conservation activities with the needs of the rural communities.

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