A profile of the mountain nyala (*Tragelaphus buxtoni*)

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1. Introduction

The mountain nyala (*Tragelaphus buxtoni*), a species of antelope found only in Ethiopia, has the distinction of being the last large ungulate discovered in Africa. After its initial discovery in 1908 by Ivor Buxton, Richard Lydekker of the South Kensington Museum first identified the species as a type of greater kudu (*Tragelaphus strepsiceros*) in an article called "The Spotted Kudu" (Lydekker, 1910a). The skins and horns were sent to Rowland Ward in London, who informed Lydekker that the specimen was indeed a new species of antelope not yet documented by western science. Lydekker wrote several descriptive papers on the new species (Lydekker, 1910a, b, 1912); however, the mountain nyala received little attention from the scientific community until Leslie Brown's expedition to Ethiopia in the early 1960s (Brown, 1963). Brown made several trips to Ethiopia, and his work is still considered the most detailed literature published on the mountain nyala (Brown, 1963, 1966, 1969a).

For several decades, information on the mountain nyala's biology, habitat, population, and distribution of the population was largely gathered and reported by trophy hunters. Major Buxton's mountain nyala specimens were taken in 1908 "south-east of Lake Zewei on the Arussi Plateau" presumably in the Galama Mountains (Lydekker, 1910a). Other early hunting expeditions by M.C. Albright, G. Sanford and S. Legendre and Major Maydon had also taken place in the Galama Mountains and were the first to report the occurrence of mountain nyala on Mt. Chilalo, Mt. Kaka, Mt. Encuolu, and the Albasso Forest north-west of Ticho (Sanford & Legendre, 1930; Wieland 1995). Prior to the 1960s, these ridges and volcanic cones were believed to be the only places to harbor mountain nyala populations. Rapid degradation of the Galama highlands, from burning and cultivation, was apparent, and in 1961 Donald Carter recommended that the species be listed as endangered by the International Union for the Conservation of Nature and Natural Resources (now called the IUCN; Brown, 1969a).

In response to the mountain nyala's endangered status, Leslie Brown made two trips to Ethiopia in the 1960s in search of other potential populations yet to be discovered (Brown, 1963, 1966, 1969a). His first trip was in 1963 through the Mendabo Mountains (now considered to be part of the Bale Mountains) beginning in Dodola, traversing through the southern highlands, and ending in Adaba. His second trip, in 1965 and 1966, included expeditions on Mt. Boset (near Munessa-Shashamane State Forest), the Mendabo Mountains, the Galama Mountains (including Mt Kaka and Mt. Badda), and Asbe Teferi (presumably what is now Kuni-Muktar Wildlife Reserve). Brown was the first to conduct a mountain nyala survey of this scale, and his assessments resulted in the removal of the mountain nyala from the IUCN's list of endangered species from 1969 to 1975.

Since then, only a few scientific studies of the mountain nyala have been conducted, mostly at Bale Mountains National Park (BMNP) where a dense population can be easily observed near the Park's headquarters and the adjacent Gaysay Valley (Hillman, 1985, 1986; Woldegebriel, 1996; Stephens *et al*., 2001). Although these studies in BMNP have been insightful in describing behavior and population dynamics of a few isolated populations, they have not acknowledged the full range of the species within the Park's boundaries. Similarly, other estimates of the total population of mountain nyala in Ethiopia have overlooked several significant ranges, relying on speculation rather than in-depth investigation (East, 1999; Malcolm & Evangelista, 2004; Refera & Bekele, 2004). Since 2000, there have been several significant populations identified that have yet to be reported or acknowledged by the scientific or wildlife conservation communities. The situation has resulted in a high degree of uncertainty in regard to the status of the mountain nyala, and inhibits the effectiveness of management plans and conservation strategies.

In this paper, we attempt to clarify many of the misconceptions surrounding the mountain nyala by examining published scientific literature, unpublished reports, and interviews with numerous rural people and community leaders, wildlife and natural resource managers, and government officials at all levels. This information is supplemented with five years of research, observations and data collection by the authors and research staff. Despite our efforts, we acknowledge that the scientific understanding of the mountain nyala, its' habitat and the total population is still far from complete. However, we hope the information presented here will improve wildlife management decisions, promote the formulation of wildlife policies, facilitate scientific research, and supplement conservation strategies.

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2. Biology

2.1 Genealogy

The mountain nyala is a member of the Bovidae family, Tragelaphinae subfamily, Tragelaphini tribe, and one of nine species in the *Tragelaphus* genus, commonly known as the spiral-horned antelopes of Africa. This genus also includes the bushbuck (*T. scriptus*), greater kudu (*T. strepsiceros*), lesser kudu (*T. imberbis*), eland (*T. oryx*), giant eland (*T. derbianus*), bongo (*T. eurycerос*), sitatunga (*T. spekei*) and common nyala (*T. angasi*). Although the fossil remains of several members of the genus have been described (Gentry & Gentry, 1978), including those of *T. nakuae* found in the Omo Basin, Ethiopia, and East Turkana, Kenya (Turner & Anton, 2004), and *T. pricei* found in Middle Awash Valley, Ethiopia (de Heinzelin *et al.*,1999), there is little evidence regarding the ancestry of *Tragelaphus*.

Within the *Tragelaphus* genus, there has been much speculation about which species is the closest relative of the mountain nyala. At the time the mountain nyala was discovered, the current *Tragelaphus* genus was actually divided into two different genera: *Tragelaphus* (bushbuck and common nyala) and *Strepsiceros* (kudu). After careful consideration, Lydekker eventually determined that the new species shared a closer resemblance to the common nyala than to the kudu. However, the mountain nyala's similarities to both genera further strengthened Lydekker's argument that the two genera should be combined, and eventually the species belonging to *Strepsiceros* were added to *Tragelaphus* (Lydekker, 1910b, 1912). Several decades later, in 1932, the Berlin Zoo secured the only known pair of live, captive mountain nyala, and there was a lobby by several German zoologists to rename the mountain nyala the "medium kudu" because they believed it resembled the lesser and greater kudu more than it resembled the common nyala (Raethel, 1980). The name change never occurred, but in 1980 a second group of zoologists from the Berlin Zoo believed the mountain nyala's combination of stripe patterns and spots resembled a western race of sitatunga and again suggested that a name change be considered (Raethel, 1980).

In 1998, the Smithsonian Museum of Natural History Laboratory of Molecular Systematics conducted a phylogenetic tree analysis (PTA) of the mountain nyala from samples submitted by a hunter and compared the cytochrome sequences of other *Tragelaphus* species acquired from Gen Bank (Braun, unpublished work, 1988; GenBank, 1998). The PTA uses a bootstrap support index from 0 to 100 to characterize the strength of the ancestry between species (Figure 1); the higher the number, the stronger the relationship. With the exception of the common nyala and lesser kudu, the results of the analysis illustrate that the species in the *Tragelaphus* genus can be divided into two significant groups (the bongo, sitatunga and bushbuck; and the eland and greater kudu) with the mountain nyala centrally placed between. A similar genealogy of spiral-horned antelopes was more recently described by Kingdon (1997). Although Kingdon's analysis lacks the bootstrap index to distinguish strength among relationships, its grouping of members within the *Tragelaphus* genus is somewhat similar to those found by the Smithsonian Laboratory of Systematics.

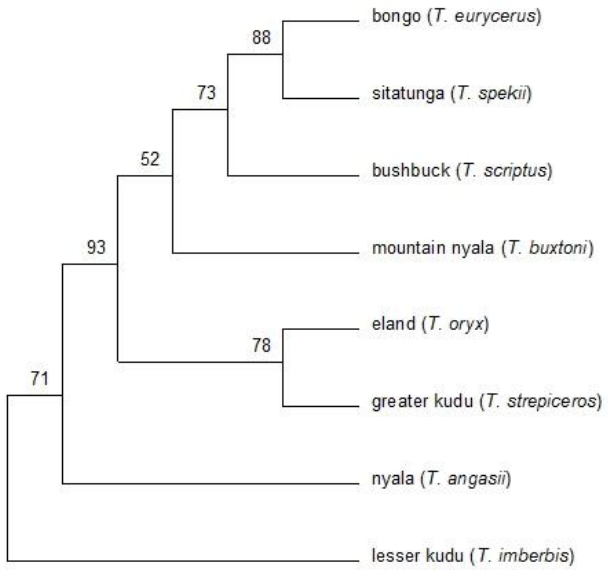

Figure 1. Phylogenetic tree of *Tragelaphus* species with bootstrap index (Braun, M., 1998).

2.2 Physical Description

Mountain nyala vary between reddish brown to dark gray in color. Calves and females are tan to reddish brown (common at BMNP headquarters) or gray (common in other forested habitats), while young males are generally gray and grow darker with age. Both sexes have distinct white patches on the throat and chest, distinctive white patterns on the inside of their legs and white on the underside of the tail (Figure 2). Mountain nyala may have up to nine lateral white stripes on each side. Spots are often present on the flanks or in a linear pattern running horizontally across the side or back, with one to three spots commonly present on the face or cheek. Both stripes and spots are regularly present on most animals but may be either obscure or absent. Markings are generally unique for each animal with the spot and stripe patterns differing on each flank of an individual (Figure 3). Male mountain nyala have a distinct white chevron and a dorsal mane that runs the

length of their back, becoming obvious on calves at about five months old. Females have faint, narrow chevrons and slight manes that are inconspicuous. The coloration and markings of mountain nyala are adaptations for concealment, similar to other forest and woodland antelopes, while the distinctive chevron and mane found on males are likely associated with intraspecific communication (Endler, 1978; Stoner *et al*., 2003).

Male mountain nyala are much larger in size and weight than females. Males average 120 to 135 centimeters (cm) tall at the shoulder; males living in alpine/heath habitat weigh between 180 and 250 kilograms (kg), and males living in other forest habitat weigh between 240 and 320 kg (Brown, 1969b; Walther, 1990; Kingdon, 1997; N. Roussos, personal communication, 2001). Females are generally 90 to 110 cm tall at the shoulder and weigh between 150 and 200 kg (Raethel, 1980; Walther, 1990; Kingdon, 1997). Only males have horns, which are spiraled, hollow, and comprised of keratin that covers a bony core that extends about two-thirds the length of the horn. Horns of mature males usually grow from 85 cm to 1 meter (m) in length and have three distinct ridges. Complete spirals do not exceed one and a half and vary considerably in the tightness of the twists and spread of the arches. Horns are visible on young males at six months old and grow rapidly during the first three years of age, completing the first spiral as early as age four (Figure 4). As males mature, the horns become thicker at the base and develop ivory colored tips. Horns on older males usually exhibit wear and occasional breaks on the tips from object-horning.

Figure 2. Spot and stripe patterns tend to be unique for each animal and may vary on each flank.

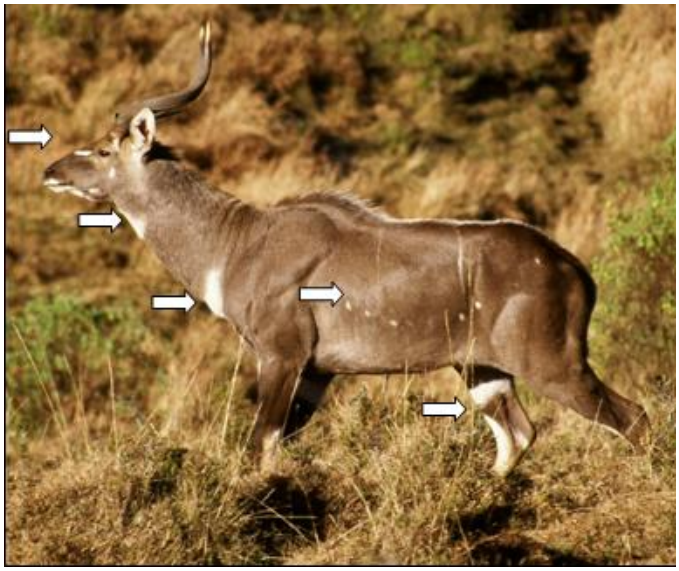

Figure 3. Distinctive marks found on both sexes of the mountain nyala.

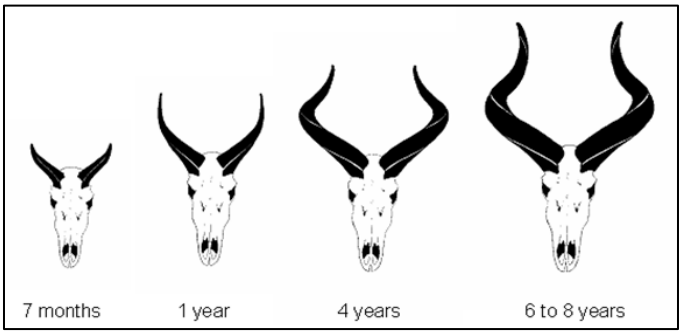

Figure 4. Temporal horn growth of male mountain nyala (Raethae.l, 1980; P. Evangelista, personal observations, 2001-2006).

Several factors allow the mountain nyala to swiftly move through thick forests and bamboo, up steep rocky slopes and across open landscapes. Their limbs are compact with muscle mass concentrated close to the body. As with all bovids, mountain nyala have an even number of functional toes on each foot (cloven hooves). The hooves are developed from elongated third and fourth digits and are centered below the axis of the foot. This digital formation creates an extra segment in the foot just above the hooves. The first digit is no longer present, and the second and fifth digits are shorter and fused together into a single canon bone that strengthens the skeletal elements within the limbs (Prothero & Schoch, 2002). The main pivot bone of the ankle, the astragalus, is highly specialized for moving forward and backward and bears the animal's weight. These physical adaptations not only enable the mountain nyala to reach speeds of 45 miles per hour, but also allow it to jump from a standing position over barriers as high as 1.75 m (Raethel, 1980). Even young calves at two months of age are extremely agile and are physically capable of eluding capture in open and forested terrain.

2.3 Reproductive Strategy

Very little is known about the reproductive processes of the mountain nyala. The only known captive specimens, located at the Berlin Zoo in the 1930's, never reproduced despite six years of cohabitation (Raethel, 1980). The first observations regarding mountain nyala reproduction were made by Brown (1969b). He suggested that mountain nyala gave birth at different times of the year with peaks during the months of April, May, and June and again in October, November, and December. Hillman (1985) suggested that mountain nyala are perennial breeders exhibiting a defined calving peak during the months of August and September. Our observations support both Hillman and Brown's reports. In Bale Mountains National Park, mating occurs during the months of December and January, with the vast majority of births occurring in August and September. However, the reproductive patterns of other mountain nyala populations tend to be more variable or peak during different months. For example, juvenile males in the Galama Mountains exhibit less disparity between age-classes, suggesting that reproductive synchrony may be subtler or have a bimodal pattern. Similar observations in the Galama Mountains were also reported by Brown (1969b) and N. Roussos (personal communication, 2001). Mountain nyala at BMNP headquarters may exhibit a unique reproductive synchrony that can be attributed to population densities, habitat type, climate or human impact.

Figure 5. Time series of two male mountain nyala fighting over female in estrous (not pictured). The eight photographs were taken over a period of eight seconds.

Mountain nyala have a polygynous reproductive strategy, which is common among non-territorial ungulates where potential mates may be widely distributed (Estes, 1991). As females come into estrus, dominant males will become less tolerant of rivals and will compete for dominance and breeding rights through a series of expressive postures, threat displays and, in rare cases, brief intensive fighting. As rival males approach each other in the presence of a female in estrus, their hair fringes and dorsal crests become erect, movement slows, the back arches, legs become stiffened and lateral horn presentation is displayed by lowering the head. These encounters between rival males are often in the form of a lateral T-position (Walther, 1984), where the defending or dominant male stands broadside to an approaching challenger while both animals exhibit the described postures and displays. At other times, when dominance is less defined, the two males will both turn broadside remaining still or moving slowly past each other in a standoff (Hillman, 1985; Hillman & Hillman, 1987). When in close proximity, one or both males may let out a long, deep exhale that can be described as a growling sound. Once a male establishes dominance, he will confidently raise his head and turn directly toward the challenger, which moves away in a submissive manner. This behavior, and modified variations of it, usually determines mating rights. Though uncommon, establishing dominance may result in physical fighting. Physical confrontations between males are short and intensive; a male will use one or two blows of the horns in an attempt to throw the opponent off balance followed by a swift, submissive retreat of the subordinate male and a brief pursuit by the dominant male (Figures 5). The subordinate male may then move on or remain close to the group at a safe distance. Although these confrontations do not usually result in serious injury, males at BMNP headquarters appear to exhibit a higher degree of injury and mortality from fighting. Park staff annually report finding five to ten mature males that have died as a result of fighting (A. Hussein, personal communication, 2006a). We suspect this incidence rate can be attributed to the high population density within the 1.2 square kilometer (km^2) fenced complex; however, it is also possible that the opportunity for finding evidence of mortality is greater near BMNP headquarters than in remote habitats.

Courtship begins when a female approaches a state of estrus and lasts until copulation is permitted. The male will follow the female closely with his neck and chin outstretched, regularly smelling the base of her tail in anticipation of ovulation. When other males are in the vicinity, the courting male will frequently raise his head high to display his horns while staying close to the female. The female will go about normal activities while

the male follows intently. If he is too persistent, the female will respond by trotting ahead or poking him with her muzzle in a defensive manner. As she approaches full estrus, she will urinate in response to the male's advances, allowing him to test her readiness by passing his tongue through her urine (Figure 6a). The male will then display a flehmen grimace, inhaling urine molecules through the incisive ducts into the vomeronasal organ and allowing him to determine her estrus status (Figure 6b; Walther, 1984). Once ready, she will allow copulation. When mating is complete, the male will turn his attention to other potential females and mating opportunities.

The gestation period of mountain nyala has never been clearly reported. Based on peak calving seasons and peak mating seasons, the gestation period is believed to be about eight to nine months (Kingdon, 1997; P. Evangelista, personal observation, 2001-2006). Twins have not been observed by the authors, but have been reported on occasion by local people. Newborn calves are kept well hidden for the first few weeks following birth and will nurse for three to four months. Calves demand feeding by moving in front of the mother's path and nudging her with their muzzle or neck. A calf will generally stay with its mother for two years (Hillman, 1985). In the second year, males are more inclined to leave the family group and join other males while females may stay with the mother and family group for a longer period of time. Females reach sexual maturity in their third year. Although sexual maturity among males is also achieved at a young age, breeding opportunities, which vary with population density, are likely to be delayed until the horns are fully developed (five to eight years) and the male can compete for mating rights.

Figure 6a: A male mountain nyala tests the readiness of a female to mate by tasting her urine. Figure 6b: Urine molecules are then inhaled through the incisive ducts during a flehmen display.

Reproductive success appears to vary considerably between mountain nyala populations in different geographic regions. Hillman (MoPED, 1993) suggested the mountain nyala may have a high reproductive rate, which can increase a population as much as 25 % each year. Refera and Bekele (2004) reported similar population increases in BMNP between 1975 and 1990. Although these reports illustrate a population's ability to achieve biotic potential under certain conditions, wildlife managers should be cautioned not to accept this as a norm.

Reproductive success is a function of environmental mechanisms related to stress, habitat quality, mortality, morbidity, density, climate and human activity, and needs to be assessed on a case-by-case basis. For example, after several years of intense persecution between 1991 and 1993, some mountain nyala populations (i.e. BMNP headquarters, Munessa-Shashamane State Forest) have made dramatic recoveries, while others (i.e. Galama Mountains, Mt. Kaka) have remained suppressed. The remarkable recovery ability of mountain nyala has undoubtedly rescued several populations from extermination, while facilitating the stabilization of others.

2.4 Social Composition and Behavior

Mountain nyala are gregarious, forming groups averaging from two to eleven individuals (Brown, 1969b; Refera & Bekele, 2004). They are considered non-territorial and are extremely tolerant of each other. Generally, mountain nyala groups are smaller (two to five individuals) in forest habitats and larger (four to ten individuals) in open habitats. These averages may vary significantly due to population density, limited habitat, the season of the year and the availability of forage and water. Family groups and bachelor groups will often associate during rest or feeding periods forming temporary herds as large as 60 to 100 animals (Refera & Bekele, 2004; N. Roussos, personal communication, 2005). Females form family groups that consist of a matriarch, several mature females and one or two offspring from each. Family groups stay relatively intact throughout the year, and the bond between members tends to be strong. Males form smaller bachelor groups of two or three individuals that are similar in age-class. As males become older, they are more likely to become solitary and avoid regular interaction with other individuals or groups.

Rank among males is usually established and reinforced through expressive postures and behavior. True dominance among mature males does not play an

important role throughout the year and is mainly sought for mating rights. Horn-pressing (Estes, 1991) is a common behavior among juvenile males as they each try to establish their rank. The confrontation usually begins with a face-off as the two males approach each other with their heads held low to the ground. As their heads or horns come into contact, each will push the other in an attempt to force the opponent's head down and back. Each engagement usually lasts only a few minutes and is frequently followed by repeated challenges from one or both males. We have yet to observe any pronounced aggression during horn-pressing engagements, which are generally playful and often interrupted by brief browsing or grooming activities.

Mature males commonly express symbolic dominance through object-horning (Hillman, 1985; Estes, 1991) by aggressively thrashing their horns into woody vegetation or into the ground. This behavior advertises a male's presence by the noise produced from the branches and by visually displaying a motivated state through aggressive actions. Branches, foliage, mud and other debris often become lodged in the horns, giving them a larger appearance that is readily displayed to other mountain nyala. Although object-horning appears be more frequent during mating seasons, displays are common throughout the year and have been observed with solitary males and males belonging to the same bachelor group. Object-horning is sometimes conducted with heated aggression and at other times with great leisure. Though the behavior is primarily used to intimidate other males or establish a symbolic dominance, it is also a likely strategy to advertise fitness to females.

The social groupings of mountain nyala play an important role in detecting and evading potential predators by increasing the number of animals that are attentive to danger. Females are more alert than males, and their tendency to congregate may be a survival advantage over less vigilant and solitary males. To rest, mountain nyala will seek higher ground, dense cover for camouflage, a clear view for danger and a quick escape route. When resting, a family group will situate itself in a defensive manner with each member having a different field of view. If a potential threat is detected, mountain nyala will remain very still in an obvious alert posture that is recognizable by other individuals. Mountain nyala are not generally vocal animals, but when alarmed they will give two distinguishable calls. Brown (1969a) described these as a "cough," emitted when a threat is less serious, and a "bark," used when a threat is of greater concern. Females and juvenile males are more vocal than mature bulls, which are more likely to flee without giving any vocal warning. When in flight, mountain nyala will raise their tails exposing the white underside to serve as a visual alarm to others. When any of these alarm behaviors are exhibited within a family group, calves direct their full attention to the actions of their mothers and follow their lead closely.

2.5 Dietary Requirements

Mountain nyala are largely browsers that feed on a variety of trees, forbs, grasses and cultivars (Brown, 1969b; Hillman, 1985). Like most bovids, they have a prehensile tongue and lack upper incisors. Their lower incisors are augmented by incisiform canines forming a row of eight chisel-shaped teeth. The upper canines are absent and cheek teeth are comprised of three premolars and three molars in each quadrant. Mountain nyala are ruminants, which are characterized by a four-chambered stomach that allows immediate processing of carbohydrates and proteins aid of microorganisms. In particular, microorganisms allow of digestion cellulose (up to 60% of cellulose content) which enables the mountain nyala to feed on a wide variety of plants Ruminant digestion can also absorb high concentrations of protein from microorganisms being flushed from through small intestine. The total digestion process for ruminants is slow, taking approximately 80 hours from food intake to excretion (Prothero & Schoch, 2002). However, ruminant digestion is extremely efficient in converting proteins to amino acids, synthesizing vitamins, and general utilization of low quality forage.

Ruminant digestion also utilizes the urea of microorganisms, which, in other types of digestion, is normally balanced through the intake of water and eliminated from the body in urine. Without the need for regulating urea concentrations, mountain nyala can go for long periods without drinking. Brown (1969a) speculated that mountain nyala drink water only on rare occasions, if at all. This may be true to some extent, but we have observed mountain nyala regularly drinking water in the late afternoon, and tracks are commonly found around water sources. Because their range generally encompasses mesic environments and higher altitudes, nighttime temperatures frequently result in frost or dew that offers hydration opportunities during early morning foraging.

The diet of the mountain nyala fluctuates with seasonal changes, habitat type and land-use activities. They mostly browse on the leaves of herbs, shrubs and trees, but are also known to eat grass, cultivars and aquatic flora. Grass species are mostly utilized during the early rains when young shoots have greater nutrition value. There have been several insightful observations regarding the mountain nyala's diet (Brown, 1969a; Hillman, 1985; Refera & Bekele, 2004). However, we believe that these observations, as well as our own, are

far from complete. Plant species known to be consumed by mountain nyala are listed in Table 1.

2.6 Habitat

Mountain nyala are commonly reported to range between 2,700 m and 4,300 m and to prefer heathland and alpine habitats (Brown, 1969b; Yalden & Largen, 1992). Their range, however, is much broader than previously described and are distributed across a variety of montane forest types. We have observed mountain nyala at elevations as low as 1,600 m occupying dense forests. Forested ecosystems provide concealment opportunities, critical cover for thermal regulation and a wide selection of available forage. Generally, mountain nyala inhabit mesic habitats between 1,800 and 3,500 m. These habitats can be broadly categorized into four altitudinal zones that are utilized by mountain nyala (Figure 7; Hedberg, 1971; Bekele-Tesemma *et al*., 1993; Bussmann, 1997).

The Afro-alpine zone, or high wurch, encompasses the highest elevations (>3,700 m). This habitat type is characterized by steep, rocky outcrops and sparse vegetation dominated by *Alchemilla* spp., *Helichrysum* spp. and the endemic *Lobelia rhynchopetalum* (Figure 8; Hedberg, 1951). The Afro-alpine zone offers minimal cover for the mountain nyala but provides year-round water and seasonal forage (Brown, 1969b). Mountain nyala use of the Afro-alpine habitat tends to be irregular and is more likely during the dry season than during the rains. The Afro-alpine may have been utilized more frequently when giant heath and montane forests were still intact and provided quick access to cover.

Table 1: Important vegetation species for the dietary requirements of the mountain nyala. References are coded as follows: [1]Brown , 1996a; [2]Hillman, 1985; [3]Hillman & Hillman , 1987; [4]Refera & Bekele, 2004; [5]Evangelista & Swartzinski, personal observation, 2001-2006.

Species	Growth Type	Preferred Parts	References
Acanthus eminens	herb	flower heads	5
Acanthus sennii	herb	flower heads	5
Agrostis spp.	grass		1, 4, 5
Alchemilla abyssinica	herb		1, 5
Alchemilla rothii	herb		3, 4, 5
Artemisia afra	shrub		2, 3, 4, 5
Asystasia gangetica	herb		5
Bothriocline schimperi	herb		3, 4, 5
Bromus leptoclados	grass		5
Canarina eminii	shrub		5
Carduus ellenbeckii	herb	flower heads	5
Carduus nyassanus	herb	flower heads	1, 2, 5
Cirsium dender	herb	flower heads	4, 5
Echinops spp.	herb	flower heads	1, 5
Erica arborea	shrub		4, 5
Hagenia abyssinica	tree	fallen leaves	3, 5
Hebenstretia dentata	herb	flower heads	2, 4, 5
Helichrysum splendidum	herb		5
Hordeum vulgare (cultivar)	grass		5
Hypericum revolutum	tree		5
Hypoestes aristata	herb		3, 4, 5
Hypoestes triflora	herb		1, 4, 5
Jasminum abyssinicum	shrub		5
Juniperus procera	tree		1, 5
Kniphofia foliosa	herb		1, 4, 5
Koeleria spp.	grass		5
Lemna minor (aquatic)	herb		5
Lobelia inconspicua	herb		1, 4, 5
Oplismenus compositus	grass	lower leaves	1
Parochetus communis	herb		5
Pennisetum spp.	grass		5
Poa spp.	grass		1, 5
Potentilla spp.	herb		4, 5
Rosa abyssinica	shrub		5
Rubus apetalus	shrub		1, 5
Rubus steudneri	shrub		1, 5
Senecio spp.	herb	crowns	5
Streblochaete longiarista	grass		5
Thymus schimperi	herb		5
Trifolium spp.	herb		5
Triticum spp. (cultivar)	grass		5
Urera hypelondendron	shrub		5

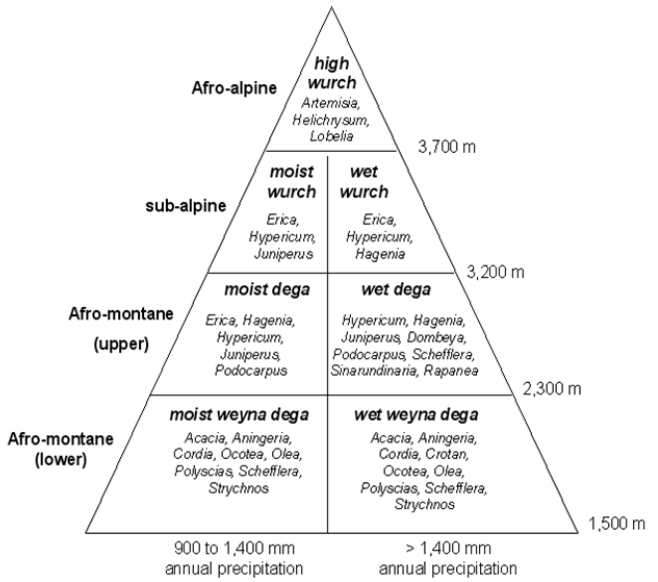

Figure 7. Bekele-Tesemma *et al*. (1993) described Ethiopia's highlands into four major habitat types and six sub-types. Mountain nyala can be found at elevations greater than 1,600 m and generally prefer forests that receive more than 1,400 mm of annual precipitation.

The sub-alpine and ericaceous zone, or moist wurch and wet wurch, ranges from 3,200 to 3,700 m in elevation (Figure 9). This habitat type is dominated by *Erica trimera* at higher elevations and *Erica arborea* at lower elevations (Miehe & Miehe, 1994; Wesche, Miehe & Kaeppeli, 2000). *Erica* spp. may grow to be 10 m tall and may take the form of a small tree when left undisturbed. Stands may become extremely dense at the lower boundary of the zone, intermixing with other shrub and tree species such as *Hagenia abyssinica*, *Hypericum revolutum* and *Rapanea simensis* (Bussmann, 1997; Nigatu & Tedesse, 1989; Weinert & Mazurek, 1984). The upper limit of the ericaceous belt is interspersed with open fens, wet meadows, and mosaic distributions of *Alchemilla* and *Helichrysum*.

The upper Afro-montane zone, or moist dega and wet dega, ranges between 2,300 and 3,250 m in elevation (Figure 10). The moist dega is dominated by the tree species *Hagenia abyssinica* and *Juniperus procera* with *Erica arborea* and *Hypericum revolutum* occupying the higher elevations (Bussmann, 1997; Bekele-Tesemma, Birnie & Tengnäs, 1993; Nigatu & Tedesse, 1989; Friis, 1986). Within the wet dega, the dominant tree species is *Hagenia abyssinica* intermixed with *Schefflera abyssinica*, *Dombeya torrida* and *Rapanea simensis* (Bussmann, 1997; Nigatu & Tedesse,1989; Friis 1986). African alpine bamboo (*Sinarundinaria alpina*) occupies the steeper slopes and drainages of these areas (Bussmann, 1997; Nigatu & Tedesse, 1989; Uhlig 1988). Mountain nyala are commonly found in the open montane grasslands interspersed throughout this zone. Common grass species include *Festuca abyssinica*, *Poa schimperiana* and *Carex* spp. The upper Afro-montane zone holds the highest mountain nyala population densities because it provides the best-quality habitat with forage and dense cover throughout the year.

Figure 8. The Afro-alpine habitat in the Galama Mountains has little vegetation structure that can provide important cover against extreme climate.

Figure 9. *Erica* species growing in the sub-alpine zone on the southern escarpment of the Bale Mountains.

The forests of the lower Afro-montane zone, or moist weyna dega and wet weyna dega, are situated between 1,500 and 2,300 m in elevation (Figure 11). This habitat type is dominated by the tree species *Aningeria aldofi-friederici*, *Sygium guineense*, *Ocotea kenyensis* and *Olea welwitschii* (Bussmann, 1997; Nigatu & Tedesse, 1989; Uhlig, 1988; Weinert, 1983). Although there have been few reports of mountain nyala occupying the lower Afro-montane forest communities, our observations indicate that these habitats are commonly utilized and, in some cases, support dense populations in the Bale Mountains.

Figure 10. The upper Afro-montane zone in the Hurufa-Soma Controlled Hunting Area in the Bale Mountains.

Figure 11. Lower Afro-montane habitat in the Abeshebe-Demero Controlled Hunting Area.

Mountain nyala also utilize forestry plantations comprised of non-native tree species in addition to the surrounding natural habitat (Figure 12). Common non-native trees include *Eucalyptus globulus*, *Eucalyptus grandis*, *Cupressus lusitanica*, *Pinus patula* and *Pinus radiata*. Although the plantation trees offer sparse herbaceous understory, they have proven to be very important habitat for mountain nyala. These forests provide valuable cover for concealment, travel corridors and thermal regulation, especially in areas where natural forests are limited. Particular areas of importance include Kuni-Muktar, Shashamane-Munessa State Forest and several small-scale plantations situated around the Galama Mountains. Another artificial habitat utilized by mountain nyala is cultivated barley, which is plentiful in the lowlands of the Arussi and Bale mountains. Although troublesome for farmers, mountain nyala will regularly feed in the cultivated fields at night. As natural habitats diminish, the seasonal availability of barley and other crops may be of growing importance in maintaining dietary needs.

Figure 12. Non-native Cupressus trees at the Munessa-Shashamane State Forest where commercial timber is planted adjacent to natural forests.

3. Distribution

The mountain nyala is only known to occur on the east side of the Rift Valley in Ethiopia, bounded by the Chercher Mountains in the north and the Bale Mountains in the south (Figure 13). We have found a few reports of small pockets of mountain nyala existing on the western side of the Rift Valley, but these are unconfirmed and unlikely (SCI, 2005). 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 and confined to "sky islands" on a handful of peaks and ridges. In the Bale Mountains, mountain nyala habitat remains moderately intact despite increasing encroachment of people and livestock.

3.1 Chercher Mountains (Ahamar)

The Chercher Mountains are the northernmost range of the mountain nyala. The mountains begin about 40 km northeast of the Rift Valley lakes and extend east toward the ancient city of Harar. Most of the mountain peaks are occupied by human settlements, agriculture and other land-use activities. During the 1970s, these mountains were well-known by safari hunters for having trophy-sized mountain nyala producing record animals through the 1980s (Mellon, 1975; N. Roussos, personal communication, 2005; SCI, 2005). Brown (1969b) described the Chercher Mountains as having a "dense

forest with lush undergrowth of shrubs" and "a variety of habitat from lush forests to bleak mountain tops." Today, mountain nyala populations are scant, largely due to the loss of available habitat and increase in human population. Only two areas in the Chercher Mountains are known to have mountain nyala populations: Kuni-Muktar and Din Din CHA.

The Kuni-Muktar Wildlife Reserve consists of two small forest areas that rest above the village of Kuni. The Muktar forest lies east of the village (Figure 14) and the Sobaly-Jelo forest lies to the west. The two upper Afro-montane forests range in elevation from 2,300 to 3,075 m and sustain the northernmost population of mountain nyala ever recorded. The native forests are primarily comprised of *Juniperus procera* and *Podocarpus gracilior* up to 2,900 m in elevation and *Dombeya* spp. at higher elevations. Collectively, the forests cover less than 25 km^2. The forests have historically supported stable populations of mountain nyala despite their small area (Brown, 1969a; SCI, 2005). In 1990, Kuni-Muktar was closed to hunting and designated as a wildlife reserve by EWCD. By 1996, poaching, deforestation and agricultural development had severely degraded the habitat, and reports indicated that the mountain nyala were no longer present (East, 1999). In 2003, however, EWCD conducted a survey of mountain nyala confirming their persistence (F. Kebede, personal communication, 2006). Mountain nyala populations in Kuni-Muktar appear to be increasing, which may be a result of two programs facilitated by the ORLDNRD. The first 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 (S. Muktar, personal communication, 2005). The second program is a reforestation effort begun in 2004 when 77 ha of *Juniperus procera* were planted in the vacated agricultural fields on Muktar Teretera and 980 ha of *Juniperus procera*, *Casuarina equisetifolia*, *Hagenia abyssinica*, *Grevillea robusta* and *Olea africana* were planted on Sobaly-Jelo Teretera. Additional reforestation efforts are planned for 2007 (K. Kabiso, personal communication, 2005; M. Eshetu, personal communication, 2005).

To the southwest of Kuni-Muktar is the Din Din CHA which is partly situated within a Forest Priority Area (FPA) and encompasses four weredas. The CHA covers approximately 500 km^2 with elevations ranging between 2000 to 3070 m. Only 223 km^2 are forested, dominated by Afro-montane species of *Dombeya torrida*, *Phytolacca dodecandra*, *Maytenus senegalensis*, *Schefflera abyssinica*, *Hypericum revoltum* and *Hagenia abyssinica* (EWCD and ORLNRD, 2002b). Logging and other anthropogenic activities have had noticeable

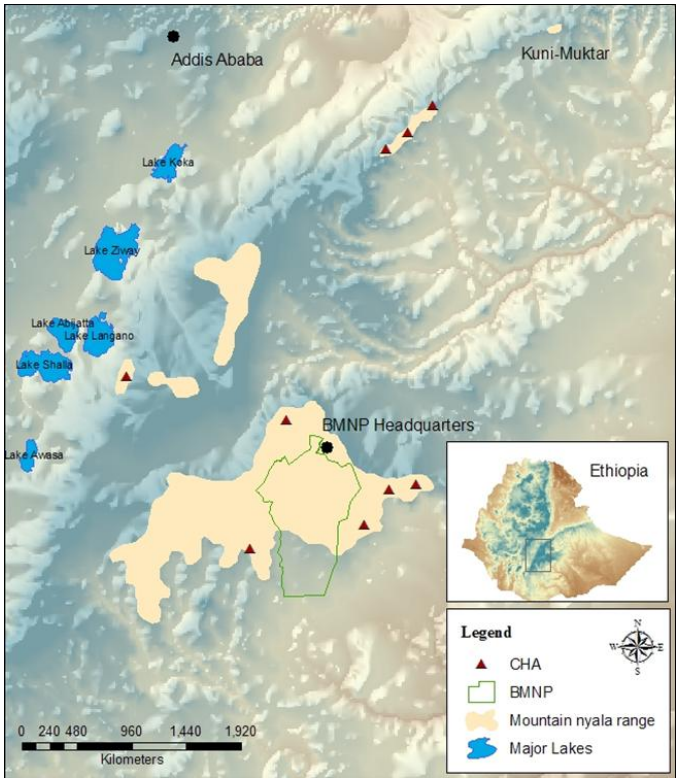

Figure 13. Distribution map of mountain nyala in the Ethiopian highlands.

Figure 14: The Muktar Forest is located on the top of a ridge. Slopes pictured in the foreground were once cultivated, but are now being planted with trees by the ORLNRD and GTZ.

impacts to the regions, and the EWCD and ORLNRD (2002b) has reported that some areas are being rehabilitated and minimally controlled for further degradation. Although the establishment of a CHA appears to have impeded destructive land-use activities, there appears to be a need for active participation by local communities and regional government agencies.

3.2 Arussi Mountains

The Arussi Mountains are the central range of the mountain nyala and lie just east of the Rift Valley lakes. Areas that mountain nyala are known to inhabit are the northern highlands (which include Arba Gugu CHA and the proposed Werganbula CHA), Galama-Chilalo Forest Priority Area (FPA), Mt. Kaka and the Munessa-Shashamane State Forest. These areas range in elevation from 2,000 to 4,300 m with annual rainfall averaging over 1,000 mm. The Arussi mountain range is not continuous but broken into the larger Galama Plateau and several isolated volcanic cones that are interspersed among large expanses of state-owned agriculture and smaller family homesteads at lower elevations.

Arba Gugu CHA lies about 100 km southwest of the Din Din CHA. Although considered to be part of the Arussi Mountains, it can be argued to be part of the Chercher Mountains. Elevations at Arba Gugu CHA range from 2,000 to 3,600 m and cover an area approximately 225 km^2. Gorges and steep valleys are characterized by forests of *Hagenia Abyssinica*, *Dombeya torrida*, *Discopodium penninevum*, *Schefflera abyssinica*, and *Hypericum revoltum*, while the uplands are covered by *Erica* spp. (EWCD & ORLNRD, 2005a). The area is under considerable threat of human encroachment and seasonal grazing of livestock is prevalent. One possible reason for the threat is the absence of permanent guards or game scouts by the safari operator. Unlike other CHAs that have permanent camps and staff, the Arba Gugu CHA lacks regular patrols of the area which would discourage destructive and illegal land-use. Steep topography has protected much of the remaining forests and provided refuge for mountain nyala and other wildlife.

A proposed mountain nyala hunting area is currently being considered by EWCD and ORLNRD called the Werganbula CHA, which lies south of the Arba Gugu CHA and east of the town of Ashmira. Werganbula proposed CHA covers an area of 78 km^2 with elevations ranging from 1800 m to 2800 m. Similar to Arba Gugu CHA, Werganbula has a rugged landscape and dominated by *Juniperus procera*, *Podocarpus gracilior* and *Schefflera abyssinica* in the protected gorges (EWCD & ORLNRD, 2005d). To the author's knowledge, the area has only been surveyed once by wildlife managers. EWCD and ORLNRD personnel have reported the area to be under pressure by cultivation, logging and settlement. The recommendation for the CHA designation is, in part, to protect for the remaining forests and wildlife while creating conservation incentives for local communities by increasing economic and social benefits (EWCD & ORLNRD, 2005d; Evangelista 2006).

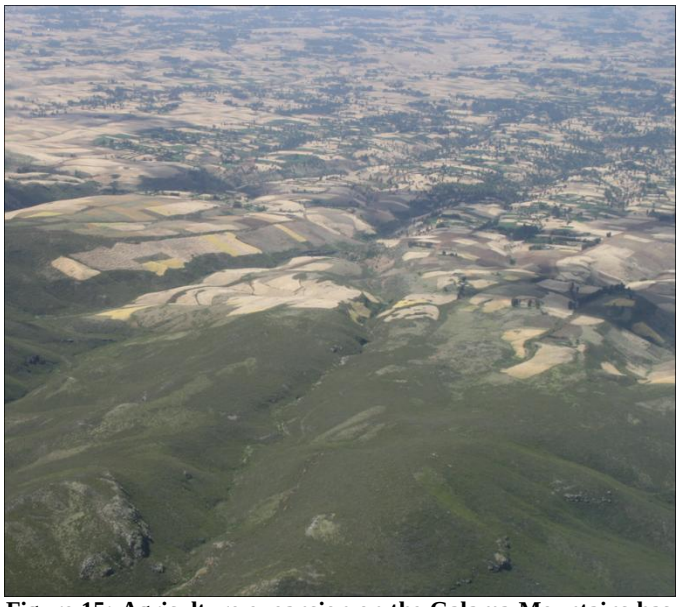

Figure 15: Agriculture expansion on the Galama Mountains has reached 3,410 m on some slopes, pushing livestock higher into heathlands and Afro-alpine.

The Galama Mountains make up the largest portion of the Arussi massif, covering an area of 1,200 km^2. The Galama Mountains have three prominent peaks: Mt. Chilalo in the northwest, Mt. Badda in the north, and the Boraluku plug located in the north-central region. From Boraluku, a long ridge stretches south toward the town of Bekoji called the Galama Ridge. To the southwest of these peaks is Mt. Kaka, a volcanic cone which was reported by local people to have historically been connected to the Galama Mountains by Afro-alpine forests. Local elders can still recall these forests harboring lion (*Pantera leo*) and elephant (*Loxodonata africana*) before human settlements and agriculture separated the two massifs (Kubsa 1999; Figure 15). Both the Galama Mountains and Mt. Kaka are covered by sub-alpine and Afro-alpine habitats; Erica spp. comprises about 70% of the area. At lower elevations on the eastern slope of the Galama Mountains (>3,200 m), only remnant stands of Afro-montane forests persist on the eastern slope. These forests are dominated by Hagenia abyssinica, Juniperus procera and Podocarpus gracilior. Although topography of the eastern slope has slowed development of agriculture, the forests are still heavily inhabited by people.

In 1995, the Galama Mountains became one of 39 FPAs in Ethiopia to be managed for the production, protection and conservation of its forests by the Ethiopia Ministry of Agriculture (MoA, 1994). This has been only minimally facilitated with the creation of a few small-scale plantations in the southern regions below the Galama Ridge. Cutting of the forests, uncontrolled burning and the expansion of agriculture continue to have a significant impact (Figure 16). Management of

the Galama Mountains FPA is particularly difficult because it encompasses portions of six different weredas of the Arsi Zone representing nearly 183,000 people (Kubsa, 1999). The boundaries of these weredas meet at the higher elevations and are not clearly defined. Lack of support for FPA objectives and loose interpretation of wereda boundaries have suppressed any effective management of the Galama Mountains and created a situation where extensive exploitation of natural resources can be conducted without regulation. The most significant threat to the Galama ecosystems is intense, uncontrolled burning of Erica to promote the growth of grasses and forbs utilized by livestock. Burning practices have presumably been a historical part of this system (Brown, 1969b; Hedberg, 1971; Kubsa, 1999); however, the extent and frequency of burning increased with the civil unrest and a brief closure of controlled hunting areas in the early 1990s. Based on plant height and canopy cover, we estimated that 95% of the ericaceous zone on the Galama Ridge had been burned between 1990 and 2000 to open the landscape for livestock grazing (P. Evangelista & P. Swartzinski, personal observation, 2000; Malcolm & Evangelista, 2004). Similar events occurred with the Mt. Kaka CHA, and by 2001 both hunting areas were abandoned and remain unclaimed at the time of report. In 2002, management of the Galama FPA was transferred from the federal government to the Oromiya Region. This was followed by the appointment of a conservation team from the ORLNRD to encourage local weredas to curb burning activities and promote expansion of several surrounding plantations (A. Hussein, personal communication, 2005b). We have received reports that the frequency of burning has been reduced with the intervention of conservation team, but have not confirmed this information.

The Munessa-Shashamane State Forest of the Oromiya Regional State was first developed as a plantation project in 1968 by the Chilalo Agricultural Development Unit in an effort to conserve forest resources. Non-native tree species of *Eucalyptus*, *Cupressus* and *Pinus* were planted and managed with native forests in Degaga, Kuke and Gambo (Hvidberg-Hansen, 1977). In 1987, the forests were merged into one management system called the Munessa-Shashamane Integrated State Forestry Development and Utilization Project (Abate, 2004) consisting of three primary forested areas: Munessa, Gambo and Shashamane. Collectively, these forests cover an area of approximately 203 km^2 with elevations between 1,900 m and 3,550 m.

The vast majority of mountain nyala inhabiting these areas are found in the Munessa Forest, an area of approximately 111 km^2 of natural Afro-montane and

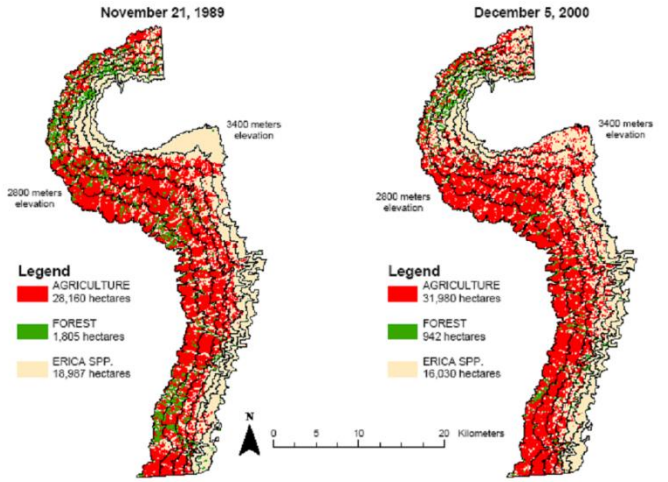

Figure 16. Using remote sensing techniques to process Landsat satellite imagery, changes in land cover can be detected over time. The analyses conducted for the western slopes of the Galama Mountains show agriculture encroachment into the ericaceous belt resulting in a decrease of habitat and highland ecosystems.

plantation forests. The Afro-montane forest, covering approximately 85 km^2, is characterized by *Podocarpus falcatus*, *Croton macrostachyus*, *Olea hochsteterii*, *Schefflera abyssinica*, *Aningeria adolf-friederici*, *Pygium africanum* and *Hagenia abyssinica*; the remaining 26 km^2 are a plantation forest consisting of *Cupressus lusitanica*, *Eucalyptus* spp., *Pinus patula*, *Pinus radiate* and *Pinus carribean* (EWCD & ORLNRD, 2001; Abate 2004).

As part of the Munessa-Shashamane State Forest's management plan to integrate multiple-use practices, the Munessa forest is open to mountain nyala hunting opportunities to generate additional funds. Despite intensive management and conservation strategies of the State Forest, Munessa was also subjected to intensive poaching during the civil unrest following the fall of the Derg government in the early 1990s. When the area was re-designated as the Munessa-Kuke CHA in 1995, laws concerning wildlife conservation and illegal hunting were quickly reinforced. The impact from poaching of mountain nyala population was evident and numbers remained low throughout the late 1990s. In recent years, however, mountain nyala have made remarkable recoveries with careful management and now serves as a model for multiple-use management while maximizing economic benefits. In addition to controlled hunting and timber harvesting, the Munessa-Shashamane State Forest hosts a number of scientific research endeavors to improve management objectives. Researchers from the University of Addis Ababa and Bayreuth University (Ger.) are studying forest dynamics, soils, climate, and variety of topics related to the flora and fauna (Figure 17).

3.3 Bale Mountains

The most prominent population of mountain nyala is found in BMNP, which was established in 1970 at the recommendation of Brown (1969b). Its primary purpose was to protect the mountain nyala, Ethiopian wolf (*Canis simensis*) and other endemic species found in Bale Mountains (Waltermire, 1975). The park encompasses 2,200 km^2 with elevations ranging from 1,500 to 4,377 m (Hillman, 1986). The elevation gradient and the abruptly rising peaks of the Bale Massif create orographic precipitation that feeds over 40 streams, numerous springs and alpine lakes that support a rich array of biodiversity (Hillman, 1988; Yalden & Largen, 1992; Williams, 2002).

All four major habitat types of the mountain nyala can be found within the borders of BMNP. The Senetti Plateau and upper Web Valley are located in the central region of the Park and ranges in elevation from 3,800 to 4,400 m. The Afro-alpine habitats are characterized by; *Helichrysum splendidum* and *Alchemilla haummanii* with scattered stands of endemic *Lobelia ryhncopetalum*. The northern slopes, between 3,000 and 3,800 m in elevation, are dominated by *Juniperus procera* and *Hagenia abyssinica* woodlands with *Hypericum revolutum* and *Erica* spp. occupying the highest elevations. The upper montane forests occur along the eastern and southern slopes where between 1,400 and 3,400 m. The Harenna Forest, located on the southern escarpment, has varying forest types of *Erica* spp., *Hypericum revolutum* and *Sinarundinaria alpina* occupying the higher slopes. At mid-slope the *Hagenia abyssinica* and *Schefflera abyssinica* forests predominate, with *Aningeria altissima* and *Podocarpus gracilior* occupying the lower elevations. BMNP has been intensively studied, and there are many detailed descriptions of the park's flora and fauna available (Yalden & Largen, 1992; Hillman, 1988; Gebre Kidan, 1996; Miehe & Miehe, 1994; Bussmann, 1997).

BMNP has a staff of about 40 people, mostly guards and scouts. Limited transportation, small operating budgets and lack of equipment hinder the staff's ability to patrol the majority of the park's landscape (F. Garedew, personal communication, 2005). The number of people and livestock that reside within the park or utilize its resources are unknown, but several small, localized studies suggest that more than 10,000 people and their livestock rely on the park's natural resources (Flinton, 2000; Stephens *et al.*, 200; F. Garedaw, personal communication, 2005; Gebre Kidan, 1996). Human presence within BMNP has been a growing issue since the late 1970s. At the time of the park's designation, there were few permanent inhabitants (Waltermire, 1975), but natural population growth,

Figure 17. Dr. Asferachew Abate (right) of Bayreuth University is studying nutrient needs and biomass of natural and plantation forests in the Munessa-Shashamane State Forest. Ecological research has played an important role in maximizing timber productivity and conservation of natural resources.

migration of people into the area and government relocation programs have all contributed to the high human population density (Admassie, 2000; F. Garedaw, personal communication, 2005; M. Eshetu, personal communication, 2005). Deforestation has resulted from fuelwood collection, clearing of forests for slash and burn cultivation and illegal commercial logging. Many of the people living near the park rely on livestock for their livelihood and have become dependent on the grazing lands within the park since traditional grazing lands outside the park have been converted to cultivated croplands (Hillman, 1988; Gebre Kidan, 1996; Stephens *et al*., 2001). BMNP has never been formally gazetted; therefore, settlements within the park's boundary and use of the park's natural resources are difficult to legally regulate.

The mountain nyala's range covers about 70% of BMNP though the population density is generally low in most places and extremely high in a few isolated regions. The highest concentrations of mountain nyala are found near the park's headquarters and in a few fragmented patches of forest outside the town of Dinsho adjacent to Gaysay Valley. Because of their accessibility, these mountain nyala have been studied more intensively than any others (Hillman, 1987; Stephens *et al*., 2001; Refera & Bekele, 2004) and are highly profiled among the general public, international community, conservation organizations, scientists and government institutions. Although most of the scientific knowledge regarding mountain nyala has been acquired from studying these populations, some of these observations may not accurately characterize the mountain nyala's natural behavior and social composition. Mountain nyala found at the park's headquarters and Gaysay Valley has unnaturally high population densities that limit habitat quality and available forage. The areas also subjected to the

continuous presence of people and domestic animals. These conditions are likely affect their natural behavior and may induce high levels of stress, increase the risk of disease and parasites, reduce genetic viability, and provide predation opportunities from domestic dogs (Sillero-Zubiri *et al*., 1996; Gebre Kidan, 1996; Stephens *et al*., 2001; A. Hussein, personal communication, 2005a).

Another significant population of mountain nyala in BMNP is found in the upper elevations of the Harenna Forest (also considered part of the southern escarpment of the Bale Mountains) between 2,200 m and 3,000 m (Evangelista, 2006). The forests at these elevations provide ideal habitat and are only minimally utilized by people and livestock. Much of the forest below the 2,200 m contour also remains intact; however, the topography of the landscape flattens, and mountain nyala are presumed to have a minimal presence. Mountain nyala from the Harenna Forest and other upper montane forests will occasionally move into the Afro-alpine habitat on the Senetti Plateau. Historic accounts by Brown (1963, 1969a) indicate that mountain nyala were once common in Afro-alpine habitats; however, heavy livestock use, seasonal settlements, evidence of poaching and the lack of park patrols have reduced their presence there.

The eastern slopes of the Bale Mountains have only recently been recognized as having mountain nyala (EWCD & ORLNRD, 2000; EWCD & ORLNRD, 2002a; Malcolm & Evangelista, 2004). This region begins about 60 km east of Robe extending southwest to the Harenna Forest in BMNP. The exact area of mountain nyala habitat is not clearly defined, but satellite images suggest that suitable habitat exceeds 1,000 km^2 (Evangelista 2006). Steep cliffs and rugged terrain on the eastern slopes have helped protect the forests from human encroachment and land-use activities. The eastern slopes rise from the sub-montane to the upper montane forests and are comprised of a wide variety of vegetation and forest types before changing into the heathlands that border the Senetti Plateau.

There are three CHAs on the eastern slopes of the Bale Mountains, all being newly recognized as having large populations of mountain nyala. The Abasheba-Demaro CHA lies the farthest east and is located about 50 km east of Robe and just south of Goro town. It is named after two mountains that define the region: Abesheba ridge (2,550 m) and Mt. Demaro (2,600 m). Three other prominent ridges, Bele, Ro-O Sada and Goro Bekelcha, add to the steep terrain that effectively limits human and livestock encroachment. The Abasheba-Demaro CHA is characterized by sub-montane and lower montane forest zones and covers approximately 210 km^2. In these forests we have observed mountain nyala at 1,600 m, which is lower than any other elevation previously documented for the species. West of Abasheba-Demaro CHA is the Besmena-Odo Bulu CHA, which lies southeast of Goba. This area covers approximately 350 km^2 and is bordered by Mt. Chertegembo to the north, Mt. Garba-koyae to the south and Mt. Wajitu-shabae to the west. Within the Besmena-Odo Bulu CHA are six prominent ridges: Besmena, Musicho, Kose, Mole, Demero and Ture. A major valley called Gora Bademena runs east through the mountains. Elevations range between 2,100 and 3,300 m and consist of mixed montane forest, upper montane forest, bamboo and giant heath. Neither CHA is significantly affected by human or livestock encroachment, but local people do rely on the forest to harvest bamboo (*Sinarundinaria alpina*), fuelwood and honey.

The southern reaches of the eastern escarpment have similar vegetation and landscape features as described in Abasheba-Demaro. A proposed CHA called Shedem-Berbere is being considered for mountain nyala hunting opportunities. The CHA covers an area of 170 km^2 with elevations between 1,500 and 2,500 m (EWCD & ORLNRD, 2005e). Dominant tree species include *Erythrina brucei*, *Ekebergia capensis*, *Shefflera abyssinica* and *Phoenix reclinata*. The area has not been hunted at the time of this report, but EWCD and ORLNRD is in the process of conducting wildlife censuses and setting harvest quotas.

Mountain nyala have never been scientifically documented on the southern escarpment of the Bale Mountains. However, our field observations in 2005 and 2006, and interviews with local people indicate that mountain nyala are widely distributed and that the area (N. Jarso, personal communication, 2006). Our observations are confirmed by the EWCD and ORLNRD, and a small portion of the area is currently under review for designation as a new CHA called Hurufa-Soma partially situated in the Mena-Angetu FPA (EWCD & ORLNRD, 2005c). The proposed Hurufa-Soma CHA ranges from 1,900 m to 3,200 m in elevation and lies partly within the Mena-Angetu FPA (Figure 18). Of the 215 km^2 encompassed by the CHA, less than 20% is impacted by human activities (EWCD & ORLNRD, 2005c). The area is dissected by the Iya River, which receives water from nine streams inside the CHA boundaries. The Hurufa-Soma CHA is bordered by high, rugged mountains to the north, BMNP to the east (including a 5 km Wildlife Reserve Area serving as a buffer zone), Baluk town and settlements to the south, and the Fecha Plain and town to the west. There are about 80 households that rely on the natural resources within the proposed CHA, mostly for subsistence

Figure 18. Sub-alpine scrubland in the Hurufa-Soma CHA where mountain nyala have been recently discovered. Fetcha Plain can be seen in the background with the Riripa Forest on the mountains seen on the distant horizon.

agriculture, livestock grazing, construction and fuel wood, honey production and bush meat (EWCD & ORLNRD, 2005c; N. Jarso, personal communication, 2006).

Other areas reported to harbor large numbers of mountain nyala on the southwestern slopes of the Bale Mountains include Riripa Forest and Goma Forest (N. Jarso, personal communication, 2006). Both areas are characterized by lower and upper montane forests (Figure 19). The Riripa Forest is defined by several large mountain peaks from 2,500 to 3,030 m that are largely isolated from human activity. However, new settlements are being established at lower elevations as people immigrate from Tulu Lencha in the west and Adele and Dodola in the north. The Goma Forest ranges from 2,270 to 2,820 m in elevation and is less accessible than the Riripa Forest (N. Jarso, personal communication, 2006). The few people that are homesteading within the Goma Forest are reported to be coming from Buluk, Bochesa and Hirboro.

The northwestern highlands of the Bale Mountains have varying densities of mountain nyala. The area was once known as the Mendabo Mountains and surveyed by Brown in 1963 and 1965 (Brown 1969a). High concentrations of mountain nyala are found in the Hanto CHA (sometimes referred to as Lajo-Spur), which lies about six km north of the park boundary and the town of Dinsho. Hanto CHA covers an area of approximately 250 km^2 with elevations reaching 3,000 m. (Figure 20) The forest is mostly comprised of Juniperus procera and Hagenia abyssinica interspersed with patches of Erica spp. Although much of the habitat remains intact, the presence of people and livestock are common. Three weredas utilize the forest resources of the Hanto CHA and water from the Hako and Hora rivers that flow west of the hunting block. Mountain are relatively confined

Figure 19. Lower montane forest (top) and upper montane forest (above) within the Mena-Angetu FPA on the southern escarpment of the Bale Mountains. Both forest types are known to have mountain nyala; however, a resident population of lions in the lower montane forest tends to push mountain nyala to higher elevations.

to the CHA by surrounding human settlements, but are believed to sometimes move south into the Gaysay Valley or other parts of BMNP.

There are two major towns in the northwestern region of the Bale Mountains called Adaba and Dodola, which are at approximately 2,400 m in elevation. Both of these towns are situated in the lower plains just below the ridgeline and on the edge of a large expanse of agriculture that runs north toward Mt. Kaka. The mountains and ridges above the two towns are part of the Adaba-Dodola FPA, which rises to elevations of 3,700 m and covers approximately 530 km^2. Reforestation efforts began in the 1980s and it became a FPA in 1995 (MoA, 1994) managed cooperatively by the ORLNRD and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). An estimated 20,000 people and 480,000 livestock utilize the Adaba-Dodola FPA

(Ameha, 2002). Although the forest is managed for multiple-use, over utilization and general degradation of the landscape are increasingly becoming problematic (Dale, 2003). The majority of the forest is Hagenia abyssinica, Podocarpus falcatus, Juniperus procera and Erica Species. Approximately 5% of the forest consists of non-native Cupressus lusitanica and Eucalyptus globulus (Ameha, 2002). Mountain nyala are known to inhabit the northern drier slopes but are generally uncommon. The southern slopes of the Adaba-Dodola FPA, where the forest is less impacted by humans and livestock, are reported to have larger numbers. These forested peaks stretch south over a vast area and connect with the Riripa Forest and other natural forests of the southern escarpment. The majority of this area has not been explored in recent years; however, satellite images indicate that the forest is largely intact and likely optimal mountain nyala habitat. The southern slopes also appear to receive more precipitation than other parts of the Bale Mountains and are characterized by rugged topography further suggesting that mountain nyala habitat may be optimal.

Figure 20. The drier northwestern border of the Hanto CHA. The pictured forests are predominantly *Juniperus* species with *Erica* growing on the steeper slopes.

4. Population Dynamics

4.1 Population Estimates

Population estimates for mountain nyala are difficult to assess due to the animal's elusive nature, preference for dense forest habitats and the uncertainty of their range. The first attempt to determine the total population was conducted by Brown (1969a). From observations in the Arussi and Bale Mountains, he estimated that mountain nyala numbers ranged between 7,000 and 8,000 individuals. Since Brown, most estimates have focused largely on mountain nyala near BMNP headquarters and Gaysay Valley and have not recognized the existence of mountain nyala on the eastern or southern slopes and forests of the Bale Massif (Hillman & Hillman, 1987; Stephens *et al*., 2001; Refera & Bekele, 2004). Hillman and Hillman (1987) reported that the population of mountain nyala at BMNP was 1,500 and that the total population was 3,000. More recently, Refera and Bekele (2004) reported a total mountain nyala population of 1,000 with 95 % of the population found at BMNP headquarters and Gaysay Valley. These studies recognized only a small proportion of the mountain nyala's full range, resulting in significant underestimates of the total population.

The most regular estimates of mountain nyala populations have been conducted by the EWCD and ORLNRD. EWCD is the federal agency responsible for managing all wildlife in Ethiopia, in cooperation with each regional government, and is responsible for setting hunting quotas. The EWCD conducts surveys every two years using variations of point and transect sampling designs (EWCD & ORLNRD, 1998, 2000, 2001, 2002a, 2002b, 2004, 2005a, 2005b; Evangelista, 2006). The results are usually made available only to the professional hunter that has leased the rights to each CHA. Some of these reports have been made available for this research effort and are presented in detail in a recent EWCD report on mountain nyala distribution (Evangelista, 2006). Discussions with EWCD officials suggest that the agency is uncertain of the full range of mountain nyala or is reluctant to openly disclose any information regarding undocumented populations.

We have attempted to identify suitable methods for estimating mountain nyala populations, but without a better understanding of their behavior, range and seasonal movements, we have yet to find an approach that is better than those employed by EWCD. In most cases, EWCD surveys correlate with our estimates. To some extent, we also agree with recent surveys using the direct count method conducted at BMNP headquarters and Gaysay Valley by Refera & Bekele (2004); however, it should be noted that direct counts frequently underestimate population numbers. Based on EWCD and ORLNRD census reports between 2002 and 2005, total population estimates in the six CHAs are 2,483 mountain nyala. These estimates were based on line-transect and stationary counts. Using the same methods in 2005 and 2006, EWCD and ORLNRD estimated the three proposed CHAs to have a total population of 644 mountain nyala (Evangelista, 2006). A census of Kuni-Muktar Wildlife Reserve by EWCD in 2002 suggested that mountain nyala estimates to be approximately 200 (F. Kebede, personal communication, 2006). Refera & Bekele (2004) estimated the mountain nyala population in Gaysay Valley and Park Headquarters of BMNP to be 732. And Evangelista and Swartzinski estimated the mountain nyala population at the Galama and Chilalo

FPA to be between 125 and 150 in 2000 (Malcolm & Evangelista, 2004). These estimates only represent a portion of the total area mountain nyala are known to inhabit, nor do they reflect large amounts of potential habitat that has yet to be surveyed. Based on these estimates, it is reasonable to conclude that the total population of mountain nyala in Ethiopia exceeds 4,000 (Evangelista, 2006).

4.2 Habitat Loss

Habitat loss and degradation is by far the largest threat to the persistence of mountain nyala and the vast majority of Ethiopia's wildlife. With a population of 75 million people, Ethiopia is the second most populous country in Africa (CIA, 2006). Eighty-five percent of the people live in rural areas and rely heavily on subsistence farming and natural resources for survival (FAO, 2006). Deforestation is widespread throughout the country, causing a host of problems including loss of resource productivity, alteration of hydrological processes, soil erosion and degradation of biodiversity (Admassie, 2000; Berry, 2003). It is estimated that Ethiopia's forests once covered 65% of the country and 90% of the highlands. Today, Ethiopia's forests cover only 2.2% of the country and 5.6% of the highlands (FAO, 2006). The current rate of deforestation is 150,000 ha per year (MoA, 1994). Loss of forests and woodlands is largely attributed to the need for cultivated lands. Approximately 95% of the country's agriculture belongs to family households that cultivate areas >2 ha (FAO 2006).

As a result of large-scale deforestation, many lowland wildlife species such as elephant and lion are now absent from Ethiopia's landscape. The mountain nyala has persisted because of its preference for highland ecosystems. However, as Ethiopia's population and demand for cultivated lands expand, mountain nyala populations have become increasingly fragmented and isolated to small patches of habitat at high elevations. The fragmentation of mountain nyala populations not only confines them to small areas but also deteriorates genetic viability. The situation is most apparent in Kuni-Muktar, Din Din CHA, Arba Gugu CHA, Mt. Kaka and the Galama Mountains. In each of these areas, mountain nyala are confined to the highest elevations or areas too steep for cultivation.

As agriculture overwhelmingly dominates lower elevations, domestic livestock are moved to higher elevations for grazing opportunities. Ethiopia has an estimated 30 million cattle, 24 million sheep and 18 million goats (Berry, 2003). Nearly 90% of livestock grazing is restricted to natural areas that have little

Figure 21. Livestock are commonly grazed in fragile Afro-alpine ecosystems at elevations that exceed 4,000 m.

farming potential. Seventy percent of Ethiopia's total cattle population and 30% of the sheep population are grazed at elevations above 1,500 m (Figure 21; Berry, 2003). Such a large number of domestic animals puts an enormous strain on the highland's floral composition and the fragile ecosystems as a whole (Nigatu & Tedesse, 1989; Wesche *et al*., 2000).

Increased competition for forage and space is not the only effect livestock grazing has on the mountain nyala. In the Galama Mountains, much of the highlands are covered with dense stands of *Erica* spp. that provide important thermal cover for mountain nyala against extreme climatic conditions (Mellon, 1975; N. Roussos, personal communication, 2001). Mature Erica stands tend to have closed canopies that suppress the growth of grasses and forbs (P. Evangelista & P. Swartzinski, personal observation, 2001). To increase forage, livestock herders regularly burn large expanses of Erica prior to the spring rains to open the landscape and promote germination of vascular plants. This practice is presumed to be decades old; however, historic accounts suggest that it was never as widespread or destructive as in recent years (Hedberg, 1971; Miehe & Miehe, 1994; Wesche *et al*., 2000).

The utilization of wood by the rural human population also significantly contributes to the degradation of mountain nyala habitat. Wood comprises 93% of Ethiopia's biomass fuel consumption (MoWR, 2001). In most cases, it is collected for use by individual households, but also collected for charcoal and sold within the community or to travelers passing through. The daily national average for wood consumption is 2 kg per capita; in the highlands, the average is 5 kg per capita (Figure 22; MoWR, 2001). Many of the tree species found in the highland forests are slow growing and do not regenerate easily. Some old-growth timber is harvested illegally by commercial enterprises, which transport large quantities of wood to saw mills where it

is processed into various wood products. Commercial forestry (legal and illegal) in areas with critical mountain nyala habitat is generally conducted at a small scale, but have severe cumulative effects. In most cases where mountain nyala are found, government programs (e.g. forestry plantations, CHAs) have been proactive in maintaining forests, and in many cases, have taken measures to increase forest areas.

4.3 Illegal and Community hunting

The range of the mountain nyala is shared with the Oromo people who occupy most of the south-central lands of Ethiopia. The Oromo are heavily engaged in barley farming and, to a lesser extent, the raising of cattle, sheep and goats. Hunting of mountain nyala and other wildlife species does not seem to play a significant role in Oromo tradition; however, occasional hunting has historically occurred and, to varying extents, still does (MoPED, 1993; Gebre Kidan, 1996; Kelbessa, 2001). Oromo tradition advises against indiscriminately killing wildlife because they may provide valuable resources in times of crisis or drought (Kubsa, 1999; Kelbessa, 2001). The exception to this tradition may be the Oromo that reside in the Arussi region. On several of Leslie Brown's expeditions to the area (1969b, 1969c), intensive hunting of mountain nyala by locals was openly admitted and discussed. Massive hunting parties were organized using horseback, spears and dogs on a regular basis. The Arussi people are also known to have a traditional hunt occurring in April called "Ofa." The term is derived from a verb in the Oromo language meaning "to drive." Kubsa (1999) reported that these hunts were once common in the Galama Mountains, but are no longer practiced. The traditional hunts were conducted by young men with intentions to marry a particular woman. Parts of the killed animal were presented to the father of the woman to announce the man's intention. Detailed accounts and information on the Ofa hunts were difficult to obtain and seem to be shrouded in secrecy, which might suggest that they still occur. Although hunting wildlife for meat and traditional group hunts have historically been illegal, the law was only minimally enforced until the mid-1970s. At that time, during the rule of the Derg, the law was more strictly enforced, and unauthorized and illegal use of many resources (e.g. timber, wildlife) was punishable by heavy fines or incarceration (Admassie, 2000). Despite the Derg's militant rule over its people, it was only marginally successful in suppressing illegal hunting.
Following the Derg's collapse in 1991, civil unrest from years of government oppression resulted in a dramatic surge of wildlife persecution and environmental destruction. There was little monitoring of human

Figure 22. Rural families rely on wood collected in natural areas for daily cooking needs, construction material and for sale of charcoal.

activities, and illegal hunting, deforestation, burning of vegetation, and new settlements took a heavy toll on the mountain nyala and other wildlife species (Sillero-Zubiri, *et al*., 1996; Gebre Kidan, 1996; N. Roussos, personal communication, 2001). Mountain nyala populations were reduced by as much as 75% in much of their range (MoPED, 1993; Gebre Kidan, 1996; N. Roussos, personal communication, 2001). Gebre Kidan (1996) reported that mountain nyala meat (presumably from BMNP) was served in hotels, coffee houses and restaurants. Similarly, the Galama Mountains, which were known for producing excellent trophy-hunting opportunities in the 1980s, were subjected to extensive burning and illegal hunting during the early 1990s (N. Roussos, personal communication, 2001; P. Evangelista & P. Swartzinski, personal observations, 2001; Malcolm & Evangelista, 2004). When safari hunting in Galama re-opened in 1995, mountain nyala populations and their habitats were so decimated that the outfitter imposed a voluntary hunting ban in 1998 (while still paying his concession fees) to allow mountain nyala populations to recover. Eventually, the CHA was abandoned due to continued uncontrolled burning and overall degradation of landscape (N. Roussos, personal communication, 2001).

4.4 Infectious Diseases and Parasites

The vulnerability of mountain nyala to infectious diseases and parasites is unknown. Throughout this investigation, we asked many local people, wildlife officials and professional hunters about mountain nyala physical and behavioral disorders or instances where the cause of death was not apparent, and no cases were reported. Examination of mountain nyala carcasses taken by legal hunting at lower elevations indicate that they are hosts to flies, ticks and a variety of ectoparasites that can

easily serve as vectors for disease. Risk of disease and parasites is also increased by the mountain nyala's social organization and mating system. New infections depend largely on host contact rates and probabilities (Altizer *et al*., 2003). New infections can result from direct transmission (such as social and sexual contacts) or indirect transmission (such as fecal matter or intermediate hosts). The transmission risk is high among mountain nyala because they tend to form family groups, are social and have a polygynous mating system. Higher population densities, such as those at BMNP headquarters, further increase inter-specific interactions. Degraded habitats and decreased forage availability may also increase stress and lead to a greater susceptibility to disease and parasites (Ezenwa, 2003). Risk of infection may also vary with climate, exposure to domestic livestock and overlapping ranges with other wildlife species (Anderson & Rowe, 1998; Vilcek *et al*., 2000; Ezenwa, 2003; Cleaveland *et al*., 2005).

Although we have found no studies regarding infectious diseases and parasites in mountain nyala, research on other *Tragelaphus* species has found the genus to be susceptible to a number of pathogens. This is important to report because the common ancestry of different species may make them vulnerable to similar parasites (Altizer *et al*., 2003). Related animals may be susceptible to specialist parasites that are a threat to a specific genus or to generalist parasites that threaten species with close geographical ranges. East Africa harbors all the *Tragelaphus* species except the common nyala. Besides the mountain nyala, Ethiopia is also home to the greater kudu, lesser kudu and bushbuck. Of these, only the Menelik's bushbuck's (*T. scriptus meneliki*) range overlaps with the mountain nyala (though both are in close proximity to greater kudu populations). Other wild ungulates that have overlapping ranges with the mountain nyala are Bohor reedbuck (*Redunca redunca*), klipspringer (*Oreotragus oreotragus*) and duiker (*Sylvicapra grimmia*).

Parasites and infectious diseases that the mountain nyala may be at risk to are: bovine viral diarrhea (found in kudus, common nyala, bushbuck and eland: Anderson & Rowe, 1998; Vilcek *et al*., 2000), bovine herpes (found in kudus, common nyala, bushbuck and eland: Anderson & Rowe, 1998), bovine tuberculosis (found in lesser kudu and bongo: Anderson & Rowe, 1998; Auclair *et al*., 2002; Cleaveland *et al*., 2005), bovine ephemeral fever (found in kudus and eland: Anderson & Rowe, 1998), bluetongue virus (found in kudus and eland: Anderson & Rowe, 1998), and a number of worms, nematodes and other gastrointestinal parasites common to the genus (Boomker, 1986; Boomker, Keep & Horak, 1987; Boomker, Anthonissen & Horak, 1988; Boomker, Horak & de Vos, 1989; Boomker, Horak & Flammand, 1991; Ezenwa, 2003). Other infectious diseases that mountain nyala may be susceptible to include anthrax, brucellosis, contagious bovine pleuropneumonia, Rift Valley fever, rinder pest and rabies (R. Tschopp, personal communication, 2006). Although many of these diseases and parasites may not cause mortality, they can have dramatic effects on population dynamics. Risks to mountain nyala are likely to be greater in populations at lower elevations and those in close proximity to cattle.

4.5 Predation

Predation of mature mountain nyala by other wildlife species appears to be uncommon due to the rarity of large carnivores within their range. Of Ethiopia's large predators, only the leopard (*Panthera pardus*) and the hyena (*Crocuta crocuta*) pose a significant threat to the mountain nyala, both sharing the majority of the mountain nyala's range and habitat (Brown, 1969a; Stephens *et al*., 2001; N. Roussos, personal communication, 2005). Mountain nyala, however, may not be easy prey. They can outrun most predators in a variety of landscapes, and sharp senses and a gregarious nature increases their ability to detect threats. Newborn calves, however, are extremely vulnerable and may be killed by jackals (*Canis mesomelas*), warthog (*Phacochoerus africanus*) or other opportunistic wildlife species, as well as domestic dogs (Gebre Kidan, 1996). On the eastern slopes of the Bale Mountains, lions are known to periodically inhabit the upper forests, but do not seem to be year-round inhabitants in most places (Hillman, 1986; N. Roussos, personal communication, 2005; Enawgaw *et al*., 2005). The exception to this is on the southern escarpment of the Bale Mountains where lions are reported to prey regularly on mountain nyala. During a field expedition in 2007, local honey gatherers reported two male mountain nyala killed by lions within the week our team was there. Although, we declined to investigate the carcasses, the informants were confident the kills were from lions and reported that the skins and horns were still at the scene. Lions above Hawo Plain can reside as high as 2,500 m and appear to influence the movement and distribution of mountain nyala (Evangelista & Swartzinski, personal observation, 2007).

5. Management

5.1 Status

The Mountain nyala is protected under Ethiopian law at both the federal and regional levels (F. Kebede, personal communication, 2006). The IUCN Red List of Threatened and Endangered Species lists the mountain

nyala as endangered due to reduced populations (A1) "of >70% over the last ten years or three generations" and population size of fewer than 2,500 mature individuals (C1) "with continuing decline of at least 20% within five years or two generations" (IUCN, 2006). At the time of this writing, the IUCN Antelope Specialist Group Northeast African Subgroup was in the process of preparing an Antelope Survey Update, which includes a status review the mountain nyala. There are currently no restrictions on the mountain nyala by the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) or U.S. Fish and Wildlife Service.

5.2 Controlled Hunting

Since its discovery, the mountain nyala has been a prized trophy among safari hunters, who have contributed the majority of historical information regarding the species and its habitat (Lydekker, 1912; Sanford & Legendre, 1930; Mellon, 1975; Braun, 1998; SCI, 2005; N. Roussos, personal communication, 2005). Historically, safari hunting for mountain nyala as always been logistically difficult, mostly due to the country's lack of infrastructure and the inaccessibility of the rugged topography of the Ethiopian highlands. Expeditions required intensive planning and normally lasted several months. During the rule of Emperor Haile Selassie, all wildlife was protected and special permission from the government was required to hunt mountain nyala (Sanford & Legendre, 1930; Brown, 1969c). By the 1980s, safari hunting was loosely regulated. Hunting only required a license and an accompanying game scout, and there were no annual quotas (N. Roussos, personal communication, 2005).

After the fall of the Derg in 1991, safari hunting was temporarily suspended from August 1993 to January 1995 while regulations were revised under the new Transitional Government of Ethiopia. Under the new hunting regulations, the mountain nyala could only be hunted in designated areas (CHA), and annual quotas were imposed with strict regulations. The rights to each CHA are allocated as a concession to a single, licensed safari outfitter or professional hunter. The concession holders are given long-term leases to create incentives for wildlife conservation, steady employment of local residents and to monitor the area for illegal exploitation of natural resources. Most safari outfitters have established very good working relationships with local communities and have voluntarily provided many direct community benefits such as new school buildings, medical facilities and clean water systems (Wakjira & Bedada, 2002; Enawgaw *et al*., 2004).

Revenues generated by safari hunting are shared between both federal and regional governments. The federal government receives 15% of the license fees, while each region receives 85% of revenues generated by licenses and 100% of the concession fee (Kubsa, 1999). Of the hunting revenues received by the region, 20% are allocated to local communities residing in the hunting concessions. Current annual quotas for mountain nyala are 1.5% of the male population, which are assessed for each CHA. Today, there are six hunting concessions for mountain nyala and three proposed areas under consideration. The six hunting concessions are located in Din Din, Arba Gugu, Munessa, Hanto, Abasheba-Demaro and Odo Bulu. Hunting concessions at Werganbula, Hurufa-Soma and Shedem Berbere are currently under review. All of the existing and proposed mountain nyala CHAs fall within the boundary of the Oromiya Regional State.

Anyone wishing to hunt mountain nyala must be guided by a professional hunter and two game scouts from the EWCD and Oromiya Region. Only trophy bulls with horns exceeding 29 inches (73.66 cm) measured on the spiral may be harvested. If an animal is shot that does not meet the minimum horn length, a $1,250 US fine is imposed on the professional hunter and if a female is shot, the fine is $5,000 US. In the event an animal is wounded and not recovered, the hunter may not continue to hunt on that particular license. Although the system has room for improvement, its aim is to distribute the benefits associated with hunting among all stakeholders while deterring unlawful exploitation. The system, in most cases, appears to be successful in limiting exploitation of natural resources and reducing human impact. Interviews with local residents and resource managers in communities situated around Munessa-Shashamane, Galama, Abasheba- Demaro, Hurufa-Soma and Odo Bulu indicate strong support for the system (Kubsa, 1999; EWCD & ORLNRD, 2001, 2002, 2004a, 2005c; N. Jarso, personal communication, 2006)

6. Conclusion

The mountain nyala is one of the most unique members of Africa's large ungulates, yet very little is known about its biology and distribution. Scientific reports and observations commonly provide contradicting descriptions of the species' physical appearance, behavior, habitat preference and distribution. In part, the contradictions are a result of inadequate applications of scientific methods, the reliance on assessable and localized animals at BMNP for research, and a general lack of collaboration and communication between independent researchers and wildlife managers. Much of the misconceptions regarding to the mountain nyala can also be attributed to the elusive nature of the species and

its preference for remote dense forests and rugged highland ecosystems. As a result, a significant amount of the mountain nyala's range has yet to be adequately surveyed by wildlife managers and scientific researchers. The total mountain nyala population is projected to be greater than 4,000. It is unlikely that the total population of mountain nyala is increasing (local increases are occurring in some areas), but as new populations are discovered the total population estimate could potentially rise. The challenge of mountain nyala conservation is in preserving critical habitat and enforcing existing wildlife laws and policy. This is a difficult task for any country with a growing human population that relies heavily on the land and natural resources for subsistence. Conservation has been further impaired by the development of Ethiopia's new government, which continues to restructure itself and divide the responsibilities of wildlife and natural resource management among several agencies. Despite management constraints and threats to habitat, the status of the mountain nyala is better than previously thought. EWCD and ORLNRD have recently recognized new and potential mountain nyala populations and are actively engaged in establishing management efforts and improving conservation strategies. Furthermore, Ethiopia is in the process of finalizing new wildlife policies and is expected to begin implementation by 2007. Much more research is needed to assess the status of localized mountain nyala populations, habitat availability and suitability, the effectiveness of management plans, and to develop sustainable conservation strategies.

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