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Greater Galagos near Mt. Kasigau, Kenya: Population Density Estimates

Andrea Falcetto
Western Kentucky University, alf0412@gmail.com

GREATER GALAGOS NEAR MT. KASIGAU, KENYA: POPULATION DENSITY ESTIMATES

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Andrea Falcetto

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Michael Stokes, Director of Thesis

Bruce Schulte

Jerry Daday

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Directed by: Michael Stokes, Bruce Schulte, and Jerry Daday

Department of Biology Western Kentucky University

This study examined population density and habitat use of a species of greater galago, genus *Otolemur*, around Mt. Kasigau, Kenya. Mt. Kasigau has a unique regional microclimate, a cloud forest, which provides many different flora and fauna a home. To examine population density, two different methods were used. The first method was using line transects and analyzing results using Distance 6.0. These surveys were conducted during both dry and wet season and results were compared after the study. The second method was to trap individuals and use mark-recapture to determine population density. When caught in a trap, individuals were also weighed and measurements were taken. Accurate weight was taken for 17 individuals; ear height, tail length, and hind foot length were recorded for 21 individuals. Mark-recapture data were analyzed using Krebs/WIN 3.0. Population density estimates using both methods were compared and provided similar results; Distance 6.0 estimated 0.62 individuals per hectare and Krebs/WIN 3.0 estimated 0.51 individuals per hectare. Morphological measurements were not consistent with published data of known species of *Otolemur garnettii*, which is the most common greater galago in East Africa. It is possible the Mt. Kasigau population is reproductively isolated and DNA analysis should be conducted in the future. Habitat usage of greater and lesser galagos and diurnal primates was examined to determine which tree species are commonly used by these individuals.

INTRODUCTION

Conservation efforts in rural Africa are more difficult than in developed countries because poverty is so high it is hard for individuals living there to think about anything else. 51% of Africans (excluding North Africa) lived on less than $1.25 per day in 2005 which is down only 7% from a survey done in 1990 (UNDP 2011). Globally, this proportion fell from 42% to 25% in the same time frame (UNDP 2011). Kenya is one of only two African countries that saw an increase in individuals living below the poverty threshold, though the increase was rather small at only 2% (UNDP 2011). Rural poverty in Africa is still at 61.6%, which is almost double the average for all developing countries (UNDP 2011). Kenya's literacy rate is 85% which is behind thirteen African countries (UNDP 2011). Approximately 55% of Kenyans had access to an improved water supply in 2008 (UNDP 2011). Kenya's unemployment rate did decrease slightly throughout the time period with a reduction of 2% (UNDP 2011). All of these factors are important to take into consideration when analyzing the conservation status of this region.

The Taita Hills of Kenya are part of the Eastern Arc Mountains, an IUCN biodiversity hotspot (Monjane 2009). Although many authors have investigated species richness in the Eastern Arc Mountains, very few biological studies have been carried out in the Taita Hills specifically (Brooks et al. 1998). There are at least 13 species of plants and nine species of vertebrates endemic to the Taita Hills (Beentje and Ndiang'ui 1988). In the Eastern Arc Mountains there are at least 96 endemic vertebrates and 68 endemic or near endemic trees (Burgess et al. 2007). More than 90% of the forest on which much of this biodiversity is based has been lost from the Taita Hills, endangering many plant and animal species. It is estimated that in prehistoric times the Taita Hills were covered by hundreds of km^2 of forest (Beentje and Ndiang'ui 1988). Beentje and Ndiang'ui (1988) estimated fewer than 294 hectares of forest remain in the Taita Hills (Mt. Kasigau was not included in this estimate). Brooks et al. (1998) estimated 400 hectares remain. This is down from an earlier estimate of at least 2020 hectares in the 1970s (Beentje and Ndiang'ui 1988). It is clear that forest in the Taita Hills has lost at least 85% of its coverage and some areas have even lost 99% of coverage from 1962-1985 (Brooks et al. 1998). For example, it is estimated forests now cover only 0.12% of the Taita Taveta district (Himberg 2004).

Mt. Kasigau is a disjunct peak of the Taita Hills. It is located at least 30 k southeast of the last peak in the range, Mt. Sagala, and is at least 60 k away from the middle of the main range of the Taita Hills. It has similar biogeographical characteristics and is the sole remaining forested mountain in the range with 203 hectares of evergreen forest under Kenya Forest Department protection (Kalibo and Medley 2007). As a result, it has become a safe haven for species now extirpated or nearly so from the remainder of the region. Many surveys of the Taita Hills do not include Mt. Kasigau in their study. In a 1998 survey by Beentje and Ndiang'ui, Mt. Kasigau is not even mentioned, and Brooks et al. (1998) did not visit Mt. Kasigau due to time and safety but recommended a similar study soon be conducted on the mountain.

Loss of forested land is mainly due to cultivation for agriculture. As the human population increases, so does the need for farmland. The Kasigau region serves as a corridor between Tsavo East and Tsavo West National Parks so wildlife frequently passes through the area. Often, this causes conflict between humans and wildlife because animals passing through will stop to feed on crops. Elephants are the biggest problem reported and have caused damage to thousands of dollars' worth of crops and several human deaths in the last year (Kagwa 2011). Other species are responsible for killing livestock at night. During an interview for the sociological side of my research (Falcetto 2012), one woman told me she had lost a goat to a leopard in the previous week.

Forests surrounding Mt. Kasigau are facing pressure from the charcoal industry, with illegal operations found on many community-owned ranches in Kasigau. Mt. Kasigau is still covered in trees but this could be due to the steep incline and frequent rock faces that make the mountain difficult to farm or harvest trees. Despite the wildlife conflicts, locals place significance on Mt. Kasigau and realize it has valuable resources. Two studies found locals realize the importance the mountain for rain collection and water conservation (Himberg 2004, Kalibo and Medley 2007). Previous studies also have discovered untouched forests are preserved because they are considered sacred by the local culture (Himberg 2004).

Cowlishaw (1999) estimated that 50% of forest-dependent primate species will go extinct based on losses of habitat that have already occurred. One genus dependent on forest habitat found in the Taita Hills is *Otolemur,* which represents the greater galagos, small, nocturnal primates. Although greater galagos are not endangered, the population within the Taita Hills is most likely very small. During a biodiversity study of the Taita Hills completed in 2000, a new species of dwarf galago was discovered as well as a greater galago identified as *Otolemur garnettii lasiotis* (Bytebier 2001). Bytebier recommends galago studies in the Taita Hills continue as funding becomes available because populations may be significantly underestimated. Perkin et al. (2002) later published a paper comparing galago calls, size, and other information to strengthen the argument for a new species of dwarf galago. Both of these studies show a need for additional galago research near Mt. Kasigau and the Taita Hills. Because *Otolemur* is common in other parts of Africa with intact forest, it could be a good indicator of forest health, which could generalize the health of other species that are more difficult to study. Arboreal primates like galagos are important species in forest ecosystems because as fruit-eating species they are able to transport seeds farther than terrestrial dispersers and dispersal from trees creates a more scattered seed dispersal pattern than ground dispersal by terrestrial mammals (Entwistle and Dunstone 2000).

LITERATURE REVIEW

Africa's Climate Change

There is evidence to support a major climate change in Africa which could mean Africa's climate was 5°C cooler than today (Flint 1959). The distribution of living organisms also shows evidence of a change (Flint 1959). As a climate changes, flora and fauna adapt to the change which can lead to speciation. Africa's climates depend on a broad atmospheric-circulation pattern with relatively few local differences due to the wide open plains with few mountain ranges (Flint 1959). It can be reasonably assumed there was once much more rainfall on the African continent. Strand lines are higher than they currently are and this change cannot be explained by a volcanic eruption or a tectonic plate shift, which suggests climate change has occurred (Flint 1959). There is also an argument that rainfall was greater and temperatures were less in equatorial Africa because evergreen forests only grow in areas receiving at least 40 inches of rain a year; usually these forests are also over 2000 m in elevation (Flint 1959). There is also evidence of montane forest stretching across the continent from Eastern to Western Africa. Similar birds and butterflies are found in both Eastern and Western Africa; however, these same species are not found in the highlands of Ethiopia which is much closer to East Africa. This shows these species were able to cross through the wetter forest area instead of the dry, arid land between Kenya and Ethiopia (Livingstone 1975). Today, equatorial locations are much drier than they were in the nineteenth century due to widening of the dry belts and shortening of the rainy season (Flint 1959). Today, equatorial Africa's rainfall follows the sun. In Kenya, heavy rains occur in November and December after the long dry season; lighter rains occur from March-May. With climate changes from the Pleistocene, many species have adapted to a warmer, drier climate as temperatures increase and rainfall decreases (Flint 1959). As forest fragmentation occurs due to climate change, populations become isolated which can result in speciation.

Primate Evolution and Taxonomy

Primates are composed of two groups: strepsirrhines and haplorhines (Groves 2001). The suborder Strepsirrhini includes galagos, lemurs, lorises and pottos. The suborder Haplorrini includes monkeys, apes, tarsiers and humans (Groves 2001). There are three specialized features which unite all living strepsirrhines: 1) a dental tooth comb with small upper incisors, 2) laterally flaring talus, and 3) a grooming claw on the second digit of their hind feet (Fleagle 1999). Lemurs are isolated to Madagascar, lorises are found in Africa and Asia, and galagos are only found in Africa. There are a few other characteristics that separate the galagos and lorises from lemurs. They have a unique blood supply to the anterior part of the brain and the tympanic ring of the ear is fused to the wall instead of being suspended like it is in strepsirrhines of Madagascar (Fleagle 1999). Cranial morphology is very similar for galagos and lorises but locomotion and postcranial morphology vary greatly which is what causes the evolutionary split between these families (Fleagle 1999).

Several genera of Primates evolved during the middle of the Paleocene epoch (Simons 1972). During the Eocene epoch, these primates died out but tarsioid prosimians, which are relatives to living strepsirrhines, became more common (Ciochon and Fleagle 1985, Simons 1972). The most numerous primates in the Miocene epoch were greater and lesser apes (Simons 1972). Fossil records of galagos and lorises indicate they were present during the Miocene epoch, which dates back approximately 18 million years; however, monkeys and galagos were still rare during this time (Masters 1988, Simons 1972). No fossil records for the family Galagonidae have been found outside of Africa (Masters 1988).

The family Galagonidae has been understudied, but recently, systematic studies have changed the taxonomy of the group (Groves 2001). Schwarz (1931) originally classified five species of galago and 27 subspecies. Hill's (1953) work suggested there are six species of galagos in two separate genera. Olson (1979) expanded on Hill's work to distinguish eleven individual species. At the 1986 International Primatological Society congress in Gottingen, Germany, galago taxonomy was discussed thoroughly. During a symposium titled "Variability within galagos" there was a lively debate in which an agreement on number of genera and species could not be met (Nash et al. 1989). Galagos were divided between one and three genera depending on the author's opinion and there were up to 11 species recognized, though some researchers chose to recognize only Hill's original six species (Nash et al. 1989). After the symposium, a number of classifications continued to be used (Nash et al 1989). Authors of more recent studies comparing penile morphology have described sixteen distinct galago species (Anderson 2000, Perkin 2007). The most recent literature (Grubb et al. 2003) recognizes 24 distinct galago species, though more research needs to be done as some are still unnamed and therefore, not widely accepted.

Galagos are widely known for their large eyes placed frontally in the head and their ability to spring from tree to tree, seldom touching the ground (Estes et al. 1992). They are very vocal animals and are often heard before seen (Estes et al. 1992). Galagos received their common name, bushbaby, because their vocalizations sound like those of a human baby (Kingdon 1974). There are four 'types' of galagos (Table 1). All species of galagos are nocturnal and mostly solitary. In *Otolemur crassicaudatus* a small overlap between female-female and male-male territories has been seen as well as male-female overlap during breeding season (Charles-Dominique 1978). Female sub-adults are also known to share territories with their mothers (Charles-Dominique 1978, Clark 1985).

Table 1. Types of galagos

Type of Galago	Genus	Average Weight
Greater	*Otolemur*	1300 g
Needle-clawed	*Euoticus*	300 g
Lesser	*Galago*	175 g
Dwarf	*Galago*	Less than 100 g

Estes et al. (1992)

The genus *Otolemur* was described by Coquerel (1859). He described it as a long-fingered lemur from Zanzibar (Coquerel 1859). It was described as having smaller eyes in proportion to the head and larger ears than the lesser galagos (Coquerel 1859). It was also described as an omnivore, observed eating fruit and meat (Coquerel 1859). There are now three recognized species of greater galago, *Otolemur crassicaudatus* (thick-tailed greater galago), which is found from South Africa to Somalia along rivers, in coastal forests, and savannahs; *Otolemur garnettii* (small-eared greater galago) found in East Africa along the Kenyan and Tanzanian coasts and in the Kenyan highlands in coastal forest and riverine galleries; and *Otolemur monteiri* (silver greater galago) found near the Winam Gulf at the northeastern corner of Lake Victoria in southwestern Kenya (Grubb et al. 2003, Kingdon 1997). A possible fourth, unnamed, smaller species was described by Kingdon (1997) from the Mwera area of Tanzania, but Groves (2001) suggested it is actually only slightly smaller than the average *O. garnettii*. Previously, *O.*

garnettii and *O. monteiri* were classified as subspecies of *O. crassicaudatus* (Schwarz 1931, Hill 1953). Dixson and Van Horn (1977) discovered *O. crassicaudatus* and *O. monteiri* were reproductively isolated in captivity but this was not reflected in nomenclatorial treatment until 2001 (Wilson and Reeder 2005). More research is needed on *O. monteiri* as distinguishing characteristics are based on small samples of *Otolemur monteiri's* subspecies *Otolemur monteiri argentatus* (Grubb et al. 2003). In Dixson and Van Horn's (1977) mating study between *Otolemur crassicaudatus* and *Otolemur monteiri* (classified by them as *Galago crassicaudatus argentatus*) only one pair became pregnant and the mother died after aborting spontaneously. There has been one known hybridization between these two species at Duke University Primate Research Center. It is unknown if the hybrid was fertile (Dixson and Van Horn 1977). Masters (1988) also reported a hybrid female offspring produced between an *Otolemur crassicaudatus* female and an *Otolemur garnettii* male born at Duke University Primate Research Center. Despite attempts to induce her, this animal never bred (Masters 1988). Olson was the first to study these differences in the wild in 1979 (Nash et al. 1989). Grubb et al. (2003) predict more species of *Otolemur* will be described in the next decade as subspecies in this genus are elevated. Table 2 compares key differences between *O. crassicaudatus* and *O. garnettii*.

It is uncertain when a single greater galago species became genetically isolated and developed into multiple species. By the late Pliocene, galagos were modernized (Masters 1988). Temperatures were extremely unstable around 14.8 million years ago during the late Miocene epoch and early Pliocene epoch causing heating and cooling of the atmosphere which could have caused tropical forest fragmentation leading to speciation (Masters 1988). While it is uncertain exactly when *O. garnettii* separated from *O. crassicaudatus*, it is suggested it happened during the late Miocene when grasslands expanded because there has been savannah separating the forest regions for nine million years (Masters 1988, Simons 1972). It is thought the savannah stretching across Africa has isolated *O. garnettii* in East Africa, separate from *O. crassicaudatus* which has a wide range over the southern part of the continent (Simons 1972).

Table 2. Comparison of two greater galago species.

	Average weight	Ear Length	Hind foot Length	Gestation Period	Litter Size	Carrying Method	Locomotion
Otolemur crassicaudatus	1131 g[1]	62 mm[1]	93 mm[1]	135 days[1]	Usually 2, up to 3-4[3]	Dorsally or orally[1]	Unable to land on hind feet[1]
Otolemur garnettii	767 g[1] 826 g[2]	45 mm[1]	91 mm[1]	130 days[1]	Usually 1, twins born in rare cases[3]	Orally[1]	Able to land on hind feet[1]

[1]Nash et al. 1989; [2]Nash and Harcourt 1986; [3]Welker and Schäfer-Witt 1988

Otolemur crassicaudatus was first described by Geoffroy as *Galago crassicaudatus* in 1812 (Nash et al. 1989). *Otolemur crassicaudatus* is the largest of the greater galago species with an average weight of 1131 g (Nash et al. 1989). This species also has larger ears and a longer snout than *O. garnettii* but hind foot length is similar, making the hind foot length of *O. crassicaudatus* proportionally shorter when adjusted for body size (Masters and Bragg 2000). Masters and Bragg (2000) found statistically significant discrimination between these two species could be made by using just three measurements: ear height, palate length, and hind foot length. Coloration in *O. crassicaudatus* is highly variable and ranges from gray to dark brown with differently colored tail tips (Kingdon 1974, Nash et al. 1989). Much of this coloration varies by geographic region and subspecies (Kingdon 1974).

In South Africa, there is one mating season a year for *Otolemur crassicaudatus* in June with offspring born in October or November (Clark 1985, Bearder and Doyle 1977). Offspring stay near their mothers for the first year; though male young will frequently expand their own range outside that of their mothers (Clark 1985). Females have a smaller range and are less likely to leave the population (Clark 1985). Individuals are known to have a home range of up to one square kilometer (Bearder and Doyle 1977). One well-studied maternal group had an established range of seven hectares (approximately 0.07 km^2) (Bearder and Doyle 1977). Individuals traveled their home range at least once per night and were seen leaving scent marks or calling as a form of communication (Clark 1985). Bearder and Doyle (1977) found galagos sleep alone half of the time and in groups of between 2-6 individuals the rest of the time. Animals were frequently observed splitting up during foraging but rejoining before moving to their sleeping site (Bearder and Doyle 1977). Sleeping sites are located between 5-12 meters from the ground, usually in a dense tangle of branches and vines, making them difficult to spot from below (Bearder and Doyle 1977). Individuals were sometimes seen using different sleeping sites in consecutive nights (Bearder and Doyle 1977).

Otolemur garnettii was first discovered by Ogilby in 1939 who described it using the genus *Otolicnus*. This genus was never accepted in the taxonomy of galagos so *Otolemur* became the proper genus (Nash et al. 1989). He noted it was much larger than *Galago senegalensis* (Ogilby 1939). *Otolemur garnettii* has small ears relative to head (Nash et al. 1989). Average body weight is 767 g though some studies have reported larger body weights in individuals in Kenya and in Northern Tanzania (Masters 1986, Nash et al. 1989, Groves 2001). Nash and Harcourt (1986) reported an average body weight of 826 g for 25 individuals in coastal Kenya. Coloration is reddish to gray-brown and tails are tipped in white, black, or brown. Often, different colors will occur in the same population (Nash et al. 1989). *Otolemur garnettii* was observed to spend only about half its time below five meters and was never observed on the ground (Harcourt and Nash, 1986). *Otolemur garnettii* is less social than *O. crassicaudatus*. In a series of captive studies, if two *O. garnettii* females bred at the same time, the infants were always killed by other mothers (Welker and Schäfer-Witt 1988). In the wild, *O. garnettii* females will leave the group before giving birth (Nash and Harcourt 1986).

Greater galagos are found in most of southern and eastern Africa. Although they are seen in suburban areas and in plantations of exotic trees, most are confined to riverine forest or riparian bush (Kingdon 1974, Bearder and Doyle 1974). Factors restricting the range are difficult to understand because galagos will live in one area, but not in another very similar area (Kingdon 1974). *Otolemur crassicaudatus* has a larger range spread over most of southern Africa while *Otolemur garnettii* is found only in coastal eastern Africa (Nash et al. 1989, Masters 1986). Fruit is thought to be a limiting factor as greater galagos are absent from areas where fruits are not abundant for at least half the year (Charles-Dominique and Bearder 1979). The greater galago's diet mainly consists of fruit, seeds, and gum; though in some locations, a diet consisting of 50% invertebrates has been observed (Kingdon 1974, Hladik 1979, Harcourt 1986, Masters et al. 1988). Masters et al. (1988) discovered galagos of Tanzania ate more fleshy fruits, like mango and paw paw, while galagos further south in Zambia and Malawi relied more heavily on gum. Harcourt and Nash (1986) also reported approximately 50% of the *Otolemur garnettii* diet was fruit. *Otolemur crassicaudatus* is thought to eat less fruit than this because fruit is not widely abundant during the South African dry season (Clark 1985, Harcourt and Nash 1986). Acacia trees are the primary gum source for greater galagos with gum use being more popular among *Otolemur crassicaudatus* (Harcourt and Nash 1986, Masters et al. 1988). Fresh gum is consumed by removing the bark while old, exposed gum is ignored (Charles-Dominique and Bearder 1979). Fruit is usually consumed directly off the plant and is ignored once it has fallen (Charles-Dominique and Bearder 1979).

This type of diet could allow for competition or co-existence between primate species. Galagos and monkeys, like vervet monkeys and blue monkeys, are likely competing for forest resources, although competition will be indirect because these monkeys are diurnal. Vervet monkeys (*Chlorocebus pygerythrus*), blue monkeys (*Cercopithecus mitis*), and *Otolemur garnettii* are all known to live in the Tana River Forest of Kenya (Karere et al. 2004). *Otolemur crassicaudatus* and vervet monkeys were observed residing in the same sleeping trees at dusk and dawn (Bearder and Doyle 1977). Vervet monkeys prefer sleeping in acacia trees and feed on invertebrates, plants, and ripe fruits (Struhsaker 1967).

Vervet monkeys are adapted to dry climates so are common throughout much of Africa, including the Mt. Kasigau region (Struhsaker 1967). They are found in a wide range of habitats from savanna, woodland, riverine, and lake-shore forests (Kingdon 1974). They are known to settle near rivers and streams if the woodland is sufficiently developed to provide fruit-bearing trees (Skinner and Chimimba 2005). Vervet monkeys are primarily vegetarians and feed on fruits, seeds, roots, gum, bark, buds, and many cultivated crops (Kingdon 1974, Skinner and Chimimba 2005). They are highly social, generally found in troops of 6-60, with an average of 20-30 individuals per troop (Kingdon 1974). It is common to find individuals of a higher dominance status sleeping at one nest site while members of lower status form their own sleeping groups (Skinner and Chimimba 2005). Some individuals will separate from the troop during the day but always return to their nest at night, well before sunset (Skinner and Chimimba 2005). Vervet monkeys are at least twice the size of the genus *Otolemur*, ranging in weight from 3.86 kg-8 kg for males and 3.41 kg-5.22 kg for females (Skinner and Chimimba 2005). Vervet monkeys are commonly found in trees along rivers. These trees are also frequently shared by blue monkeys, particularly Acacia and fig trees (Struhsaker 1967). Blue monkeys are found in East Africa in a wide range of forests at all altitudes and humidity levels (Kingdon 1974). Diet of blue monkeys is highly variable depending on physical conditions of the forest. When there is a consistent food supply available, over 60% of the diet consists of fruit, young leaves, shoots, flowers, and occasional insects (Kingdon 1974).

Primate species are often well studied because they are large in size and easily observed. This has allowed us to learn about their preferred habitats and behaviors. Harcourt (2000) suggests primates be used as indicator species in countries with less opportunity for biological surveys because understanding their distributions could be extremely important as surrogate knowledge for other species that are more difficult to survey but have similar habitat requirements.

Galagos on Mt. Kasigau have never been studied so all data collected are unique. I will compare the means from my measurements to means of known species published in the literature. The alternate hypothesis is that my measurements will be statistically different from previously published measurements. I hypothesize this because very few measurements are available and galago taxonomy is constantly changing as new subspecies are discovered.

I will also describe habitat usage by greater galagos, lesser galagos, vervet monkeys, and blue monkeys by looking at tree species and tree height. I hypothesize greater galagos (*Otolemur*) will use taller trees than lesser galagos (*Galago*).

STUDY AREA AND METHODS

Study Area

Kenya is located in East Africa along the Indian Ocean. It is bordered by Tanzania, Uganda, South Sudan, Ethiopia, and Somalia (Figure 1).

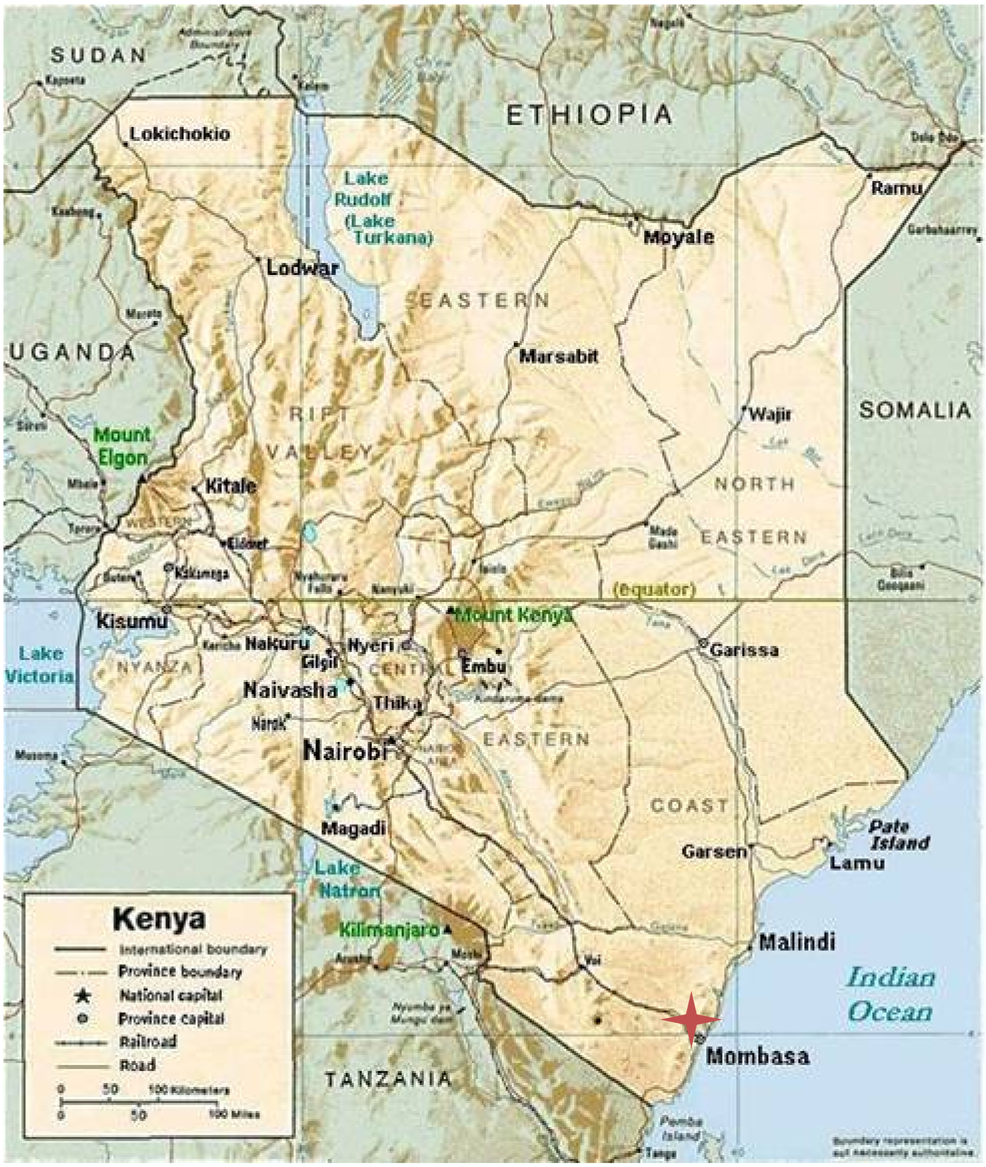

Figure 1. Map of Kenya. Kasigau is marked with a red star in the southeast corner of the country. (Nation Master 2012)

The Taita Hills make up the most northeastern part of the Eastern Arc Mountains.

Total forest area in the Taita Hills is estimated at 6 km^2 with only 4 km^2 remaining as enclosed forest (Burgess 2000). The Taita Hills are 165 km from the Kenyan Coast (Burgess et al. 1998). Their altitude ranges from 1500 m to 2140 m (Burgess et al. 1998). The main hill complex with the majority of forest fragments is Dabida. The range is also comprised of Mbololo to the northeast and Mt. Sagala and Mt. Kasigau to the southeast (Figure 2) (Bytebier 2001).

Figure 2. Map of Mt. Kasigau and Mt. Sagala in relation to the Taita Hills.

Kasigau is in the Taita-Taveta District (now County) in the Coast Province of Kenya between 38° 37" and 38°42" E, and 3° 46" and 3°52" S. Kasigau has a population of 13,813 in 2742 households (Kenya National Bureau of Statistics 2009). There are seven main villages surrounding Mt. Kasigau (Figure 3). Rukanga, Jora, Bungule, Makwasinyi, and Kitege are all adjacent to the base of the mountain. Kisimenyi and Ngambenyi are located in drier scrub brush further from the base of the mountain. These seven villages are divided into two sub-locations, Makwasinyi and Rukanga. Makwasinyi sublocation is 415.2 km^2 and includes Makwasinyi, Kitege, and Kisimenyi (Kenya National Bureau of Statistics 2009). Rukanga sublocation is 1,106.5km^2 and includes Rukanga, Ngambenyi, Jora, and Bungule (Kenya National Bureau of Statistics 2009). All trapping in this study took place at the base of the mountain in Rukanga, Makwasinyi, Kitege, and Bungule. Transects were located in these locations, as well as Jora, and one was conducted in the agricultural land between Kitege and Kisimenyi to use as a comparison between riverine forest habitat and the drier scrub brush.

Figure 3. Villages around Mt. Kasigau.

Mt. Kasigau is surrounded by flat bush land where the people of Kasigau live. There is no permanent river in Kasigau so seasonal rains fill riverbeds and seasonal pools and provide water for wildlife coming from Tsavo East and West National parks looking for a water source. Most agricultural farms are found in a transition zone between bush land and the forested mountain (Kalibo and Medley 2007). Rainfall in these plains ranges between 300 mm and 500 mm (Kalibo and Medley 2007).

Closed-canopy forest on the mountain is estimated at less than 2 km^2 (Rodgers 1993). Mt. Kasigau rises steeply from 600 m to 1641 m in less than two kilometers (Kalibo and Medley 2007). Vegetation on Mt. Kasigau is split into an evergreen forest above 1200 m and montane forest below it. The evergreen forest is able to trap rains resulting from humidity from the Indian Ocean causing cloud formations due to adiabatic cooling. This forest provides a unique ecosystem to plants and animals of the region as well as a water source for the Kasigau community (Kalibo 2004).

The people of Kasigau are primarily farmers, growing crops on both private and communal lands. Crops grown include maize, pigeon peas, beans, and cassava. There are also fruit groves for mangos, oranges, and avocado. Most families keep chickens or goats. Community ranches are also common for livestock rearing. The women of Kasigau have formed basket weaving associations in all villages. These baskets are sold to tourists and provide the majority of income for these women. Many villages have even built infrastructure to use as a meeting place. Men make stools and cooking tools out of locally available trees. Many community members also seek employment in the nearby mines looking for tanzanite and other gemstones. Young males frequently leave Kasigau to seek employment in a larger city like Mombasa. Some illegal charcoal burning and poaching also occur.

There are two main tribes in Kasigau. The most numerous tribe in Kasigau is Taita. The Kamba tribe is also found in the villages located farther from the mountain, Kisimenyi and Ngambenyi. Taitas are a Bantu tribe living in the Taita Hills in southwest Kenya. The original Taitas were thought to be non-Bantu language speaking but no one is certain of the history (Bravman 1998). The second group of early inhabitants were agro-pastoralists replacing their hunter-gathering predecessors (Bravman 1998). The Bantu language-speaking ancestors came from many directions over a long period of time (Bravman 1998). This tribal diversity allowed for conflict among groups (Bravman 1998). No lineage was able to establish political dominance in the Taita Hills; so instead, critical resources became land, livestock, and number of tribe members to show power (Bravman 1998).

Methods

I used transects for two types of methods; distance methods and mark re-sight methods. Trapping and population density estimates took place on nine transects around Mt. Kasigau (Figure 4). The key for numbers corresponding to each transect is found in the appendix. Transect sites were chosen based on their accessibility, location on the mountain, and type of vegetation found in the area. Preferred vegetation included tall, riverine trees that make suitable galago habitat. Seven transects were adjacent to or crossed a seasonal river because these trees often line riverbanks. One of these transects rose in elevation up Mt. Kasigau from 612 m to 773 m. One other transect ran parallel to the base of Mt. Kasigau. The final transect was placed 3 k from the base of the mountain in the drier agricultural area and scrub brush northwest of the mountain. When possible, transects were 1000 m long. In some areas where a transect followed a riverbed, it was impossible to extend transects to this length. In one case, a transect was longer than 1000 m at 1200 m in length.

Figure 4. Transect locations around Mt. Kasigau.

Distance Sampling

To estimate galago population density, I sampled the population by a systematic transect method. For my analysis, I used Distance 6.0 release 2, a software program for analyzing transect data (Thomas et al. 2010). I recorded the total number of galagos sighted and distance of each from the transect midline and used distance methods to derive an estimate of population density. I conducted surveys between 19:30 and 01:00

local time when galagos are the most active. The first surveys took place during the dry season in August 2011. Another set of surveys took place during the wet season in November and December 2011. Distance produced two models and selected the model with the minimum AIC (Akaike Information Criterion).

Trapping

To conduct the population study, I trapped and collared greater galagos near Mt. Kasigau. Due to the limited number of traps and the distance between transects, trapping was only done on two transects at a time. Traps were placed in areas with high density estimates from the transect method. Trapping was conducted on five transects: Rukanga A, Makwasinyi River, Kitege River, Bungule Cottage, and Bungule Town (Table 3).

Table 3. Description of trapping sites.

Transect Name	Description
Bungule Cottage	Both sides covered by small, (5m tall) trees with no tree taller than 15 m
Bungule Town	Patches of trees and open farmland on both sides until half way when tall, riverine trees are on both sides of the transect
Kitege River	Along a seasonal river on one side, farmland on the other side, until the last 300 m when riverine forest is on both sides of the line
Makwasinyi River	Transect crosses a seasonal river twice, mostly surrounded by riverine trees with small patches of farmland
Rukanga A	Along a seasonal river, adjacent to Rukanga town. For 500 m there are riverine trees on one side and houses and businesses on the other side.

Each galago was collared with a uniquely colored, reflective, break-away collar (Figure 5). A break-away collar was used for several reasons: it was difficult to catch the same animal twice in order to remove the collar; it provided safety for the animal because it would release itself if caught on a branch or other object, and lastly, a radio transmitter was not necessary for this basic population study. A previous study on the spectral tarsier (*Tarsius spectrum*), a primate with similar morphological and behavioral characteristics, revealed radio collars weighing up to 7% of the animal's body weight had no effect on behavior so I did not expect a much lighter collar to have an effect (Gursky 1998). The collar used for this study used vinyl wristbands designed for hospital patients. A 2 cm section of rubber band was attached with a rivet on each end, which allowed the collar to stretch and break. The section of vinyl behind the rubber band section was cut away. Reflective tape was placed on each collar in a unique pattern for identification of individuals. This collar design was tested on a captive female galago at Tampa's Lowry Park Zoo to ensure its function and safety before entering the field. Lowry Park staff reported she did not struggle with the collar and they removed it two weeks later.

Figure 5. Collar with reflective tape.

To attach collars on galagos, animals were trapped using Havahart® live traps, model 1089, collapsible, medium-sized rabbit/squirrel cage traps. Traps were secured in trees along the transect line using binding wire (Figure 6). Traps were baited between 16:00-18:30 as most nocturnal animals are captured soon after nightfall (Jolly et al. 2003). Two types of bait were tested: raisins and bananas. More individuals were caught using bananas in the first village, Rukanga, so bananas were used for all other trapping. Each transect had four or five traps placed on it with traps placed at least 100 m apart. Traps were baited for a minimum of three nights before they were set so animals were allowed to habituate to the presence of traps to improve trapping success. Traps were then set for at least one week on each transect. Traps were checked between 0400-0630 with every effort made to release individuals before sunrise so they could find their sleeping sites. I checked for potential predators before release but no predators were ever seen at any trapping location.

Figure 6. A galago caught in a trap. Binding wire can be seen securing the trap to the tree.

I removed animals from the trap using leather gloves with a disposable latex barrier and transferred them into a handling bag where the collar was attached. Collars were attached securely, usually in the smallest position possible on the collar. I checked to make sure a finger could slip under the collar but also to make sure it was not loose enough for the individual to remove on their own. Sex, weight, hind foot length, ear height, and tail length also were recorded. Approximate age of males was determined by development of testes; categories were sub-adult male or adult male. A Pesola® Model

42500 2500 g scale with a precision of ± 0.3% was used to record weight. A section of fur was removed from the tail of each individual using pliers. Hair roots were kept intact, to be used in DNA analysis at a later date. The animal was then released unharmed. Weight, hind foot length, ear height, and tail length were analyzed using SPSS. Means from my individuals were compared with means from known subspecies recorded in the literature. With these means, I had two hypotheses for each measurement:

1: H_o = my individuals are the same as the known subspecies.

2: H_a = my individuals are statistically different from the known subspecies

Hypotheses were tested using four separate subspecies of *Otolemur garnettii*, which have previously been reported in Kenya by Olson (1979). These means were compared using a t-test and the t distribution value was then checked in a table (Statsoft 2012) to look for significance.

Nine individuals were caught multiple times. I did not plan to recapture individuals but decided to use this information since it was recorded. To use this information, mark re-capture data were entered into the Krebs/WIN version 0.94 software program to obtain density estimates (Brzustowski 1998).

Habitat Analysis

During distance sampling and trapping, tree species and tree height were recorded. Most of the time, my research assistant was able to accurately identify tree species. If a tree could not be identified, it was marked with flagging tape so I could return with a village elder to identify the species. Tree height was estimated the same way distances were estimated. Usually, my research assistant and I estimated the same height; if there was a small discrepancy, the average of our estimates was taken. This information was used to look at preferred tree use and competition between diurnal primates.

Diurnal Primate Surveys

The line transect method was also applied to transects during the day to look at habitat use in other primate species. These walks were conducted the same day as a nocturnal transect, usually beginning around 15:00. In some cases, daytime transects were conducted in the morning, beginning at 09:00 and nocturnal transects were not completed until around 12 hours later. Primate species, troop size, location, and tree species were recorded.

RESULTS

Galago population survey by transect

Greater galagos were sighted on seven of nine transects. The transects without sightings were Kitege Bush, located furthest from the base of the mountain, and Bungule Cottage, which was located on the dry side of the mountain and did not have many trees over 5m tall. Transect data were analyzed using Distance 6.0 release 2; however, only three individual transects had enough sightings to produce a 95% confidence interval (Table 4). The total density estimate on all transects combined is 0.33 individuals per hectare with a coefficient of variation of 28.4%. Kitege River during the wet season produced the highest estimate of 2.61 individuals per hectare with a coefficient of variation of 17.9%. The probability of observing galagos in the defined areas is p=0.49 with a standard error of ±0.05 as determined by Distance (Thomas et al. 2010). The effective strip width was 49.56 m with a standard error of ±4.91.

Table 4. Density estimates from Distance

Transect	Density per hectare	Standard Error	Coefficient of Variation %	95% Confidence Interval	Observation Size
Bungule Cottage Dry	0.0000	0.0000	0.0000	0.0000	0
Bungule Cottage Wet	0.0000	0.0000	0.0000	0.0000	0
Bungule Town Dry	16.9490	0.0000	0.0000	0.0000	1
Bungule Town Wet	1.1299	0.3995	35.3500	0.0000	2
Jora Dry	0.0694	0.0000	0.0000	0.0000	1
Jora Wet	0.1389	0.0000	0.0000	0.0000	1
Kitege Bush Dry	0.0000	0.0000	0.0000	0.0000	0
Kitege Bush Wet	0.0000	0.0000	0.0000	0.0000	0
Kitege River Dry	0.3304	0.1629	49.3100	0.0009 124.01	2
Kitege River Wet	2.6095	0.4680	17.9400	1.7767 3.8327	14
Kitege River Combined	1.3707	1.0609	77.4000	0.0018398 1021.2	16
Makwasinyi-Kitege Mountain Dry	0.6251	0.2895	46.3200	0.0000	2
Makwasinyi-Kitege Mountain Wet	0.2083	0.0737	35.3500	0.0000	2
Makwasinyi River Dry	1.4495	0.3234	22.3100	0.8453 2.4856	7
Makwasinyi River Wet	0.3950	0.1197	30.3200	0.1843 0.8465	6
Makwasinyi River Combined	0.6193	0.2202	35.5500	0.2246 1.7079	13
Rukanga A Dry	0.2837	0.1044	36.7900	0.0913 0.8818	4
Rukanga A Wet	0.0195	0.0068	34.7700	0.0095 0.0398	15
Rukanga A Combined	0.1516	0.0000	0.0000	0.0000	19
Rukanga B Dry	0.0000	0.0000	0.0000	0.0000	0
Rukanga B Wet	0.0000	0.0000	0.0000	0.0000	0
Total	0.3287	0.0935	28.4300	0.1859 0.5811	55

The three transects with enough observations to produce a confidence interval are all small strips of riverine forest no more than 200 m wide and 100 m long. More animals were spotted during the dry season than the wet season with the exception of Kitege River wet season which had the highest density estimate of any transect by far. Fourteen individuals were spotted in the same night giving a density estimate of 2.61 individuals per hectare. The average sighting distance during the dry season was 31.68 m, SE=7.27 and the average sighting distance during wet season transects was 30.03 m, SE=4.38.

A detection model which split observation distance into 14.3 m strips away from the midline provided the most accurate fit with my observations with p=0.948, which is the probability of a greater chi-square value (Table 5). This was obtained by comparing observed and expected values for each cut point.

Table 5. Detection model

	Cut Points		Observed Values	Expected Values	Chi-square Values
1	0.000	14.3	16	15.52	0.015
2	14.3	28.6	15	13.69	0.126
3	28.6	42.9	10	10.64	0.038
4	42.9	57.1	5	7.29	0.721
5	57.1	71.4	5	4.41	0.080
6	71.4	85.7	3	2.35	0.181
7	85.7	100.	1	1.10	0.010

Total Chi-square value = 1.1703 Degrees of Freedom = 5.00

Probability of a greater chi-square value, p = 0.94769

Trapping Results

Trapping took place on five transects: Rukanga A, Makwasinyi River, Kitege River, Bungule Town, and Bungule Cottage. A total of 29 individuals were trapped, collared, and released. Nine individuals were caught at Rukanga A, and at Makwasinyi River; 8 individuals from Kitege River; three individuals were caught in Bungule Town, and no individuals were caught on the Bungule Cottage Transect. Of these 29 individuals, 19 were males and 10 were females. Accurate weights were determined for 17 individuals; hind foot length, tail length, and ear height were recorded for 21 individuals. Average weight, ear height, hind foot length, and tail length can be seen in

Table 6. Analysis comparing males and females was done using SPSS and all variables had normal distribution. In tables 7 and 8, these measurements are separated by sex.

Table 6. Average measurements for all individuals

	Mean	Standard Deviation	Standard Error	Sample size
Weight	941.06g	± 138.15	33.51	N=17
Ear height	4.801cm	± 0.38	0.08	N=21
Hind foot length	9.66cm	± 0.68	0.15	N=21
Tail length	35.61cm	± 1.79	0.39	N=21

Table 7. Average measurements for males

	Mean	Standard Deviation	Standard Error	Sample size
Weight	929.82 g	± 160.16	49.29	N=11
Ear height	4.9 cm	± 0.36	0.096	N=14
Hind foot length	9.57cm	± 0.67	0.67	N=14
Tail length	35.89cm	±1.91	0.18	N=14

Table 8. Average measurements for females

	Mean	Standard Deviation	Standard Error	Sample size
Weight	961.67 g	± 94.80	38.70	N=6
Ear height	4.61 cm	± 0.36	0.14	N=7
Hind foot length	9.83 cm	± 0.71	0.27	N=7
Tail length	35.06 cm	± 1.50	0.57	N=7

There was no significant difference between males and females for any of these results. Using a standard t-test for independent samples, the p-values can be seen in Table 9.

Table 9. Comparison of male and female measurements

	p-value
Weight	0.203
Ear height	0.776
Hind foot length	0.960
Tail length	0.313

There were six males which appeared sexually immature because their testes were not completely developed. I eliminated these males and also compared male and female weights to see if the immature males were accounting for some of the results. Comparing female weight with only adult male weight also produced insignificant results with $p=0.089$. I also compared adult males with immature males; these results were also insignificant and can be seen in Table 10.

Table 10. Comparison of male and young male measurements

	p-value
Weight	0.199
Ear height	0.312
Hind foot length	0.122
Tail length	0.126

One way to help determine species in galagos is by looking at pelage color and tail tip color. In my sample, all individuals had the same pelage color; however, multiple individuals on the same transect had different colored tail tips. Tail tip coloration from the Kitege transect can be seen in figures 7 and 8. Pictures of the entire individual can be seen in figures 9 and 10. Tail tip color was not recorded until the end of trapping. I recorded 6 white tips, 4 black tips, and 1 brown tip with the very end mostly white. Coloration along the back is seen in figures 11 and 12 from individuals caught in Makwasinyi and Bungule.

Figure 7. White tail tip on Kitege River transect 10/23/2011.

Figure 8. Black tail tip caught on Kitege River transect 10/23/2011.

Figure 9. White tipped female caught on Kitege River transect 10/23/2011.

Figure 10. Black tipped male caught on Kitege River transect 10/23/2011.

Figure 11. Back and tail of male caught on Makwasinyi River transect 10/30/2011.

Figure 12. Back of female caught on Bungule Town transect 12/2/2011.

Comparing trapping measurements with known species measurements

Table 11 lists previously recorded weights for various subspecies of *Otolemur garnettii* as described by Olson (1979). I compared these with my measurements using a two-tailed t-test when mean and standard deviation were provided. In two subspecies, Olson (1979) only had a sample size of one individual. In this case, a one-tailed t-test was used instead because standard deviation for published measurements is unknown. These results are seen in table 12.

Table 11. Known means of *Otolemur garnettii* subspecies and *Otolemur crassicaudatus* measurements (Olson 1979).

Subspecies of *Otolemur garnettii*	Weight (g)	Tail length (cm)	Hind foot length (cm)	Ear height (cm)
O.g. garnettii	1227.9 ± 224.9	38.32 ± 3.02	9.16 ± 0.46	6.10 ± 0.32
O.g. lasiotis	859.5 ± 117.0	36.50 ± 2.82	8.98 ± 0.48	4.55 ± 0.33
O.g. panganiensis	730.0	37.55 ± 2.74	9.61 ± 0.33	4.56 ± 0.45
O.g. kikuyuensis	826.0	34.81 ± 2.65	8.79 ± 0.43	4.17 ± 0.50
Otolemur crassicaudatus	990.0 ± 80.9	41.36 ± 2.43	9.21 ± 0.51	6.15 ± 0.36
My individuals	941± 138.15	35.61± 1.79	9.66± 0.68	4.80± 0.38

Table 12. Statistical difference between my means and means of known species (Olson 1979)

Subspecies of *Otolemur garnettii*	Weight	Tail length	Hind foot length	Ear height
O.g. garnettii	t=4.7, df=41, p=0.00	t=3.85, df=76, p=0.000	t=3.66, df=74, p=0.000	t=14.92, df=74, p=0.000
O.g. lasiotis	t=1.6, df=27, p=0.12	t=1.38, df=79, p=0.18	t=4.92, df=77, p=0.000	t=2.84, df=77, p=0.006
O.g. panganiensis	t=6.3, df=16*	t=2.5, df=34, p=0.018	t=0.247, df=34, p=0.806	t=1.50, df=30, p=0.14
O.g. kikuyuensis	t=3.4, df=16*	t=1.2, df=43, p=0.26	t=4.78, df=40, p=0.000	t=4.47, df=39, p=0.000
Otolemur crassicaudatus	t=0.74, df=22, p=0.46	t=8.18, df=36, p=0.00	t=2.05, df=34, p=0.049	t=10.51, df=35, p=0.000

*indicates a one-tailed t-test was used

My samples were different in all categories from *Otolemur garnettii garnettii;* however, the ear height measurements provided by Olson (1979) are larger than other published ear height averages (Nash et al. 1986). Average weight for *Otolemur garnettii* without regard to subspecies was published by Nash et al. (1986) as 767 g; the published weight in Olson's (1979) study was much larger at 1227 g. Taxonomy of *O.g. garnettii* in Olson's (1979) study could have changed as many species were incorrectly classified as experts learn more about each species. My samples were similar in weight to *Otolemur crassicaudatus* but different in all other categories. Weight and tail length were most similar in *O.g. lasiotis* and *O.g. kikuyuensis*. Hind foot length and ear height were most similar in *O.g. panganiensis*.

These same comparisons were performed using published data from Perkin et al. (2002). They trapped seven *Otolemur garnettii lasiotis*, four males and three females. Comparisons between these data and my measurements can be seen in Table 13.

Table 13. Comparison between Perkin et al. (2002) published measurements and my measurements.

	Weight	Tail length	Hind foot length	Ear height
Male	p=0.875	p=0.235	p=0.110	p=0.414
Female	p=0.030	p=0.000	p=0.009	p=0.950
Combined	p=0.127	p=0.002	p=0.002	p=0.417

Tail length and hind foot length are significantly different for females which influences the combined result. There is also a significant weight difference between females I caught and others caught in the Taita Hills. My average weight for females was over 200 g larger than that published by Perkin et al. (2002).

Recapture Data

Limited recapture data were available. On the Makwasinyi River transect, four of nine individuals were caught more than once. Two of these four were caught twice, one individual was caught three times, and one individual was caught four times. Data were analyzed using Krebs/WIN version 0.94 software program (Brzustowski 1998). Estimations from Makwasinyi mark re-capture and confidence intervals can be seen in Table 14.

Table 14. Estimation and 95% Confidence Intervals for Makwasinyi mark re-capture

Trapping Instance	Proportion Marked	Size of Marked Population	Population Estimate	Total Population with 95% confidence intervals low	estimate	high
1	0.000	0.0	(a)	(a)	(a)	(a)
2	0.333	1.0	3.0	2.1	3	8.5
3	0.500	14.0	28.0	5.9	28	315.9
4	0.667	5.5	8.3	5.8	8.3	14.7
5	0.500	18.0	36.0	7.5	36	404.3
6	1.000	23.0	23.0	7	23	157
7	0.500	14.0	28.0	5.9	28	315.9
8	1.000	17.0	17.0	5.4	17	114.4
9	0.500	10.0	20.0	4.3	20	227.3
10	1.000	11.0	11.0	3.8	11	71.8
11	1.000	5.0	5.0	2	5	25
12	1.000	(a)	(a)	(a)	(a)	(a)

Between 3-36 individuals are estimated to live within a 38.6 hectare patch. There are between 0.077-0.933 individuals per hectare in Makwasinyi with an average of 0.505 individuals per hectare. In Kitege, nine individuals were caught and two were re-caught once each. This is presented in Table 15.

Table 15. Estimation and 95% Confidence Intervals for Kitege River mark re-capture.

Trapping Instance	Proportion Marked	Size of Marked Population	Population Estimate	Total Population with 95% Confidence Intervals low	estimate	high
1	0.000	0.0	(a)	(a)	(a)	(a)
2	0.500	2.0	4.0	1.2	4.0	47.0
3	0.667	1.0	1.5	3.9	1.5	2.4
4	1.000	1.0	1.0	1.4	1.0	1.9
5	0.500	0.0	0.0	0.0	0.0	0.0
6	0.500	0.0	0.0	0.0	0.0	0.0
7	0.500	(a)	(a)	(a)	(a)	(a)

Habitat Usage

Table 16. Tree species used

Tree Species	Average Height	Event	# of occurrences with galagos	# of occurrences with diurnal primates
Acacia mellifera	7.5 m	transect	2	
Acacia nilotica	36.6 m	transect, trapping	15	2
Acacia robusta	17.6 m	transect, trapping	10	1
Acacia tortilis	30 m	trapping	2	
Adansonia digitata	30 m	transect	1	
Albizia anthelmintica	7 m	transect	1	
Balanites aegyptiaca	17.5 m	transect, trapping	2	1
Commiphora baluensis	25 m	transect	3	
Cordia goetzei	7.3 m	transect, trapping	6	
Ficus thonningii	50.45 m	transect, trapping	11	
Mangifera indica	28.3 m	transect, trapping	3	1
Melia vokensii	5.4 m	transect, trapping	3	
mwanga	11.83 m	transect, trapping	6	1
Senna siamea	15 m	transect	0	1
Terminalia prunoides	42.5 m	transect	2	
Trichilia enetia	15 m	transect	3	

Tree species usage can be seen in table 16. *Acacia nilotica* (gum Arabic tree) was the most common tree species with 15 encounters of galagos. It was also commonly used by vervet monkeys. *Ficus thonningii* had eleven encounters of Galagos and *Acacia robusta* had ten encounters of galagos. Diurnal primates use both of these species. *Ficus* *thonningii* is used frequently by all primate species when figs are available. All trees were at least 5 m tall with *Ficus thonningii* the tallest at 50.45 m.

Diurnal Primate Surveys

Diurnal primates were spotted on five of nine transects. These walks were conducted the same day a night transect walk was conducted so these diurnal primates were using the same forest area as galagos within a 24-hour period. Transects with diurnal primates were: Bungule Cottage, Bungule Town, Jora, Makwasinyi River, and Rukanga A. No diurnal primates were ever seen on the Kitege River transect while walking or setting up traps. Also, no greater galagos were ever seen on the Bungule Cottage transect. Three species of diurnal primates were recorded; vervet monkey (*Cercopithecus pygerythrus*), blue monkey (*Cercopithecus mitis*), and olive baboon (*Papio anubis*). Vervet monkeys were the most common, accounting for 13 sightings of troops; and two sub-adults were even caught while trapping for galagos on the Rukanga A transect. Blue monkeys were spotted seven times on Bungule Cottage, Bungule Town, Makwasinyi River, and Rukanga A transects. Baboons were spotted twice on Bungule Town and Jora transects. When fig trees were producing fruit, vervet monkeys, blue monkeys, and galagos were all seen using the same tree within a 24-hour period. On other transects, a vervet monkey was spotted in a tree during the day and a galago spotted in the same tree at night. During one night transect along Makwasinyi River, blue monkeys were seen moving through the trees near two galagos.

Lesser galagos

Lesser galagos (genus *Galago*) were seen on four of nine transects (Figure 13). They were most frequently spotted on the Kitege Bush transect where no other primate species were recorded. They were also spotted on the three transects that were closest to, or on the mountain. These were Bungule Cottage, Jora, and Makwasinyi-Kitege Mountain transects. Greater galagos (*Otolemur*) were found in close proximity to this smaller species (*Galago*) on Jora and Makwasinyi-Kitege Mountain transects. With only a few sightings, it is difficult to identify which species of lesser galago is present in Kasigau.

Figure 13. Lesser galago sighted in scrub brush and agricultural area near Kitege when looking for areas to set up transects.

Tree Height Comparison: *Otolemur* vs. *Galago*

I compared heights of trees *Otolemur* was found in with heights of trees containing *Galago* (Table 17). Genus *Galago* was found in *Acacia mellifera*, *Albizia anthelmintica*, and *Cordia goetzei*. Genus *Otolemur* was only found in one of these three species; *Cordia goetzei*.

Table 17. Mean tree height of *Otolemur* vs. *Galago*

Genus	Mean tree height (m)	Standard deviation	Standard Error Mean
Otolemur	27.30	21.62	3.30
Galago	7.20	2.28	1.02

Using a two-tailed t-test, the results are significant; p=0.045 with a standard error difference of 9.76. The mean difference between tree heights used by each genus was 20.10 m. *Otolemur* are using taller trees than *Galago*.

DISCUSSION

Otolemur is most commonly found in riverine habitat. The only transects with enough sightings to produce an analysis of density estimates were all in riverine areas. In Kasigau, riverine habitat is located around seasonal rivers; which means this habitat is very small and fragmented. Greater galagos were seen on transects which did not follow a seasonal river but they were not as abundant in these areas. No signs of greater galagos were present on the transect a few kilometers from Mt. Kasigau or on the dry side of Mt. Kasigau. All sides of Mt. Kasigau are surrounded by drier scrub brush. This suggests the population of greater galagos in the Kasigau area is isolated to the mountain and seasonal rivers at the base of the mountain because there is no corridor to provide access to other populations. The closest forested patch to Mt. Kasigau is Mt. Sagala which is approximately 30 k to the northwest. Habitat patches are common with *Otolemur garnettii* with the exception of continuous coastal forests (Olson 1979).

Only one transect had enough recaptures to produce results with confidence limits. This was the Makwasinyi River transect. The population density estimate from Makwasinyi River combined transect is 0.6193 individuals per hectare with percent coefficient of variation at 35.5 and standard error equal to 0.22. Mark-recapture along this same transect produced similar density estimates of 0.505 individuals per hectare. Obtaining similar numbers using two different methods to estimate population density shows the preciseness of these measures. Using a 14.3 m strip detection model, my results were not statistically significant which shows I have an accurate fit.

I was surprised to obtain a higher density estimate during dry season than I did during wet season. I have two hypotheses that could explain this: (1) There is more tree cover in the wet season as trees have grown, and food is widely available so individuals can move out of the riverine forests for more space; or (2) more tree cover prevents individuals from being sighted as easily. Average sighting distance for wet and dry season only varied by 1 m so this rules out hypothesis 2, which means individuals are likely covering a larger range during the wet season because there is an ample food source and a high density of tree coverage. I was unable to find any other study which looked at density estimates of *Otolemur* which is why this finding is unique.

Trapping results did show females were heavier than males; however, these results were not statistically significant. Greater galagos exhibit sexual dimorphism with males often weighing between 100-250 g more than females (Nash et al. 1989). There are two possible reasons my individuals were approximately the same size. Both of these reasons can be attributed to breeding season, which is known to occur between August-November, with births occurring between December and April (Nash and Harcourt 1986). Males could be smaller because they are sub-adults, almost a year old, born during the last season and learning to explore on their own for the first time. Females may also be slightly heavier because they are carrying offspring and near the end of their gestation period. Hind foot length, ear height, and tail length were also not significant when comparing males to females.

Although measurements between males and females did not statistically differ, behavior patterns among sexes were anecdotally different. Females were always more aggressive, trying to bite, grab on, or call out for help when they were being handled. Males as a whole were much calmer and did not struggle when I was taking the measurements. In two cases, the individual in the trap held on so tight we struggled to get the individual inside the handling bag. Both of these times, it was a young male which was holding on.

Several colors of tail tips were seen throughout Kasigau. White tail tips are a characteristic of *Otolemur garnettii lasiotis*, a subspecies which has been identified in the Taita Hills by Bytebier (2001). Olson (1979) identified the *Otolemur* species in the Taita Hills as *Otolemur garnettii garnettii*, which is synonymous with *Otolemur garnettii lasiotis* (Grubb et al. 2003). This is also the subspecies in which he recorded the most white tail tips. Olson found *Otolemur garnettii lasiotis* in coastal areas but said the range can stretch inward up to 200 km (1979). Olson (1979) did find individuals this far inland but they were restricted to river basin or mountain forest habitat. Nash and Harcourt (1986) found both light and dark tail tips in the Kenyan coastal forest, approximately 200 km from Kasigau. In Nairobi, tail tips of *Otolemur garnettii kikuyuensis* were usually either dark brown or black with two white tips seen (Olson 1979). As a result of Olson's (1979) study he is doubtful whether tail coloration is an informative characteristic used to determine species. It is likely, based on these descriptions, *Otolemur garnettii lasiotis* is the species on Mt. Kasigau. This cannot be confirmed without DNA analysis because *Otolemur* taxonomy is still changing as new studies are conducted. DNA analysis could compare *Otolemur garnettii lasiotis* with the other species of *Otolemur* to look for similarities.

When my results are compared with those in the literature it is not likely my species is *Otolemur crassicaudatus.* While weights were similar, the weight for *O. crassicaudatus* in this study is also much smaller than other published weights for *O. crassicaudatus.* Nash et al. (1986) publish 1131 g as the average weight of *O.*

crassicaudatus; Estes et al. (1992) estimates weights at 1300 g. Another factor that contributes to this conclusion is ear height. On average, *O. crassicaudatus* ear height is 2 cm taller than *O. garnettii* ear height. Another reason for this conclusion can be seen in galago movement. My individuals were seen hopping on their back legs along the ground after being released from the handling bag. Nash et al. (1989) compared *Otolemur* species and report *O. crassicaudatus* is unable to land on their hind feet after jumping while *O. garnettii* are able to land on their hind feet.

When I compared my means of taken measurements to known means of four different subspecies of *O. garnettii*, my null hypothesis that my measurements would be similar to published measurements was rejected for at least one aspect in every subspecies. The most similar weights and tail lengths to my samples were of *O.g. lasiotis* and *O.g. kikuyuensis* while *O.g. panganiensis* was the most similar when comparing hind foot length and ear height. *O.g. kikuyuensis* is most common in the Kenyan highlands near Nairobi and not commonly found in lower forests (Olson 1979). *O.g. panganiensis* is common in East Africa but their range is thought to expand through most of northern Tanzania to the southwest of the Kenyan coastal forests containing *O.g. lasiotis* (de Jong and Butynski 2009). Based upon tail tip coloration and weight, it is most logical for my population to be classified as *O.g. lasiotis*. My individuals were slightly larger in size than the average *O.g. lasiotis* from Olson (1979) and Perkin et al. (2002) but show other similar characteristics. Perkin et al. (2002) published mean weights of *O.g. lasiotis* from the Taita Hills, recording average male weight at 916 g and average female weight at 755 g. My average male weight is 928 g which could support my hypothesis that some females were pregnant during the trapping season. While my females were significantly larger in weight, tail length and hind foot length were also significantly different. This is the first time individuals have been trapped around Mt. Kasigau so it is also possible inland individuals could differ from the individuals living along the coast. With the differences between my females and others trapped in the Taita Hills, it is also possible the Mt. Kasigau population is unique.

Acacias and fig trees were the most common trees used by galagos. This matches their dietary needs as they are known to feed on fruits and gum (Masters et al. 1988). Fruit and insects make up the majority of *O. garnettii's* diet (Masters et al. 1988). *Otolemur crassicaudatus* is known to feed on Acacia trees for gum but this is less common in *O. garnettii*. Harcourt and Nash (1986) did not find galagos feeding on gum in coastal Kenya because Acacia trees were not present in either site. I never observed an individual feeding so it is possible they are only using Acacia trees for habitat. They could also be reliant on these trees like *O. crassicaudatus* in South Africa.

Diurnal primates were found in both acacia and fig trees. Both blue monkeys and vervet monkeys were observed picking figs from one of the trees in which I had placed a trap to catch galagos. One evening when setting traps, a galago even chased a young vervet monkey from a tree before the vervets had all gone to sleep, just as galagos were waking up to forage. Galagos were seen simultaneously with blue monkeys and were also found in a tree hours after a vervet monkey was in the tree. This indicates there is coexistence among species as they share feeding trees and sleeping sites.

The lesser galago in Kasigau is not likely to compete with *Otolemur* over food resources and habitat. These individuals seem to prefer smaller trees in drier areas. Results showed tree heights used by *Otolemur* and *Galago* were significantly different.

Galago were only found in trees under 10 m tall. Harcourt and Nash (1986) found *Otolemur garnettii* and *Galago zanzibaricus* were able to share the same range with little competition due to differences in habitat and diet. Perkin et al. (2002) identified a new species of dwarf galago to the Taita Hills of Kenya. Butynski (2004) conducted a survey of this species on Mt. Kasigau assuming this was another likely spot for their presence. He heard calls of *Otolemur garnettii* but did not see either species.

CONCLUSION

This study does provide new and interesting information about the genus *Otolemur*. These are the only population density estimates that have been published for greater galagos. Results show how many galagos can utilize a small, fragmented, forest habitat.

With *Otolemur* commonly found in tall, lush trees, they can serve as an indicator for forest health. Around Mt. Kasigau, galagos were present in all riverine habitat surveyed. These individuals were not found in the dry, scrub brush further away from the mountain showing they are in an isolated range. If this habitat around Mt. Kasigau becomes more fragmented, *Otolemur* will not have a place to survive. The lower portion of the mountain where *Otolemur* densities are the greatest is also where the highest pressure from human activity is found. While Mt. Kasigau rises steeply quickly, the base of the mountain is still easily accessible. *Otolemur* has no other available forested habitat to move into if human pressure on Mt. Kasigau continues to increase.

Measurements from trapping provided interesting results as my measurements did not completely match the means of any one of the subspecies found in Kenya. There are very few publications including measurements of *Otolemur garnettii*, especially of specific subspecies, so these measurements will add to what is already available. It is likely *Otolemur garnettii lasiotis* is the species present in Kasigau but this cannot be confirmed without DNA analysis. At this time, I could not find gene sequences available for individual subspecies; however, it is possible this is a separate species entirely. It is also possible this population is reproductively isolated, sharing a very small range and unique from all other populations of *O. garnettii*, so it could be its own subspecies. The approximate area of covered forest on Mt. Kasigau and around the base of the mountain is 2780 hectares.

The small galago sighted on Mt. Kasigau was not identified during my study. Butynski (2004) conducted nocturnal primate surveys on Mt. Kasigau for a few days to look for a newly identified species, the Taita mountain galago. He did not find any trace of this galago on the mountain. I however, did find a smaller species of galago (Genus *Galago*) present on the mountain on the Jora transect, Bungule Cottage transect, and the Kitege-Makwasinyi mountain transect. Therefore, the Taita mountain galago or another small galago species is in fact present on Mt. Kasigau. Future studies could focus on finding and identifying this species.

As galago taxonomy continues to change, more research should be conducted around Mt. Kasigau. The fourth greater galago species published by Kingdon (1997) still has not been confirmed and it is possible there are other unique species which still have not been identified. The smaller galago seen along four of my transects could be *Galago senegalensis* as previously identified in the Taita Hills. It is also possible this is the species Butynski (2004) was looking for on Mt. Kasigau. In either case, more research should be conducted as Mt. Kasigau has a unique ecosystem and species reliant on this climate might only survive a few kilometers from the mountain in riverine basins. These rivers dry up less than five kilometers from the base of the mountain so this habitat is likely very small.

APPENDIX A

Transect Details

Name	Number	Length	Coordinates: Start	Coordinates: End
Bungule Cottage	1	1000 m	3°50'50.99"S 38°40'56.10"E	3°50'53.80"S 38°40'39.40"E
Bungule Town	2	590 m	3°50'54.30"S 38°39'56.90"E	3°50'37.10"S 38°40'5.20"E
Jora	3	720 m	3°50'21.50"S 38°38'51.80"E	3°50'3.60"S 38°39'8.90"E
Kitege Bush	4	1000 m	3°47'27.90"S 38°38'24.30"E	3°46'55.20"S 38°38'24.30"E
Kitege River	5	1080 m	3°47'53.00"S 38°38'36.70"E	3°48'13.80"S 38°39'4.90"E
Kitege-Makwasinyi	6	1000 m	3°46'48.90"S 38°40'19.10"E	3°47'9.30"S 38°39'55.60"E
Makwasinyi River	7	540 m	3°48'50.00"S 38°40'40.60"E	3°48'50.50"S 38°40'23.10"E
Rukanga A	8	1000 m	3°48'51.19"S 38°38'28.01"E	3°48'50.51"S 38°37'59.44"E
Rukanga B	9	1200 m	3°49'17.32"S 38°37'52.08"E	3°48'58.78"S 38°38'27.81"E

APPENDIX B

Raw Transect Data - Night

Date	Time	Transect number	sight/ call	distance	species	tree species	tree height	Collar	Coordinates
8/6/2011	22:32	1	sight	0.1 m off line	*Galago*	?	9 m		S 3^{o}50'53.8 E 38^{o}40'39.4
8/6/2011	20:36	2	call	200 m	*Otolemur*	-	-		S 3^{o}50'54.0 E 38^{o}39'58.0
8/6/2011	21:15	2	sight	0.5 m	*Otolemur*	?	8 m		S 3^{o}50'37.7 E 38^{o}40'04.8
8/12/2011	21:41	8	sight (2)	25 m	*Otolemur*	*Ficus thonningii*	70 m		S 3^{o}48'52.3 E 38^{o}38'19.6
8/12/2011	21:48	8	sight	3 m	*Otolemur*	*Acacia nilotica*	60 m		S 3^{o}48'50.1 E 38^{o}38'17.3
8/12/2011	22:08	8	sight	80 m	*Otolemur*	*Mangifera*	55 m		S 3^{o}48'53.7 E 38^{o}38'04.9
8/13/2011	22:48	4	sight	60 m right	*Galago*	*Acacia mellifera*	10 m		S 3^{o}47'13.7 E 38^{o}38'26.7
8/13/2011	20:45	5	call (2)/sight (1)	200 m, left line and spotted one	*Otolemur*	*Commiphora baluensis*	40m		S 3^{o}47'52.1 E 38^{o}38'49.7
8/13/2011	21:02	5	call	50 m left of line	*Otolemur*	-	-		S 3^{o}48'01.6 E 38^{o}38'52.0
8/13/2011	21:10	5	call	100 m right of line	*Otolemur*	-			S 3^{o}48'05.1 E 38^{o}38'53.1
8/13/2011	21:13	5	sight	30 m left of line	*Otolemur*	*Balanites aegyptiaca*	20 m		S 3^{o}48'05.0 E 38^{o}38'55.4
8/13/2011	21:30	5	sight	20m ahead on line	*Otolemur*	*Acacia nilotica*	50 m		S 3^{o}48'06.0 E 38^{o}39'01.0

8/13/2011	21:45	5	call	20 m left of line	*Otolemur*	-	-	S 3°48'07.3 E 38°39'02.4
8/14/2011	23:00	6	sight, call first	20 m right	*Otolemur*	*Terminalia prunoides*	15 m	S 3°46'53.9 E 38°40'20.7
8/14/2011	23:36	6	sight	5 m right	*Galago*	*Albizia anthelmintica*	7 m	S 3°47'03.9 E 38°40'08.8
8/14/2011	23:50	6	call	300 m left	*Otolemur*	-	-	S 3°47'06.6 E 38°39'59.7
8/14/2011	3:07	6	call	100 m ahead (past end of transect)	*Otolemur*	-	-	S 3°47'09.4 E 38°39'55.8
8/14/2011	21:02	7	sight	25 m right	*Otolemur*	*Acacia nilotica*	70 m	S 3°48'51.6 E 38°40'36.1
8/14/2011	21:09	7	sight (2), call first	10 m left	*Otolemur*	*Terminalia prunoides*	70 m	S 3°48'50.9 E 38°40'36.8
8/14/2011	21:14	7	sight, call first	80 m left	*Otolemur*	*Acacia nilotica*	60 m	S 3°48'51.5 E 38°40'36.1
8/14/2011	21:18	7	sight	25 m left	*Otolemur*	*Acacia nilotica*	15 m	S 3°48'52.0 E 38°40'34.8
8/14/2011	21:20	7	sight	5 m left	*Otolemur*	*Acacia nilotica*	10 m	S 3°48'52.1 E 38°40'34.3
8/14/2011	21:30	7	sight	30 m left of line	*Cercopithecus mitis*	*Ficus thonningii*	40 m	S 3°48'52.9 E 38°40'33.1
8/15/2011	19:54	3	sight	100 m left	*Otolemur*	*Acacia nilotica*	50 m	S 3°50'14.4 E 38°38'55.4
8/15/2011	20:22	3	call	75 m right	*Otolemur*	-	-	S 3°50'09.5 E 38°39'04.8

10/2/2011	20:12	8	sight	50 m left of line	*Otolemur*	*Ficus thonningii/Acacia nilotica*	10 m/40 m	NC	S 3^{o}48'51.5 E 38^{o}38'22.9
10/2/2011	20:18	8	sight	60 m left	*Otolemur*	*Ficus thonningii*	60 m	colla r	S 3^{o}48'50.5 E 38^{o}38'20.7
10/2/2011	20:23	8	call	70 m left	*Otolemur*	*Ficus thonningii*	25 m		S 3^{o}48'51.6 E 38^{o}38'20.4
10/2/2011	20:36	8	call	70 m left	*Otolemur*	-	_		S 3^{o}48'51.1 E 38^{o}38'14
10/3/2011	5:00	8	call	20 m left of line	*Otolemur*	-			S 3^{o}48'53.1 E 38^{o}38'23.8
10/3/2011	5:00	8	call (2)	10 m right	*Otolemur*	-			S 3o48'53.1 E 38o38'23.8
10/3/2011	5:05	8	sight	60 m left	*Otolemur*	*Ficus thonningii*	60 m	NC	S 3^{o}48'50.7 E 38^{o}38'20.6
10/3/2011	5:10	8	call	80 m left	*Otolemur*	-			S 3^{o}48'50.5 E 38^{o}38'19.0
10/3/2011	5:14	8	call	50 m left of line	*Otolemur*	-			S 3^{o}48'51.4 E 38^{o}38'13.8
10/6/2011	4:37	8	sight	60 m left	*Otolemur*	*Ficus thonningii*	60 m	colla r	S 3^{o}48'51.6 E 38^{o}38'19.8
10/6/2011	5:06	8	call (2)	50 m left of line	*Otolemur*	-			S 3^{o}48'50.7 E 38^{o}38'22.3
10/6/2011	5:12	8	sight	40 m left	*Otolemur*	?	?	colla r	S 3^{o}48'53.7 E 38^{o}38'26.6
10/6/2011	20:19	8	sight	15 m ahead	*Otolemur*	*Adansonia digitata*	30 m	NC	S 3^{o}48'50.0 E 38^{o}38'17.6

10/12/2011	20:12	8	sight (call first) x 4	40 m left	*Otolemur*	*Acacia robusta*		1 collar, 3 NC	S 3°48'52.0 E 38°38'13.2
10/12/2011	20:17	8	sight (call first)	15 m left	*Otolemur*	*Mangifera*	15 m	collar	S 3°48'52.1 E 38°38'13.6
10/14/2011	4:44	8	sight	10 m ahead	*Otolemur*	?	5m	NC	S 3°48'54.3 E 38°38'25.7
10/14/2011	5:00	8	call	200 m	*Otolemur*	-			S 3°48'50.1 E 38°38'17.6
10/14/2011	-	8	sight	50 m right	*Otolemur*	?	25 m	NC	-
10/14/2011	-	8	sight (call first)	10 m left	*Otolemur*	*Acacia nilotica*	10 m	NC	-
10/14/2011	-	8	call	8m right	*Otolemur*	?	20 m		-
11/3/2011	20:39	5	sight x 2	3 m left	*Otolemur*	*Acacia robusta*	8 m	2 collars (red)	S 3°47'57.8 E 38°38'46.0
11/3/2011	20:53	5	sight x 2	10 m left	*Otolemur*	*Cordia goetzei*	7 m	NC	S 3°48'00.01 E 38°38'50.9
11/3/2011	21:04	5	sight x 2	40 m left	*Otolemur*	*Acacia robusta*	15 m	NC	S 3°47'59.2 E 38°38'48.2
11/3/2011	21:11	5	call	50 m right	*Otolemur*	-			S 3°48'00.3 E 38°38'50.8
11/3/2011	21:29	5	sight	7 m left	*Otolemur*	*Melia volkensii*	7 m	NC	S 3°48'05.4 E 38°39'00.3
11/3/2011	21:42	5	sight	20 m left of line	*Otolemur*	?	25 m	silver collar	S 3°48'06.6 E 38°39'03.4

11/3/2011	21:44	5	sight	5 m left	*Otolemur*	*Trichilia enetia*	5 m	NC	S 3°48'06.7 E 38°39'03.8
11/3/2011	21:47	5	sight	15 m left	*Otolemur*	*Trichilia enetia*	10 m	NC	S 3°48'06.7 E 38°39'03.8
11/3/2011	21:48	5	call	15 m right	*Otolemur*	-			S 3°48'06.8 E 38°39'04.0
11/3/2011	22:06	5	sight x 2	20 m ahead	*Otolemur*	*Cordia goetzei*	5 m	NC	S 3°48'11.8 E 38°39'05.1
11/3/2011	22:08	5	sight x 2	5 m right	*Otolemur*	*Acacia robusta*	20 m	NC	S 3°48'12.4 E 38°39'05.1
11/15/2011	19:00	7	sight	20 m ahead	*Otolemur*	mwanga	15 m	NC	S 3°48'50.0 E 38°40'40.1
11/15/2011	19:18	7	sight	10 m right	*Otolemur*	mwanga	10 m	NC	S 3°48'52.0 E 38°40'34.7
11/15/2011	19:41	7	sight	100 m right of line	*Otolemur*	?	?	NC	S 3°48'53.8 E 38°40'28.6
11/16/2011	20:10	6	sight x 2	60 m right	*Otolemur*	*Commiphora baluensis*	15 m	NC	S 3°46'53.0 E 38°40'20.3
11/16/2011	20:37	6	call	100 m ahead	*Otolemur*	-			S 3°47'08.3 E 38°40'18.5
11/16/2011	21:07	6	call	30 m left of line	*Otolemur*	-			S 3°47'03.1 E 38°40'07.0
11/16/2011	19:26	7	sight (call first)	1 m left	*Otolemur*	mwanga	10 m	NC	S 3°48'51.1 E 38°40'36.5
11/16/2011	19:33	7	sight	50 m left of line	*Otolemur*	mwanga	6 m	collar (red)	S 3°48'51.9 E 38°40'33.5
11/16/2011	19:34	7	sight	50 m left of line	*Otolemur*	*Acacia robusta*	8 m	collar (silver)	S 3°48'51.8 E 38°40'34.7

11/24/2011	19:51	4	sight	5 m left	*Galago*	*Acacia mellifera*	5 m	NC	S 3^{o}47'10.7 E 38^{o}38'26.8
11/25/2011	20:11	8	sight	40 m right	*Otolemur*	*Acacia nilotica*	15 m	NC	S 3^{o}48'55.9 E 38^{o}38'28.5
11/25/2011	19:53	9	call	200 m behind	*Otolemur*	-			S 3^{o}49'13.6 E 38^{o}38'01.5
11/25/2011	20:37	9	call	100 m right	*Otolemur*	-			S 3^{o}49'06.7 E 38^{o}38'10.4
11/26/2011	19:09	3	call	400 m right	*Otolemur*	-			S 3^{o}50'20.7 E 38^{o}38'53.1
11/26/2011	19:12	3	call	200 m right	*Otolemur*	-			S 3^{o}50'19.0 E 38^{o}38'54.7
11/26/2011	19:15	3	sight	50 m right	*Otolemur*	*Commiphora baluensis*	20 m	NC	S 3^{o}50'18.3 E 38^{o}38'55.8
11/26/2011	19:37	3	call	100 m right	*Otolemur*	-			S 3^{o}50'11.5 E 38^{o}39'04.4
11/26/2011	20:00	3	call	50 m left of line	*Otolemur*	-			S 3^{o}50'12.1 E 38^{o}39'01.4
11/26/2011	20:00	3	sight	5 m right	*Galago*	*Cordia goetzei*	5 m	NC	S 3^{o}50'12.1 E 38^{o}39'01.4
12/8/2011	19:17	2	call	100 m left	*Otolemur*	-			S 3^{o}50'49.5 E 38^{o}40'01.4
12/8/2011	19:40	2	call	70m left	*Otolemur*	-			S 3^{o}50'38.5 E 38^{o}40'04.0
12/8/2011	19:12	2	sight	15 m left	*Otolemur*	*Acacia robusta*	20 m	collar (silver)	S 3^{o}50'51.4 E 38^{o}40'00.2
12/8/2011	19:32	2	sight	15 m left	*Otolemur*	*Acacia robusta*	25 m	collar (red/silver)	S 3^{o}50'37.3 E 38^{o}40'06.6

APPENDIX C

Raw Transect Data – Day

Date	Time	Transect	sight/call	distance	animal species	tree species	tree height	Age/ #	Coordinates
10/2/2011	9:32	8	sight x 7	25 m left	*Chlorocebus pygerythrus*	*Acacia nilotica*	30 m	all juvenile	S 3^{o}48'52.1 E 38^{o}38'23.8
10/2/2011	9:35	8	sight x 2	50 m ahead	*Chlorocebus pygerythrus*	on ground/*Balanites aegyptiaca*	20 m	2 adults	S 3^{o}48'51.0 E 38^{o}38'22.7
10/2/2011	9:36	8	sight	10 m	*Chlorocebus pygerythrus*	*Senna siamea*	15 m	adolescent	S 3^{o}48'51.1 E 38^{o}38'21.5
10/2/2011	9:37	8	sight	50 m left	*Chlorocebus pygerythrus*	*Mangifera*	10 m	adolescent	S 3^{o}48'50.7 E 38^{o}38'20.4

10/2/2011	9:42	8	sight x 2	30 m left	*Chlorocebus pygerythrus*	*Acacia nilotica*	30 m	adults	S 3^{o}48'50.3 E 38^{o}38'14.8
11/15/2011	16:26	7	sight x 2	10 m right	*Chlorocebus pygerythrus*	mwanga	10 m	adults	S 3^{o}48'51.9 E 38^{o}40'35.7
11/25/2011	7:23	8	call	100 m right	*Chlorocebus pygerythrus*				S 3^{o}48'53.6 E 38^{o}38'04.3
11/25/2011	7:54	8	sight	5 m ahead	*Chlorocebus pygerythrus*	on ground		adult	S 3^{o}48'51.0 E 38^{o}38'23.2
11/26/2011	7:46	3	call	100 m behind	*Chlorocebus pygerythrus*				S 3^{o}50'17.7 E 38^{o}38'55.4
11/26/2011	8:49	3	sight	50 m right	*Papio anubis*	on ground		adult male	S 3^{o}50'21.5 E 38^{o}38'51.6

11/28/2011	15:11	1	sight	20 m right	*Cercopithecus mitis*	on rock			S 3°50'52.3 E 38°40'31.0
12/8/2011	7:16	2	sight	20 m left	*Chlorocebus pygerythrus*			5 adults, two sub-adults, two juveniles, one infant (carried by mother)	S 3°50'50.5 E 38°40'01.0
12/8/2011	7:27	2	sight	10 m ahead	*Cercopithecus mitis*	mklifi/Acacia Robusta	15 m/20 m	8 adults, one juvenile	S 3°50'43.3 E 38°40'05.0
While setting traps									
11/29/2011	16:21	2	sight	5 m right	*Chlorocebus pygerythrus* troop			10 + all ages	S 3°50'50.5 E 38°40'00.2

11/29/2011	16:34	2	sight	10 m right	*Cercopithecus mitis*	2 adults, 2 juveniles	S 3°50'42.3 E 38°40'04.3
11/30/2011	day	2	sight	20 m left	*Chlorocebus pygerythrus* troop		S 3°50'50.5 E 38°40'00.2
11/30/2011	day	2	sight	10 m right	*Cercopithecus mitis*	1 adult, 2 juveniles	S 3°50'42.3 E 38°40'04.3
12/1/2011	day	2	sight	5 m left	*Chlorocebus pygerythrus* troop		S 3°50'50.5 E 38°40'00.2
12/1/2011	day	2	sight	10 m right	*Cercopithecus mitis*	2 adults, 2 juveniles	S 3°50'42.3 E 38°40'04.3
12/3/2011	day	2	call	50 m left	*Papio anubis*	male and female	S 3°50'38.2 E 38°40'04.4

APPENDIX D

Raw Trapping Data

Date	Tran-sect	tree species	tree height	Coordinates	Sex	Weight (g)	Hindfoot length (cm)	Tail length (cm)	Ear length (cm)	collar pattern	ID Num-ber	Recapture notes/ tail tip color
9/20/2011	8	*Acacia robusta*		S 3°48'53.9 E 38°38'26.5	male	-	-	-	-	1 horizontal stripe	1	
9/20/2011	8	*Ficus thonningii*	60 m	S 3°48'51.9 E 38°38'20.1	male	-	-	-	-	2 horizontal stripes	2	
9/20/2011	8	*Ficus thonningii*	45 m	S 3°50'50.5 E 38°40'01.0	female	-	-	-	-	3 horizontal stripes	3	
9/21/2011	8	*Acacia robusta*		S 3°48'53.9 E 38°38'26.5	male	-	-	-	-	4 diagonal stripes	4	

9/21/2011	8	*Mangifera*	15 m	S 3^{o}48'51.9 E 38^{o}38'13.9	male	-	-	-	-	blank	5		
9/22/2011	8	*Ficus thonningii*	45 m	S 3^{o}50'50.5 E 38^{o}40'01.0	female	-	-	-	-	5 dots	6		
9/22/2011	8	*Acacia nilotica*	60 m	S 3^{o}48'50.6 E 38^{o}38'17.0	female	-	-	-	-	4 X's	7		
9/26/2011	8	*Ficus thonningii*	45 m	S 3^{o}50'50.5 E 38^{o}40'01.0	male	-	-	-	-	diagonal lines	8		
9/29/2011	8	*Ficus thonningii*	45 m	S 3^{o}50'50.5 E 38^{o}40'01.0	female	-	9.8	35	4.5	4 spots	9		
10/13/2011	7	mwanga (1)	15 m	S 3^{o}48'50.3 E 38^{o}40'37.1	female	1050 g	10.2	35.3	4	1 red stripe	10	recaught 10/22/11 *Acacia nilotica*	recaught 11/2/11 mwanga

10/17/2011	7	*Acacia nilotica*	40 m	S 3^{o}48'52.3 E 38^{o}40'36.4	female	980 g	9.2	34.7	4.8	1 silver stripe	11	recaught 10/22/11 *Acacia robusta*	recaught 10/25/11 *Ficus thonningi i*
10/17/2011	7	*Acacia robusta*	10 m	S 3^{o}48'52.6 E 38^{o}40'34.7	male	-	10.8	36.6	4.3	2 red stripes	12	recaught 10/19/11 *Ficus thonningii*	recaught 10/25/11 *Acacia nilotica*
10/18/2011	7	mwanga	15 m	S 3o48'50.3 E 38o40'37.1	young male	-	9.4	34.6	4.6	2 silver stripes	13		
10/19/2011	7	*Acacia nilotica*	40 m	S 3^{o}48'52.3 E 38^{o}40'36.4	young male	910 g	9.9	37.3	4.7	3 diagonal red stripes	14	recaught 10/31/11 *Ficus thonningii*	recaught 11/2/11 *Acacia robusta*
10/20/2011	7	*Acacia robusta*	10 m	S 3^{o}48'52.6 E 38^{o}40'34.7	young male	-	8.4	34.6	5.2	4 red dots	15		
10/23/2011	7	*Acacia nilotica*	40 m	S 3^{o}48'52.3 E 38^{o}40'36.4	male	753 g	9.5	37.7	5	4 silver dots	16		

10/23/2011	5	*Melia volkowsii (2)*	5 m	S 3°47'55.4 E 38°38.44.3	female	825 g	11.1	36.3	4.9	1 red stripe	17	recaught 10/27/11 same trap	
10/23/2011	5	*Cordia goetzei (1)*	10 m	S 3°47'58.3 E 38°38'46.4	young male	995 g	9.8	31.5	4.9	1 silver stripe	18		white tail
10/23/2011	5	*Cordia goetzei (2)*	7 m	S 3°48'04.7 E 38°38'59.3	male	815 g	9.7	35.7	5.4	2 red stripes	19		black tail
10/24/2011	5	*Melia volkowsii (2)*	5 m	S 3°47'55.4 E 38°38.44.3	female	1075 g	9.9	36.8	5.1	2 silver stripes	20		white tail
10/27/2011	5	*Cordia goetzei (1)*	10 m	S 3°47'58.3 E 38°38'46.4	male	585 g	9.1	34.7	4.7	3 diagonal red stripes	21	recaught 10/30/2011 *Melia volkowsii*	
10/29/2011	7	*Acacia nilotica*	40 m	S 3°48'52.3 E 38°40'36.4	male	1000 g	10	39	5.2	3 diagonal silver stripes	22		black tail

10/30/2011	7	*Acacia nilotica*	40 m	S 3°48'52.3 E 38°40'36.4	male	1080 g	8.7	34.2	4.5	red v	23		white tail
10/31/2011	5	*Melia volkowsii (1)*	5 m	S 3°47'52.6 E 38°38'40.1	male	1110 g	10.6	36.3	5.2	3 diagonal silver stripes	24		white
11/1/2011	5	*Melia volkowsii (1)*	5 m	S 3°47'52.6 E 38°38'40.1	male	1030 g	9.7	37.6	5.5	4 red dots	25		white
11/2/2011	5	*Trichilia enetia*	30 m	S 3°48'04.7 E 38°38'59.3	male	1060 g	9.5	35.5	4.8	silver v	26		white
12/2/2011	2	mwaguba	30 m	S 3°50'50.9 E 38°40'00.5	female	890 g	8.9	32.1	4.4	1 red stripe	27	recaught 12/7/2011 mwanakul e	black
12/4/2011	2	mwaguba	30 m	S 3°50'50.9 E 38°40'00.5	female	950 g	9.7	35.2	4.6	1 silver stripe	28	recaught 12/8/2011 mwanakul e	brown with mostly white tip

12/8/2011	2	*Balanites aegyptiaca*	15 m	S 3°50'38.1 E 38°40'04.1	young male	890 g	8.9	37.2	4.6	1 silver, 1 red	29

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