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A SURVEY OF THE LARGE AND MEDIUM SIZED MAMMALS OF ARAWALE NATIONAL RESERVE, KENYA

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ABSTRACT

Between March 2005 and February 2006 we surveyed the large and medium sized mammals (>5 kg) of Arawale National Reserve, NE Kenya. Twenty-three mammal species were counted during the period, using ground transects. This included eight species listed in the 2008 IUCN Red List of Threatened Species. Densities and biomass of the larger mammals in the Reserve were generally low as compared to other protected areas in East Africa. There were no seasonal differences in the number of mammals counted, but differences between habitats were highly significant. Despite the low mammal densities, Arawale National Reserve is important for the conservation of threatened species, especially hirola *Beatragus hunteri* and wild dog *Lycaon pictus*.

Keywords: Arawale, larger mammals, density, hirola, *Beatragus hunteri*

INTRODUCTION

Not much is known about the species composition, population sizes and densities of wildlife species in Arawale National Reserve in north-eastern Kenya. Banditry, inaccessibility due to poor roads and neglect (political and economic) from the Kenya Government have collectively contributed to the restricted ecological studies in this region. Previous ecological studies conducted in Arawale National Reserve concentrated mainly on the critically endangered hirola *Beatragus hunteri* (Andanje, 2000; Dahiye & Aman, 2002; IUCN SSC Antelope Specialist Group, 2008) or were aerial surveys (DRSRS, 1997). The region, however, is attracting interest from the government and foreign investors as a result of an increasingly favourable

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political climate, coupled with the need to expand the country's tourist circuits and to reduce poverty in the region. This study documents the relative densities of large and medium sized mammals, their seasonal variations and distribution in Arawale National Reserve. This information is often a prerequisite for preparation of protected area management plans, conservation programmes and tourism development activities.

For the purposes of this study, large and medium sized mammals were defined as any mammal whose known average weight, as given by Stuart & Stuart (2006), exceeds 5 kg.

MATERIALS AND METHODS

Description of the study area

Arawale National Reserve (1°15'–1°34'S, 40° 04'–40°20' E; 85–100 m) covers an area of about 450 km^2, and lies 77 km south of Garissa town, astride the border between Garissa and Ijara Districts in North Eastern Province of Kenya (figure 1). The Reserve was gazetted in 1976 as the only main *in situ* conservation site for *B. hunteri*, a monotypic antelope endemic to north-eastern Kenya and south-west Somalia (where the population status is unknown) (Ottichilo *et al.*, 1995). The Reserve is a refuge for protecting a wide range of wildlife species that include *B. hunteri* (Bunderson, 1977; 1979; Andanje, 2002), the rare wild dog *Lycaon pictus* (McCreery & Robbins, 2004; Githiru *et al.*, 2008) and occasionally the African elephant *Loxodonta africana* (DRSRS, 1997). The historical range of the endangered Grevy's zebra *Equus grevyi*, extends to the Reserve (Kingdon, 1997), but there are no recent records. The Reserve used to support a population of black rhinoceros *Diceros bicornis*, but this species was extirpated by poachers during the 1960's and 1970's (Dahiye, 1999). Other key wildlife species that occur in Arawale include cheetah *Acinonyx jubatus* and the little-known desert warthog *Phacochoerus aethiopicus delamerei*. Past aerial surveys (in 1977 and 1997) of the Reserve recorded thousands of ungulates typical of thorn bushland and woodland habitats of the Reserve (DRSRS, 1997).

Vegetation in the Reserve consists of a mosaic of grassland, bushland and open woodland dominated by *Acacia, Commiphora* and *Combretum* species. The soils are predominantly the flood-prone black cotton soils that make most parts of the Reserve inaccessible by vehicle during the rainy season. Yearly rainfall in the region is highly variable. On average the area receives 200–500 mm of rainfall per year during two wet seasons (April–June and October–December), separated by two distinct dry seasons (January–March and July–September). These seasons were not clearly distinct during the study period except that changes in ambient temperatures were noticeable. There were scattered water-points throughout the Reserve (figure 1), most of them shallow water pans that hold seasonal rain waters for up to two months during the dry season.

The Reserve is inhabited mainly by nomadic Somali pastoralists. Over 90% of the population in the region relies on livestock production of mainly cattle, goats, sheep and camels (Little, 2003). This socio-economic activity is very unreliable because of the frequent cycles of droughts, flooding and diseases, sometimes with little time to recover from the previous cycle (Kalff *et al*. 1985). Land for grazing is therefore a limiting natural resource for the nomadic pastoralists and Arawale National Reserve forms part of their historical grazing rangeland. Grazing is permitted in the Reserve, hence the presence of many satellite camps—temporary camp sites away from homesteads- used by nomadic herdsmen within the Reserve (figure 1).

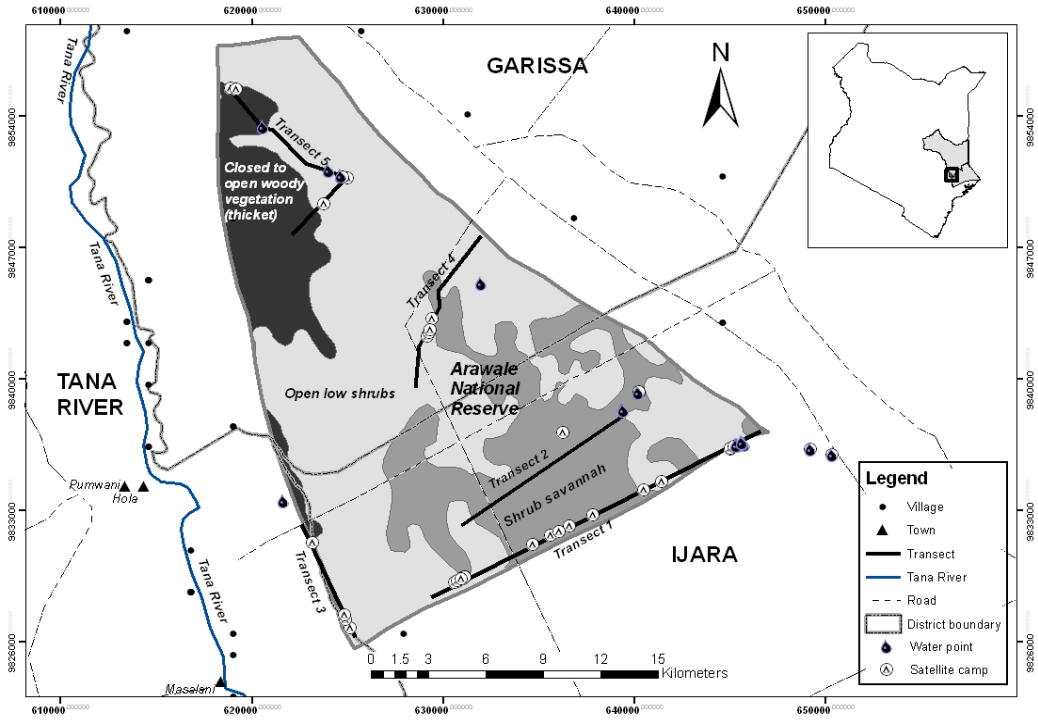

Figure 1. Map of Arawale National Reserve, showing transect layout and the major habitat types in the Reserve. Habitat types are derived from FAO's LCCS categories (FAO 2000). The inset shows the location of the Reserve in Kenya.

Survey methodology

We selected five transects located to cover a large proportion of Arawale National Reserve and traverse the three major habitat types in the Reserve (figure 1). Existing tracks and roads were used in some inaccessible areas. Transects ranged in length from 9.5 km to 22 km. Trial transect runs were conducted prior to the start of the actual transect counts to train local scouts, observe for changes in animal behaviour and estimate detection distances for different animal species in different habitats. Between March 2005 and February 2006 all transects were quietly walked (average speed 4 $km.h^{-1}$) by two trained scouts, except the longest transect, which was driven at < 10 $km.h^{-1}$, once every month (same date every month). Whereas driving transects and walking them could potentially yield different results because of the reaction by animals, we believe that the results discussed in this paper were not affected in any significant way. Walking and driving transects have been combined in the past to estimate mammal densities in similar habitat types in East Africa *e.g.* Okello (2006). Counting started at 06:00 h and was completed before 12:00 h. When an individual animal or group of animals was sighted movement stopped and species, geographic location, and number of individuals in the group were recorded. For every sighting, the location was read using a hand-held Global Positioning System (GPS). The perpendicular distance from the transect line to the animal (or the animal approximately at the centre of a group of individuals) was estimated. Later, each sighting was placed either inside or outside a belt whose width varied both with habitat type and by species. Detection distances for different

mammal species (estimated during trial runs) were used to determine the width of the transects for each species. For example, for Kirk's dikdik *Madoqua kirkii* it was 30 m on both sides of the transect line in closed to open woody thickets, but 80 m in both open low shrubs and shrub savannah habitat types. We did not observe any significant changes in detectability over the seasons. All livestock *i.e.* cattle, sheep, goats and camels seen within 100 m on either side of the transect belt were also counted. For logistical reasons, no transect counts were undertaken at night during the study.

Habitat types in the Reserve and their total areas were derived from the standard Land Cover Classification System (FAO, 2000) using Arcview (ESRI, 1996). The three major habitat types in Arawale National Reserve were 'shrub savannah' (open shrubs with closed to open herbaceous layer and sparse trees, 20–10% crown cover; % area covered = 35.7), 'open low shrubs' (65–40% crown cover; % area covered = 49.9) and 'open to closed woody vegetation or thickets', (70–60% crown cover; % area covered = 14.3). We superimposed GPS coordinates of all mammal sightings on an Africover Landcover Classification map in Arcview (ESRI, 1996), to obtain the actual habitat type for each sighting and filter for records outside the Reserve boundaries. Similarly, the area (using belt widths based on species-specific detection distances) of each habitat type that each transect traversed was calculated.

We then calculated monthly densities (individuals.km^{-2}) for each species using the two-belt transect method, which uses stratified observations depending on the type of habitat and corrects for species detectability using a linear model (Bibby *et al.*, 2000; Burnham *et al.*, 1980). Thus density D (individuals.km^{-2}) was calculated as:

$D = N^{*}k/L$ where

K= (1-SQRT(1-p))/w; *L= transect length; w=transect width (as estimated for each species;* N=*Total number counted along the transect;* N_1=*Total number counted within w;* p = *proportion within w i.e.* $p=N_1/N$

The biomass of each species in each habitat was obtained by multiplying the calculated density (individuals.km^{-2}) in that habitat by the mean of female and male weights taken from Stuart & Stuart (2006) to give a biomass measure in kg.km^{-2}. We did not calculate a livestock biomass because our data did not include species composition and numbers of livestock herds. To test for seasonal and habitat differences, monthly densities of each species were first log transformed to attain normality (Sokal & Rohlf, 1981). Variation in densities and biomass across the species was tested across the habitat types and between (climatic) seasons. Season was incorporated in the model as dry (Jan–Mar and Jul–Sept) or wet (Apr–Jun and Oct–Dec), or with the two sub-seasons separate as dry 1 (Jan–Mar), wet 1 (Apr–Jun), dry 2 (Jul–Sept) and wet 2 (Oct–Dec). We used sighting frequencies for each species (*i.e.* the number of times individuals or groups were seen in various habitat types) to test for differences in habitat use.

RESULTS

Twenty-three mammal species were recorded in Arawale National Reserve during the study period including fourteen ungulates, two primates and seven carnivores (table 1). An extra four species—eland *Taurotragus oryx,* honey badger *Mellivora capensis*, caracal *Felis caracal* and vervet monkey *Chlorocebus pygerythrus hilgerti*—were seen outside the transect

sessions. Eight species recorded in Arawale are listed as threatened in *IUCN's Red Data List* (IUCN, 2008; see table 1). In addition there were five observations of signs of the presence (old foot prints and dung) of the globally near-threatened African elephant *L. africana*.

M. kirkii had the highest estimated density (3.85 ± 9.60 individuals.km^{-2}), followed by gerenuk *Litocranius walleri* (1.82 ± 3.98 individuals.km^{-2}) and yellow baboon *Papio cyanocephalus* (1.81 ± 9.19 individuals.km^{-2}) in Arawale during the study period (table 2). Densities of mammalian carnivores in the Reserve were very low even though seven species were counted (overall density: 0.05 individuals.km^{-2}).

Mammal biomass (kg.km^{-2}) excluding livestock, in Arawale National Reserve was 4206.90 kg.km^{-2} over the entire study period. Mammal biomass was highest in the shrub savannah habitat (1937.01 kg.km^{-2}), while the open low shrubs had the lowest (1021.03 kg.km^{-2}). The mammal biomass of the open to closed woody thickets was intermediate (1248.94 kg.km^{-2}). Giraffe *Giraffa camelopardalis reticulata* had the highest biomass in all the three habitat types (table 2). Of the seven carnivores recorded in the Reserve, only the black-backed jackal *Canis mesomelas* occurred in the shrub savannah habitat, which was the habitat with the highest herbivore biomass.

Table 1. The list of large and medium sized mammals recorded in Arawale National Reserve during the survey including their conservation status (LC-Least concern; N-T-Near-threatened; V-Vulnerable; E-Endangered; CE-Critically Endangered), number of times individuals or groups were seen (sighting) and the total number counted.

Species	Threat category	Number of sightings	Number counted
Kirk's dikdik *Madoqua kirkii* Gunther, 1880	LC	291	579
Hirola *Beatragus hunteri* Sclater, 1889	CE	72	474
Giraffe *Giraffa camelopardalis* Linnaeus, 1758	LC	60	461
Gerenuk *Litocranius walleri* Brooke, 1878	N-T	127	316
Lesser kudu *Tragelaphus imberbis* Blyth, 1869	N-T	139	297
Oryx *Oryx beisa* Ruppell, 1835	N-T	21	79
Grant's gazelle *Nanger granti* (Brooke), 1872	LC	37	160
Topi *Damaliscus korrigum* (Ogilby), 1836	LC	7	49
Eland *Taurotragus oryx* Pallas, 1766	LC	2	26
Desert warthog *Phacohoerus aethiopicus* (Pallas), 1766	LC	32	89
African Buffalo *Syncerus caffer* Sparrman, 1779	LC	5	16
Bush Duiker *Sylvicappra grimmia* Linnaeus, 1758	LC	5	5
Common zebra *Equus quagga* Boddaert, 1785	LC	4	37
African elephant *Loxondonta africana* Blumenbach 1797	N-T	signs of presence only	
Yellow baboon *Papio cyanocephalus* Linnaeus, 1766	LC	9	190
Vervet monkey *Chlorocebus pygerythrus* (cuvier), 1821	LC	1	10
Cheetah *Acinonyx jubatus* (Schreber), 1775	V	3	5
Lion *Panthera leo* (Linnaeus), 1758	V	2	5
Caracal *Felis caracal* Schreber,1776	LC	1	1
Spotted hyena *Crocuta crocuta* (Erxleben), 1777	LC	3	4
Black-backed jackal *Canis mesomelas* Schreber, 1775	LC	2	4
Wild dog *Lycaon pictus* Temminck 1820	E	2	14
Honey badger *Mellivora capensis* Schreber, 1776	LC	1	1

Mammal densities differed significantly between all the three habitat types for all species (table 2) except for *G. camelopardalis*, African buffalo *Syncerus caffer*, common zebra *Equus quagga*, bush duiker *Sylvicappra grimmia* and spotted hyena *Crocuta crocuta*. Densities of most species were significantly higher in the north western part of the Reserve (transect 5), which was in or adjacent to the closed-to-open woody thickets. Livestock densities were also significantly higher in this habitat than in the shrub savannah and the open low shrubs (table 2). There was no significant effect of season on mammal densities ($p > 0.05$). The interaction of habitat and season, *i.e.* the result of mammals in different habitats responding differently to changing seasons, was not significant for all species, except for the *G. camelopardalis* (which was only marginally significant; $p = 0.05$).

Table 2. The mean density (individuals.km^{-2}), density estimates and biomass kg.km^{-2} (in brackets) by habitat type of medium and large sized mammals (> 5 kg) in Arawale National Reserve together with p-values for ANOVA tests for differences between habitats. SS-Shrub savannah; OLS- open low shrubs; COWT-closed to open woody thicket.

Species	Mean Density	SS	OLS	COWT	p-value
Madoqua kirkii	3.85 ± 9.60	1.38 (6.9)	4.04 (20.18)	6.13(30.70)	P<0.05
Beatragus hunteri	0.93 ± 3.50	2.68 (347.9)	0.12 (14.97)	0.00	P<0.05
Giraffa camelopardalis	0.72 ± 2.61	1.01(1210.64)	0.52 (629.52)	0.61(736.74)	ns
Litocranius walleri	1.82 ± 3.98	1.74 (69.78)	1.89 (75.83)	1.82 (72.87)	P<0.05
Tragelaphus imberbis	0.89 ± 2.13	1.55 (123.95)	1.04 (83.0)	0.12 (8.55)	P<0.05
Oryx beisa	0.37 ± 1.46	0.21 (47.11)	0.17 (37.76)	0.72 (158.37)	P<0.05
Nanger granti	0.49 ± 2.26	0.85 (50.95)	0.63 (37.64)	0.00	P<0.05
Damaliscus korrigum	0.09 ± 0.55	0.27 (36.49)	0.00	0.00	P<0.05
Phacohoerus aethiopicus	0.83 ± 2.89	0.09 (6.45)	1.11 (77.56)	1.29 (0.08)	P<0.05
Syncerus caffer	0.03 ± 0.32	0.00	0.04 (27.78)	0.06 (37.79)	ns
Papio cyanocephalus	1.81 ± 9.19	1.079 (8.76)	0.00	4.95 (100)	P<0.05
Sylvicappra grimmia	0.013±0.01	0.03 (0.60)	0.001 (0.02)	0.00	P<0.05
Equus quagga	0.03 ± 0.38	0.08 (25.78)	0.00	0.00	ns
Acinonyx jubatus	0.04±0.41	0.00	0.03 (1.50)	0.09 (4.50)	ns
Panthera leo	0.02±0.18	0.00	0.06 (10.74)	0.00	ns
Crocuta crocuta	0.05±0.43	0.00	0.01 (0.65)	0.13 (8.45)	P<0.05
Canis mesomelas	0.09±0.76	0.17 (1.7)	0.00	0.09 (0.90)	ns
Lycaon pictus	0.045±0.64	0.00	0.144 (3.89)	0.00	P<0.05
Livestock (cattle, camel, sheep and goats)	46.69±211.73	10.86	26.30	102.93	P<0.05

For most species, there were significant differences in the number of sightings in different habitat types (table 3). *M. kirkii*, *L. walleri*, *T. imberbis* and *P. aethiopicus* were more likely to be seen in the open low shrubs, Grant's gazelle *Nanger grantii* and *B. hunteri* in the shrub savannah, while *G. camelopardalis* and oryx *Oryx beisa* did not show preference for any particular habitat. When the sighting frequency was separated by season, only *L. walleri* and *P. aethiopicus* showed significant change of preferred habitat. Both species showed no habitat type preference during the dry season (Kruskal-Wallis: *L. walleri: $H = 4.8$, $P=0.093$*; *P. aethiopicus: $H = 3.3$, $P=0.2$*), but were most often seen in the open low shrubs during the wet season. For this analysis there were not enough data from carnivore sightings. However, most carnivores were seen in the open low shrubs (8 out of 13 sightings) particularly in the north western part of the Reserve (Transect 5).

Table 3. The number of sightings of different species in Arawale National Reserve separated by habitat type together with p values for Kruskal-Wallis significance tests for frequency of sighting between habitats. SB-Shrub savannah; OLS- open low shrubs; COWT-closed to open woody thickets; _insufficient data (N< 5).

Habitat type	SB	OLS	COWT	χ^2	d.f.	p value
Madoqua kirkii	62	175	54	13.17	2	0.001
Litocranis walleri	52	56	19	12.63	2	0.002
Nanger grantii	34	3	0	25.45	2	P<0.001
Beatragus hunteri	59	11	2	21.23	2	P<0.001
Oyrx beisa	8	5	8	0.78	2	0.676
Phacohoerus aethiopicus	5	18	9	8.45	2	0.015
Giraffa camelopardalis	29	21	10	6.25	2	0.054
Tragelaphus imberbis	73	60	6	22.96	2	P<0.001
Equus quagga	4	0	0	_	_	_
Damaliscus korrigum	7	0	0	_	_	_
Syncerus caffer	0	2	3	_	_	_
Sylvicappra grimmia	4	1	0	_	_	_
Taurotragus oryx	2	0	0	_	_	_
Papio cyanocephalus	3	6	0	_	_	_
Chlorocebus pygerythrus	0	0	1	_	_	_
Panthera leo	0	2	0	_	_	_
Acinonyx jubatus	0	2	1	_	_	_
Felis caracal	0	1	0	_	_	_
Canis mesomelas	1	0	1	_	_	_
Crocuta crocuta	0	1	2	_	_	_
Lycaon pictus	0	1	1	_	_	_
Mellivora capensis	0	1	0	_	_	_

DISCUSSION

Medium and large mammal densities and biomass in Arawale National Reserve during the study period (March 2005 to February 2006) were not as high as those recorded in some other protected areas in East Africa with similar habitat types, even though we recorded 23 medium and large mammal species. For instance, our biomass was ten times lower than that of Katavi National Park in Tanzania, a park with similar habitat types and mammal diversity (24 medium and large mammal species recorded; biomass:23,138.7 $kg.km^{-2}$) (Caro, 1999a; 1999b). However, Arawale's large mammal biomass was higher than that of Loldaiga Hills ranch in Laikipia District, Kenya; a livestock/wildlife ranch in a region of comparable habitat and climate (60 large mammal species; biomass: 1543 $kg.km^{-2}$; Mizutani, 1999). The low biomass can be explained by the absence of megaherbivores particularly *L. africana* and hippopotamus *Hippopotamus amphibious,* and the probable under-estimation of nocturnal mammals. *L. africana* was probably a common species in the Reserve before being extirpated by poachers (DRSRS, 1997), but now only visits occasionally as suggested by the old foot prints and dung observed. *H. amphibious* is probably an occasional nocturnal visitor from the nearby Tana River, although no signs of its presence were seen during this study. *D. bicornis* (race *micheali*) whose range extended throughout northern Kenya and into Somalia used to occur but was also wiped out by poachers in the 1970s (DRSRS, 1997). Despite the generally

low mammal densities in the Reserve, densities of *B. hunteri* obtained during this study were a few times higher (0.93 individuals.km^{-2}) than those obtained by Andanje (2002) in Arawale (between 0.02 individuals.km2 and 0.53 individuals.km^{-2}). We were not able to come up with a clear explanation for this, but Andanje's work covered a greater area and recorded seasonal movements for this species, which were not evident in this study.

The low mammal densities may be related to several factors that are known to limit mammal densities such as rainfall amounts and patterns (see Coe *et al.*, 1975) and poaching pressure (Bonnington *et al.*, 2007). No evidence of poaching was reported during this study even though poaching used to be common in the past (Andanje, 2002) and is blamed for the decimation of the megaherbivores (DRSRS, 1997). Although conditions that favour poaching such as poor security and ineffective law enforcement persist, poaching may no longer be a worthwhile activity in the region because of the low mammal densities. The low densities of carnivore species observed during this study may also be attributed to some extent to the low densities of their prey species (although some do prey on mammals $<$ 5 kg too). It was likely that our survey methodology also underestimated carnivore species because most are nocturnal. Most carnivores were recorded around transect 5, the area of the Reserve with the highest herbivore densities.

There were no significant changes in mammal densities between seasons, which indicates little movement of mammals into or out of the Reserve during the study period. This is unusual for livestock and the nomadic tribesmen but they are known not to move far from areas with permanent water sources during drier years (de Leeuw *et al.*, 2001). Spatially, there were higher densities of mammals in the north-western part (transect 5) of the Reserve, an area where the habitat is predominantly closed to open woody thickets. This transect had more waterholes than the rest (figure 1), and also known to retain water for prolonged periods during the dry season, which may account for not only the higher mammal densities in the area, but also for the lack of seasonal (large scale) movements out of the Reserve during the dry season.

Some mammals in Arawale National Reserve were found in certain habitat types more often than in others. For example, *B. hunteri* and *N. grantii* were seen almost exclusively in shrub savannah habitat type, *M. kirkii*, *P. aethiopicus*, *T. imberbis* and *L. waleri* in the open low shrubs. These findings conform to the well established knowledge about habitat preferences in African ungulates (see Estes, 1991; Kingdon, 1997). No mammal species showed significant preference for the closed to open woody thickets. This was probably due to the high density of livestock recorded in this habitat. Livestock presence is known to negatively impact on the abundance of some mammal species in some places (*e.g.* Bergstrom & Skarpe, 1999; Bonnington *et al.,* 2007; Corti *et al.,* 2002).

In conclusion, Arawale National Reserve remains a stronghold for the endemic *B. hunteri* and a probable refuge for *L. pictus*, *A. jubatus* and occasionally *L. africana*. *E. grevyi*, whose global range covers the Reserve (Kingdon, 1997), probably occurs in very low numbers here, hence the lack of any observations. Arawale National Reserve is also home to two little known mammal species, *P. aethiopicus* and Somali lesser galago *Galago gallarum* Thomas, 1901. The presence of these species alone justifies the importance of this little known Reserve hitherto largely ignored by researchers and the Government.

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