

Primate Diversity and Population Ecology in Sambisa Game Reserve Borno State Nigeria

M. Modu¹, A. A. Alarape², J. K. Omifolaji³ and A. Aliyu⁴

¹Department of Forestry and Wildlife, University of Maiduguri.

²Department of Wildlife and Ecotourism Management, University of Ibadan.

³Department of Forestry and Wildlife, Federal University Dutse.

⁴Department of Forestry Technology, Mohamet Lawan College of Agriculture, Maiduguri.

ARTICLE INFO

Article history:

Received: 9 December 2015;

Received in revised form:

12 February 2016;

Accepted: 17 February 2016;

Keywords

Diversity,
Population,
Estimate density,
Survey,
Primate.

ABSTRACT

The diversity and population density distribution survey of primate was conducted in Sambisa Game Reserve. The study noted three diverse primate species dominant that include Baboon (*Papio anubis*), Tantalus monkey (*Cercopithecus tantalus*) and Red patas monkey (*Erythrocebus patas*). The aim of the study was to determine density estimate, population structure and the relative abundance between species and habitat disturbances. Information on the objectives of this study is not sufficiently documented, it is therefore right to carry out such study so as to provide baseline information that could be used to plan conservation management strategies for primate. The line transect sampling method was used for the enumeration. The data obtained was analysed using the software package *DISTANCE* 6.0 to determine population density estimate. The result showed that primate population was concentrated in three ranges of the reserve (Kwada, Yuwe and Jeltete). Balda range has suffered habitat disturbances resulting into insignificant number of primate. The mean encounter rates (MERs) for the three species were 1.85km⁻¹, 0.94/km⁻¹ and 1.58km⁻¹ for Baboon, Patas monkey and Tantalus monkey respectively. Baboon had the highest estimated density of about 12km⁻². The estimated density of Tantalus monkey in the study area was about 11km⁻². Patas monkey had a density estimate of about 7km⁻². There was a significant difference in the pattern of primate species densities for morning and evening count. The result indicated less activity in the evening for all the 3 primate species in the study area. The mean encounter rate for Baboon were 1.15 km⁻¹ (n=110) and 0.71 km⁻¹ (n= 68) individual animals for morning and evening sightings respectively. Similar results were obtained for the density estimate of both Tantalus and Patas monkey. The relative density for the three primate species across the four ranges in the reserve revealed that Baboon was not recorded in Balda range and only 2 individuals sighted in Jeltete. Kwada and Yuwe ranges had the highest abundance of 119 and 57 individuals sighted respectively. The population structure showed declining trend as number of juveniles was relatively lower than adult population. However, the relatively higher percentage of female adults may result in population growth, if majority of them are within the breeding age. The diversity of primates in Sambisa Game Reserve is distributed throughout the reserve within a wide range of habitat types. The highest numbers of primate species were found in the centre of the reserve (Kwada and Yuwe) where habitat disturbances were controlled.

© 2016 Elixir All rights reserved.

Introduction

Primates are almost exclusively tropical radiation, and there are currently over 200 species of primates living in the tropics of Asia, Africa and the Americas, (Cawlinshaw and Dambar 2000). Although primates represent one of the best known taxonomic groups, numerous important questions remain concerning taxonomy, distribution, abundance, conservation status, and priorities for conservation actions. In addition, field studies in which the phenotypic variation of primate species and subspecies is a rare. Undiscovered species or subspecies of primates are still being found and the knowledge about how many species and subspecies of primates occur and the level of extinction risk of each is vital

for primate conservation (Yvonne and Buttynski 2009). The nonhuman primates have a wide distribution throughout the tropical latitudes of Africa, within this tropical belt, which lies between latitudes 25° N and 30° S, they have a considerable vertical range. In Ethiopia the gelada (genus *Theropithecus*) is found living at elevations up to 5,000 meters above sea level (Mittermeier, 1987). Primates are highly intelligent animals that live in family groups in a number of habitats throughout the world. Chimps live in forest, woodland and savannah habitats in family groups that are predominantly female (Lawton, 1995). Sambisa game reserve is home to several primate species. Some of these include Baboon (*Papio anubis*), Tantalus monkey (*Cercopithecus tantalus*) and Red

Tele:

E-mail address: malamodu50@gmail.com

© 2016 Elixir All rights reserved

patas monkey (*Erythrocebus patas*). Baboon and Tantalus monkey are both endemic to this reserve. Wildlife population survey in the reserve has been scarcely carried out with little or no information on the ecology and status of primate, although this appears to be relatively abundant there is no available quantitative data. Sambisa game reserve has a wide range of forest habitats with different levels of human activity, which is ideal for investigating anthropogenic influence on primate abundance and distribution. Within the reserve are several degraded forests important as centers of biodiversity and water catchments. Hunting can seriously affect the population of primates. Hunting is common throughout Nigeria. However, some communities consider certain animals sacred thus they are not hunted (Oates *et al.*, 2000). Information on the diversity and abundance of primate in the reserve is scanty; therefore the study estimated primate relative abundance and diversity as well as relative dominance within the diverse species of primates in the reserve.

Study Area

Sambisa Game Reserve is situated in the southern part of Borno state approximately 70 km by road from Maiduguri town. The study area lies between longitude 13°30'–14°00'E and latitude 12°00'–13°30'N (Agboola, 1987). It is bordered by Konduga, Gwoza and Bama Local Government Areas to the north, south and east respectively. The Reserve was the combination of two contiguous Northern and Southern Sambisa Native Authority Forest Reserves and was constituted and gazetted in 1977 as Game Reserve. It has an area of approximately 518 Square Kilometres (MAFR 1997).

The climate within the reserve is rather uniform, with slightly higher rainfall in the south. The area experiences distinct wet and dry season. The wet season last from May to October while the dry season, which is usually longer last from November to April. Mean annual rainfall varies between 500mm to 950mm per annum. The highest rainfall is recorded in August. The mean monthly temperature ranges from 20.6°C to 32.0°C with the lowest recorded in the month of January and the highest in the month of April (Agboola, 1987). The soils are both recent and older alluvial deposit. They are leached allomorphic sandy loam and clay with a distinct structural horizon around the streams. The soil of the rest of the reserve is non-leached allomorphic cracking clay or black cotton soil and has high salinity (Ibrahim 2012). Bawdeen (1972) described the northern part of north-eastern Nigeria where the study area is located as consisting almost entirely of extensive flat or very gently undulating plains. The different between the highest and the lowest points seldom exceed 15 meters. The southern part is more varied with a more complex geology and associated topographical features and soil. The reserve is fairly flat but slightly slopping towards the east, south and south-west. The north-east is thus a more elevated area.

In dry climate zones as found in this area where evaporation exceed precipitation, movement of soluble soil constituents is either negligible or upward (Faniran and Ojo, 1980). Where rainfall below 500mm per annum, the leaching of clay becomes very minimal and salts may accumulate on the surface through evaporation particularly in depressions (Carroll and Klikenberg 1972). The soil of the reserve itself consist mainly of non-leached allomorphic cracking clays of alluvium deposits and hydromorphic soils with vertical tendencies, consisting mostly of clay.

The reserve is drained by tributaries of the Yadzeram river system which forms the part of the lake Chad basin

drainage area (Bawdeen, 1972). The tributaries include Kwada, Sambisa and Alau. The Yadzeram itself touches the reserve boundary where its confluence with the kwada occurs. It reaches its peak flow in the middle of September. During this period the surrounding area becomes flooded. The river usually dries up at the end of dry season due to evaporation and net loss (Bawdeen, 1972).

In addition to these streams ponds and water holes exist within the reserve. Durwagwa water holes located at higher elevated north- eastern part of the reserve is artificial. The rest mostly natural and are concentrated in at the lower laying southern and south- eastern part of the reserve. Although almost most part of the reserve gets flooded during the rainy season, several areas are readily identified as floodplains or Fadamas' which is more heavily inundated for longer period. They are concentrated in the west and north-western part of the reserve where Faama, Gyeiya, Chore and the extension of Gombole swamps occur. These water bodies provide drinking water to wild animals within the reserve. However, they dry up during the dry season leaving only few isolated water body particularly on the streambed of Kwada.

The two main forest types in the Reserve are the Sudan zone (thorn tree savannah) in the North and the Northern Guinea zone (broad leaves savannah) occupying the southern part. The Sudan zone is characterized by few trees and grass form the principal part of the vegetation. Seasonal drought is also a normal feature of the zone and animals best fitted are those that can survive on grass without regular water to drink (Ajayi 1981). The reserve is characterised by thorny trees of *Acacia* species such as *Acacia senegal*, *Acacia sayel*, *Acacia nilotica*, mixed with *Fadhabia albida*, *Balanite egyptiaca*, *Zizipus mauritiana*, *Anageirsus leocarpus*, *Combretum spp*, *Prosopis africana*, *Lannea humilis* and *Sterculia setigera*. The stream side trees are usually large with open canopy formation. They formed dense wood land and the species are *Khaya sensgalensis*, *Daniellia oliveri*, *Vitex doniana*, *Acacia sieberiana*, *Diospyros mespliformis* and *Cratoya adosenii* which lead into open wood land with *Hypherrhenia involucrate* and *Andropogon gayanus* as tall grass (MAFR 1997).

The reserve is one of the areas where conservation effort has been intensive in the state since 1970s. The protection accorded to the reserve has lead to increase in reasonable number of game animals. Game species found in the reserve include Roan Antelopes (*Neotragus pygmaeus*), Kob (*Adenota kob*), Red fronted Gazelle (*Gazella rufifrons*), Duiker (*Cellophalophus nigrifrons*), Warthog (*Phacochoerus aethiopicus*), Eland (*Taurotragus derbianus*), Hyena (*Crocuta crocuta*) etc. Primates are represented by troops of Baboon (*Papio anubis*), Tantalus monkey (*Cercopithecus tantalus*) and Red patas monkey (*Erythrocebus patas*). Sambisa Game reserve is also home to a variety of avian species such as Ostrich (*Struthio camelus*), Secretary bird (*Sagittarius serpentarius*) Marabou stork (*Leptoptilos crumeniferus*) Bustard (*Neotis senegalensis*), Ground hornbill (*Tockus nasutus*), Stone partridges (*Ptilophachus petrosus*) and Guinea fowl (*Numida meleagris*).

Methodology

A reconnaissance visit was conducted to provide a general picture of the distribution of primates and to locate definite position where transects baseline would be located in the four ranges of the study area. Information on population density was gathered from game rangers. A sketch map of the reserve (figure: 1) was used to study vegetation types and important

communities and their relative position. Survey was made for the signs left by primates such as footprint, faeces and nesting sites. Existing human paths and streambeds as described by Walsh and White, (1999) was used to walk through for the Reconnaissance survey. Since line transect samples were not conducted in addition to reconnaissance surveys, the bias in measures of relative abundance introduced by walking along existing trails during reconnaissance surveys could not be determined (Walsh and White 1999). Vegetation types and level of human disturbance in some part of the study area was recorded.

The reconnaissance survey revealed that the distribution of primates in the Reserve falls within the three ranges where all the 3 species were sighted in abundance while only 1 species of the red patas monkey that was very few was sighted in the Jeltere range. The visit also revealed that primates have escaped from areas where disturbance level to vegetation is high and has naturalised in the interior part of the reserve where disturbance level is minimal. Most disturbances level are encroachment by farmers around the buffer zone, some areas were selectively logged and some vegetation destroyed by hunter's fire. The survey noted the vegetation composition and structure as well as the general topography and nature of the soil. Changes in vegetation composition and structure that seem peculiar to any local habitat conditions were noted. It has become apparent that the reserve can be divided into 3 fairly distinct eco-habitat zones. Along the course of Sambisa and Kwada stream and the access track that runs from Bulanjibiya westward is characterised by many flood plains. The soil for most part was loamy clay while in few cases reddish clay occurred. The vegetation in most parts is scattered trees and shrubs that characterised the structure and composition of savannah vegetation. Meanwhile, there are other parts occupied by tall and thorny with dense impermeable thickets.

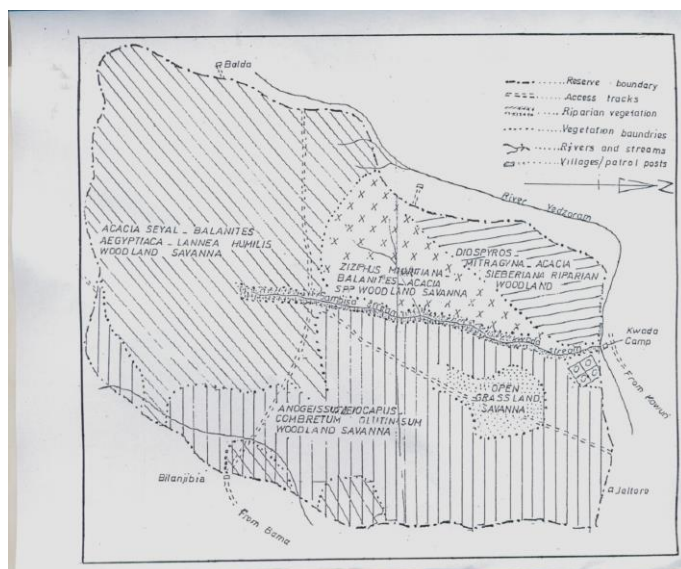


Figure 1. A sketch map of the study area showing important communities and their relative positions

The line transects method for surveying vertebrate reviewed by Buckland *et al*, (1993) was adopted for the determination of the relative abundance of the constituent species of primates in the study area. The streambed of river Yadzaram that cut across the 3 major ranges of the reserve was used as transects line and their orientation runs through East- West and West-East direction in Kwada-Jeltere and Yuwe-Balda ranges respectively. Starting point for each transect was randomly selected and its bearing was determined

using magnetic compass. Transect lines were run perpendicular to the streambed. There were 4 line transects (T1-T4) in each range of the reserve of 3 km long and positioned 2 km apart. Each line was clearly distinguished by its unique number. Because of the savannah nature of vegetation, clearance to facilitate movement along transect was very minimal. With the use of 50 meter tape every distance at 100 meter along the transect lines was marked by writing on marker tape and tightened on a tree or sapling by the side of the distance.

Survey for direct observation of primates was done in the morning and evening. Census data was obtained via line transects methods. Daytime census walk was begins at 07:00–10:45 hours at an average speed of about 1 km h^{-1} , including a pause at every 100 meters looking from side to side recording all sightings of primates. Additional repeated evening walked censuses were done between 16:00-19:45 hours. At the start of each transect walked the top part of the data sheet that contained information on observers names, name of transect, coordinate and date was filled. While running through the survey line, when primates were sighted or their presence was detected either by branch movement or alarm call, this was recorded immediately on the data form. For each primate sighting the recorded parameters are the time, species, estimated number of individuals, closest distance from transect to the first individual seen (perpendicular distance), and location of the observer along the transect. The estimated location on transect was obtained by referring to numbered tags placed every 100 meters along the trails. Perpendicular distance was determined by direct measurement using 50 meter tape. Transect line was surveyed twice (morning and evening) each and was repeated at fourth week. Total distance of 92 km of transect line was surveyed within 8 weeks and 190 observation were made.

Data obtained from this study was organized for analysis. A Microsoft computer software package, *DISTANCE* version 6.0 was used. The software facilitates all the computations and plotting needed in the analysis. Analysis phase involves exploratory phase that takes care of preparation of histograms of the distance data under several groupings to assess presence of heaping, evasive movement, outliers and the occasional gross error. The distance program allows explanatory option like grouping or truncation of data set prior to further analysis (Rebecca and Brigida, 2004).

Result

In modeling detection probabilities and computations of densities and encounter rates for all the categories of analyses presented in this study, all the four types (uniform, hazard rate, half-normal and polynomial) with different adjustment factors of *Distance* models were tried. The best model for each of the categories was selected based on *akaike* information criterion (AIC) value. Model with minimum AIC was selected for each of the categories, and are presented in the results.

Table 1 presents the estimates of density and abundance for the three primate species in the study area. The result reveals that Baboon was the most sighted with a total number of 178 sightings after a survey efforts of 96km. This was followed by Tantalus monkey, with 152 sightings. Of the three species, Patas monkey was the least sighted with a total of 90 sightings. The mean encounter rates (MERs) for the three species were 1.85 km^{-1} , 0.94 km^{-1} and 1.58 km^{-1} for Baboon, Patas monkey and Tantalus monkey respectively. Baboon has the highest estimated density of about 12 km^{-2} . The estimated density of Tantalus monkey in the study area is 11 km^{-2} .

Table 1. Estimates of density and abundance of primate species in Sambisa game reserve

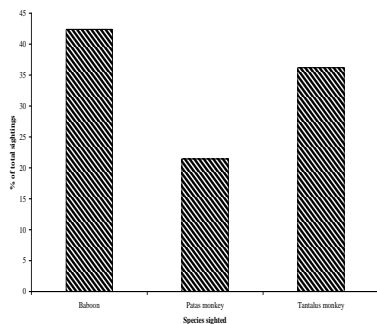
Species	n	% of total sightings	N	MER	Dkm ⁻²	CI	AIC
Baboon	178	42.38	6399	1.85	12.35	7.45-20.49	1553.7
Patas monkey	90	21.43	2541	0.94	7.39	4.12-13.26	800.83
Tantalus monkey	153	36.19	4528	1.58	11.13	3.97-10.84	1321.6
Total	421	100	13468	4.37	30.87		

N.B: n = observation; N = estimated abundance; MER = mean encounter rate (nkm⁻¹); D = density; CI = confidence interval; AIC = akaikie information criterion

Table 2. Densities of primate species during morning and afternoon surveys in Sambisa game reserve

Species	Morning			Afternoon		
	N	MER (nkm ⁻¹)	Dkm ⁻²	n	MER (nkm ⁻¹)	Dkm ⁻²
Baboon	110	1.15	7.51	68	0.71	4.48
Patas monkey	55	0.76	4.51	35	0.49	2.91
Tantalus monkey	85	0.54	3.55	67	0.43	0.16

N.B: n = observation; MER = mean encounter rate (nkm⁻¹); D = density

**Figure 2. The proportion of each of the three primate species sighted in the study area**

In table 2 the results of sightings for the three primate species during morning and afternoon surveys is presented. The result for baboons shows that 110 and 68 animals were sighted during the early day hours and at late afternoon respectively. For the Patas monkey, 55 and 35 sightings were made during the morning afternoon surveys respectively. The result for the Tantalus monkey reveals that 85 and 67 sightings were made during the surveys respectively. The results for the encounter rates and density reveal that baboon has mean encounter rates of 1.15km⁻¹ and 0.71km⁻¹ with corresponding densities of 7.51km⁻² and 4.84km⁻² during morning and afternoon surveys respectively. With respect to the Patas monkey, the mean encounter rates were 0.76km⁻¹ and 0.49km⁻¹ with corresponding densities of 4.51km⁻² and 2.91⁻² for the surveys respectively. Tantalus monkey during morning and afternoon surveys were 0.54km⁻¹ and 0.43⁻¹ with corresponding density of 3.55km⁻² and 3.16km⁻² respectively.

The relative density for the three primate species across the four ranges in the study area are presented in Table 3. There was no baboon sighted in *Balda* range. A total of 2 sightings were recorded in *Jeltere* range, 119 sightings were recorded in *Kwada* range. A total of 57 baboons were sighted in the *Yuwe* range. No Patas monkey was sighted in *Kwada* and *Yuwe* ranges of the game reserve. A total of 12 Patas monkeys were recorded in *Balda* range while 78 individuals were recorded in *Jeltere* range of the game reserve. Tantalus monkeys were present in all the four ranges of the game reserve. A total of 21 Tantalus monkey were sighted in the *Balda* range. Only 11 sightings were recorded in the *Jeltere* range. A total of 40 and 80 sightings were recorded for Tantalus monkey in *Kwada* and *Yuwe* ranges respectively.

Baboon was not encountered in *Balda* range. Similarly, Patas monkey was not sighted in the *Kwada* and *Yuwe* ranges of the game reserve. Baboon has mean encounter rates (MERs) of 0.17, 2.48 and 1.58 in *Jeltere*, *Kwada* and *Yuwe* ranges of the reserve respectively. With respect to Patas monkey, the mean encounter rates (MERs) were 0.50km⁻¹ and 1.63km⁻¹ in *Balda* and *Jeltere* ranges respectively. Tantalus monkey was present in all the four ranges with mean encounter rates of 0.58km⁻¹, 0.31km⁻¹, 1.11km⁻¹, and 1.67km⁻¹ in *Balda*, *Jeltere*, *Kwada* and *Yuwe* ranges respectively. The estimated densities of baboons were 1.07km⁻², 19.09km⁻² and 10.12km⁻² in *Jeltere*, *Kwada* and *Yuwe* ranges respectively. Patas monkey has estimated densities ranging from 2.95km⁻² and 9.60km⁻² in *Balda* and *Jeltere* ranges to none in *Kwada* and *Yuwe* ranges respectively. Tantalus monkey had estimated densities of 5.73km⁻², 2.11km⁻², 8.63km⁻² and 10.85km⁻² in *Balda*, *Jeltere*, *Kwada* and *Yuwe* respectively.

Table 4 presents the results of the analysis with respect to the sex and status of the three primate species in the study area. The result for baboon shows that, of the 178 total sightings, 107 baboons were adult female, 52 were adult male, 16 were juvenile and other 3 were sighted from a far distance, and as such could not be classified into the three known (male, female, or juvenile) categories. Out of the total of 90 individuals of sighted Patas monkey, 44 were adult females, 31 were adult male, 8 were juvenile and 7 others were sighted from far, and could not be classified. With respect to Tantalus monkey, 92 of the individual sighted were adult female, 45 were adult male, 7 were juvenile and 8 others could not be classified into the three (male, female, or juvenile) categories. Furthermore, the mean encounter rates for adult female, adult male and juvenile baboon were 1.11km⁻¹, 0.54km⁻¹ and 0.17km⁻¹ respectively. The corresponding densities for the three categories of baboons in the study area were 7.56km⁻², 3.46km⁻² and 1.24km⁻² respectively. With respect to Patas monkey, the mean encounter rates were 0.61km⁻¹, 0.43km⁻¹ and 0.12km⁻¹ with corresponding densities of 3.61km⁻², 2.54km⁻² and 0.57km⁻² for the adult female, adult male and the juvenile respectively. The mean encounter rates for adult female, adult male and the juvenile Tantalus monkeys were 0.58km⁻¹, 0.29km⁻¹ and 0.045km⁻¹ with corresponding densities of 4.12km⁻², 1.99km⁻² and 0.39km⁻² respectively.

Table 3. Relative densities of the three primate species across the four ranges in Sambisa game reserve

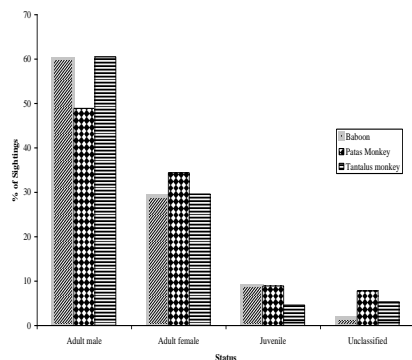
species Range	Baboon			Patas monkey			Tantulus monkey		
	n	MER	Dkm ⁻²	n	MER	Dkm ⁻²	n	MER	Dkm ⁻²
Balda	ns	-	-	12	0.50	2.95	21	0.58	5.73
Jeltere	2	0.17	1.07	78	1.63	9.60	11	0.31	2.11
Kwada	119	2.48	19.09	ns	-	-	40	1.11	8.63
Yuwe	57	1.57	10.12	ns	-	-	80	1.67	10.85
Total	178	4.45	30.28	90	1.68	12.55	152	3.67	27.32

N.B: n = observation; MER = mean encounter rate (nkm⁻¹); D = density

Table 4. Populations structure of the three primate species in Sambisa game reserve

species Sex	Baboon			Patas monkey			Tantulus monkey		
	n	MER	Dkm ⁻²	n	MER	Dkm ⁻²	n	MER	Dkm ⁻²
Female (adult)	107	1.11	7.56	44	0.61	3.61	92	0.58	4.12
Male (adult)	52	0.54	3.46	31	0.43	2.54	45	0.29	1.99
Juvenile	16	0.17	1.24	8	0.12	0.57	7	0.045	0.39
Unidentified	3	0.21	0.19	7	0.097	0.57	8	0.051	0.33

N.B: n = observation; MER = mean encounter rate (nkm⁻¹); D = density

**Figure 3. Compositions of the three primate species in the study area**

Discussion

Transect data on primate abundance in Sambisa Game Reserve were analysed with *DISTANCE* software to estimate density by fitting several possible methods. Group density estimates were obtained using either the hazard rate or half-normal models with a cosine adjustment (Buckland *et al.*, 1993). In this study, different data analyzing protocols of the line transect method were tested. *DISTANCE* selects the model that best fits to the data according to the Akaike's Information Criterion (AIC) (Buckland *et al.*, 2001). The aggregate population densities of Baboon, Tantalus and Red patas monkeys were 12.35, 11.13 and 7.39 individual km⁻² respectively. A similar pattern was obtained for whole groups; the overall group density for Baboon was more than double than that of Red Patas monkey, and almost twice of Tantalus monkey. This indicates that the mean encountered rate per kilometer (km⁻¹) walked for the 3 primate species in the study area was approximately 2, 2 and 1 for Baboon, Tantalus and patas monkeys respectively. The pattern of primate species densities for morning and evening count compared revealed a significant difference. The result suggests less activity in the evening for all the 3 primate species in the study area. This

variation in density estimates for diurnal and nocturnal primate could be caused by different factors. One factor could be that nocturnal monkeys spend much of their time silent and motionless; they can easily go undetected unless the observer relies on a visual search image (Defler and Pintor, 1985). Another possible factor could be the influence of moonlight on behaviour has been well documented for many nocturnal mammals, including primates. The populations of primate species in the 4 ranges are unevenly distributed. The overall result remains significantly lower in *Balda* range. The direction is not the same for all the species: abundance of both Baboon and Tantalus monkey is clearly high in *Kwada* and *yuwe* range while patas monkey has higher abundance in *Jeltere*. The diversity of primates in Sambisa Game Reserve is distributed throughout the reserve within a wide range of habitat types. The area with the highest primate species was found to be at reserve centre where habitat disturbances were minimal. These apes inhabit a wide range of habitat in primary forest traversed by the *Kwada* stream. In *Jeltere* range habitat for primate survival is under threats. Habitat loss and habitat degradation in the area were principally due to illegal logging, forest fires and forest clearance for agriculture. The trends of habitat disturbances were as a result of communities' settlement at the buffer zone of that part of the reserve. Carlos and Erwin (2004), noted that forest disturbance results in making patches and changing the tree composition and structure of the forest. The abundance and size of canopy gaps are increased and the proportion of larger trees is reduced. This is a real problem to many primate species, which are completely arboreal and might result in isolation of primate populations. This in turn will result in a loss of genetic variability due to genetic drift and inbreeding depression making all these populations more vulnerable to extinction. The floristic composition, and resulting spatial and temporal abundance of food resources, may have a large effect on the abundance and ranging ecology of primates (Felton *et al.*,

2003). The population structure of the 3 primate species sighted in this study suggests that the number of adult females is greater than male adults and juveniles with the lowest ratio. This structure suggests declining population as number of juveniles is relatively lower than adult population. One of the reasons why adult females have the highest population might be due to nature of primate social structure. The olive baboon lives in groups of 15–150, made up of a few males, many females, and their young, (Cawthon 2006).

Conclusion

The study on the diversity and abundance of primate in Sambisa Game Reserve provides secondary data that could serve for future studies. The species relative ecology that incorporate data on land use and social parameters, in term of income of the local people and hunting pressure in Sambisa game reserve might explain distribution patterns better in the threatened Sudan savannah forests. The higher density of primates distributed at Kwada and Yuwe range could be partly explained by the Kwada steam drainage and higher productivity of these sites. The floristic composition, and resulting spatial and temporal abundance of food resources, may have a large effect on the abundance and ranging ecology of primates at the reserves' area. Despite the declining trend of juvenile and male adult primate species within their population structure, a threshold level has not been reached. Hence, with adequate protection against poaching, reduction of predators as well as proper habitat management can restore balance in the structure. Nevertheless, the highest number of female adults can sustain optimum population structure if they are within the breeding age. The most abundant primate species sighted in Sambisa Game Reserve was Tantalus monkey and it occurred in all the ranges.

References

Agboola, S. A. (1987). *Agricultural Atlas of Nigeria*. Oxford University Press. London, UK.

Ajayi, S. S. (1981). A Survey of Wildlife in Kwainibana Game Reserve, Nigeria. *Afri. Journal of Ecol.* Vol. 19(3): 295.

Bawdeen, M. G. (1972). *Physiography in Atchinson et al (Eds). The Land Resource of North Eastern Nigeria, Vol. 1. The Environmental Survey England*, pp 43-155.

Buckland, S. T., Anderson D. R., Burnham K.P. and Laake J. L. (1993). *Distance Sampling: Estimating Abundance of Biological Populations*. Reprinted 1999 By RUWPA, University of St. Andrews, Scotland.

Buckland, S. T., Anderson D. R., Burnham K.P., Laake J. L. and Thomas L. (2001). *Introduction to Distance Sampling: Estimating Abundance of Biological Population*. Oxford University Press, New York.

Caro, I. D. M. and Klinkenberg K. (1972). *The Land Resources of North Eastern Nigeria. Vol. 1. The Environment Survey*, England.

Carlos, A. and Erwin P. (2004). *Primate Population Densities in three Nutrient poor Amazonian Terra Firme of South Eastern Colombia*. School of Environmental Sciences, University of East Anglia, Norwich, UK.

Cawlinshaw G. and Dambar R. (2000). *Primate Conservation Biology*, University of Chicogo Press. (An Excellent Reference for Primate Conservation with many Specific Examples of Primate Communities around the World).

Cawthon, L. K. A. (2006). "Primate Factsheets: Olive Baboon (*Papio anubis*) Behaviour".

Defler, R. T. and Pintor D. (1985). *Censusing Primates by Transect in a Forest of known Primate Density*. *htt. J. primatol.*, 6:243-259.

Faniran H. and Ojo, (1980), *Man's Physical Environment*

Felton, A., L. Engstrom, Felton, E. A. and C. Knott (2003). "Orangutan Population Density, Forest Structure and Fruit Availability in Hand-Logged and Unlogged Peat Swamp Forests in West Kalimantan, Indonesia." *Biological Conservation*, 114(1): 91-101.

Ibrahim, A. and B. Bawa 2012 *Analysis of Awareness and Adaptation to Climate Change among Farmers in the Sahel Savannah Agro-ecological Zone of Borno State*

Lawton, J. H. (1995). *Population Dynamic Principles. Extinction Rates* (ed. by J.H. Lawton and R.M. May), pp. 147–163. Oxford University Press, Oxford.

Mittermeier, R. A. (1987). *Effects of Hunting on Rain Forest Primates*. In Marsh, C. W., and Mittermeier, R. A. (eds.), *Primate Conservation in the Tropical Rain Forest*. A. R. Liss, Inc., New York, USA, pp. 109–146.

MAFR, (1997). *Ministry of Animal and Forest Resources, Sambisa Game Reserve a Haven*

Oates, J. F., Abedi-Lartey, M., Scott McGraw, W., Struhsaker, T. T., and Whitesides, G. H. (2000). *Extinction of a West African Red Colobus Monkey*. *Conserv. Biol.* 14(5): 1526–1532.

Rebecca, S. G. and Brigida A. R. (2004). *Distance Sampling for Density Estimation*. 9th National Convention on Statistics (NCS) EDSA Shangri Hotel.

Walsh, P.D. and White, L.J.T. (1999). *What it will Take to Monitor Forest Elephant* *Biology* 13: 1194-1202.

Yvonne, A., de Jong and Butynski, T. M. (2009). *Eastern Africa Primate Diversity and Conservation Program, Nanyuki, Kenya. Report to the Critical Ecosystem Partnership Fund* March, 2009.