

# Preliminary Study of the Population Density of Mona Monkeys (*Cercopithecus mona*) in Omo Forest Reserve

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## Abstract

In the last 40 years, threats to the survival of wild primate population have greatly increased. Globally, primate population is severely threatened with extinction especially due to habitat loss from conversion of forest areas to farmland and/or unsustainable logging. There is paucity of information on the population density and abundance of Mona monkeys in Omo Forest Reserve. The population density and distribution of Mona monkeys were conducted in two forest blocks of Omo Forest Reserve (OFR). The objective of the study therefore, is to determine the population density and distribution of Mona monkey, and ascertain the presence of other primate species in sympatric relationship with the monkey. The line transect sampling method was used for the enumeration. Data were collected from seven (7) transects randomly selected from two forest blocks; the Elephant Sanctuary (4) and the Strict Nature Reserve (3). Other primate species were considered to be sympatric with Mona monkeys if they were encountered within 20 m proximity range with the target species. Data on threat of human activities were collected in Omo Forest Reserve based on four major categories (Hunting/Poaching, Logging, Farming, and Collection of Non-Timber Forest Products). Analysis was carried out using IBM SPSS Statistics 20 to determine population density estimate and the relative density in the two forest blocks. The field work took 30 days each, in September, 2015 and March 2016 that covered both seasons. Results revealed that a total number of 57 Mona monkeys with density of 0.44 km<sup>-2</sup> in the entire reserve were sighted during the survey. The relative density across the two forest blocks surveyed in the forest reserve revealed that Mona monkeys were present in both the Elephant Sanctuary (ES) (n = 42) and Strict Nature Reserve (SNR) (n = 15) with density of 0.27 km<sup>-2</sup> and 0.18 km<sup>-2</sup>, respectively. The species were observed to be more active during morning sur-

veys than in the evening surveys, with densities of  $0.77 \text{ km}^{-2}$  and  $0.4 \text{ km}^{-2}$  recorded, respectively. The mean encounter rates for the species were  $3.31 \text{ km}^{-1}$  and  $1.5 \text{ km}^{-1}$  for morning and evening surveys, respectively.

## Keywords

Population Density, Mona Monkey, Primates, Sympatry, Anthropogenic Activities, Omo Forest Reserve

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## 1. Introduction

Mona monkeys are small to medium sized old world monkeys that live in groups of more than 30 [1]. The Nigeria Mona monkeys are endemic to Nigeria and Cameroon and maintain the least concern category on the IUCN red list [2] [3]. Nigeria has the last great community of Mona monkeys in Africa and the world at large [4] and as a result has become the centre of a number of researches. Knowledge on the species population in the country is limited and basically anecdotal. This species has not been studied extensively and available literatures are on its time budget [5], group size and composition [6] [7] [8] and [9] and its density in Afi Mountain [10]. There is a paucity of information on the population density of Mona monkeys in Omo Forest Reserve. This study therefore provides baseline scientific information on the population density of Mona monkeys in Omo Forest Reserve. Information on the density of Mona monkeys is very vital as it will guide natural resource managers in decision making and potential economic gains from ecotourism.

Globally, primate populations are confronted with the challenge of coping with changing habitat as they must continue to adapt to a continually changing habitat. In Nigeria, the population of primates is confronted with a myriad of problems as a result of human activities [11]. The rate of deforestation in Nigeria is about 3.5% per year [12]. This translates to a loss of 350,000 - 400,000 ha of forest land per year. Recent studies show the remainder forests occupy 923,767  $\text{km}^2$  or about 10 million ha. This is about 10% of Nigeria's forest land area and well below FAO's recommended national minimum of 25% [12]. The ultimate cause of forest destruction is the explosive human population growth. Other causes include conversion for agriculture, logging, and fire wood gathering etc. The habitat range of many primates in Nigeria has been depleted especially due to agriculture. This has affected, to a great extent primate population, leaving only isolated populations in fragmented forests. Logging is another driver of habitat loss. The intensity of timber exploitation in tropical forests has greatly increased and is impacting on forest-dependent vertebrates. The impact is varied, ranging from loss of habitat and food resources to isolation of population and declining population [13]. Johns and Skorupa [14] noted that of the 38 tropical primate species they considered, 71% declined after logging, while 22% increased and 6.7% were apparently unaffected.

A very dynamic habitat is not the only challenge primates have to confront; they are also hunted, mostly illegally, as bushmeat and pets by humans. Poaching feeds the bushmeat industry and it is arguably the foremost threat to primate existence [15] [16]. In the west and central African forest zone, subsistence hunting is increasingly supplemented by hunting for cash income. Commercial hunting can relatively quickly deplete populations of large-bodied, slow-reproducing game species, such as anthropoid primates, which are typically among the most commonly captured prey in the African forest zone [17]. Primates are also captured live to supply the live pet trade. Mona monkeys are extensively poached, served at local restaurants and sometimes traded as pets in the southwestern part of Nigeria.

Omo Biosphere Reserve, which derives its name from River Omo that traverses it, is located north of Sunmoge in the Ijebu area of Ogun State, southwestern Nigeria. The reserve is very diverse having the richest species of butterflies in Africa, high richness of birds and mammal diversity [18]. A study by BRAAF (1999) asserts that there are four primate species in the reserve and these include Potto (*Perrodictitus potto*), Demidoff's galago (*Galagoides demidovii*), Mona monkeys (*Cercopithecus mona*) and Red Capped Mangabey (*Cerocebus torquatus*). However, the study recorded the presence of the last three during the time of survey. Five hundred and four plant species were encountered during the biodiversity inventory [19]. Of the 504 species, 245 species were trees, 71 shrubs, 118 herbs, 50 climbers and 20 climbing shrubs and lianas. 29 species of orchids, 28 species of Pteridophytes, 27 species of Bryophytes, 17 species of fungi (mushroom) and 3 species of lichens were inventoried during the biodiversity survey. The reserve has a wide range of forest habitat that is highly threatened by different levels of anthropogenic and natural activities. Timber exploitation, establishment of monoculture stands of tree crops, clearance for cultivation and gap formation, created by wind throw, snapping, branch fall and standing dead trees, within the reserve have seriously altered the forest structure, species composition and the habitat. The forest has been severely cleared for the *Gmelina arborea* plantation to supply the Iwopin pulp/paper factory. Also portions of the forest are also cleared for the cultivation of plantain, kola, cocoa and other cash crops. All of these results in habitat fragmentation which can limit the range of primates or cause a decline in the primate abundance.

Primate population monitoring is important for a number of reasons. A biologist may, for example, need to assess the status of a threatened species or the progress of a recovery program for that species. Also, the population of a primate species may be an actual or potential pest capable of causing agricultural, property, or natural resource damage or of posing a human or livestock disease or safety hazard. Furthermore, a biologist may want to determine the abundance, distribution and/or diversity of primate species and to monitor changes in these over time. Whatever the reasons may be, results from population monitoring inform natural resource managers on management practices for primates and their habitat. A large array of methods has been developed and used to

monitor wildlife population [20] [21] [22] but the distance sampling method (line transect survey) is widely used for estimating abundance of primate population [23] [24].

## 2. Materials and Methods

### 2.1. Study Area

Omo Biosphere Reserve is located north of Sunmoge, between latitudes 6°35' to 7°05'N and 4°19' to 4°40'E in the Ijebu area of Ogun State in southwestern Nigeria. The Reserve was constituted in 1925 as part of a bigger Shasha Forest Reserve. Shasha was later split into Omo, Oluwa and Shasha Forest Reserves, the last two lying to the east and north-east of the present Omo. To the north and north-west of the Reserve are Ife and Ago-Owu, and Oshun Forest Reserves, respectively. The records of mammals from reconnaissance survey transect and other survey work are evidence (Figure 1). Omo covers about 130,500 hectares, which includes a 460 ha Strict Nature Reserve [25]. Omo Biosphere Reserve derives its name from the River Omo that transverses it.

The Reserve is in the mixed moist, semi-evergreen rainforest zone, in the Congolian sub-unit of the Guinea-Congolian Centre of Endemism or Phytochorion [18] [26]. The Guinea-Congolian zone is extremely rich in species and has very high levels of endemism. The northern part of Omo Biosphere Reserve is, considering the north-south length, relatively dry forest. Five hundred and four plant species were encountered during a biodiversity inventory [19]. The most common tree species include *Diospyros* spp., *Strombosia pustulata*, *Rinorea dentata*, *Voacanga africana* and *Drypetes* spp. Other tree species include *Khaya ivorensis*, *Cordia millenii*, *Sterculia* sp., *Nauclea diderrichii*, *Mansonia altissima*, *Terminalia* sp., *Celtis* sp., *Brachystegia* sp., *Alstonia congensis* and *Milicia excelsa*.



**Figure 1.** Map of the study area showing waypoint records of mammals from recce transects (light blue) and other survey work (dark blue).

Forty-two mammals and 15 reptiles can be found in the reserve. There are 110 avian species in 38 families. The Accipitidae, Columbidae and Esterildidae contained more than 20% of all the species in the reserve. The Blue Headed Wood Dove is most abundant in the core while the Green Frutt Pigeon is most abundant in the taungya farms. Some of the wildlife species in the reserve include Forest Elephant (*Loxodonta cyclotis*), White throated monkey (*Carcopithecus albogularis*), Red-river hog (*Potamochoerus porcus*), Duiker (*Cephalopus* spp.), Small spotted genet cat (*Genetta genetta*), Civet cat (*Viverra civetta*), Brush-tailed porcupine (*Atherurus africanus*), Pangolin (*Manis* spp.).

## 2.2. Reconnaissance Survey

A reconnaissance survey was conducted to establish the distribution of primate species and to locate appropriate positions where transects would be laid. Information on population density was gathered from the forest guard and hunters. Existing trails were walked during the reconnaissance survey. The survey revealed that the distribution of primates within the reserve was more in the forested areas of Erin camp where two species of primates were sighted. Another revelation was that primates were not present in areas with high anthropogenic activities. The survey noted the forest structure nature of streams and human disturbances in the forest. The vegetation type is typical of a rainforest as tree canopy is dense in the undisturbed region.

## 2.3. Methods of Data Collection

The line transects method was used in this study to obtain the relative density of primates [27]. The following assumptions were made while using the line transect technique in surveying Mona monkeys

- 1) All Mona monkeys on the transect are certainly detected
- 2) Mona monkeys do not move away from transect before detection
- 3) The measurement of distances are exact and that the location of Mona monkeys are independent of transects [28]

Line transects, which is a distance sampling technique was used to collect distance data for this survey. It is the main method of surveying diurnal primates because it is relatively simple, rapid, cost effective, accurate and quite precise [29].

## 2.4. Field Procedure for Ecological Data Collection

A total of seven line transects were used. Four (4) lines transect were laid in the Elephant sanctuary and three (3) were laid in the Strict Nature Reserve (SNR) which make up the forest blocks of Omo Biosphere reserve. Each transect was labelled with a special number. Transects were 2 km long and 1 km apart. The starting point for each transect was randomly selected and the coordinates was taken with a GPS.

Survey for direct observation of primates was done in the morning and in the evening. Morning survey started at 07:00 am - 11:00 am while evening survey

began 03:00 pm - 06:00 pm. Transects was walked at a speed of  $1.5 \text{ kmh}^{-1}$  as recommended by White and Edwards [30]. Ten minutes pause was taken after every 100 metre walk in order to increase the chances of detecting Mona monkeys which may hide or flee when approached [31]. At the start of the transect walk all required fields on the data sheet such as, name of transects, coordinates and date of observation were recorded. During transect walk, any sighting of primates, their calls and their food crumbs was recorded. Parameters recorded include the name of the species, time the species was sighted, estimated number of individuals, perpendicular distance and sighting distance. Transect lines were surveyed twice (morning and evening) each and were repeated every two weeks for four weeks. A total of 56 km was walked during the survey. Primate species sighted within 20 m of Mona monkeys sighting were also recorded and individual Mona monkey was considered a member of on group when it was sighted within 20 m of a troop [32]. Signs of human activities in these forests reserves were widespread and frequent. The distribution of signs of logging, farming, hunting and the gathering of non-timber forest products (NTFP) were recorded on transects. Surprisingly, the largest number of human signs per km were found on the western Omo transects. We also encountered more farms and settlements scattered through the forest in western Omo than in the other continuous forest areas. On the other hand, the highest frequency of signs was in Oluwa, where encountered more hunters on foot and bicycles in the forest. The average rate of encounter with human signs on all transects (1.29 per km) was very similar to the rate of encounter with signs of mammals (1.35 per km). The field survey took 30 days each in September, 2015 and March, 2016. Ten Game-guards and 5 forest guards were recruited for this survey.

## 2.5. Data Analysis

Data obtained during this study were analysed for density ( $\text{km}^{-2}$ ), Mean Encounter Rate (MER) and percentage sighting. T-test was used to compare the density and MER of the primate species encountered during the study. The software Microsoft Excel (2016) and IBM SPSS Statistics 20 were used to facilitate all the computations and plotting needed in the analysis. The T-test estimator is given as follows

$$t = \frac{X_A - X_B}{SX_A - X_B}$$

where,

$$SX_A - X_B = \sqrt{\frac{S_A^2}{n_A} + \frac{S_B^2}{n_B}}$$

## 3. Results

### 3.1. Estimates of Density of Mona Monkey in Omo Forest Reserve

**Table 1** presents the estimates of density as well as the mean encounter rates of Mona monkeys in Omo forests reserve. A total of 57 sightings were made for

**Table 1.** Estimated density of Mona monkeys.

Species	N	MER	Dkm <sup>-2</sup>
Mona monkey	57	3.11	0.44

Mona monkeys during the survey. The study shows that the density of Mona monkeys is 0.44 km<sup>-2</sup>. The mean encounter rates (MERs) for Mona monkeys is 3.11 km<sup>-1</sup>. The MER implies the likely number of individual species that can be sighted per kilometre during transect walk or survey in the area.

### 3.2. Densities of Mona Monkey during Morning and Evening Surveys

**Table 1** and **Table 2** present the results of sightings for Mona monkeys during morning and evening surveys. The results show that for Mona monkeys, the MERs was 3.31 km<sup>-1</sup> and 1.5 km<sup>-1</sup> with a corresponding density of 0.77 km<sup>-2</sup> and 0.4 km<sup>-2</sup> for morning and evening survey respectively.

### 3.3. Relative Density of Mona Monkeys across the Two Forest Blocks

The relative density of Mona monkeys across the study sites is presented in **Table 3**. Mona monkeys were sighted in both forest blocks, either in Elephant sanctuary (ES) and the strict nature reserve (SNR). A total of 42 sightings of Mona monkeys were recorded in the Elephant sanctuary. In the strict nature reserve, a total of 15 sightings of Mona monkeys were recorded. The density of Mona monkeys in ES is 0.27 km<sup>-2</sup> while in SNR, it is 0.18 km<sup>-2</sup>

## 4. Discussion

Information on species density and distribution is very important to understanding their significance in the ecosystem and their importance in tourism development [31]. Information on population distribution is also important in identifying and evaluating conservation hotspots, significant presence of the species (**Figure 2**), ecotourism potential, the nature and extent human-wildlife conflicts, and sustainable harvesting by local communities [33]. The population density and distribution of Mona monkeys in Omo Forest Reserve were found to vary across the two forest ranges (ES and SNR) (**Table 4**), which is distributed within remaining natural forest (dark green) in the target reserve as indicated in satellite imagery (**Figure 4**). The highest population of Mona monkeys was encountered in the Elephant Sanctuary (ES) of the forest reserve with 42 sightings at an average of 0.27 encounter rate and density of 0.23/km<sup>2</sup>. A total of 15 sightings of Mona monkeys with an average of 0.17 encounter rate and 0.18/km<sup>2</sup> were recorded (**Table 5**) in the Strict Nature Reserve (SNR). The high presence of Mona monkeys in the ES could be connected to the active presence of forest patrol officials. This suggests the ES is better protected from anthropogenic activities such as poaching and illegal logging, thereby boosting the population of

**Table 2.** Densities of the primate species during morning and evening surveys.

Species	Evening				Morning	
	N	MER (nkm <sup>-1</sup> )	Dkm <sup>-2</sup>	n	MER (nkm <sup>-1</sup> )	Dkm <sup>-2</sup>
Mona monkeys	53	3.31	0.77	4	1.5	0.4

**Table 3.** Relative density of Mona monkeys across the ranges.

Range	N	MER (nkm <sup>-1</sup> )	Dkm <sup>-2</sup>
Elephant Sanctuary	42	0.27	0.23
Strict Nature Reserve	15	0.17	0.18

**Table 4.** Areas of surveyed reserved and areas of natural forest in the reserve.

S/No	Forest Reserve	Reserve Area (km <sup>2</sup> )	Natural Forest Area (km <sup>2</sup> )	Percent of Reserve Under Natural forest
1	OMo	1,325	381.2	28.8
2	Oluwa	827	347.9	42.1
3	Shasha	309	240.8	77.8
4	Ago-owu	240	79.4	33.1
5	Ife	142	75.8	53.2

**Table 5.** Human activities records from recce transects.

Human activities	Western Omo			Shasha R. Oni R			Oluwa F.R.		
	No.	no. per	No per	No	No per	No per	No	No per	No per
		Recce	km		Recce	km		Recce	Recc
Farming	10	1.11	0.22	2	0.33	0.07	9	1.29	0.26
Hunting	15	1.67	0.33	3	0.50	0.10	17	2.43	0.49
Logging	33	3.67	0.73	13	2.17	0.43	19	2.71	0.54
NTFP	6	0.67	0.13	1	0.17	0.03	3	0.43	0.09
gathering camps	7	0.78	0.16	2	0.33	0.07	2	0.29	0.06
TOTAL SIGNS	71	7.89	1.58	21	3.50	0.70	50	7.14	1.43

**KEY:** Farming = crops, clearing, bush burning, hunting = carbide, cartridge, gunshot, logging = loggers, trucks, recently felled trees, Non-timber forest products (NTFP) = gathering of chewing sticks, sanda sticks, and others: Camps = shelters, and signs of human occupation such as buckets, used toiletries and so on.

Mona monkeys in this range and also anthropogenic degradation of Gmelina plantation, (Figures 3-5). The lower density of Mona monkeys in the SNR can be partly attributed to the infrequent patrol of forest guards in that forest block. During this survey, many spent cartridges were observed and several gunshots heard in the SNR. This is consistent with submission of [34] that habitat disturbance affected the distribution of White Throated Monkeys in Okomu National

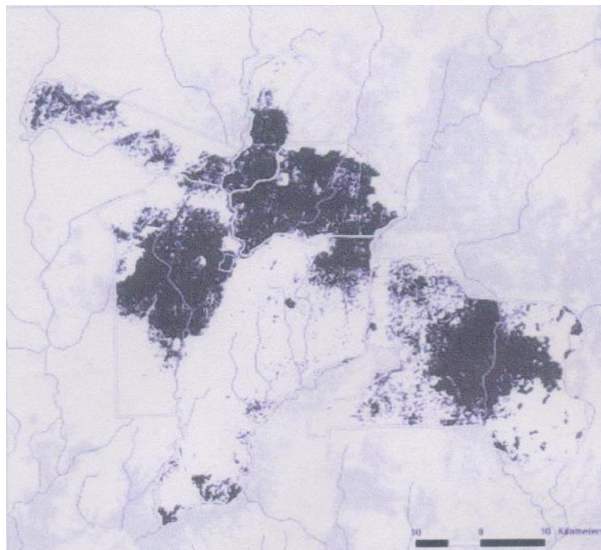




**Figure 2.** Elephant dung, Omo Forest Reserve.



**Figure 3.** “Sanda” stick gathering and processing, Omo Forest Reserve.



**Figure 4.** Distribution of remaining natural forest (dark green) in the target reserve (satellite imagery).



**Figure 5.** Degraded Gmelina plantation, Omo Forest Reserve.

Park. Moreover, the species is quite affected by habitat destruction and hunting for bushmeat, it appears that the species can adapt well to secondary habitats and as a result remains common in the ES section of Omo forest reserve [35].

## 5. Conclusion

The study on the density and distribution of Mona monkeys shows that there are populations of the monkey in the two forest blocks of Omo forest reserve (**Table 4**). The result of the study provides a valuable basis for future studies on the species' behavioural ecology including data on habitat fragmentation, land use, hunting pressure which will better explain distribution patterns. The higher density of Mona monkey in the ES than the SNR can be partly explained by the frequent presence of anti-poaching patrol officers in the ES. Secondly, though the species is quite affected by habitat destruction and hunting for bushmeat, it appears that the species can adapt well to the secondary habitats and as a result remains common in the ES section of Omo forest reserve. The proximity of human activities in the buffer zone of the SNR underlines the species' low density in that forest block of the SNR (**Figure 3** and **Figure 5**). The study shows the presence of Mona monkey in the Forest reserve; the reserve is however still under anthropogenic threats (**Table 5**). In order to encourage higher population of the species in the sanctuary, adequate conservation and management of plant and soil ecosystem should be improved as the habitat resources continue to serve as sources of food, cover and breeding spaces for the species population that inhabits the protected area. The Red capped mangabey was the only species observed to be sympatric with Mona monkeys. The two primate species were found to occur in overlapping ranges in both forest blocks of the reserve. Omo reserve is gradually being encroached by the surrounding communities and migrant settlers due to quest for agricultural expansion and demand for firewood. It is obvious that the rural dwellers co-existence with wildlife and negative impact is difficult to maintain due to increasing socio-economic activities of our rural population (**Table 5**). Therefore, the active participation of the local communi-

ties and public awareness about the importance of wildlife conservation range management is fundamental to establishment, development and sustenance of any protective area/park to have meaningful economic value and maintenance of stable range resources of the reserve.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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