Assessment of Population Abundance, Density and Habitat Preference of Sclater's Guenon (*Cercopithecus sclateri* Pocock 1904) in Aboh-Mbaise Communal Forest, Imo State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Aims: We assessed the population abundance, density and habitat preference of sclater's guenon (*Cercopithecus sclateri*) in Aboh-Mbaise communal forest to inform conservation efforts for the species now and in the future.
Study Design: We used the point count sampling method to estimate population size.
Place and duration of study: The study was carried out in Lagwa communal forest, Aboh-Mbaise Local Government Area, Imo State, between December 2019 and November 2021.
Methodology: We laid-out eight 2.5-km transects in a land area of 28,500km^2. We enumerated and measured trees using the point-centered quarter method.
Results: Results of this study indicated that they were 738 individual monkeys, 392 in dry and 346 in the wet seasons. The population density was 0.04 ± 0.01 individuals/km^2, with troop sizes of 4.09 ± 0.83 and 3.68 ± 0.75 for dry and wet seasons, respectively. The monkeys were sighted mostly in secondary forest, sacred groves, and economic trees. Most of the trees were within the diameter-at-breast-height class of 21cm-30 cm. A total of (304) plant species were used by the monkeys for cover in both seasons; these included *Dacryodes edulis*, *Elaeis guinensis*, *Magnifera indica*, *Treculia africana* and *Pterocarpus erinaceous*.

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> **Conclusion**: The findings of this research is a prelude to understanding the population dynamics and habitat structure of the sclater's guenon in the study area. Massive sensitization of the locals, regeneration of the remaining fragmented habitat and establishment of a wildlife sanctuary are needed to allow conservation of the species and its habitat.

1. INTRODUCTION

The Sclater's guenon (*Cercopithecus sclateri*) is a primate endemic to Nigeria. It is classified as endangered by the International Union for the Conservation of Nature [1] and listed on Appendix 2 of the Convention on International Trade in Endangered Species (CITES). The species was originally thought to be nearly extinct until the late 1980s. The Sclater's guenon is restricted to the rainforest on the flood plain between the Niger and Cross Rivers in southeast Nigeria [2]. Its extent of occurrence is 28,500km^2 [3]. Much of the remaining forest throughout the species' range comprises small, often degraded forest fragments within a largely agricultural landscape, swampy areas difficult to farm, or strips of forest along waterways.

Three populations of Sclater's guenon survive in mostly deforested communities where the local human population regards this mo-key as sacred. Although they are not hunted in these sites, the monkeys' sacred status does not necessarily guarantee their long-term survival. The population of this species is dwindling largely due to four factors; extremely small range, high human population where this species is found, habitat fragmentation, and hunting. The species does not occur in any officially protected areas, but three populations of the species are known to be protected by local people who consider the monkeys' sacred status.

Anthropogenic disturbance occasioned by habitat destruction, hunting, and conversion of land for agricultural use are the major threats to the survival of the Sclater's guenon, a situation which has led to the species occurring only in small and isolated patches of forests. The communal forest of Aboh-Mbaise is an important habitat for this species largely because the species is associated with shrines and sacred groves of trees in the area. Also, due to taboos associated with killing or eating the monkeys, the species is protected in this area [4].

Presently, the consequences of human-guenon conflict are very evident in the area as the guenons participate in agricultural damage, thereby causing some of the indigenous people to contemplate disregarding the taboos associated with these monkeys. The species cannot be found in any of the protected areas in Nigeria. The species is known to occur in captivity only at the Centre for Education, Rehabilitation, and Conservation of Primates and Nature (CERCOPAN) in Cross River State, Nigeria [1].

Even though the species' natural habitat is primary and secondary growth forest just like most of the other species of guenon, it is said to be surviving in extremely dissipated habitats [5]. The species preferred habitat is in Igbo villages and their sacred tree groves, which are mostly surrounded by non-native tree plantations and agricultural areas.

In one community called Lagwa in Imo State, all the patches of forest which the monkeys previously inhabited have been destroyed, leaving the animals to roam and live in villages, where food from gardens and farms is stolen by the animals [6]. Closely related species appear to prefer the lower levels of the canopy and sometimes come to the ground [7].

Small populations numbering eleven have been confirmed to exist in states such as Akwa Ibom, Enugu, Imo, Abia and Cross River State. The localities known for this species include Utuma, Stubbs creek, Akpugoeze, Osomari, Lagwa, Blue River, Enyong creek/Ikpa River [8].

The study evaluates the population abundance, density, and habitat preference of sclater's guenons in the area of study to inform conservation efforts for the species now and in the future.

2. METHODOLOGY

2.1 Study Area

The study was carried out in Lagwa community forest of Aboh-Mbaise Local Government Area in Imo State (Fig. 1). The land area of Aboh-Mbaise is about 184km^2, and lies between latitude 6°50'E and 7°25'E N and longitude 4°45'N and 7°15'N. Its annual rainfall is about 2,297mm.

Aboh-Mbaise had a population of 195,652 according to the 2006 census.

Lagwa is one of the twelve council wards and the largest traditional community in Aboh-Mbaise local government area. Comprising eight communities of Umunikwu, Umuabazu, Umunoke, Umunokere, Eziudo, Obo, Okwuato and Umuosi, people have been living here since the 15th century alongside the monkeys. Lagwa and Aboh-Mbaise people are mostly farmers and traders, cultivating and domesticating the popular non timber forest product species called Okazi (*Netum africana*). The popularity of this community in the world is due to the presence of the Sclater's guenon in the area [9].

2.2 Determination of the Population Status of the Sclater's Guenon

The point counts method of survey was used for this study. On arrival in each point, (5) minutes was allowed for the animals to settle, while (10) minutes which is the minimum time required for less mobile and visible species was used to sample guenons in each points in each of the eight communities in the study area, with between five to ten minutes spent moving from one point to another. Sampling points were taken in each of the eight communities, with the distance between points and radius from the point of detection of the species measured [10].
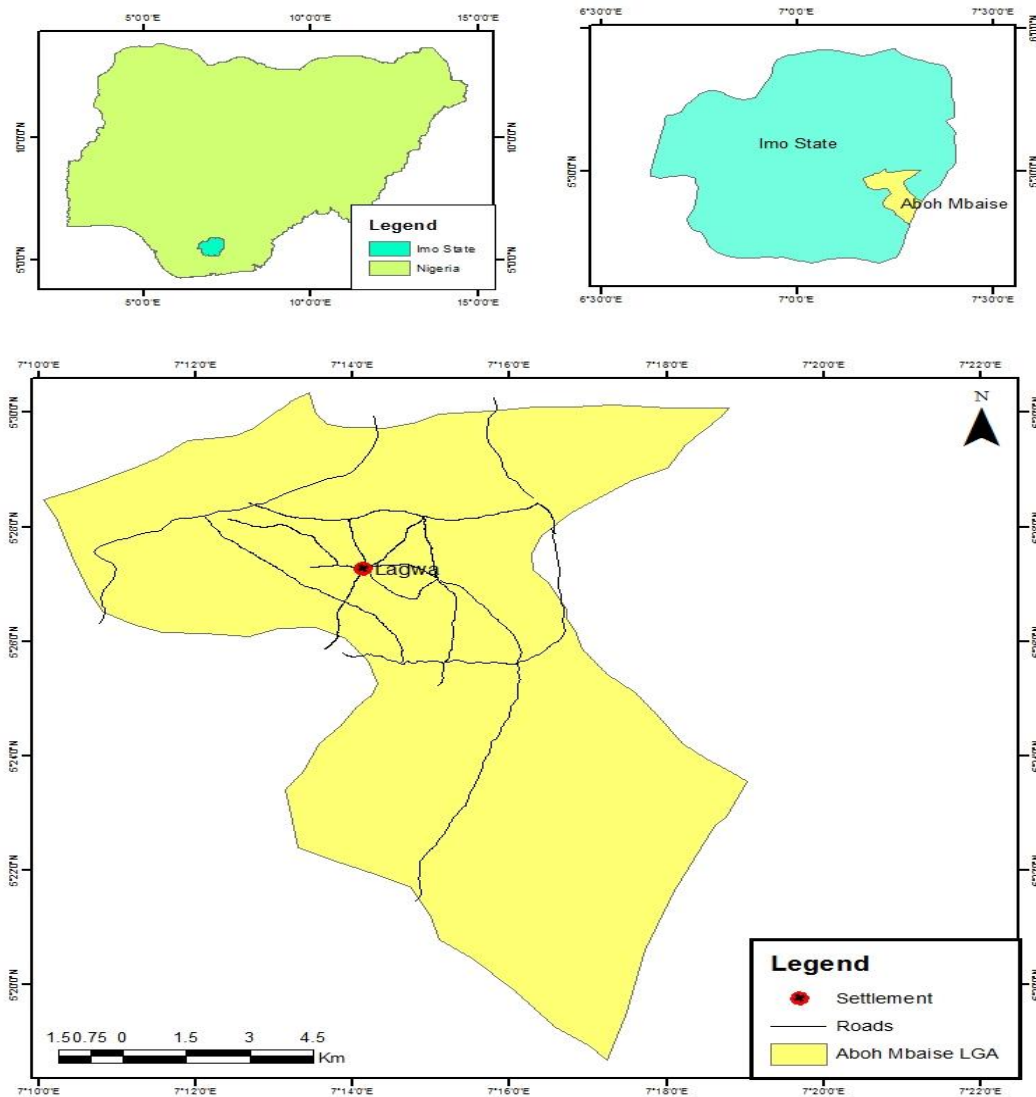
Fig.1. Map of Aboh-Mbaise showing Council Wards
(Source: Imo State Forestry Commission (Owerri)

The survey with each transect length of 2.5-km, and 160m between points, was carried out twice every month for (8) months, (4) months each (both dry and wet seasons) in each of the communities, and every (14) days per community, between 9.00 am and 4.00 pm and with the help of trained and experienced indigenes who were used as research assistants. The assistants were trained on how to use the GPS and binoculars, the census protocol and how to record data such as time, number of animals, number of groups sighted, behavioural characteristics such as feeding habits/signs, interaction with other wildlife species, and mating. Visual and sound observations encountered were recorded. The survey was avoided during rainy days, since raindrops in the forest creates unfavourable sound background for survey reducing the ability to observe animal movements, and potentially preventing the detection of the monkeys.

2.3 Determination of the Habitat Requirements of the Sclater's Guenon

The Point-Centred Quarter Method (PCQM) as described by Kevin [11] was employed to determine the relative importance of the various tree species in a community. The importance value index was determined via density, size and frequency of the species. In each of the 2.5-km transects (10) points were randomly selected, and data collected, with the smallest random number indicating the first sampling point. At every sampling point an imaginary line was drawn perpendicular to the transect, dividing it into four equal quarters. In each of the quarters, the nearest tree to the point with diameter not below 4cm, the species and the distance from the sampling point to the trunk of the tree was also recorded. The trees were identified with the help of a taxonomists to species and family levels in the study area.

2.4 Data Analysis Techniques

Density and abundance of the Sclater's monkey were estimated using the following formula.

$$Dp = NLW / A \tag{1}$$

Where: Dp: population density; number of individuals N; transect length (km) L; transect width (m) W; transect area (km^2) A; [12,13,14,15].

Troop size was estimated with the equation:
$$ANS / Ni \tag{2}$$

Where: ANS = number of animals sighted and Ni = number of observations

The importance value index for the tree species enumerated were calculated using the equations:

Relative density (RD) = density of a species / total density of all species * 100   (3)

Relative frequency (RF) = frequency of a species / total frequency of all species * 100   (4)

Relative dominance (RDO) = dominance of a species / total dominance of all species * 100 (5)

Importance value index = RD + RF + RDO   (6)

The t-test statistical analysis was used to determine whether troop sizes and troop densities differed significantly between the dry and wet seasons, and between the different locations.

3. RESULTS AND DISCUSSION

3.1 Seasonal Population Density/Troop Sizes of the Sclater's Guenon

The study revealed a population size of 738 individuals, 346 in the wet season and 392 in the dry season. The troop sizes of the monkeys was 4.09±0.83 for dry season, while observed population density was 0.04±0.01individuals/km^2 (Table 1).

Troop sizes for dry and wet seasons were 16.0 and 14,0 respectively. Though the total population of the guenons seemed high, there was a low population density of the Sclater's monkey in the study area, which was at variance with its population.

The troop sizes of the monkeys for the wet season was averaged 3.68 ± 0.75, and their density was 0.035 ± 0.007 (Table 2).

This very low population density might be a result of evident habitat decimation, land encroachment, and emigration of the species to other areas. The high number of individuals in all communities where the study was undertaken correlates with work of Lynne *et al*, [9] that reported cases of killing the guenons had negative impact on the population of the species. The high population size recorded in both seasons was also a result of the local taboo which prohibits from killing the monkeys. This population size also corroborates with Lynne and Olusegun (2007), that the guenons reproduce at early stages of their lives and survives in habitats

that are fragmented. The low density recorded may also have been due to the fact that some monkeys may have migrated to other areas or were missed during the survey period.

Though there was no significant difference in troop size for both seasons, there was however, a difference in troop density as indicated in the t-test analysis (Table 3).

The troop sizes and density were higher in the dry season than in the wet season, and may be because they was less disturbance during the dry season than the wet season, as the monkeys were more visible during the dry season. Several individuals of these species were sighted in different locations during the study, against reports from different researches that the sclater's guenons are rare and at the brink of extinction. The relatively bigger size of the guenons compared to other monkeys made the monkeys visible from a distance in all transects surveyed. The monkeys are very intelligent, and can spot and runaway from humans very quickly as reported by some hunters encountered [16]. Primates generally are important for the conservation of other species of animals, as their emotional, fascinating, and redolent nature makes them attractive to people [17]. The health of guenon population is a reflection of the general health of an ecosystem, making it an indicator species [18].

Table 1. Dry season summary population data of Sclater's monkeys in the study area

Location	Troop size	Density (Troops/KM^2)
DT$_1$	7.29	0.070
DT$_2$	6.01	0.058
DT$_3$	2.08	0.020
DT$_4$	4.59	0.044
DT$_5$	0.00	0.000
DT$_6$	2.67	0.026
DT$_7$	4.92	0.047
DT$_8$	5.13	0.049
Mean± S.E	**4.09 $\pm$ 0.83**	**0.039 $\pm$ 0.008**

DT (Dry Season Transect)

Table 2. Wet season summary population data of Sclater's monkeys in the study area

Location	Troop Size	Density (Troops/KM^2)
WT$_1$	6.29	0.054
WT$_2$	5.26	0.056
WT$_3$	4.46	0.044
WT$_4$	1.88	0.000
WT$_5$	2.13	0.039
WT$_6$	0.00	0.021
WT$_7$	4.58	0.040
WT$_8$	4.84	0.024
Mean± S. E	**3.68 $\pm$ 0.75**	**0.035 $\pm$ 0.007**

WT (Wet Season Transect)

Table 3. T-test analysis (at P =.05) for troop size and troop density

	Troop size		Troop density	
	Dry Season	Wet Season	Dry Season	Wet Season
T$_1$	7.29	6.29	0.070	0.054
T$_2$	6.01	5.26	0.058	0.056
T$_3$	2.08	4.46	0.020	0.044
T$_4$	4.59	1.88	0.044	0.000
T$_5$	0.00	2.13	0.000	0.039
T$_6$	2.67	0.00	0.026	0.021
T$_7$	4.92	4.58	0.047	0.040
T$_8$	5.13	4.84	0.049	0.024
T-cal.	**0.607**		**0.97.36**	
P-value	**56**			
T (Transect)				

Table 4. Distribution of tree plant species and in their habitats in the study area

Family	Species	DPF	OPF	SF	VT	HP	SH	SG	ET
Anacardiaceae	*Magnifera indica*	-	+	+	-	-	-	-	+
Arecaceae	*Elaeis guinensis*	-	+	+	-	-	-	-	+
Burseraceae	*Dacryodes edulis*	+	+	+	-	-	-	+	+
Combretaceae	*Terminalia ivorensis*	+	+	-	-	-	-	-	-
	T. superba	+	-	+	-	-	-	+	-
Fabaceae	*Afzelia africana*	+	+	+	-	-	-	+	-
	Brachystegia eurycoma	-	-	+	-	-	-	+	+
	Parkia biglobosa	-	-	+	-	-	-	-	+
	Tetrapleura tetraptera	-	+	+	-	-	-	+	-
Irvingiaceae	*Irvingia gabonensis*	-	-	-	-	-	-	-	+
	I. wombulu	-	-	+	-	-	-	-	-
Lamiaceae	*Gmelina arborea*	-	+	+	-	-	-	-	+
	Tectona grandis	-	+	+	-	-	-	+	+
Lecythidaceae	*Napoleona vogelli*	-	-	-	-	+	-	-	-
Leguminosae	*Pterocarcus mildbradii*	-	-	-	-	-	+	-	-
	P. osun	-	-	-	-	-	+	-	-
Malvaceae	*Bombax buonopozense*	-	-	+	+	-	+	-	-
	Bosqueia angolensis	-	+	-	-	-	-	-	-
	Tripochiton scleroxylon	-	-	+	+	-	+	-	+
Meliaceae	*Khaya ivorensis*	-	+	-	+	+	+	-	+
Moraceae	*Melicia excelsa*	-	+	-	-	+	-	-	-
	Treculia africana	-	+	-	+	-	+	-	+
Myristicaceae	*Pycnathus angolensis*	-	+	-	-	+	-	-	-
Poligalaceae	*Carpolobia lutea*	-	-	-	-	-	-	+	-
Rubiaceae	*Heinsa crinata*	-	+	-	-	-	+	-	-
	Nauclea diderrichi	-	+	-	+	-	+	-	+
	Randia longiflora	-	+	-	-	+	-	-	-
Rutaceae	*Citrus sinensis*	-	+	-	+	-	+	-	-
Sterculiaceae	*C. gigantean*	-	+	+	-	-	-	+	-
	C. nitida	-	+	+	-	-	-	+	-
	Sterculia oblonga	-	-	+	-	-	-	-	-
	Sterculia tragacantha	-	-	+	-	-	-	-	-
Urticaceae	*Musanga cercopoides*	-	+	-	-	+	-	-	-
	Myrianthus arboreus	-	-	-	-	+	-	-	-

- Not Available, + Available; DPF Dense Primary Forest, OPF Open Primary Forest, SF Secondary Forest, VT Vine Tangle, HP Herb Patch, SH Shrubs, SG Sacred Groves, ET Economic Trees. Source: Field Survey 2019-2021

The classification of human beings as primates stimulates their conservation, providing opportunity for studying its behaviour and ecology [19]. The role of guenons in seed germination, dispersal and plant pollination is ecologically viable. These ecological functions are vital in the functioning of the ecosystems they are found.

3.2 Habitat requirements /species distribution of the Sclater's guenon

The study revealed that the Sclater's monkeys were restricted mostly to secondary forest, sacred groves and economic trees (Table 4).

This was largely so because most, if not all, of the primary forest is lost to land development, agricultural and livestock farming. This assertion is in line with Lynne *et al*, [4], that habitat decimation has greatly impacted the Sclater's monkeys negatively [20]. Small numbers of the monkey, occasionally were sighted in the remaining fragmented portions within dense and open primary forest. This habitat loss may be responsible for the shrinking density of the Sclater's monkeys.

The most dominant plant species throughout the study area were *Khaya ivorensis*, *Treculia africana*, *Nauclea diderrichi*, *Gmelina arborea*,

Magnifera indica and *Tectona grandis*, while the least dominant plant species was *Bosqueia angolensis* (Table 5).

The domination of the habitats by a few indigenous tree species like *Khaya ivorensis*, *Treculia africana*, *Nauclea diderrichi*, and more of *Gmelina arborea*, *Tectona grandis* and *Magnifera indica* is an indication that the habitat is highly degraded, and have become more or less a plantation, with a conglomeration of exotic tree species within the animal's range. This forced the animals most of the time, especially during the dry season to take refuge in sacred shrines, mango, oil palm and kolanut trees. Apart from a few indigenous tree species, the monkeys spent much of its time resting, playing and feeding around mango, orange, oil palm, gmelina and teak, as indicated by the importance value index (IVI).

Table 5. Trees/plant species composition in the study area

| Species	Frequency	No. of trees/ha	Rel. Density %	Relative Dominance %	Rel. freq. %	IVI
Afzelia africana	11	84	3.3416	3.9069	3.6184	10.8669
Bombax buonopozense	5	38	1.4413	1.0799	1.6447	4.1659
Bosqueia angolensis	1	8	0.5437	0.1134	0.3289	0.986
Brachystegia eurycoma	9	68	2.7781	4.5993	2.9605	10.3379
Carpolobia lutea	1	8	0.5437	0.1278	0.3289	1.0004
Citrus sinensis	7	53	2.4215	1.786	2.3026	6.5101
Cola gigantean	8	61	2.6514	6.0015	2.6316	11.2845
Cola nitida	11	84	3.3416	7.3744	3.6184	14.3344
Dacryodes edulis	12	91	3.8341	2.4987	3.9474	10.2802
Elaeis guinensis	13	99	3.9672	1.7665	4.2763	10.01
Gmelina arborea	27	205	7.4402	6.7615	8.8816	23.0833*
Heinsa crinata	3	23	0.7673	0.7522	0.9868	2.5063
Irvingia gabonensis	3	23	0.7673	1.0892	0.9868	2.8433
Irvingia wombulu	1	8	0.5437	0.3239	0.3289	1.1965
khaya ivorensis	39	296	9.7231	12.5765	12.8289	35.1285**
Magnifera indica	24	182	7.5642	6.1051	7.8947	21.564*
Milicia excelsa	3	23	0.7673	3.545	0.9868	5.2991
Musanga cercopoides	5	38	1.4413	0.8116	1.6447	3.8976
Myrianthus arboreus	2	15	0.2647	1.1418	0.6579	2.0644
Napoleona vogelli	1	8	0.5437	0.0441	0.3289	0.9167
Nauclea diderrichi	26	198	7.3764	8.8261	8.5526	24.7551*
Parkia biglobosa	2	15	0.6579	0.4163	0.6579	1.7321
Pterocarpus mildbraedii	1	8	0.5437	0.1978	0.3289	1.0704
Pterocarpus osun	1	8	0.5437	0.2447	0.3289	1.1173
Pycnathus angolensis	3	23	0.7673	1.573	0.9868	3.3271
Randia longiflora	4	30	1.3158	1.3659	1.3158	3.9975
Sterculia oblonga	1	8	0.5437	0.2305	0.3289	1.1031
Sterculia tragacantha	2	15	0.2647	0.8877	0.6579	1.8103
Tectona grandis	24	182	7.5642	3.8492	7.8947	19.3081*
Terminalia ivorensis	12	91	2.7641	3.3687	3.9474	10.0802
Terminalia superba	3	23	0.7673	1.1982	0.9868	2.9523
Treculia africana	26	198	7.3764	10.8005	8.5526	26.7295**
Tripochiton scleroxylon	10	76	3.7363	3.2499	3.2895	10.2757
Tetrapleura tetraptera	3	23	0.7673	1.3864	0.9868	3.1405
	304	2310.4	99.7516	100.0002	99.9992	299.7510

Source: Field Survey 2019-2021
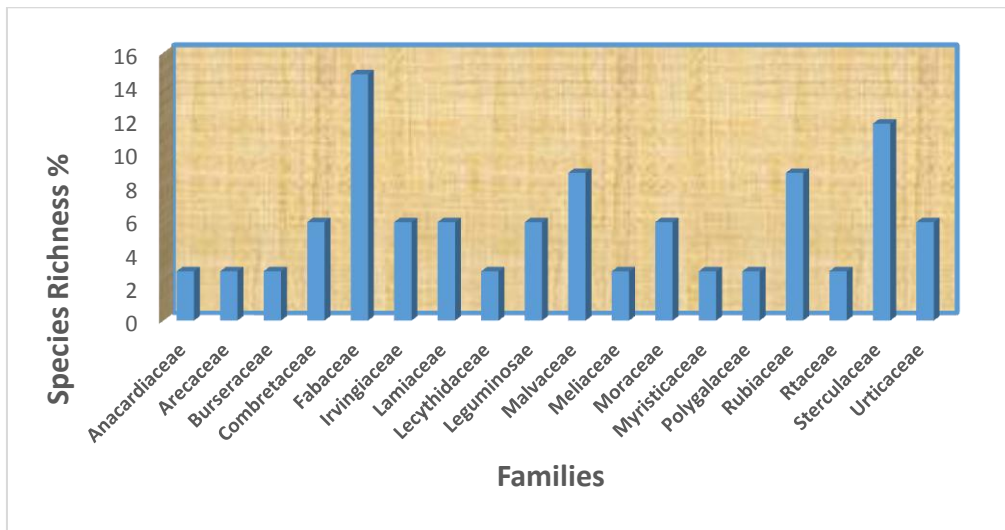
Fig. 2. Trees species families in the study area

Table 6. Diameter at breast Height (DBH) Class distribution of trees in the study area

Location	% DBH Class (cm)				
	10 ≥20	21 ≥ 30	31 ≥ 40	41 & above	Total
1	12.50	25.00	37.50	25.00	100
2	20.00	45.00	22.50	12.50	100
3	20.00	35.00	37.50	7.50	100
4	15.00	70.00	15.00	0.00	100
5	15.00	62.50	22.50	0.00	100
6	20.00	45.00	35.00	0.00	100
7	10.00	45.00	12.50	32.50	100
8	32.50	32.50	12.50	22.50	100
Mean	**18.13**	**45.00**	**24.38**	**12.50**	**100**

Source: Field Survey 2019-2021

The family *Fabaceae* was higher in species richness, followed by *Sterculaceae*, *Malvaceae*, and *Rubiaceae* (Fig. 2).

Major tree species had diameter at breast height (dbh) between 21 and 30cm, an indication of a highly degraded habitat, with sparsely distributed tree species [21]. Though the habitat was dominated by *Tectona grandis* and *Gmelina arborea*, mahogany, kolanut, obeche, opepe, silk cotton and bush apple were richer in diversity. This implies that indigenous tree species still enjoy some form of conservation in the form of sacred groves and shrines. The Sclater's guenons are a diverse group of organisms with ecological and behavioural variability. They inhabit a variety of habitats and consume different variety of diets, and understanding the diversity of this biological community becomes therefore imperative [22].

An increase in cases of conflict between humans and wildlife are a result of expansion into the natural habitats of the animals. This results in the destruction of the natural food sources of the guenons, and replaced with those planted by humans. According to a research by Shek and Cheng (2010), the feeding of monkeys on these anthropogenic crops is the reason for why the monkeys are usually regarded as pests.

4. CONCLUSION

The conservation and management of wild animal species population is better achieved through monitoring programs such as changes in population of wild animals, habitats, food availability and anthropogenic activities. In most cases, individual population may increase but available habitat may not be able to cater for the needs of such individuals. The range of these animals has shrunk due to habitat fragmentation, causing the animals to now compete with humans within the surrounding communities for survival. This portends danger for the animals as

no one can predict what the future holds for the animals. If the only protection the animals enjoy is that of a taboo which forbids its killing, then with increasing land development and expansion of agricultural fields, continuous raiding of farms, gardens and homes by the monkeys, which may result in more conflicts, this unconscious form of conservation may not be sustainable in the long run. These conflicts are threats to the remaining very fragile population and habitats, and extinction of the animal may be imminent. Resistance against the conservation of the species by the host communities may spell doom for the animal, further aggravating the conflict which may cause severe alteration to the habitat, and forcing the animals to migrate to other areas. Concerted efforts are therefore needed by all concerned to ensure that the animal's populations and habitats are not negatively impacted. There should be conscious efforts geared towards restoration of the Sclater's monkey's habitat; through regeneration programs such as indigenous tree planting and regulated felling. The guenons should be considered as species of urgent public attention, necessitating the establishing of a wildlife sanctuary in the area to ensure the complete protection of the species.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Appendix 1. Global Positioning System Transects Coordinates in the study area

Transect	Coordinates
1	5.412691^{0}N,6.514272^{0}E
2	5.731462^{0}N, 4.751621^{0}E
3	5.625171^{0}N, 6.461320^{0}E
4	5.491721^{0}N, 6.772130^{0}E
5	5.561413^{0}N, 4.756135^{0}E
6	5.596141^{0}N, 7.415260^{0}E
7	5.643121^{0}N, 7.315612^{0}E
8	5.714213^{0}N, 5.168174^{0}E

Appendix 2. Other wildlife species observed in the study area

Family	Species	Frequency	%	Rem.
Ardeidae	Grey Heron	5	1.4	DS
	Plantain Eater	12	3.3	DS
	Laughing Dove	63	10.1	WS
	Common Bulbul	37	10.1	WS
	Senegal Coucal	18	4.9	DS
	Cattle Egret	42	11.5	DS
	Pied Crow	26	7.1	DS
	Grey Headed Sparrow	29	7.9	WS
	Little Egret	48	13.2	DS
	Village Weaver	67	18.4	WS
	Black Kite	6	1.6	DS
	Red Bishop	3	0.8	DS
	Fire-Crown Bishop	7	1.9	DS
	Yellow-Mantled Whydal	2	0.5	DS
Total	**14**	**365**	**92.9**	

DS (Dry Season), WS (Wet Season)