

## Floristic and mammalian composition and diversity in a logged-over secondary regrowth rainforest ecosystem in Amahor Forest Reserve, Edo State, Nigeria

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### ABSTRACT

A diagnostic study on floristic and mammalian composition and diversity was conducted in an intensely logged Amahor Forest Reserve, Edo State, Nigeria. Tree height and girth ( $\geq 30\text{cm}$ ) were measured in 10 (50m x 40m) randomly located plots using Nikon Laser Rangefinder (Forestry 550) and girthing tape respectively while evaluation of natural regeneration was conducted in ten (10m x 10m) plots. Mammals were assessed within six (0.5km) line transects sited in existing and constructed trails using direct and indirect survey techniques. Data were analysed using descriptive statistics, Shannon-Weiner (H') diversity and Important Value indices. Results on floristic richness revealed 249 trees distributed among 70 species in 31 families while species diversity was 3.73. *Ricinodendron heudelotii* and Caesalpinioideae were the most important tree and family respectively. For wildlife, 80 individuals distributed among 21 species in 13 families were recorded while species diversity was 2.796. *Cricetomys gabianus* and Bovidae were the most important species and family respectively. Among the mammals, only two – the White-throated guenon and African white bellied pangolin – were classified “endangered” on the IUCN Red List. However, based the National Biodiversity classification approach, four species were ‘endangered’, three ‘threatened’ and two ‘rare’. Regardless of the level of species erosion and ecosystem degradation, Amahor Forest Reserve has fairly rich soil seed and seedling banks of important timber tree species. It is imperative for Edo State Government to mobilize resources, engender and incentivize forest dependent communities; and provide an enabling policy for the rehabilitation of the landscape and its vanishing biodiversity through participatory approach.

**Keywords:** Biodiversity loss, degraded ecosystem, endemic taxa, natural regeneration, stakeholder participation.

### INTRODUCTION

Forest Reserve or Protected Area system was historically a forest management instrument introduced by the colonial administration in pursuance of the veiled objectives of exploiting the rich timber and allied resources in the rainforest region of southern Nigeria. Within the context of society and conservation in contemporary

times, forestry is no longer perceived as mere repository of trees of timber importance; it is about people (cf. Westoby, 1989). In democracies imbued with good forest governance, conservation attention is being re-awakened towards the use of participatory techniques to marshal ecological sustainability in degraded fragile ecosystems; but this is yet to gain currency

in Nigeria. Forests in protected areas are managed to reconcile local livelihoods with biodiversity conservation; thus the protected-area approach has achieved positive results in terms of establishing barriers to the progress of uncontrolled logging, species erosion and deforestation while at the same time conserving species and prolonging ecosystem functions (FAO and UNEP, 2020). The International Union for Conservation of Nature (IUCN) defined protected area (PA) as “a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values” (IUCN/WCPA, 2010).

In Edo State, the Department of Forestry in the Ministry of Environment is shouldered with the responsibility of protecting and managing the forest estate located in 48 forest reserves and off reserve (free) areas. But the prevailing forest management policy is the polycyclic system underscored by the ‘fences and fines approach’ which encourages wasteful practices and dysgenic assortments. This ‘strait jacket’ policy inspires logging or exploitation of the best timber products under a winner-takes-it-all; thus leaving derelict (genetically inferior) individuals to perpetuate future generations (populations) (Isikhuemen, 2014). As it obviously occurs in weird (or absence of good) forest management planning, illegal and/or uncontrolled logging leads to the loss or destruction of forests; and the concomitant habitat and biodiversity losses threaten the survival of important flora and fauna species (FAO and UNEP, 2020).

The primary drivers of species erosion and ecosystem degradation in Edo State are legion, and basically anthropogenic. These include: oil prospecting/exploration activities, de-reservation and conversion of forested landscapes to other land uses, illegal/unsustainable logging, poaching of wildlife, slash and burn agriculture as well as nomadic herding and associated wild

fires (Isikhuemen and Ikponmwonba, 2020). For example, over 50% of the protected areas under reservation in Edo State has been excised to, or annexed by, communities and private concerns for purposes of expansion and agricultural development purposes. Besides, a great majority of important timber tree species have been exploited, and the rainforest vegetation replaced by fire-climax and/or vestiges of secondary regrowth vegetation. Redhead (1971) had classified the important timber trees of southern Nigeria into four utilization classes: Class I (species of major economic timber importance); Class II (species of lesser timber importance); Class III (species of possible timber importance), and Class IV (species likely to be of use only for fuel, charcoal, or for industrial use). Presently, these keystone tree species are not only receding in population but their survival is increasingly threatened together with the rainforest ecosystem.

Forest regeneration is a long-term successional process that occurs in stages defined by vegetation structure, species composition and functional attributes (Chazdom, 2014); the process unfolds in stages, based on available source pool of species, dispersal events and the history and nature of disturbance (Chazdom, 2017). Forest or wildlife inventory – including diagnostic assessment – is an essential component of species demography that guides planning, management/conservation and rehabilitation as well as the sustainable use of forest and allied resources. Amahor Forest Reserve is only old growth moist rainforest ecosystem in the dominantly dry deciduous/derived savanna ecology in the central senatorial district of Edo State. Despite its unique ecology and bewildering landscape, the protected enclave has witnessed several decades of intensive and unrestrained logging resulting in species erosion and impairment of the fragile ecosystem (Federal Ministry of Environment, 20005). Ironically, Edo State

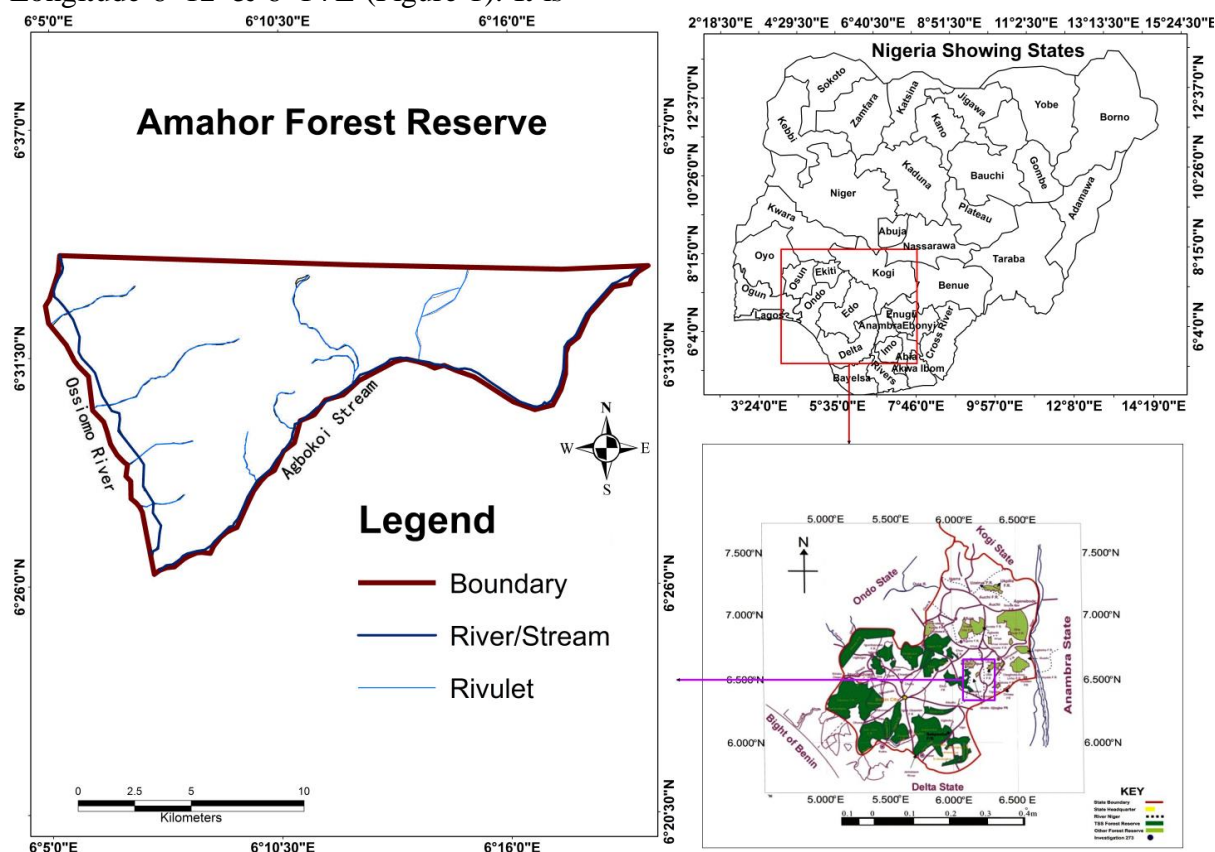
has no up-to-date information and empirical data on the current condition of the relic rainforest ecosystem spanning 15 out of 48 forest reserves. This paper evaluates floristic (tree) and mammalian species diversity and richness in Amahor Forest Reserve.

## MATERIALS AND METHODS

### Study Area

Amahor Forest Reserve (AFR) is located between Latitude  $6^{\circ} 45' & 6^{\circ} 48' \text{N}$  and Longitude  $6^{\circ} 12' & 6^{\circ} 14' \text{E}$  (Figure 1). It is

situated on the southern fringe of Amahor town in Igueben Local Government Area of Edo State. Covering an area of  $15.31 \text{ km}^2$ , AFR is bound on the north by an expansive rubber plantation/regrowth fallow vegetation with Amahor waterside (village) at the far end. In the northwest is the confluence of Ebah stream and Ossiommo River (Figure 2); and has Ehor Forest Reserve (BC16/1) to the west while the union of Agbokoi and Ossiommo Rivers forms a V-shape at the southern boundary.



**Fig.1.** Composite maps showing Amahor Forest Reserve (left); Nigeria (top right) and Edo State Forest Reserves (below right).



**Fig. 2.** Ebah stream and Ossiomo river confluence on the north-west fringe of AFR

The topography consists of a medley of plateaus and valleys crisscrossed by streams and rivulets. The soil is poorly drained with occasional or partially weathered rock fragments (regolith) which are gravely, mottled or tainted grey to dark brown. The forest reserve, which is about six kilometers from the King's palace at central area of Amahor town Amahor town was founded by an emigrant who hailed from Ute-Nugbeze in the present day Benin kingdom around 1805 (Chief Lawrence Ordia, Ezomo of Amahor, *per.com.*). It has seven neighborhoods, namely, Eguare, Ogo, Oguelegbon, Obodeko, Odin, Usenu, and Waterside. The people are basically farmers; although they also engage in trading, lumbering, hunting, etc. Land tenure system is communal or family holding.

## DATA COLLECTION

### Floristic Survey

Ten rectangular plots measuring 50m x 40m were established randomly at different locations in the accessible portions of the forest reserve where the topography was relatively flat or gentle; thus translating to sampling intensity of 0.13%. Assignment/delineation of sample plots was carried out with due diligence while caution was exercised to avoid steep slopes and gorges (>35% gradient) where

movement was difficult owing to the slippery nature of the terrain. The Nikon Laser Rangefinder (Forestry 550) was used to measure tree height while girth ( $\geq 30\text{cm}$ ) was measured using a girthing tape at breast height level (1.3m). In few exceptional cases, particularly with trees whose buttresses transcend 1.3m, girth was measured 15cm above the buttress (Isikhuemen and Ola-Adams, 2011).

### Diagnostic assessment of natural regeneration and juveniles

Ten (10m x 10m) natural regeneration plots were subjectively sited in gaps – avoiding areas with high incidence of liane tangles/infestation – inside the larger 50m x 40m plots. To obtain an unbiased regeneration count, the following were considered: guild of species and peculiarity of seed/seedling bank (i.e. pioneer or climax), gap status (shade or open); germination type (phanerocotylar, cryptocotylar, etc.) and seed/seedling life expectancy (persistent or transitory). The determination of heights of natural regeneration, saplings and poles followed Whitmore (1998) and Isikhuemen and Oyibotie (2017).

### Fauna Survey

Six line transects consisting of *ca.* 0.5km each were purposively located in existing

and new trails established on relatively flat terrain and gentle slopes ( $<45^{\circ}$ ). Line transects were carefully / cautiously demarcated to allow ease of movement for the wildlife survey team but with minimum disturbance to wildlife habitat. Transects were allowed to rest for 48 hours to allow animals that might have fled or relocated return to their habitats. The direct and indirect wildlife survey techniques (e.g. sighting, calls, faecal droppings, nesting sites, footprints, burrows, etc.) (Jean and Pierre, 1970) were used in conjunction with the six assumptions of Dunn (1993). Each trail was traversed thrice daily between 7:00 and 18:00 hours (local time) with an average walk speed of one kilometer per hour. While traversing a transect, a 200m dash-off was made to both sides of the main track at 500m intervals (Buckland *et al.*, 2004). Periods of traverse were intermingled with intervals of silence, watch and rest in order to increase chances of detecting animals that run for cover or fled upon the approach of the observers (Oates, 1995). The Bushnell Binoculars (10 x 40) were used to observe and detect features of distant or fleeing animals.

### Data analysis

Data were analysed using descriptive statistics as well as Shannon-Weiner diversity and Important Value Indices (Peters, 1996). Classification of trees and natural regeneration into utilization classes followed Redhead (1971) while tree identification followed Keay (1989). Mammalian species classification was based on International Union for the Conservation and Natural resources (IUCN Red list (2019-3) and the National Biodiversity approach (NBSAP) (Federal Government of Nigeria, 2010).

### Shannon wiener's Index of diversity (H')

#### RESULTS

#### Tree Species Richness and Diversity

Seventy (70) species consisting of 249 individuals were recorded in the study area (Table 1).

$$H' = -\sum_{i=1}^s p_i (\ln p_i) \dots \dots \dots (eqn. 1)$$

where  $H'$  = Shannon index of diversity,  $p_i$  = the proportion of importance value of the  $i^{\text{th}}$  species ( $p_i = \frac{n_i}{N}$ ),  $n_i$  is the importance value index of  $i^{\text{th}}$  species and  $N$  is the important value index of all the species.

### Importance Value Index (IVI)

The sum of  $RD_o$ ,  $RD$  and  $RF$  gave the importance value index for each species (Peters, 1996). The index is use to express the share of each species in the tree community (Rajkumar and Parthasarathy, 2008)

### Basal Area

Basal area for all trees was determined using

$$BA = \frac{G^2}{4\pi} \quad \text{OR} \quad 0.0796 G^2 (m^2)$$

$$\pi = \frac{22}{7} \dots \dots \dots (eqn. 2)$$

Where  $BA$  = Basal area ( $m^2$ );  $G$  = girth at breast height (m)

Relative frequency (%) of species was computed (e.g. Brashears, Fajvan and Schuler, 2004):

$$RF = \frac{n_i}{N} \times 100 \dots \dots \dots (eqn. 3)$$

where  $RF$  = relative frequency;  $n_i$  = the number of individual species

$N$  = total number of species inventoried.

Relative dominance (%) of each species was estimated as follows

$$RD_o = \sum \frac{B_{ai}}{B_{as}} \times 100 \dots \dots (eqn. 4)$$

where  $Rd_o$  = Relative dominance;  $B_{ai}$  = Basal area of all individual  $i^{\text{th}}$  species  
 $B_{as}$  = Basal area of stand.

Relative density (%) of each species was computed as thus;

$$RD = \frac{\text{density of species } n_i}{\text{total density of species}} \times 100 \dots (eqn. 5).$$

**Table 1:** Check list of tree species in assessed plots in Amahor Forest Reserve

S/No	Species	Freq.	S/No	Species	Freq.
1	<i>Albizia adianthifolia</i>	3	37	<i>Klainedoxa gabonensis</i>	1
2	<i>Angylocalyx zenkeri</i>	3	38	<i>Lecaniodiscus cupanioides</i>	1
3	<i>Anthonota crassifolia</i>	1	39	<i>Lovoa trichilioides</i>	1
4	<i>Antrocaryon micranta</i>	1	40	<i>Macaranga barteri</i>	1
5	<i>Baphia pubescens</i>	4	41	<i>Maesopsis emini</i>	1
6	<i>Barteria grandifolia</i>	1	42	<i>Monodora myristica</i>	1
7	<i>Berlinia auriculata</i>	1	43	<i>Musanga cecropioides</i>	8
8	<i>Berlinia grandiflora</i>	22	44	<i>Myrianthus arboreus</i>	1
9	<i>Berlinia heudelotii</i>	1	45	<i>Nauclea diderrichii</i>	1
10	<i>Bosqueia angolensis</i>	5	46	<i>Nesogordenia papaverifera</i>	6
11	<i>Brachystegia eurycoma</i>	5	47	<i>Oxystigma oxyphyllum</i>	19
12	<i>Brenania brieyi</i>	4	48	<i>Pachystelia brevipes</i>	4
13	<i>Celtis mildbreadi</i>	4	49	<i>Panda oleosa</i>	1
14	<i>Celtis zenkeri</i>	10	50	<i>Pausinystalia johimbe</i>	2
15	<i>Cleistopholis patens</i>	1	51	<i>Pentadesma butyraceae</i>	1
16	<i>Coelocaryon preusii</i>	1	52	<i>Petersianthus macrocarpus</i>	4
17	<i>Daniella orgea</i>	7	53	<i>Piptadeniastrum africanum</i>	1
18	<i>Desplatsia dewevrei</i>	2	54	<i>Poga oleosa</i>	2
19	<i>Diospyros crassiflora</i>	4	55	<i>Polyalthia suaveolens</i>	2
20	<i>Diospyros dendo</i>	11	56	<i>Pterygota macrocarpa</i>	1
21	<i>Diospyros suaveolens</i>	4	57	<i>Pycnanthus angolense</i>	3
22	<i>Discoglypremna caloneura</i>	1	58	<i>Rauvolfia vomitora</i>	1
23	<i>Entandrophragma angolense</i>	1	59	<i>Ricinodendron heudelotii</i>	16
24	<i>Entandrophragma cylindricum</i>	1	60	<i>Rothmania hispida</i>	4
25	<i>Entandrophragma utile</i>	1	61	<i>Scottellia coriacea</i>	1
26	<i>Eribroma oblonga</i>	3	62	<i>Staudtia stipitata</i>	2
27	<i>Ficus exasperata</i>	1	63	<i>Sterculia tragacantha</i>	13
28	<i>Funtumia africana</i>	1	64	<i>Strombosia grandifolia</i>	1
29	<i>Funtumia elastica</i>	1	65	<i>Symphonia globulifera</i>	1
30	<i>Gilbertiodendron dewevri</i>	1	66	<i>Terminalia superba</i>	1
31	<i>Gmelina arborea</i>	1	67	<i>Trichilia heudelotii</i>	5
32	<i>Guarea cedrata</i>	4	68	<i>Triplochiton scleroxylon</i>	1
33	<i>Hannoa kleaniana</i>	6	69	<i>Zanthoxylum gillettii</i>	2
34	<i>Hexalobus monopetalus</i>	1	70	<i>Zanthoxylum zanthoxyloides</i>	1
35	<i>Homalium letestui</i>	9			
36	<i>Hylodendron gabunense</i>	11			

The Caesalpiniaceae family had the highest number of species; although > 50% of species recorded in the families were

monospecific (i.e. families represented by single species) (Table 2).

**Table 2:** Families and associated species recorded in Amahor Forest Reserve

/No	Family	Species	S/No	Family	Species
1	Anacardaceae	1	16	Myristicaceae	3
2	Anisophyllaceae	1	17	Olacaceae	1
3	Annonaceae	3	18	Pandaceae	1
4	Apocynaceae	4	19	Papilionoidae	2
5	Caesalpinioideae	9	20	Passifloraceae	1
6	Combretaceae	1	21	Rhamnaceae	1
7	Ebenaceae	3	22	Rubiaceae	5
8	Euphorbiaceae	2	23	Rutaceae	2
9	Flacourtiaceae	1	24	Samydaceae	1
10	Guttiferae	2	25	Sapindaceae	1
11	Ivingiaceae	1	26	Sapotaceae	1
12	Lecythidaceae	1	27	Simaroubaceae	1
13	Miliaceae	7	28	Steculiaceae	5
14	Mimosoideae	2	29	Tiliaceae	1
15	Moraceae	3	30	Ulmaceae	2
			31	Verbanaceae	1
<b>Total</b>				<b>31</b>	<b>70</b>

The Shannon Weiner H' diversity index for floristics (trees) was 3.73 while the most important tree based on IVI ranking was *Ricinodendron heudelotii*. Of the 31

families recorded in the forest reserve, 12 accounted for *ca.*55% of total stems; 50% of most important timber trees, and 59% of cumulative basal area (Table 3).

**Table 3:** IVI ranking for 12 most important timber trees in Amahor Forest Reserve

S/No.	Scientific name	No. of stems	IVI Value	Bai (m <sup>2</sup> )
1	<i>Ricinodendron heudelotii</i>	16	31.85	3.225
2	<i>Berlinia grandiflora</i>	22	16.18	0.576
3	<i>Oxystigma oxyphyllum</i>	19	16.16	0.745
4	<i>Sterculia tragacantha</i>	13	12.78	0.596
5	<i>Musanga cecropioides</i>	8	12.13	1.03
6	<i>Homalium letestui</i>	9	11.62	0.664
7	<i>Hylodendron gabunense</i>	11	11.47	0.63
8	<i>Diospyros dendo</i>	11	10.79	0.413
9	<i>Celtis zenkeri</i>	10	9.98	0.576
10	<i>Danielia orgea</i>	7	7.72	0.346
11	<i>Nesogordenia papaverifera</i>	6	5.76	0.175
12	<i>Hannoa kleaniana</i>	6	4.75	0.134
<b>Total</b>		<b>138</b>	<b>151.19</b>	<b>9.11</b>
<b>Total for all individuals</b>		<b>249</b>	<b>300</b>	<b>15.34768</b>

#### Status of Natural regeneration and juveniles in Amahor Forest Reserve

Table 4 shows the results of natural regeneration and their occurrence within diagnostic plots. Of the 19 species which

recorded >25% occurrence in plots, seven (or 37%) had absolute frequency. Only six species across all growth stages were recorded in Class I; four in Class II, three in Class III and six in Class IV (Table 4).

**Table 4:** Report of diagnostic survey of natural regeneration and juveniles in AFR

S/No.	Species Scientific Name	Species Growth Stage			Incidence in Plots (%)	Classification (e.g. Redhead, 1971)
		Seedling	Sapling	Pole		
1	<i>Abizia spp.</i>		✓	✓	75%	Class II
2	<i>Barteria spp.</i>			✓	25%	Class IV
3	<i>Berlinia sp.</i>	✓	✓	✓	100%	Class II
4	<i>Brenania brieyi</i>		✓	✓	25%	Class IV
5	<i>Celtis spp</i>	✓	✓	✓	100%	Class III
6	<i>Diospyros spp.</i>	✓		✓	50%	Class IV
7	<i>Entandrophragma angolensis</i>	✓	✓	✓	100%	Class I
8	<i>E. cylindricum</i>		✓		25%	Class I
9	<i>Guarea spp.</i>	✓	✓	✓	100%	Class I
10	<i>Hannoa klaineana</i>		✓	✓	75%	Class III
11	<i>Homalium spp.</i>			✓	50%	Class III
12	<i>Hylocladon gabunense</i>	✓	✓	✓	100%	Class IV
13	<i>Khaya anthotheca</i>	✓		✓	25%	Class I
14	<i>Musanga cercropoides</i>			✓	25%	Class IV
15	<i>Nesogordonia papavorifera</i>			✓	25%	Class I
16	<i>Oxystigma spp.</i>	✓	✓	✓	100%	Class II
17	<i>Piptadeniastrum africanum</i>		✓		25%	Class II
18	<i>Triplochiton scleroxylon</i>		✓	✓	25%	Class I
19	<i>Strombosia spp.</i>	✓	✓	✓	100%	Class IV

**Mammalian Richness and Diversity**

Eighty mammals distributed among 21 species and 13 families were recorded (Table 5). The Shannon Wiener index of diversity ( $H'$ ) was *ca.* 2.80. Giant rat (*Cricetomys gabanus*) had the highest number of individuals while Bovidae family recorded the most abundant species (Table 5).

**Classification of mammals based on IUCN Red list and National Biodiversity approach**

Of the 21 species of mammals recorded, only eight occurred simultaneously on both the IUCN Red List and the National Biodiversity approach (NBSAP) (Table 6).

**Table 5:** Wildlife Species assessed in Amahor Forest Reserve

S/No	Family	Species	Common name	Frequency
1	Bovidae	<i>Kobus defassa</i>	Waterbuck	2
2	Bovidae	<i>Cephalophus rufilatus</i>	Red-flanked duiker	3
3	Bovidae	<i>Sylvicapra grimmia</i>	Common duiker	2
4	Bovidae	<i>Taqualaphus scriptus</i>	Bush buck	7
5	Bovidae	<i>Cephalophus maxwellii</i>	Maxwell duiker	2
6	Sciuridae	<i>Epixerus erythropus</i>	Striped ground squirrel	3
7	Suidae	<i>Potamochoerus porcus</i>	Red River hog	4
8	Procavidae	<i>Dendrohyrax dorsalis</i>	Tree hyrax	5
9	Cercopithecidae	<i>Cercopithecus mona</i>	Mona monkey	1
10	Cercopithecidae	<i>Cercopithecus erythrogaster</i>	White throated guenon	2
11	Galangidae	<i>Galagoides demodori</i>	Galago / Bush baby	2
12	Thryomyiinae	<i>Thryonomis swinderianus</i>	Grass cutter	4
13	Sciuridae	<i>Xerus erythropus</i>	Climbing squirrel	3
14	Archachatina	<i>Archachatina marginata</i>	Giant land snail	3
15	Sciuridae	<i>Funisciurus anerythrus</i>	Red-less tree squirrel	1
16	Cricetomyiinae	<i>Cricetomys gabianus</i>	Giant rat	16
17	Hystriidae	<i>Atherurus africanus</i>	Brush tailed porcupine	7
18	Sciuridae	<i>Epixerus ebii</i>	African palm squirrel	5
19	Manidae	<i>Manis tricuspis</i>	White bellied pangolin	3
20	Viverridae	<i>Viverra civet</i>	African civet cat	2
21	Varanidae	<i>Varanus niloticus</i>	Nile monitor lizard	3
<b>Total</b>				<b>80</b>

**Table 6:** Classification based on IUCN Red list and National biodiversity approach

Common name	Scientific name	Local Name (Benin)	National Biodiversity approach	IUCN Red List
African civet cat	<i>Viverra civeta</i>	Edi	Endangered (EN)	This taxon has not yet been assessed for the IUCN Red List, and also is not in the Catalogue of Life
Brush-tailed Porcupine	<i>Atherurus africanus</i>	Okhaen, Okham	Threatened	Status: Least Concern; Pop. trend: stable
Grey duiker	<i>Sylvicapra grimmia</i>		Endangered	Status: Least Concern; Pop. trend: decreasing
Maxwell duiker	<i>Philantomba maxwellii</i>	Uzo, Uso	Endangered	Status: Least Concern; Pop. trend: decreasing.
Mona monkey	<i>Cercopithecus Mona</i>	Ogin	Threatened	Status: Least Concern; Pop. trend: unknown
Red river hog	<i>Potamochoerus porcus</i>	Esi, Isi	Rare	Status: Least Concern; Pop. trend: decreasing
Tree Hyrax	<i>Dendrohyrax dorsalis</i>	Akwagha gha	Rare	Status: Least Concern; Pop. trend: unknown
White-Throated Monkey	<i>Cercopithecus erythrogaster</i>	Ekhokho	Endangered	Status: Vulnerable; Popn. trend: decreasing
White bellied pangolin	<i>Manis tricuspis</i>	Ekhui	Endangered	Status: Endangered A2c+4cd; Popn. trend: decreasing

## DISCUSSION

The study elucidates the enormous damage to the fragile rainforest ecosystem and loss of tree species of timber importance and wildlife. Of the 70 trees enumerated, 35 (or 50%) were each represented by a single individual. In an earlier inventory of floristic composition in Amahor Forest Reserve (using lower diameter limit of 10 cm), 1695 stems were recorded with species density ranging from 76 to 308 trees/ha (Federal Ministry of Environment, 2005). An appraisal of 12 most important species recorded in the forest reserve during the current study revealed that *Nesogodonia papaverifera* (3 stems/ha) was the only species encountered in Class I while *Oxystigma oxyphyllum* (9 stems/ha) and *Danielia orgea* (4 stems/ha) were recorded among Class II species. The sharp decline and noticeable rarity of important timber trees and mammals amid largescale

degradation in Amahor Forest Reserve succinctly suggests that the fragile rainforest ecosystem has been overly logged and poached beyond elastic limits. While the results of the study on floristics appeared reasonably high: species richness (70), families (31) and Shannon-Wiener index of diversity (3.7); the outcomes for mammals were invariably low: species richness (21), families (13) and Shannon-wiener diversity index (2.8). However, of the 21 species of mammals enumerated, only two – the White-throated guenon (*Cercopithecus erythrogaster*) and White bellied pangolin (*Manis tricuspis*) were listed on IUCN Red list as endangered taxa. Aremu *et al.* (2009) reported 47 woody species, 24 families and Shannon-Wiener diversity index of 3.13 for floristics, and 33 species and 13 families for wildlife in Amahor Forest Reserve. Ogunjemite (2015) also reported 71 species among 27

families and Shannon-Wiener diversity index of 3.0 for woody species in Presco Conservation Areas (CAs) in Ologbo concession, formerly Ologbo Forest Reserve, Edo State. But Adekunle *et al.* (2010) recorded 90 species, 30 families and Shannon-Wiener diversity index of 3.75 in relatively intact Strict Nature Reserve (SNR) I in Akure Forest Reserve, Ondo State, Nigeria.

But regardless of the low flora and fauna species' diversity and richness; and the apparent decline in ecosystem productivity (e.g. Vásquez-Grandón *et al.* 2018); a juxtaposition of the result of Shannon-Wiener diversity index obtained in this study with the findings by Aremu *et al.* (2009) would portray the rainforest biome in Amahor Forest Reserve as species-rich and reasonably intact. According to Duran *et al.* (2006), 'a Shannon-Weiner index that ranges between 2.68 and 3.33 can be considered high: maximum diversity (equitability) exists if each individual belongs to a different species; and minimum diversity, if all individuals belong to one species'. It does not necessarily follow that a higher species diversity index value is better than a low species diversity index value, nor does it follow that high diversity indices can be interpreted as being a reflection of high quality habitat (Spellerberg 1991).

The discernible low species population amidst high level of degradation of the relic rainforest paints a gloomy picture of an enclave that has witnessed several decades of unauthorized and intensive exploitation by loggers, and concomitant neglect by the relevant department/agency shouldered with the statutory responsibility of protecting/managing the state's forest estate. With over 60% of the original vegetation and associated flora and fauna in fragments, it is safe to suggest that the entire ecosystem has reverted to the 'gap phase' dynamics (*cf.* Whitmore, 1998). This is the most turbulent stage of forest

growth/development cycle where lianes and ecosystem volunteers play crucial roles in determining which of the two major guilds – pioneers or climax species – substitute or outcompete the other when perturbations transcend the limits of inherent repairs (Isikhuemen and Ola-Adams, 2011).

A glimpse at the structural composition of the vegetation would reveal significant departure from the five distinct strata (emergent, upper and lower canopies, shrub and herbal layers) which is a common feature of any intact tropical rainforest ecosystem (*cf.* Keay, 1959). One tangible change in the physiognomy of the rainforest ecosystem in Amahor Forest Reserve is the apparent dilution of the vertical structure and vegetation profile – which is symptomatic of a highly impacted ecosystem – and the disappearance of the emergent and upper canopy layers owing to intensive and unrestrained exploitation for several decades. Ogunjemite (2015) reported similar findings in a study on floristics in Presco Conservation Areas, Ologbo concession, Edo State.

## CONCLUSION

This indicative study reveals a steady decline in population and diversity of tree and mammalian species in the fragile rainforest ecosystem in Amahor Forest Reserve. But despite the wide-ranging ruins and loss of important timber trees species, the rich soil seed bank and preponderant seedling bank of natural regeneration can be harnessed to rehabilitate important timber tree species and/or restore the degraded ecosystem. To this end, Edo State Government, the *de facto* manager of Amahor Forest Reserve should, as a matter of urgency, mobilize resources for the rehabilitation of the protected area through enrichment planting or assisted natural regeneration using participatory approach. However, while all forms of exploitation or logging activities should be prohibited; concerted effort should be made to establish

alternative livelihood projects and incentivized small forest businesses for the forest dependent poor in fringing communities.

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