



ASSESSMENT OF TREE SPECIES DIVERSITY STATUS IN SOME FOREST RESERVES OF GOMBE STATE: STRATEGY FOR ECOSYSTEMS MONITORING IN ARID REGIONS OF NIGERIA

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ARTICLE INFO

Article History:

Received 06th June, 2019

Received in revised form 14th July, 2019

Accepted 23rd August, 2019

Published online 28th September, 2019

Key words:

Diversity, Forest Reserves, Relative Density, Dominance, Important Value Index

ABSTRACT

The study assessed tree species diversity status of three Forest Reserves (Kanawa, Kaltungo and Wawa) in Gombe State, North-eastern Nigeria. Parameters determined were tree species diversity and composition, relative density and dominance, important value index, species richness and evenness in the Reserves. Five sample plots (100m²) were laid at random in each of the Reserves and tree species were enumerated by sample plot method. A total number of 196, 242 and 205 trees belonging to 15, 19, and 16 families and 28, 36 and 28 species were recorded in Kanawa, Kaltungo and Wawa Forest Reserves respectively. Families and numbers of species recorded in Kanawa Forest Reserve were; *Combretaceae* 6, *Anacardiaceae* and *Mimosaceae* 4 species each; *Caesalpiniaceae*, *Fabaceae*, *Meliaceae* and *Myrtaceae* 2 species each while all the other families had 1 each. In Kaltungo Forest Reserve *Mimosaceae* had 7 species, *Moraceae* 4, *Caesalpiniaceae*, *Fabaceae* and *Rhamnaceae* had 3 each while *Combretaceae* and *Malvaceae* had 2 and the other families 1 each. In Wawa Forest Reserve, *Mimosaceae* had 6 species, *Caesalpiniaceae* and *Moraceae* had 3 each. *Combretaceae*, *Meliaceae* and *Rhamnaceae* had 2 each while the other families had 1 each. The highest relative density, Dominance and Important Value Index of 24.50%, 24.43% and 24.97%; 9.09%, 10.28% and 9.68% were recorded for *Azadirachta indica* and *Azanza garckeana* in Kanawa and Kaltungo Forest Reserves respectively. *Vitalleria paradoxa* had the highest relative density and important value index of 11.21% and 10.09% while *Anogeissus leiocarpus* had the highest relative dominance of 11.38% in Wawa. Shannon's diversity index was 2.49, 3.30 and 3.10 for Kanawa, Kaltungo and Wawa respectively. Species evenness (E_H) was 0.75, 0.92 and 0.93, Species richness (d) 2, 2.31 and 1.96 and Shannon's maximum diversity (H_{max}) was 3.3, 3.6 and 3.3 for the three forest reserves respectively. It is thus concluded that the reserves had moderate diversity. Closure of the forests to exploitation and conservation efforts are thus recommended.

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INTRODUCTION

Scientists conceived that the best answer to the problem of biodiversity loss is the conservation of their habitats [1]. The effective conservation of resources depends on the sound management policies and schemes which are very much determined by adequate and appropriate data of existing resources, their supporting systems and on the anthropogenic components affecting them. [2] observed that ecological areas rich in living species of plants and animals are important field laboratories for research purposes. For example, research in medicine frequently depends on the availability of plant and wildlife species. Currently, most of the advances in biological and medical research came through the use of biodiversity [3]. Educationally, biodiversity provides the basic knowledge needed by man in understanding how nature works and functions [4].

Soule [5] reported that conservation of biodiversity has become eminent because there are some products to be obtained from the natural ecological systems that can provide direct consumptive needs or social benefits for man. For instance, forest provides food, wood, wildlife and plant materials for various domestic uses including clothing and medicine [6]. Beside the aforementioned, forests also enhance water and soil conservation, oxygen and food chain. In trying to meet their daily needs, people subject forests, woodland and grassland to the highest rate of change [7]. As noted by Tudunwada[8], our forest today is faced with all sorts of anthropogenic activities, including illegal felling of trees for fire wood and roofing, illegal cultivation and conversion of parts of the forest for residential purposes by nomads. The loss of biodiversity in Nigeria is alarming; at a rate of 3.5% (about 350,000-400,000 ha) per annum in land coverage over the past 50 years [9, 10]. This is precisely due to five principle pressures which are intensified on a daily basis; habitat loss and degradation, over exploitation, climate change, excessive nutrient load and other forms of pollution, and invasive alien

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species. It therefore becomes pertinent to ascertain the habitat loss and degradation, biodiversity status, (richness, evenness and abundance) and also the anthropogenic activities that have manifested within and around forest reserves ecosystems of Nigeria, particularly Gombe State.

MATERIALS AND METHODS

The Study Area

The three (3) Forests Reserves are located in Gombe State, North East Nigeria, between latitudes 10° 15' and 10° 250' N and longitude 10' and 11° 167'E. It has a total land area of 18,768 Km² with a population of 2,353,000 million inhabitants [11]. The state is dominated by Sudan Savanna vegetation, and has a distinct climate of dry season (November- March) and rainy season (April- October), with an average rainfall of 850 mm (Gombe State Ministry of Environment, 2014). Kanawa Reserve is located between latitudes 10° 17'N and longitude 10° 16' E, in Yamaltu-Deba Local Government Area, Kaltungo Reserve is located in Kaltungo Local Government Area between latitudes 9° 47'N and longitude 10° 16' E and Wawa Reserve is located in Nafada/Dukku Local Government Area between latitudes 10° 50'N and longitude 10° 26' E, (Gombe State Ministry of Land and Survey, 2013) (Figure 1).

Data Collection

Sample plot method was adopted for the study. Each forest was divided into square plots of 1 ha and five (5) plots were selected in each reserve for the purpose of data collection using the simple random sampling technique. Within each of the selected sample plots, identification and measurement were made of all woody plants; Diameter at Breast Height (DBH) was measured in centimeters using diameter tape while height (H) was measured in meters using a Spiegel Relaskop. The number and scientific names of all the tree species encountered in each field plot were recorded. Where it was difficult to identify the species in the field, the common/local name were recorded, and plant specimens collected for identification at the herbarium of the Department of Forestry and Wildlife Management ModdiboAdama University of Technology, Yola, Adamawa State Nigeria.

Data Analyses

Tree species diversity

The following indices were calculated following the methods adopted by [13, 14, 15, 16]. ANOVA was also done for

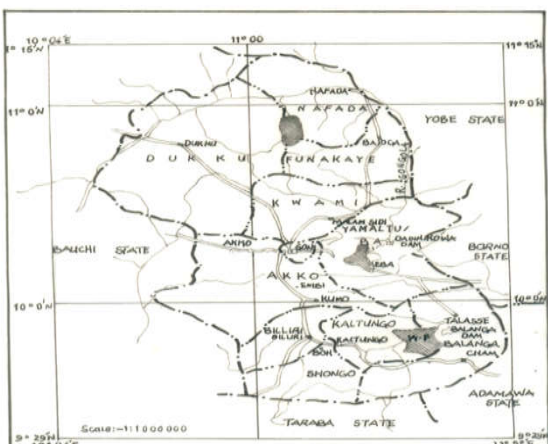


Figure 1 Map of Gombe State Showing the Forest Reserves

Source: Gombe State Ministry of Land and Survey (2013)

Relative density, dominance and important value index:

Basal Area of the entire trees encountered in the sample plot in the study area was calculated using the formula:

$$BA = \frac{\pi D^2}{4}$$

Where;

BA =Basal Area (m²)

D = Diameter at breast height (cm)

$$\pi = \frac{22}{7} \text{ or } 3.142$$

Basal area per plot was obtained by adding the basal area of all individual trees within the plot. Mean plot basal area were computed by summing the total plot basal areas of the sample plots and dividing it by the number of sample plots. Basal area per hectare was then obtained by multiplying the mean plot basal area by the number of sample plots per hectare.

Species Relative Density (RD) was obtained using the formula below[17]:

$$RD = \left(\frac{n_i}{N}\right) \times 100$$

Where; RD= Relative Density

n_i= Number of individual species i

N= Total number of individual in the entire population.

Relative Dominance (RDo)

$$RDo = \left(\frac{\sum Bai \times 100}{\sum Ban}\right)$$

Where;

RDo = Relative Dominance

Bai= Basal Area of individual trees belonging to a particular specie i,

Ba_n = Standard basal area of all species, as adopted by [18].

Importance Value Indices of woody plant species were computed using the formula below[17]:

$$IVI = \frac{RD + RDo}{2}$$

Where:

IVI = importance value

RD = relative density

RDo = relative dominance

Diversity analysis: The Shannon-Wiener diversity index (H'), species evenness (E) and species dominance index were calculated to determine the tree species diversity.

Shannon's Species Diversity Index

$$H' = \sum_{i=1}^n Pi \ln(Pi)$$

Where;

H' = Shannon -Wiener diversity index

P = the proportion of a species to the total number of plant in the community

Ln = the natural logarithm [13]

Shannon-Wiener Diversity Index (H'): The Shannon-Wiener diversity index is the most widely used index in community ecology. The values of Shannon-Wiener diversity index is usually found to fall between 1.5 and 3.5 and only rarely surpasses 4.5 [20].

Shannon's Maximum Diversity Index

$$H_{max} = \ln(s)$$

Where;

H_{max} = the number derived from the Shannon's Diversity Index

S= total number of species.

Species Richness or variety Index(d)

$$d = \frac{S}{\sqrt{N}} \quad [21, 22]$$

Where;

Where S = number of species in a collection

N = number of individuals collected

Species evenness in the community was obtained using Shannon's equitability (E_H):

$$E_H = \frac{H'}{H_{max}}$$

Where:

E_H = Species evenness

H' = Shannon- Wiener diversity index,

H_{max} = Shannon's Maximum diversity index

RESULTS AND DISCUSSION

The numbers of tree species recorded in the three forest reserves were 28, 36 and 28 belonging to 15, 19 and 16 families for Kanawa, Kaltungo and Wawa forest reserves respectively (Table 1).

Table 1 Checklist of Woody Species in the Forest Reserves

Family	Species	Kanawa	Kaltungo	Wawa
Anacardiaceae	<i>Sclerocaryabirrea</i>	+	-	-
	<i>Mangifera indica</i>	+	-	-
	<i>Lannea acida</i>	+	-	+
	<i>Haematotaphis barberi</i>	-	+	
Annonaceae	<i>Annona senegalensis</i>	-	+	+
Asclepiadaceae	<i>Calotropis procera</i>	-	+	-
Arecaceae	<i>Raphiasudanica</i>	+	-	-
Bombacaceae	<i>Adansonia digitata</i>	-	+	+
Balanitaceae	<i>Balanites aegyptiaca</i>	-	+	-
Burseraceae	<i>Boswellia dalzielii</i>	-	+	-
Caesalpinaceae	<i>Tamarindus indica</i>	+	+	-
	<i>Detarium microcapum</i>	+	+	-
	<i>Philostigma thoningi</i>	-	+	+
	<i>Daniellia oliveri</i>	-	-	+
	<i>Isoberinadoka</i>	-	-	+
Combretaceae	<i>Anogeissus leiocarpus</i>	+	+	+
	<i>Combretum molle</i>	+	-	+
	<i>Tarminalia superb</i>	+	-	-
	<i>Combretum lamprocarpum</i>	+	-	-
	<i>Tarminalia acatapa</i>	+	-	-
	<i>Combretum paniculatum</i>	+	-	-
	<i>Guiera senegalensis</i>	-	+	-
Ebenaceae	<i>Diospyros mespiliformis</i>	-	+	+
Fabaceae	<i>Senna siamea</i>	+	-	-
	<i>Albizia lebeck</i>	+	-	-
	<i>Dichrostachys golmerata</i>	-	+	-
	<i>Dichrostachys cineraria</i>	-	+	-
	<i>Entadastuhlmannii</i>	-	+	-
	<i>Azalia africana</i>	-	-	+
Lamiaceae	<i>Gmelina arborea</i>	+	-	-
Malraceae	<i>Ceiba pentandra</i>	+	-	+
Malvaceae	<i>Azanzagarckeana</i>	-	+	-
	<i>Gerewiavenusta</i>	-	+	-
Meliaceae	<i>Khayasenegalensis</i>	+	+	+
	<i>Azadirachta indica</i>	+	-	-
	<i>Gardenia aqualla</i>	-	-	+
Mimosaceae	<i>Acacia sieberiana</i>	+	+	+
	<i>Acacia senegal</i>	+	+	+
	<i>Acacia seyal</i>	+	+	+
	<i>Acacia nilotic</i>	-	+	+
	<i>Parkia biglobosa</i>	-	+	+
	<i>Prosopis africana</i>	-	+	+
Moraceae	<i>Faidherbia albida</i>	-	+	-
	<i>Ficus platyphylla</i>	+	+	+
	<i>Ficus polita</i>	-	+	+
	<i>Ficus sycomorus</i>	-	+	+
	<i>Ficus thonningii</i>	-	+	-

Myrtaceae	<i>Psidium guajava</i>	+	-	-
	<i>Syzygium guineense</i>	+	-	-
Olacaceae	<i>Ximenia americana</i>	+	-	+
	<i>Ziziphus spina-christi</i>	-	+	+
Rhamnaceae	<i>Ziziphus mauritiana</i>	-	+	+
	<i>Ziziphus macrurata</i>	-	+	-
	<i>Ziziphus mucronata</i>	-	+	-
Rubiaceae	<i>Gardenia ternifolia</i>	-	+	-
Sapotaceae	<i>Vitaleria paradoxum</i>	+	+	+
Sterculiaceae	<i>Sterculia setigera</i>	+	+	+
Strychnaceae	<i>Strychnos innocua</i>	+	-	-
Verberaceae	<i>Vitex doniana</i>	-	+	+

Key: Present +, Absent -

Source: Field Work, 2015

In all, a total of 643 trees belonging to 26 families and 62 species were recorded in the fifteen (15) randomly selected sample plots divided into square plots of 100 x 100 m (1 ha) in size from the three (3) Forest Reserves. Families with high numbers of different species were *Mimosaceae* and *Combretaceae*, *Fabaceae*, *Moraceae*, *Caesalpinaceae*, *Anacardiaceae*, *Meliaceae* and *Rhamnaceae*, *Malvaceae* and *Myrtaceae*. The remaining 16 families had one species each which may imply that they have low conservation status or over exploited and that they are currently threatened and may go into extinction in the different Forest Reserves, except measures are put in place to ensure their regeneration.

Results obtained from this study indicates that, species of trees found in Kanawa, Kaltungo and Wawa Forest Reserves were higher than that reported by [23] where 22 species of trees and shrubs belonging to 19 genera and 12 families were identified in West Tangaza Forest Reserve, Sokoto State, but lower than that reported by [24] in the forest –savanna ecotone of Ghana where in all, 1453 trees representing 88 species, 78 genera and 30 families were identified. The results, were close to the findings by [16] in their studies of Kogo Forest Reserve in Zamfara State Nigeria in which they reported 29 species. The differences may perhaps be attributed to variations in edaphic factors and level of exploitation in these ecological zones. This is in line with the report of [25] which suggested that illiteracy and poverty are some of the factors responsible for overdependence on fuelwood as a source of energy leading to increase in the rate of deforestation as a result of fuelwood collection and the report of [26] who noted that areas originally perceived as forest reserves have suffered from overexploitation leading to massive decline in tree population. Species with high Relative Density (RD) in the study sites included *A. indica*, *A. leiocarpus*, *S. siamea*, *Haematotaphis barberi*, *Azanzagarckeana* and *Vitaleria paradoxum*. Results of Importance Value Index (IVI) of tree species indicated that *A. indica* had the highest IVI in Kanawa, *Azanzagarckeana* in Kaltungo and *A. leiocarpus* and *Vitaleria paradoxum* in Wawa forests respectively (Tables 2–4). According to [27, 28,23] high Importance Value Index (IVI) of a species indicated its dominance and ecological success, its good power of regeneration and greater ecological amplitude and also those plants need monitoring and management, while, species which were grouped as low needed high conservation efforts.

The diversity for the sites is shown in Table 5. Shannon Wiener diversity index (H') and Shannon's maximum diversity index (H_{max}) followed the order Kaltungo > Wawa > Kanawa forest (Table 5). The values were average indicating a more or less complex community because a community dominated by one or two species is considered to be less

diverse than one in which several different species have a similar abundance and greater variety of species allows for more species interactions, hence greater system stability, and indicates good environmental conditions [23].

Table 2 Relative Density, Relative Dominance and Important Value Index of Kanawa Forest Reserve

Species	Freq.	Rd	RDo	IVI
<i>Lanneaacidia</i>	2	1.020408	2.209654	1.615031
<i>Mangiferaindica</i>	2	1.020408	0.956101	0.988254
<i>Sclerocaryabirrea</i>	1	0.510204	0.477455	0.49383
<i>Raphiasudanica</i>	12	6.122449	4.543049	5.332749
<i>Tamarindusindica</i>	2	1.020408	1.121144	1.070776
<i>Detariummicrocapum</i>	6	3.061224	4.08667	3.573947
<i>Anogeissusleiocarpus</i>	31	15.81633	24.48626	20.1513
<i>Combretumlamprocarpum</i>	3	1.530612	0.666635	1.098624
<i>Tarminalia superb</i>	1	0.510204	0.856836	0.68352
<i>Tarminaliacatapa</i>	1	0.510204	1.316274	0.913239
<i>Combretum mole</i>	1	0.510204	0.106233	0.308219
<i>Combretumpaniculatum</i>	17	8.673469	6.649698	7.661584
<i>Senna siemea</i>	30	15.30612	12.03922	13.67267
<i>Albizialebeck</i>	1	0.510204	0.245442	0.377823
<i>Gmelinaarborea</i>	1	0.510204	0.696211	0.603207
<i>Cebapentandra</i>	2	1.020408	2.064497	1.542453
<i>Khayasenegalensis</i>	3	1.530612	1.836562	1.683587
<i>Azadirachtaindica</i>	50	25.5102	24.4318	24.971
<i>Acacia sieberiana</i>	2	1.020408	0.532017	0.776212
<i>Acacia Senegal</i>	1	0.510204	0.881142	0.695673
<i>Acacia seyal</i>	1	0.510204	0.152977	0.331591
<i>Ficusplatyphylla</i>	7	3.571429	1.897074	2.734251
<i>Psidiumguajava</i>	2	1.020408	0.800405	0.910407
<i>Syzgiumguineense</i>	4	2.040816	1.876847	1.958832
<i>Ximena Americana</i>	8	4.081633	2.667222	3.374427
<i>Vitaleriparadoxum</i>	1	0.510204	0.424933	0.467569
<i>Sterculiasetigera</i>	2	1.020408	0.967149	0.993779
<i>Strychnosinocua</i>	2	1.020408	1.010492	1.01545
Total	196	100	100	100

Source: Field Survey (2014)

Table 3 Relative Density, Relative Dominance and Important Value Index of Kaltungo Forest Reserve

Species	Freq	Rd	RDo	IVI
<i>Haematotaphisbarteri</i>	20	8.264463	7.33757	7.801016
<i>Annona senegalensis</i>	6	2.479339	2.336716	2.408027
<i>Calotropisprocera</i>	9	3.719008	3.830237	3.774622
<i>Balanitiesaegyptiaca</i>	5	2.066116	3.586326	2.826221
<i>Adansonia digitate</i>	3	1.239669	2.055009	1.647339
<i>Boswelliadalzielli</i>	18	7.438017	6.646228	7.042122
<i>Tamarindusindica</i>	3	1.239669	0.851788	1.045729
<i>Detariummicrocapum</i>	10	4.132231	2.808852	3.470542
<i>Philostigmathingi</i>	15	6.198347	7.34109	6.769719
<i>Anogeissusleiocarpus</i>	15	6.198347	6.902721	6.550534
<i>Guierasenegalensis</i>	4	1.652893	1.887753	1.770323
<i>Diospyromespiliformis</i>	12	4.958678	6.244744	5.601711
<i>Dichrostachysgolmerata</i>	5	2.066116	1.717437	1.891776
<i>Dichrostachyscineria</i>	4	1.652893	1.019516	1.336204
<i>Dendrostaphylmannii</i>	2	0.826446	0.604604	0.715525
<i>Azanzagarckeana</i>	22	9.090909	10.28198	9.686444
<i>Gerewiavenusta</i>	4	1.652893	2.5425	2.097696
<i>Khayasenegalensis</i>	4	1.652893	1.205979	1.429436
<i>Acacia sieberiana</i>	8	3.305785	2.164983	2.735384
<i>Acacia Senegal</i>	3	1.239669	1.758741	1.499205
<i>Acacia seyal</i>	2	0.826446	0.531175	0.67881
<i>Acacia Nilotic</i>	4	1.652893	1.05912	1.356006
<i>Prosopis Africana</i>	7	2.892562	2.362325	2.627444
<i>Parkiabiglobosa</i>	6	2.479339	2.210367	2.344853
<i>Faidherbiaalbida</i>	1	0.413223	0.285729	0.349476
<i>Ficusplatyphylla</i>	2	0.826446	1.529103	1.177775
<i>Ficuspolitia</i>	2	0.826446	0.532024	0.679235
<i>Ficussycomorus</i>	3	1.239669	1.242354	1.241012
<i>Ficusthonningii</i>	7	2.892562	1.440716	2.166639
<i>Ziziphusmacurnata</i>	2	0.826446	0.634011	0.730228
<i>Ziziphuspina-christi</i>	2	0.826446	1.465362	1.145904
<i>Ziziphusmouritiana</i>	1	0.413223	0.591686	0.502455
<i>Gardenia ternifolia</i>	4	1.652893	0.855659	1.254276
<i>Vitaleriparadoxum</i>	10	4.132231	4.749806	4.441019
<i>Sterculiasetigera</i>	5	2.066116	1.103144	1.58463

<i>Vitexdoniana</i>	12	4.958678	6.28265	5.620664
Total	242	100	100	100

Source: Field Survey (2014)

Table 4 Relative Density, Relative Dominance and Important Value Index of Wawa Forest Reserve

Species	Freq	Rd	RDo	IVI
<i>Lanneaacidia</i>	5	2.439024	1.77489	2.106957
<i>Annona senegalensis</i>	11	5.365854	3.977064	4.671459
<i>Adansonia digitate</i>	3	1.463415	0.974943	1.219179
<i>Danielliaoliveri</i>	6	2.926829	2.469682	2.698255
<i>Philostigmathingi</i>	4	1.95122	3.132746	2.541983
<i>Isoberinadoka</i>	4	1.95122	2.156208	2.053714
<i>Anogeissusleiocarpus</i>	18	8.780488	11.38703	10.08376
<i>Combretum mole</i>	3	1.463415	0.706764	1.085089
<i>Diospyromespiliformis</i>	5	2.439024	4.103298	3.271161
<i>Azelia Africana</i>	2	0.97561	0.483082	0.729346
<i>Cebapentandra</i>	3	1.463415	1.227158	1.345286
<i>Khayasenegalensis</i>	1	0.487805	0.648299	0.568052
<i>Gardenia aqualla</i>	4	1.95122	1.754139	1.852679
<i>Acacia sieberiana</i>	2	0.97561	0.620364	0.797987
<i>Acacia Senegal</i>	4	1.95122	1.839927	1.895573
<i>Acacia seyal</i>	8	3.902439	2.592443	3.247441
<i>Acacia nilotica</i>	2	0.97561	0.467717	0.721663
<i>Parkiabiglobosa</i>	6	2.926829	3.815964	3.371397
<i>Prosopis Africana</i>	12	5.853659	7.345037	6.599348
<i>Ficusplatyphylla</i>	10	4.878049	4.467455	4.672752
<i>Ficuspolitia</i>	11	5.365854	5.077443	5.221648
<i>Ficussycomorus</i>	11	5.365854	6.004297	5.685076
<i>Ximena Americana</i>	6	2.926829	1.432283	2.179556
<i>Ziziphuspina-christi</i>	10	4.878049	5.02736	4.952704
<i>Ziziphusmouritiana</i>	6	2.926829	3.633586	3.280207
<i>Vitaleriparadoxum</i>	23	11.21951	8.972224	10.09587
<i>Sterculiasetigera</i>	8	3.902439	2.943784	3.423111
<i>Vitexdoniana</i>	17	8.292683	10.96481	9.628747
Total	205	100	100	100

Source: Field Survey (2014)

Key: Rd = Relative Density, RDo = Relative Dominance, IVI = Important Value Index,

Table 5 Summary of the Results of Various Analyses Conducted for the Three Study Sites

Indices	Taxa	No. of families	Individuals	Dominance	H'	H _{max}	E _H
Kanawa	28	15	196	0.1306	2.491	0.4311	0.7475
Kaltungo	36	19	242	0.046	3.295	0.7493	0.9195
Wawa	28	16	205	0.05413	3.099	0.7921	0.93

H' = Shannon-Wiener diversity index; H_{max} = Shannon's maximum diversity index; E_H = Shannon's equitability (species evenness); D = difference between the diversity index (H') and its maximum value (H_{max}), d = Species richness or variety.

Diversity in the present study is higher when compared to (2.63) reported by [16] for Kogo Forest Reserve in the extreme northern guinea savanna of North-Western Nigeria. In a similar study, [29] obtained a Shannon index that ranged between 2.69 and 3.33, which indicated a similar diverse ecosystem. These differences may perhaps be due to differences in fertility related parameters and degree of exploitation in the reserves. The Nigerian savanna ecosystem can be said to be dominated by members of *Mimosaceae*, *Combretaceae*, *Fabaceae*, *Moraceae*, *Caesalpinaceae*, *Anacardiaceae*, *Meliaceae*, *Rhamnaceae*, *Malvaceae* and *Myrtaceae* among others. The dominance of *Mimosaceae* and *Combretaceae* families in the three Forest Reserves conforms to the findings of [16] in a different savanna ecosystem. Similarly, this observation is in agreement with the findings of [30, 31] that the Leguminosae and Combretaceae were dominant tree families in guinea savanna vegetation.

The result of Analysis of Variance (ANOVA) done for Relative density, dominance and important value index among all the reserves showed that there is no significant difference ($p \leq 0.05$), implying that the distribution pattern of tree species were similar in all the reserves (Table 6, 7 and 8). This could be due to the fact that all the reserves are located in the same ecological zone and the anthropogenic activities exerting pressure on them are from communities with similar socio-cultural backgrounds.

Table 6 Comparative Analysis of Relative Density of Woody Species in all Forest Reserve

Source of variation	SS	Df	Ms	F	P value	F Crit
Treatments	13.80262	2	6.90131	0.466901	0.628469	3.09887
Error	1315.517	89	14.78109			
Total	1329.32	91				

($P \leq 0.05$)

Table 7 Comparative Analysis of Relative Dominance of Woody Species in all Forest Reserves

Source of variation	SS	Df	Ms	F	P value	F Crit
Treatments	13.80262	2	6.901308	0.391259	0.677363	3.09887
Error	1569.848	89	17.63874			
Total	1583.65	91				

($P \leq 0.05$)

Table 8 Comparative Analysis of Important Value Index of Woody Species in all Forest Reserve

Source of variation	SS	df	Ms	F	P Value	F Crit
Treatments	13.80262	2	6.901312	0.438119	0.646633	3.09887
Error	1401.939	89	15.75212			
Total	1415.65	91				

($P \leq 0.05$)

CONCLUSION

The phytosociological assessment as well as the species diversity and abundance compared favorably with other similar forest ecosystems and that some species were facing the threat of extinction which may be as a result of climatic and/or edaphic factors and probably over-exploitation. The values of the ecosystems services provided by these forest reserves vis-a vis their species diversity will give policy makers reasons to conserve the various ecosystems in their domains. This therefore underscores the need to focus the forest policy of Gombe State and that of Nigerian arid region towards an integrated conservative approach that will restore the diminishing potentials of the forest.

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How to cite this article:

Dishan, E. E, Yekini, N and Jatau, D. F (2019) 'Assessment of Tree Species Diversity Status In Some Forest Reserves of Gombe State: Strategy For Ecosystems Monitoring In Arid Regions of Nigeria', *International Journal of Current Advanced Research*, 08(09), pp. 19930-19935. DOI: <http://dx.doi.org/10.24327/ijcar.2019.3877.19935>
