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Research Article

Habitat Characteristics of Wildlife Species in Pandam Wildlife Game Reserve, Plateau State, Nigeria

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Article Info

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Abstract

The paper assessed the vegetation composition and structure within the existing habitats in Pamdam Wildlife Game Reserve. Line transects (2 km each) were laid 1 km apart; Savannah Woodland (SW), Riparian Forest (RF) and Swamp Land (SL). A total of 48 (50 x 50 m^2) sample plots established on 12 transect lines were delineated at 500 m intervals. Tree species of Dbh $\geq$10 cm was identified and enumerated (individuals /ha). Shrubs [individuals /m^2] and herbs [individuals/m^2] were enumerated in 5 x 5 m^2 and 1 x 1 m^2 quadrats, respectively. Data were analyzed using descriptive statistics and ANOVA at α0.05. Simpson's (D) and Shannon-Weiner (H') indices were estimated for trees and understorey. Density of trees (188 individuals /ha), shrubs (162), and herbs (1012) were the highest in SW and the least in RF (respectively 80, 86, and 567) were recorded. Tree species with highest Important Value Index (IVIs) were *Parinari curatellifolia* (12.9%), *Vitex doniana* (14.0%) and *Mitragyna inermis* (27.1%) in SW, RF and SL, respectively. The D and H' were the highest for trees and shrubs in SW while they were the least in RF. The study revealed that especially conservation attention for the particular habitat so as to maintain persistent wildlife population in the reserve..

Keywords: habitat, soil parameters vegetation components, Nigeria

1 Introduction

Habitat relationships are paramount to determining the ecosystem productivity, function, and sustainability of wild animals. It is thus defined as the retinue of ecosystem resources that are integral to wild animal habituation and productivity (Sinclair et al. 2005). It is an area that harbors a particular or defined state of vegetation type, in terms of quality and quantity. Habitat portrays functional components that uniquely define an organism in a particular manner that suit the animal in question. A habitat depot's coverage of an area marked and occupied by wild animals comprises features like water bodies, food, soil formation, and type, as well as the associated

vegetation (Dalle et al. 2014). 1 For instance, the slope or level of terrain, water sources, and soil properties may influence the distribution of animals and plants development and growth (Yang et al. 2009; Wu et al. 2023). Game Reserve protects the integrity of the natural environment and also serves as the cornerstone for biodiversity conservation and their biomass and soil (e.g., Montagnini and Nair 2004). It is among the sites for biodiversity conservation in Nigeria and the whole world. Game Reserve is the most feasible strategy to manage and conserve biodiversity (Thomas and Middleton 2003). Game Reserve harbor most of our remaining forest vegetation and fauna species which play key roles in climate change, habitat structure, biodiversity conservation, and ecotourism (Yager *et al.* 2015; Odunlami and Ijeomah 2016; Maradana and Owk 2016).

Game Reserve vegetation diversity and structure are important to range ecologists to assess the capacity of habitat in forage resources production (Schoenholtz *et al.* 2000; Maradana and Owk 2016; Saka *et al.* 2018). Habitat losses in several Game Reserve occasioned by degradation in range structure had drastically impacted negatively on wildlife populations' especially mammalian herbivores, which form a crucial trophic level in the food chain.

Game Reserve ecosystems at all levels have high and productive surface areas and are acknowledged to harbor a notable portion of global biological resources (Baraloto *et al*. 2013). According to Tyowua *et al.* (2012), wildlife studies are considerably valued when assessments incorporate their habitat. However, the primary limiting component that affects wild animal population changes is the quality and size of the habitat. Sustainable management ofGame Reserve-ecosystems demands a comprehensive insight into its resources. This could be available mostly through knowledge of the forest ecosystem. The evaluation and management of woody plants and the understorey ecosystem should be continuous, considering they are vital variables of vegetation composition (Attua and Pabi 2013).

The roles of plants in Game Reserve ecosystems are numerous. Its' covers aid fauna prey species with protection. Habitat composition contributes to carbon sequestration, nutrient cycling, and organic matter composition (Pan *et al*. 2011). Vegetation is the major constituent of wildlife habitat component that can directly influence cover and food availability and indirectly detect water availability and quality. However, anthropogenic threats such as agricultural expansion, settlement, and extractive forest use around the research site lead to vegetation degradation and loss in wildlife habitat, ultimately deteriorating wildlife habitat quality. A change in plant species composition and structure in a wildlife habitat corresponds to a change in wild faunal composition (McNear Jr 2013; Fu *et al*. 2015). Mammalian herbivores dwell in all major terrestrial ecosystems on Earth (Ripple *et al*. 2015) and require large home ranges (Berger 2004). Hence, they are also referred to as important species that require large and suitable habitats for their conservation and management (Isasi-Catala 2011). Despite the fact that mammals require large, extensive, quality wildlife habitats and that their habitats are under immense pressure, studies on the vegetation- wildlife relationship are limited in number and scope. Most studies focused either on floral diversity or wildlife species, with a clear link between habitat vegetation composition and structure and wildlife species. Therefore, the present study is aimed at evaluating the floristic composition (tree and understory (shrubs and herbs)) and structure of the Game Reserve.

2 Material and Methods

2.1 Description of the study area

The African Union (AU) pioneered the setting up of reserves, including Pandam WildlifeGame Reserve, Plateau State, Nigeria, which was established in 1972. Pandam Wildlife Game Reserve is a swamp, and wooded Guinea- savannah habitat located in the north-central of Nigeria (8º 35' N and 8º 55' N and 8º 00' E and 10º 00' E) (Figure 1; Ezealor 2002). The PWP protects a forested area of 327.54 km^2, with an important water source (a Y-shaped lake being the major tributary of River Benue) for much of the Qu'apam Local Government Area. The elevation range of the Game Reserve (from 91 to 206 m above sea level) results in three diverse ranges of habitat. The Savannah-woodland is dominated by *Parinari curatellifolia, Combretum nigricans,* and *Vitellaria paradoxa;* Swamp land *Mitragyna inermis, Acacia nilotica,* and Riparian Forest mostly along the tributaries of the banks of the Pandam Lake, dominated by *Vitex doniana, Erythrophleum suaveolens, Rauvolfia vomitoria, Prosopis africana,* and *Elais guinensis*. The soil is ferruginous and lies over sedimentary rocks (Akosim *et al*. 2004). The mean annual rainfall ranges from about 1000 to 1500 mm (Samson 2016). The annual mean temperature of the Game Reserve is 39ºC. The reserve is surrounded by areas of high human population density and intense agricultural practice. Human activities encroaching on the Game Reserve have led to high levels of habitat degradation through unmanaged logging, charcoal production, and livestock grazing. The perimeter wire fence erected at the early time of the Game Reserve creation (1973), to help preserve the ecosystem while protecting neighboring communities from damage caused by wildlife, has been pulled down.

2.2 Data collection procedure and analyses

We surveyed the three existing habitats in Pandam Game Reserve using a total of 48 plots established on 12 transect lines. Line transects of 2 km in length, each spaced 1km apart, were established across three different habitat types (savannah woodland (SW), riparian forest (RF), and swamp land (SL)). Proportional to the size of each habitat type, a total of 4, 3 and 3 transects were established in savannah woodland, riparian forest and swamp land, respectively. On each transect, a total of four (50 x 50 m^2) sample plots spaced at 500m intervals were established. In each plot, tree species of Dbh $\geq$10 cm at 1.3 m above the ground were identified and enumerated (number/ha). Trees were identified according to the International Plant Nomenclature Index (IPNI, 2008). Nested quadrats were laid at the center and four corners of each plot and used to estimate the density of shrubs [/m^2] and herbs [/m^2] in 5 x 5 m^2 and 1 x 1 m^2 quadrat, respectively.

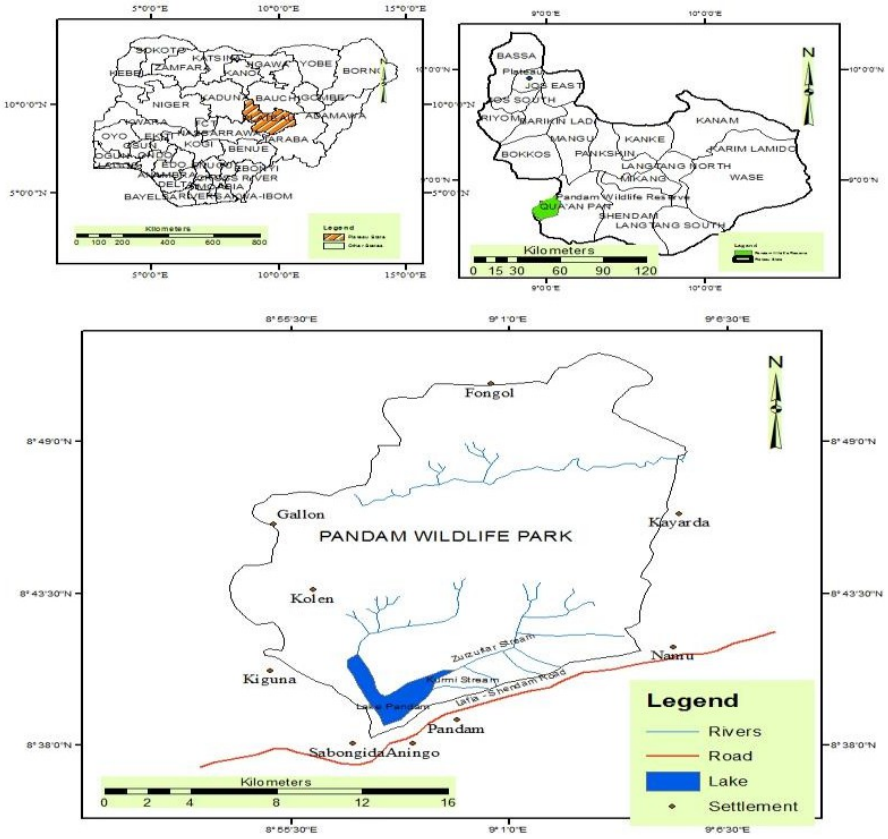

Figure 1: Study area Map

2.3 Data Analysis

Important value index was calculated on the basis of RF, RD and RDo

$$RF = \frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100$$

$$R_0 = \frac{\text{Number of a species}}{\text{Total Number of all species}} \times 100$$

$$R_{0_0} = \frac{\text{Summation based areas of all trees of a species}}{\text{Summation of basal areas of all trees}} \times 100$$

$$IVI = \frac{(RD + RF + RDo)}{3}$$

Where:

- RF: Relative frequency
- RD: Species relative density
- RDo: Species relative dominance
- IVI: Species importance value index

Diversity indices such as Simpson $(1 - D)$ index and Shannon-Wiener (H') index (Magurran, 2004), Evenness (E_u), and Margalef Index (MI) were computed to compare the plant diversity among habitat types and for the pooled diversity using equations 6 to 10 below.

The overall diversity index and the diversity among habitat types were computed using Simpson's diversity index formula below (equation 7):

$$D^S = 1 - \sum \frac{n_i(n_i - 1)}{N(N - 1)}$$

Likewise, the overall diversity index and the diversity among habitat types were also computed using Shannon-Wiener Index (H') formula below (equation 8) — The index depends on species richness and evenness:

$$H' = -\sum \left(\frac{n_i}{n} \times \ln \frac{n_i}{n}\right)$$

Pilon evenness (J) was used compares the actual diversity value among habitat types and the pooled:

$$J = \frac{h\nu}{n_{\max}}$$

In addition, the Margalef's index (MI) among habitat types and for the overall was also computed using the equation below:

$$MI = \frac{n-1}{\ln N}$$

Where n is the number of individuals or amount (biomass) of each of the i species and N is the total number of individuals (or biomass) for the site.

3 Results

3.1 Family representation of plant species of Pandam WildlifeGame Reserve

A total of 37 families were recorded in the plant life forms; out of this number, tree species were represented by 20 (54.05%), shrubs 11 (27.03%) and herbs 7 (18.92%) families. The tree species result revealed that 12 families had just a species each, while 3 families had 7, 6, 4, and 3 species, respectively. Also, 2 families had 2 species each. The dominant family was Fabaceae with 7 species (16.67%), followed by Combretaceae with 6 species (14.29%), and the least were Bombacaceae, Caesalpiniodeae, Leguminosae, Simaroubaceae, Anacardiaceae, Ochnaceae, Celastraceae, Apocynaceae, Sterculiaceae, Myrtaceae, Sapotaceae and Verbenaceae with one species each (Figure 2).

For the shrub species recorded, the family Malvaceae was most dominant with 3 species (21.43), followed by Arecaceae and Fabaceae with 2 species each (14.29%) and the least dominant families were; Mimosoideae, Connaraceae, Asteraceae, Vitaceae, Euphorbiaceae, and Sapotaceae with a species each (Figure 3). Among the herb species, Poaceae was the most dominant with 13 species (54.17%), followed by the family Cyperaceae with 4 species (16.67%) and the least dominant families were; Acanthaceae, Euphorbiaceae, Amaranthaceae, and Melastomataceae with a species each (Figure 4).

3.2 Tree and understorey species composition and structure

A total of 6,451 individuals of plant species in 37 families were recorded; of these, 1,338 (20.74%) were trees, 738 (11.44%) were shrubs and 4,375 (67.82%) were herbs. Out of the total of 80 species, 42 (20 families) were trees, 24 (7 families) were herbs and 14 (10 families) were shrubs (Table 1).

The result in Table 2 depicts the tree species' relative frequency (RF), relative density (RD), and relative dominance (RDO) and Important Value Index (IVI) across the habitats. In Savannah Woodland (SW), RF, RD, RDO and IVI values ranged from 1.01 to 8.08%, 0.26 to 16.49%, 0.13 to 15.00% and 0.48% to 12.85%, respectively. Within the Riparian Forest RF, RD, RDO and IVI values ranged from 0.53 to 17.46%), (1.61 to 11.29%), 0.36 to 14.10%) and IVI 1.44% to 13.96% respectively. In the Swamp land (SL) RF, RD, RDO and IVI values ranged from 2.70 to 10.81%, 1.02 to 43.88%, 0.21 to 26.71%, and 1.31% to 27.13% respectively.

The most occurring tree species in savannah woodland was *Maranthes polyandra* with the highest relative frequency of 8.08%, in riparian forest *Vitex doniana* occurred most with a relative frequency of 17.46% and in swamp land, *Mitragyna inermis* was the most occurring tree species with the relative frequency of 10.81%. *Parinari curatellifolia* was the most populous tree species in the savannah woodland with an RD value of 16.49%, while *Vitex doniana* (11.29%) was the most populous tree species in the riparian forest and *Mitragyna inermis* with an RD value of 43.88% being the most populous tree species in the swamp land of theGame Reserve. Tree species dominance in savannah woodland revealed that *Parinari curatellifolia* was the highest with an RDO value of 15.00%, while in riparian forest *Erythrophleum suaveolens* had the highest RDO value of 14.10%, and *Mitragyna inermis* had an RDO value of 26.71% in swamp land. The Important Value Index (IVI) provides knowledge on important species in a floristic community. Based on the IVI, *Parinari curatellifolia* was the most dominant tree species in savannah woodland with an IVI of 12.85 and riparian forest *Vitex doniana* with an IVI of 13.96, and *Mitragyna inermis* in swamp land with IVI value of 27.13 (Table 2).

3.3 Trees /understorey (herbs and shrubs) species diversity across habitats of Pandam Wildlife Game Reserve

The result of trees, herbs, and shrubs' species diversity is given in Tables 4 to 6. Several trees and density were higher in SW (33,188) and least in RF (15, 80). Simpson index (D) and Shannon- wiener (H') were also highest in SW (D = 0.92, H' =2.97), followed by SL (D = 0.88, H' =2.63) and the least in RF (D = 0.80, H' =1.97) (Table 4).

The number, density and diversity of shrub species given in Table 5 revealed a higher abundance in SW (14, 162), followed by SL (12, 116) and the least in RF (9, 86). Simpson index (D) and Shannon-wiener (H') were also highest in SW (D = 0.91, H' = 2.52), followed by SL (D = 0.91, H' = 2.45) and the least in RF (D = 0.77, H' = 1.85). The herb species number, density and diversity indicated the highest dominance in SW (23, 1012), followed by SL (19, 702) and the least was RF (17, 567). Simpson index (D) and Shannon-wiener (H') were also highest in SW (D = 0.95, H' = 3.08), followed by SL

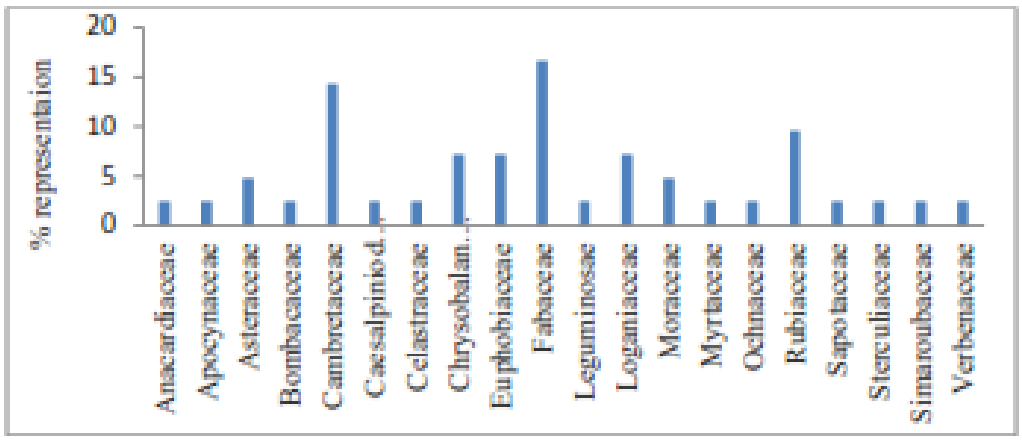

Figure 2: Family representations of tree species in Pandam Wildlife Game Reserve

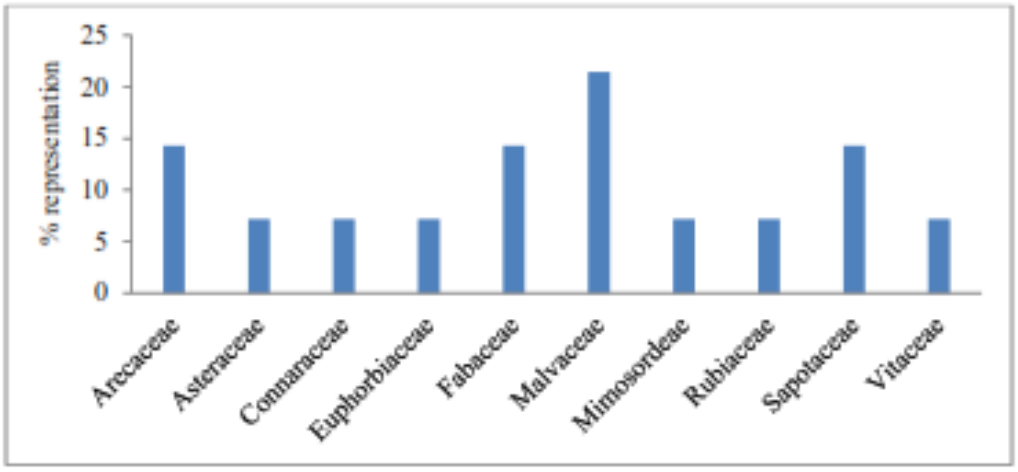

Figure 3: Family representations of shrubs species in Pandam Wildlife Game Reserve

(D = 0.94, H' = 2.86) and the least in RF (D = 0.93, H' = 2.7) (Table 6).

4 Discussion

4.1 Plant species composition, Important Value Index (IVI), and family representation

This study revealed a clear distinction between the savannah woodland, riparian forest, and swamp land in terms of tree and understorey species distribution in the Game Reserve. There was a discernible pattern of plant existence for tree species as one moved from savannah woodland to the riparian forest and understorey species from savannah woodland to swamp land. Information on habitat characteristics is relevant to plant ecology as it also describes the state of vegetation in line with wildlife species' habituation, abundance, and survival. The composition of varied plant species indicates the structure of the habitat.

The IVI reveals the ecological importance of a species in a given ecosystem and is thussed for prioritising species conservation strategies (Kacholi 2013). The IVI value thus ranges from 0.00 to 3.00 (or 300%). The high IVI exhibited by *Parinari curatellifolia, Combretum nigricans, Maranthes polyandra*, and *Daniellia oliveri* at savannah woodland; *Vitex doniana, Rauvolfia vomitoria, Erythrophleum suaveolens* and *Daniellia oliveri* at the riparian forest; and *Mitragyna inermis, Erythrophleum suaveolens, Vitex doniana* and *Acacia nilotica* at swamp land is largely due to its higher species density compared to other species at different habitats of theGame Reserve. The occurrence of many species with lower IVI values in the Game Reserve is an indication that the majority of species were rare in the forest. This finding is also supported by the frequency of the family distribution of plants. However, the top five important families of plants recorded in the reserve were in line with the reports of some researchers like Maradana and Owk (2016) and Wakawa *et al.* (2017). The dominance of the two families Fabaceae and Poaceae were mainly due to high species abundance in trees and herbs species. Generally, trees belonging to these families are widespread in the subtropics and tropical forests, and play significant roles in the socio-economic life of people, improve soil fertility, serve as forage resources, and are rich in medicinal values (Addo-

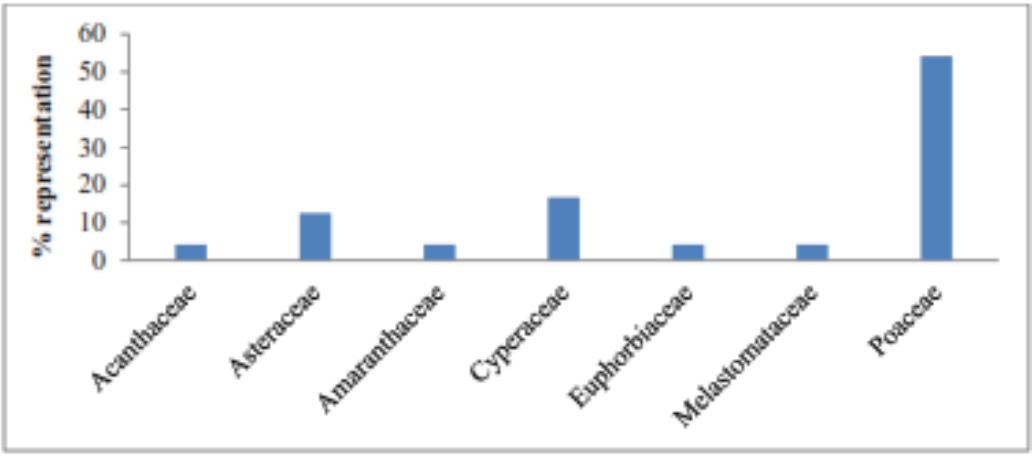

Figure 4: Family representations of herbs species in Pandam Wildlife Game Reserve

Table 1: Plant species richness distribution according to life forms in Pandam Wildlife Game Reserve

S/No.	LF	FI	Total	Families
1	Tree	42	42	20
2	Shrubs	14	14	10
3	Herbs	24	24	7
	Total	80	80	37

Note: LF - Life form, FI - fully identified

Fordjour *et al*. 2009; Aladesanmi *et al.* 2017; Wakawa *et al.* 2017). The rare number of species encountered in theGame Reserve confirms the commonly acclaimed notion that most of the species in the altered ecological forest are rare, rather than common (Magurran 2004). The rarity may be due to anthropogenic disturbance in the Game Reserve, especially logging and charcoal production that occurred at its peak in late 2017 up to 2018 within the research period.

4.2 Plant species density and diversity

Tree species diversity in both guinea savannah and tropical forest differ, even within the same forest (Steege *et al.* 2000; Neumann and Starlinger 2001). The tree species diversity assessed with Simpson (D) and Shannon-Weiner (*H'*) was found to be higher in savannah woodland with 2.97. Diversity indices measured for understorey (herbs and shrubs) species were also found to be higher (D-3.0: H'-2.25) in savannah woodland. Species diversity measures the composition and assemblage of species which indicates their relative abundance (Gotelli and Chao 2013). The decrease in tree species diversity indices from riparian forest to swamp land suggests that tree distribution and composition declined with the corresponding effect by land-use type. Evidence of logging especially in the riparian part of the Game Reserve was high. Understorey composition also decreased in riparian forest to swamp land and was dominant in the savannah woodland, suggesting that herbs especially are favored by undisturbed areas (Ares *et al*. 2010). The value for tree species determined by the Shannon- Weiner index reflected a moderate diversity in the Game Reserve. The values, however, compare favourably with the values of Bello *et al.* (2013) in Kogo Forest, Wakawa *et al.* (2017) in Sahelien forest in Yobe State, and Asinwa *et al*. (2018) in Ogun River Watershed. The values are less compared with David (2014), Maradana and Owk (2016), and Aladesanmi *et al.* (2017). The stand density (202 trees ha^{-1}) of the Pandam Wildlife Game Reserve (PWP) is low compared with Duran *et al.* (2006) with a value of 347 trees ha^{-1}; Kessler *et al.* (2005) obtained 544 trees ha^{-1}. In any given forest, lower tree stands in an area usually reflect the higher composition of understorey vegetation (Pardini *et al*., 2005). This was evident in the Game Reserve as reflected high diversity of understorey species.

5 Conclusion

Protected Areas like Game Reserve require a continuous update of information on the status and trend of habitat components. This research presents methods for evaluating floristic diversity and structure. Savannah woodland habitat is the most diverse in tree and shrub species and understory herb species, which corresponds to better cover and foraging opportunities for the wildlife species in the game reserve. This calls for especially conservation attention for the particular habitat so as to maintain persistent wildlife population in the reserve. However, to make apply sound wildlife habitat management prescriptions there is also a need for further study on the relationship between floristic diversity and structure and wildlife species population abundance.

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Conflict of interest:

No conflict of interest

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Table 2: Tree species composition based on Importance Value Index across the habitats in Pandam Wildlife Game Reserve.

S/N	Species	Savannah woodland				Riparian forest				Swamp Land			
		RF	RD	RD	IVI	RF	RD	RD	IVI	RF	RD	RD	IVI
1	Acacia nilotica	2.020	1.047	1.547	1.538	1.058	3.226	1.520	1.935	5.405	5.102	11.230	7.246
2	Anogeissus leiocarpa	2.020	2.618	5.368	3.335	0	0	0	0	2.703	1.020	2.096	1.940
3	Anthocleista djalonensis	1.010	0.262	0.276	0.516	2.646	3.226	1.294	2.389	2.703	1.020	0.216	1.313
4	Antidesma venosum	1.010	0.262	0.261	0.511	0	0	0	0	2.703	1.020	0.598	1.440
5	Bombax costatum	1.010	0.524	1.142	0.892	0	0	0	0	0	0	0	0
6	Borassus aethiopum	0	0	0	0	3.704	4.839	6.071	4.871	2.703	1.020	2.096	1.940
7	Burkea africana	5.050	5.236	6.844	5.710	0	0	0	0	2.703	1.020	0.329	1.411
8	Combretum nigricans	7.070	15.183	8.963	10.405	6.878	6.452	2.814	5.381	0	0	0	0
9	Combretum spp	4.040	2.094	1.235	2.456	0	0	0	0	5.405	8.163	2.624	5.397
10	Combretum zenkeri	0	0	0	0	1.587	3.226	0.586	1.800	0	0	0	0
11	Crossopteryx febrifuga	5.050	2.356	1.234	2.880	0	0	0	0	2.703	1.020	0.788	1.504
12	Dialium guineense	0	0	0	0	0	0	0	0	5.405	2.041	0.979	2.808
13	Daniellia oliveri	4.040	7.068	9.220	6.779	9.524	8.065	5.701	7.763	2.703	1.020	2.731	2.151
14	Elaeis guineensis	0	0	0	0	0	0	0	0	5.405	2.041	2.984	3.477
15	Erythrophleum suaveolens	0	0	0	0	0	0	0	0	5.405	6.122	20.694	10.740
16	Ficus asperifolia	1.010	0.524	0.404	0.646	0	0	0	0	0	0	0	0
17	Ficus sur	0	0	0	0	1.058	3.226	1.370	1.885	0	0	0	0
18	Hymenocardia acida	1.010	1.047	0.127	0.728	0	0	0	0	2.703	1.020	0.376	1.366
19	Lannea schimperiana	7.070	3.665	6.699	5.811	0	0	0	0	5.405	2.041	1.046	2.831
20	Lophira lanceolata	2.020	0.785	1.391	1.399	0	0	0	0	0	0	0	0
21	Maytenus senegalensis	1.010	0.262	0.177	0.483	0	0	0	0	0	0	0	0
22	Maranthes polyandra	8.080	9.424	6.918	8.141	9.524	8.065	3.722	7.104	0	0	0	0
23	Mitragyna inermis	1.010	0.262	0.270	0.514	0	0	0	0	10.811	43.878	26.711	27.133
24	Pachystela msolo	0	0	0	0	2.116	3.226	1.480	2.274	0	0	0	0
25	Parinari curatellifolia	7.070	16.492	14.996	12.854	0	0	0	0	0	0	0	0
26	Parinari polyandra	1.010	1.310	2.143	1.488	0	0	0	0	0	0	0	0
27	Parkia biglobosa	2.020	1.310	2.467	1.670	0	0	0	0	0	0	0	0
28	Prosopis africana	2.020	0.524	0.937	1.160	2.646	3.226	13.198	6.357	5.405	2.041	1.796	3.081
29	Pterocarpus erinaceus	4.040	3.665	3.526	3.744	0	0	0	0	2.703	1.020	1.138	1.620
30	Rauvolfia vomitoria	0	0	0	0	13.757	4.839	7.458	8.685	0	0	0	0
31	Sarcocephalus latifolius	1.010	0.262	0.114	0.462	1.058	3.226	0.417	1.442	5.405	2.041	1.001	2.816
32	Sterculia setigera	2.020	0.524	0.546	1.030	0	0	0	0	2.703	1.020	1.284	1.669
33	Strychnos innocua	5.050	4.712	1.898	3.887	0	0	0	0	0	0	0	0
34	Strychnos spinosa	1.010	0.262	0.481	0.584	0	0	0	0	0	0	0	0
35	Syzygium guineensis	2.020	1.047	1.951	1.673	0	0	0	0	2.703	1.020	6.805	3.509
36	Terminalia avicennioides	2.020	1.832	1.800	1.884	5.291	6.452	2.859	4.867	0	0	0	0
37	Terminalia schimperiana	6.060	4.712	3.232	4.668	2.646	3.226	2.384	2.752	0	0	0	0
38	Uapaca togoensis	1.010	0.262	0.321	0.531	0	0	0	0	0	0	0	0
39	Detarium microcarpum	0	0	0	0	0	0	0	0	2.703	3.061	9.451	5.072
40	Vitellaria paradoxa	5.050	4.450	8.013	5.838	0	0	0	0	1.587	4.839	0.891	2.439
41	Vitex doniana	4.040	5.497	7.791	5.776	17.460	11.290	13.135	13.962	8.108	10.204	10.782	9.698

Table 3: Understorey (herbs and shrubs) species composition of Pandam Wildlife Game Reserve.

	Species	Habitats (N/m^2)		
		SW	RF	SL
Herbs	*Ageratum conyzoides*	60	0	0
	Andropogon tectorum	110	160	80
	Axonopus flexuosus	68	20	60
	Brachiaria brachyticha	59	68	45
	Eragrostis ciliaris	68	0	74
	Eragrostis tremula	73	68	47
	Imperata cylindrica	80	80	89
	Leersia hexandra	120	50	0
	Leptochloa caerulescens	70	60	201
	Oplismenus burmannii	87	0	60
	Panicum brevifolium	92	48	52
	Panicum congoense	80	54	0
	Pennisetum pedicellatum	0	50	80
	Pennisetum subscrobiculatum	0	47	39
	Pilea africana	201	89	60
	Pilea buettneri	89	0	60
	Pycreus polystachyos	63	47	80
	Rottboellia cochinchinensis	53	0	78
	Sacciolepis africana	79	78	0
	Sida rhombifolia	72	48	54
	Sporobolus pyramidalis	89	25	60
	Synedrella nodiflora	100	100	66
	Tridax procumbens	109	48	89
	Vernonia cinerea	80	0	0
Shrubs	*Acacia gourmaensis*	12	0	10
	Borassus aethiopum	40	11	15
	Bridelia ferruginea	30	13	0
	Byrsocarpus coccineus	20	0	13
	Chromolaena odorata	41	0	10
	Combretum collinum	34	14	14
	Ficus platyphylla	34	9	0
	Gardenia aqualla	24	12	18
	Mimosa diplotricha	17	12	7
	Mimosa invisa	41	20	7
	Pachystela brevipes	14	14	17
	Raphia sudanica	13	0	19
	Sclerocarya birrea	13	0	9
	Triumfetta rhomboides	60	84	18
	Waltheria indica	20	17	14

SW: Savannah woodland, RF: Riparian forest, SL: Swamp land

Table 4: Tree species number, density, and diversity indices across habitats of Pandam Wildlife Game Reserve.

Parameters	Savannah Woodland	Riparian Forest	Swamp Land	Pooled
Taxa_S	33	15	24	42
Individuals	716	296	362	1338
Number of Individuals ha^{-1}	188	80	96	202
Dominance_D	0.08	0.20	0.12	0.06
Simpson_1-D	0.92	0.80	0.88	0.94
Shannon_H	2.97	1.97	2.63	3.19
Evenness_eˆH/S	0.54	0.48	0.58	0.58
Margalef	4.87	2.46	3.90	5.70

Table 5: Shrubs species number, density, and diversity indices across habitats of Pandam Wildlife Game Reserve.

Parameter	Savannah Woodland	Riparian Forest	Swamp Land
Taxa	14	9	12
Individuals	380	194	164
Density	162	86	116
Dominance	0.09	0.23	0.09
Simpson	0.91	0.77	0.91
Shannon	2.52	1.85	2.44
Evenness	0.88	0.71	0.96
Margalef	2.19	1.52	2.15

Table 6: Herbaceous species number, density, and diversity indices across habitats of Pandam Wildlife Game Reserve.

Parameter	Savannah Woodland	Riparian Forest	Swamp Land
Taxa	23	17	19
Individuals	1950	1051	1374
Density	1012	567	702
Dominance	0.05	0.07	0.06
Simpson	0.95	0.93	0.94
Shannon	3.08	2.73	2.86
Evenness	0.95	0.90	0.92
Margalef	2.90	2.30	2.49