



ASSESSMENT OF FLORA CHARACTERISTICS OF SAMBISA GAME RESERVE, BORNO STATE, NIGERIA

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ABSTRACT: The study was aimed at assessing the flora characteristics of Sambisa Game Reserve. Preliminary study was carried out for the purpose of identifying and delineating major wildlife habitats of the game reserve based on major plant communities in which inventory of flora was done. Relative frequency and density of woody plant species was obtained by counting all woody plants present in a 15m x 15m quadrat laid at each 100m along established transects. Relative dominance of tree species were obtained by measuring girth sizes by placing a girth tape around the circumference of tree trunks at 1.3m off the ground. Importance value index of woody plant species were calculated using the results of relative frequency, relative density and relative dominance. Heights of trees were measured using clinometers. Crown area of tree species were obtained by measuring perpendicular distances of a tree crown with measuring tape. Survey for species listing, density and ground cover of herbaceous plant species were carried out using 1m x 1m quadrat laid at 100m interval along established transects. There were 37 species of woody plants belonging to 19 families. The relative dominance of *Diospyros mespiliformis* (32.31) was higher than all the other woody plants. The highest importance value of 14.53 was obtained for *Ficus* species and least of 5.30 for *Faidherbia albida*. Over 50% of the woody plants were in the height class of 0≤3m. About 52% of trees were in the girth class of 20≤40cm. Tree crown area coverage ranges from 22.15% in *Acacia-Ziziphus* complex to 60.22% in the *Khaya-Combretum* association habitats. There were 24 species of herbaceous plants inventoried dominated by annuals covering 41.10% of the ground. The woody plants are the draught resistant and fire tolerant species characteristics of savannah woodland.

Key words: Species list, relative dominance, species diversity, height, cover

1. INTRODUCTION

Game reserves are areas set aside by State Governments for the protection of wildlife resources managed through legal or other effective means (Lanjouw *et al.* 2000). They are important reservoirs for forest products (Ezealor 2002). Apart from providing the support zone communities with basic amenities of life, game reserves also protect the environment and the indigenous genetic resources which are the basis for any agricultural improvement in agricultural development and production (Ezealor 2002). According to Alo *et al.*, (1997) and Anderson (2009), the benefits of game reserve used for wildlife conservation are enormous; these, according to them are perpetuation of gene pool, provision of conducive climate, conservation of habitats (water and landscape) and the resultant ecological stability.

Sambisa Game Reserve was gazetted as a forest reserve in 1958 and was constituted to a Game reserve

in 1978 by the Borno State Government, Ministry of Natural Resources (1978). The main objectives of establishing Sambisa Game Reserve was to protect, conserve and manage representative samples of indigenous faunal and floral resources unique to the North-Eastern geographical sub-region of Nigeria; provide wild vegetables, fruits and other minor forest products, to encourage general interest in wildlife resources and to educate the public on the knowledge of wildlife resources (Ministry of Natural Resources, 1978).

The flora provides the varying cover and food resources based on the requirement of wildlife species. White and Edward (2000) observed that height of trees, canopy cover, tree density, girth size and basal area determine the quantity of sunlight that reaches the ground which strongly influence the species composition of trees and other plants, and in turn influence which animal species are found there. The level of destruction of the flora is high because of

incessant burnings, grazing use and illegal felling of trees. The aim of this study therefore is to investigate the flora characteristics of the game reserve to provide a baseline for management plan in view of sustaining the resources.

2. MATERIALS AND METHODS

2.1. Study Area

Sambisa Game Reserve is located between Longitudes 13° 30' and 14° 00' East and Latitudes 11° 00' and 11° 30' North. It is about 70km south of Maiduguri in Borno State and is located 14km off Kawuri village along Maiduguri-Bama road. The reserve is located in an area of low human population density cutting across three local government areas of the state, namely Konduga, Gwoza and Bama. The major tribes of the support zone communities are Kanuri, Fulani, Gamargu and Gwoza whose occupations are majorly farming and livestock rearing.

The reserve covers an area of 518km² on a fairly flat land drained by three seasonal flowing streams (Kwada, Sambisa and Yuwe) which are tributaries of River Yedzeram. The drainage is poor and the land is liable to flooding with the entire game reserve getting waterlogged and marshy in the rainy season (MNR 1978). The climate is characteristic of Sudan Savannah marked by hot, dry and wet climate with mean annual temperature of 28°C and a maximum temperature of 45°C at the onset of the rains (Borno State Government, 2008) Minimum temperature of 21.50°C is recorded between December and February during the harmatan period. The rains commence in May and ends in September with a mean annual rainfall of 708 mm and a relative humidity of 49% (BOSG2008). The vegetation of the area is broadly that of Sudan Savannah with open woodlands and patches of gallery forests comprising of drought resistant and fire tolerant tree species. The combined long time effect of grazing, fire and felling of trees have significantly altered much of the natural vegetation. The reserve has relatively abundant fauna resources (Chad Basin National Park 2000). Commonly sighted are primates, antelopes, hares, squirrels, guinea fowls, francolins and weavers.

2.2. Study Design and Data Collection

Preliminary study of the area was carried out to identify and delineate major vegetation communities/wildlife habitats of the game reserve. Preliminary assessment of the vegetation types showed that the reserve can be broadly divided into woodland savannah and riparian vegetation. Further assessment using belt transect based on the dominant plant species of the woodland savannah led to the classification of vegetation types into riparian

vegetation (RP), *Anogeissus-Piliostigma* association (AP), *Balanites-Ziziphus* association (BZ), *Acacia-Ziziphus* complex (AZ) and *Khaya-Combretum* association (KC). These five vegetation communities formed the wildlife habitats in the reserve as they provided varying cover and food resources based on the requirements of the wildlife species.

Survey of woody plants for relative frequency, relative density, relative dominance, importance value index, girth and height classes and crown area were done as described by Kershaw (1979) and Oyeboade and Adekunle (2010) and carried out simultaneously.

Species listing was done using tables.

- (a) Relative Frequency, was obtained by counting all the woody plants in a 5m×5m quadrat laid at each 100m along the established transects and estimated as follows:

$$\text{Relative frequency: RF} = \sum \frac{n_1}{N_{1-i}}$$

Where RF = relative frequency

n_1 = number of sampling points in which the species occurred.

N_{1-i} = total number of sampling points

- (b) Relative density is the number of individual plants per unit area. Density of woody plants in the reserve were obtained from counting the number of each species in a quadrat of 10m×10m at every 100m length along the transects established in the habitat types delineated. Relative densities of woody plants were estimated as follows:

$$\text{RD} = \sum \frac{n_i}{N_{\text{Area}}}$$

Where RD = relative density

n = number of individuals of that species

N = number of individuals of all species

- (c) Relative Dominance of a tree species is obtained by measuring the girth size. Girth size of a tree is measured by placing a girth tape around the circumference of the tree trunk at 1.3m off the ground (Oyeboade and Adekunle 2010). The basal area of a tree is calculated by dividing the girth size by two to get the radius; which is squared and multiplied by π i.e 3.1416 (White and Edward 2010). Relative dominance is calculated as follows:

$$\text{RD} = \left(\frac{\text{Girth size}}{2} \right)^2 \pi$$

- (d) The importance value index (IVI) of the woody plant species was calculated using the results of relative frequency, relative density and relative dominance using the formula of Oyeboade and Adekunle (2010) as stated below;

$$IVI = \frac{RF+RD_1+RD_2}{3}$$

Where IVI = importance value

RF = relative frequency

RD₁ = relative density

RD₂ = relative dominance

The values of relative density, relative dominance and importance value were presented in a table.

- (e) Girth sizes of trees were measured using a specially marked girth tape by placing the tape around the circumference of tree trunks at 1.3m off the ground.
- (f) Heights of trees were measured using clinometers and height classes were calculated using percentages.
- (g) Crown area of the trees were obtained by measuring perpendicular distances of a tree crown with a measuring tape and estimated according to Oyebode and Adekunle (2010) as follows:

$$\text{Crown area} = \frac{[(D_1+D_2)^2 \bar{X}]}{4}$$

Where D₁ and D₂ = Perpendicular diameters of a tree crown

\bar{X} = Mean perpendicular diameters of a tree crown

The herbaceous plant species survey for species listing, density and ground cover were carried out using one meter square quadrat laid at 100m interval along established transects as outlined by Austin (1989), Sutherland (1999) and Greig (2000). Ten quadrats were laid in each of the habitat types. In each quadrat, all herbaceous plant species were identified, counted and recorded. From the data, species list, densities of each species present and ground cover of each species were estimated following Austin, (1989). Ground cover and density were expressed in percentage. Descriptive statistics in form of tables, frequencies and percentages were used to analyze the data.

3. RESULTS

3.1 Checklist of Woody Plants

Species list of woody plant species in Sambisa Game Reserve according to habitat types is shown in Tables 1 and 2. There were 37 species of woody plants inventoried belonging to 19 families. Families with the highest number of species are the Mimosaceae (7), Combretaceae (6) and Moraceae (5). On plant community bases, the *Anogeissus-Piliostigma* association contained 22 species of woody plants, *Khaya-Combretum* association (14) *Balanites-Ziziphus* association (14) while 16 species were found in Riparian vegetation and 13 species in *Acacia-Ziziphus* complex. *Faidherbia albida* and *Piliostigma thonningi* occurred in four habitat types while *Diospyros mespiliformis* was found to be present in the riparian vegetation only.

Table 1: Species List of Woody Plants in the Study Area

Plant species Family/ Scientific Name	RP*	AP	BZ	AZ	KC
Balanitaceae					
<i>Balanites aegyptiaca</i>	X	-	X	-	X
Combretaceae					
<i>Combretum paniculatum</i>	-	X	-	-	X
<i>Combretum glutinosum</i>	-	X	-	-	X
<i>Anogeissus leiocarpus</i>	-	X	X	X	-
<i>Guiera senegalensis</i>	-	-	X	X	-
<i>Terminalia gloucescens</i>	X	-	X	X	-
<i>Terminalia macroptera</i>	-	-	X	-	-
Bombacaceae					
<i>Adansonia digitata</i>	-	X	-	-	X
Caesalpinaceae					
<i>Tamarindus indica</i>	X	X	-	-	X
<i>Piliostigma thonningi</i>	X	X	X	-	X
<i>Bauhinia rufescens</i>	-	X	-	-	X
Ebenaceae					
<i>Diospyros mespiliformis</i>	X	-	-	-	-
Rhamnaceae					
<i>Ziziphus mauritiana</i>	-	X	-	-	-
<i>Ziziphus spina-christi</i>	-	X	-	-	-
<i>Ziziphus mucronata</i>	X	-	X	X	-
Mimosaceae					
<i>Acacia nilotica</i>	X	X	-	X	-
<i>Acacia Senegal</i>	-	X	-	X	-
<i>Acacia seyal</i>	-	X	-	X	-
<i>Acacia radiana</i>	X	X	-	X	-
<i>Faidherbia albida</i>	-	X	X	X	X
<i>Dichrostachys cineria</i>	X	-	-	-	-
<i>Acacia mellifera</i>	-	-	-	X	-
Meliaceae					
<i>Khaya senegalensis</i>	X	X	-	-	X
Sapotaceae					
<i>Butyrospermum paradoxon</i>	-	-	X	-	-

Source: Field Survey 2009 * RP- Riparian Vegetation, AP- *Anogeissus-Piliostigma* Association, BZ- *Balanites-Ziziphus* Association, AZ- *Acacia-Ziziphus* Complex and KC- *Khaya-Combretum* Association

Table 2: Other Species of Woody Plant in the Study Area

Plant species Family/ Scientific Name	RP*	AP	BZ	AZ	KC
Olacaceae					
<i>Ximenia Americana</i>	-	X	-	-	X
Asclepiadaceae					
<i>Calotropis procera</i>	-	X	-	-	X
Moraceae					
<i>Ficus platyphylla</i>	X	-	-	X	-
<i>Ficus polita</i>	X	X	-	X	-
<i>Ficus ingens</i>	X	-	X	-	-
<i>Ficus sycomorus</i>	X	X	-	-	-
<i>Ficus gnaphalocarpa</i>	X	-	-	X	-
Sterculiaceae					
<i>Sterculia setigera</i>	-	-	X	-	-
Rubiaceae					
<i>Gardenia ternifolia</i>	-	X	X	-	X
Tiliaceae					
<i>Grewia flavescens</i>	-	X	-	-	-
Capparideaceae					
<i>Bosia angustifolia</i>	-	X	-	-	X
<i>Strychnos spinosa</i>	-	-	X	-	X
Verbenaceae					
<i>Vitex doniana</i>	X	-	X	-	-

Source: Field Survey 2009 * RP- Riparian Vegetation, AP- *Anogeissus-Piliostigma* Association, BZ- *Balanites-Ziziphus* Association, AZ- *Acacia-Ziziphus* Complex and KC- *Khaya-Combretum* Association

3.2 Species list and relative densities of some herbaceous plants

Species list and relative densities of herbaceous plant species inventoried in Sambisa Game Reserve is presented in Table 3. There were a total of 24 species listed in which grasses were 15 (54%). Of the grass species *Cenchrus biflorus* had the highest relative density of 8.95%, followed by *Setaria pallidifusca* with 7.88%; *Aeschynomene indica* had the highest relative density among the forbs with 2.98%; *Eupherbia glamerata* had the least of 0.54%. Annuals form majority of the herbaceous plant (54%) and perennials, 46%. Three (3) species were identified to be undesirable.

Table 3: Species list and Relative Densities of Herbaceous Plant Species

Species	AN	P	UP	RD*
<i>Cenchrus biflorus</i>	X	-	-	8.95
<i>Setaria pallidifusca</i>	X	-	-	7.88
<i>Hyperhenia rufa</i>	-	X	-	7.73
<i>Eragrostis ciliaris</i>	X	-	-	7.57
<i>Paspalum conjugatum</i>	X	-	-	7.04
<i>Schoenefeldia gracilis</i>	X	-	-	6.73
<i>Pennisetum pedicellatum</i>	X	-	-	6.66
<i>Digitaria longiflora</i>	X	-	-	6.43
<i>Cassia tora</i>	X	-	X	5.59
<i>Andropogon gayanus</i>	-	X	-	4.97
<i>Sida acuta</i>	-	X	-	4.36
<i>Aeschynomene indica</i>	X	-	-	2.98
<i>Aristida stipoides</i>	X	-	-	2.83
<i>Imperata cylindrica</i>	-	X	-	2.07
<i>Cynodon plectostachyus</i>	X	-	-	1.68
<i>Brachiaria platyphylla</i>	X	-	-	1.61
<i>Hyptis suaveolens</i>	-	X	X	1.61
<i>Sporobolus pyramidalis</i>	-	X	-	1.45
<i>Panicum maximum</i>	X	-	-	1.45
<i>Desmodium adsensens</i>	X	-	-	1.38
<i>Mimosa pudica</i>	-	X	X	0.99
<i>Tridax procumbens</i>	-	X	-	0.84
<i>Euphorbia hirta</i>	-	X	-	0.69
<i>Caladium esculenta</i>	-	X	-	0.46
TOTAL				100

Source: Field Survey, (2009)

AN = Annual, PR = Perennial, UP = Undesirable plant, RD = Relative density.

3.3 Importance Value Index of some Woody Plants

Table 4 shows the importance value index of some woody plant species following the estimations of relative frequency, relative density and relative dominance. The result of relative frequency shows that *Ficus* species, *Balanites aegyptiaca* and *Acacia* species had their relative frequencies higher than 10 while *Adansonia digitata* had the least relative frequency of 1.70. The result of relative density of woody plants showed that 12 species had a relative density higher than 5 while lower densities of 1.22 and 1.70 were recorded for *Bauhinia rufescens* and *Parkia biglobosa* respectively. The relative dominance of *Diospyros mespiliformis* (32.31) was higher than all the other woody plants in the game reserve. It was followed by *Adansonia digitata* (30.30) and *Parkia biglobosa* (27.82). The highest importance value index of 14.53 was recorded for *Ficus* spp followed by *Diospyros mespiliformis* (12.93) and *Balanites aegyptiaca* (11.41). The result of the importance value index assessment shows that *Faidherbia albida* had the least by 5.30 (Table 4).

3.4 Height Class and Crown Cover of Trees and Shrubs

Height classes and crown cover of trees in each habitat are shown in Table 5. The lowest values of 32.42% and 42.00% from the $0 \leq 3\text{m}$ height class were obtained from *Khaya-Combretum* association and riparian vegetation respectively. The *Acacia-Ziziphus* complex recorded the lowest value of 17.50% in the $3 \leq 6\text{m}$ height class and equally 0.00% in both height classes of $6 \leq 9\text{m}$ and $9 \leq 12\text{m}$. The highest value of 6.25% for $9 \leq 12\text{m}$ height class was recorded in the *Khaya-Combretum* association. Crown cover was higher in the *Khaya-Combretum* and *Anogeissus-Piliostigma* associations. The value of 2215.00 m² / ha obtained in the *Acacia-Ziziphus* complex was about 36.78% of the area covered in the *Khaya-Combretum* association and 40.34% of the area covered in the *Anogeissus-Piliostigma* association, it also forms 49.81% of the cover in the riparian vegetation and 52.60% in *Balanites-Ziziphus* association (Table 5).

3.5 Girth Classes of Trees

Table 6 shows the girth classes of the trees found in the habitat types. Generally, the girth class of $20 \leq 40\text{cm}$ had the highest appearance (51.59%) followed by the girth class of $20 \leq 40\text{cm}$ (32.61%). Only 2.80% of trees in *Balanites-Ziziphus* Association habitat of the game reserve were of girth class $10 \leq 20\text{cm}$ (Table 6).

Table 4: Importance value of woody plant species

Habitat type	Plant species	Relative frequency	Relative density	Relative dominance	Importance value index
Riparian vegetation					
	<i>Ficus species</i>	12.20	6.10	25.30	14.53
	<i>Diospyros mespilliformis</i>	3.57	2.90	32.31	12.93
	<i>Tamarindus indica</i>	3.70	3.11	26.54	11.12
	<i>Dichrostachys cineria</i>	7.32	8.13	11.27	5.91
Anogeissus- piliostigma association					
	<i>Adansonia digitata</i>	1.70	2.11	30.30	11.37
	<i>Parkia biglobosa</i>	2.30	1.70	27.82	10.61
	<i>Piliostigma thonningi</i>	8.43	7.70	5.30	7.14
	<i>Bauhinia rufescens</i>	1.89	1.22	17.10	6.74
	<i>Anogeissus leiocarpus</i>	8.13	9.20	8.70	6.68
Balanites-ziziphus association					
	<i>Balanites aegyptiaca</i>	11.27	6.35	16.60	11.41
	<i>Ziziphus species</i>	9.30	8.11	11.20	9.54
	<i>Guiera senegalensis</i>	3.27	5.90	13.10	7.42
	<i>Vitellaria paradoxa</i>	2.20	4.81	12.90	6.64
	<i>Vitex doniana</i>	4.80	5.20	9.00	6.33
	<i>Sterculia setigera</i>	3.60	2.80	9.90	5.43
Acacia-ziziphus complex					
	<i>Acacia species</i>	12.70	16.10	3.62	10.81
	<i>Terminalia species</i>	5.20	6.62	4.32	5.38
	<i>Faidherbia albida</i>	4.66	3.13	8.12	5.30
Khaya combretum association					
	<i>Khaya senegalensis</i>	7.30	9.20	7.38	7.96
	<i>Combretum species</i>	6.41	8.27	7.22	7.30
	<i>Strychnos spinosa</i>	5.34	4.23	9.24	6.27

Source: Field Survey (2009)

Table 5: Height Classes and Crown Cover of Trees

Habitat Type	% In Height Classes(m)				Crown cover (M ² /ha)	% Cover
	0 ≤ 3	3 ≤ 6	6 ≤ 9	9 ≤ 12		
Riparian vegetation	42.00	34.56	20.44	3.00	4446.85	44.47
Anogeissus-Poliostigma Association	49.25	33.75	15.00	2.00	5490.45	54.90
Balanites-Ziziphus Association	48.26	47.00	4.74	0.00	4211.20	42.11
Acacia-Ziziphus complex	82.50	17.50	0.00	0.00	2215.00	22.15
Khaya-Combretum Association	32.42	30.52	30.81	6.25	6021.50	60.22
Mean	50.89	32.66	14.20	2.25	4477	44.77

Source: Field Survey (2009)

Table 6: Girth Classes of Tree Species (≥ 10cm dbh) in the Habitat types

Habitat Type	% In Girth Classes(cm)			
	10 ≤ 20	20 ≤ 40	40 ≤ 60	TOTAL
Riparian vegetation	11.70	64.30	24.00	100
Anogeissus-Poliostigma Association	22.10	30.70	47.20	100
Balanites-Ziziphus Association	2.80	70.20	27.00	100
Acacia-Ziziphus complex	34.65	62.12	3.23	100
Khaya-Combretum Association	7.75	30.65	61.60	100
Mean	15.80	51.59	32.66	100

Source: Field Survey (2009)

4. DISCUSSION

There were a total of 61 plant species i.e. 37 species of woody plants and 24 species of herbaceous plants inventoried in Sambisa Game reserve. The woody plants are the draught resistant and fire tolerant species characterizing savannah wood lands. The relative frequencies and relative densities of woody plants in the game reserve varied between the habitat types. *Diospyros mespilliformis* had the highest relative dominance while *Khaya senegalensis* had the highest importance value. The general pattern of height classes of trees showed that majority of the trees (50.89%) were in the $0 \leq 3$ m height category while only 2.25% were in the $9 \leq 12$ m height category. Trees in the girth class of $20 \leq 40$ cm predominate in the *Balanites-Ziziphus* association, Riparian vegetation and *Acacia-Ziziphus* complex habitats. However, the *Khaya-Combretum* and *Anogeissus-Piliostigma* associations recorded 61.60% and 47.20% respectively of trees in the girth class $40 \leq 60$ cm. This suggests the presence of reasonable number of tall trees and the occurrence of dense crown cover in *Khaya combretum* association ($6021.50 \text{ M}^2/\text{ha}$) and *Anogeissus piliostigma* association ($5490.45 \text{ M}^2/\text{ha}$) in these habitats which may be significant for the survival of primates particularly the Tantalus and red-patas monkeys as observed by White and Edwards (2000).

Conservation research and activities tend to focus on animals, particularly large mammals and birds. However, one cannot escape the fact that by their very nature, it is the plants that define the forest environment. The structural complexity of plant communities has often been correlated with animal diversity and that animals segregate by strata in physically complex ranges (Trivedi 2004). Forests are home to a great diversity of plant species representing many forms and life-styles. Thus, floral diversity in turn creates a wide variety of habitats and foods for animals. This agrees with White and Edwards (2000) that plants increase the temporal diversity of the forest, since animal reproduction and migration usually are linked to the timing of fruits, flowers and leaf production. Therefore, plant diversity correlate well with overall species diversity.

Herbaceous plants species was dominated by grasses (perennial and annual grass species). The annual grass species were more abundant than the perennial ones in relative density in all the habitat types with higher diversity in *Balanites-Ziziphus* association habitat. Herbaceous ground cover was dominated by grasses in the woodlands, while in the riparian vegetation, litter cover was more pronounced with low percentage of bare ground. The occurrence of low litter in the woodland habitats may be the result of indiscriminate wildfire in the reserve which is one of the characteristics of tropical habitat lands as stated by

Heady and Heady (1982) and Ogogo (2008). Forbs which are mainly perennials are abundant in the *Acacia-Ziziphus* complex, *Balanites-Ziziphus* association and riparian vegetation habitats. This perhaps accounts for the preference of these habitats by antelopes. This agrees with the report of Stoddart et al. (1975) that herbivores particularly antelopes prefer silos dominated by perennial forbs and grasses. Happold (1987) and Khamis (2008) also stated that wild animals select and inhabit habitats that best meet their basic requirements of food, cover and water. However, the woodlands are without water during most part of the dry season as all the streams get dried up during this period of the year. Hence, only animal species that are adaptable to drier areas such as *Lepus capensis*, *Epixerus epii*, *Erythrocebus patas* and *Carcopithecus aethiops* as well as birds showed preference for the woodland savannah habitats.

5. CONCLUSIONS

From this study the following conclusions can be drawn:

1. Results of the study showed that Sambisa Game Reserve contains representative samples of flora that are found in the savannah of Nigeria.
2. The level of destruction of the flora is high because of anthropogenic factors which include collection of non-timber forest products, illegal grazing by livestock rearers and wild fire which should be checked by the management through increased surveillance, reseeding and replanting of the habitats with native species for the improvement of food and cover for the animals in the game reserve.

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