Evaluation of Range Condition and Trend of Ikwe Forest Reserve Igbor, Gwer-East Local Government Area of Benue State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author GOY designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AAA and MSB managed the analyses of the study. Author AAA managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Public concern over biological resources assessment has grown over the decade due to a decline in resources through habitat fragmentation. The study was designed to evaluate the range condition and trend of Ikwe Forest Reserve in Gwer-East local government area of Benue State, Nigeria. Assessment of herbaceous cover and composition, woody plant/shrubs density and plant vigor were carried out in randomly selected sample plots. Litter cover was determined by step point transect method, while erosion and its extent were assessed by presence and degree of gullies. Data collected was analyzed using descriptive statistics and analysis of variance (ANOVA). Results obtained showed that the herbaceous cover composed of perennials (39%) and annuals (61%).

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Mean litter cover and mean tree/shrub density were 37% and 252 trees and shrubs per hectare. The relative density of general herbaceous species shows that *Ludwigia decurrens* was the highest (8.22%) whilst *Tephrosia bracteolate* was the lowest (1.27%). Grass species shows that *pennisetum pendicellatum* had the highest relative density at 17.58% (320 species) while *Mariscus alternifolis* has the lowest at 1.21% (22 species). The range condition was evaluated to be in fair condition (total score of 41.5%) when compared to a key for rating condition, and on a downward trend because of the rapid succession of less desirable plants (annuals and weeds), stunted plants and presence of slight erosion. Range management and improvement practices such as prescribed burning, range seeding and reseeding, control rate of livestock grazing and other sustainable management practices should be put in place to restore the reserve.

1. INTRODUCTION

All nature reserves are adjudged based on the range condition (number and types of trees species and animals co-existing) in an area [1]. Public concern over biological resources assessment has grown over the decades. The concern stems from overexploitation of and dependence on renewable natural resources which can result in high rate of extinction of plant and animal species [2,3]. Many factors that affect the biodiversity of any area of land or water are human induced [4,5].

A large proportion of Nigerian grassland may be considered in the accepted definition of range as land producing nature forage for animal consumption or land that are naturally or artificially revegetated. The vegetation varies a great deal in the savanna zones, consisting of rather open savanna woodland, shrubs and dominant grassland. The application of range ecology is one of fundamental building blocks upon which the field of rangeland condition, trend and management has been fashioned, therefore, the range condition and trend constitutes the important component of any reserve, and most often reflect the suitability of choice of habitat for fauna species. Generally, rangeland ecosystems are dynamic and complex to evaluate and understand because they are constantly changing as a result of human and nature induced forces [6].

Range condition is the state of health and vigor of a rangeland in relation to its full productive potential [7]. It determines the improvement or inclining in relation to traditional composition of a rangeland over a time. Therefore, it is the basis for adjusting and restocking of biological resources and the revision of management plans [8]. Thus, range protection and its proper management increase total palatable vegetation cover [9]. Range condition is one of the basic tools used in range evaluations to enable adequate judgment of stocking rate of both flora and fauna resources, and management practices [10,11]. Range composition of botanical species is the proportion of various plant species in relation to the total plant species in a given area. It measures the degree of deterioration and improvement of a rangeland [12].

Range trend indicates the changes in status of resources at a site and is usually expressed as improving, declining or stable [13]. It originally pertained to any goal defined by management such as vegetation cover by adjusting stocking rates [14]. Its assessment depends upon evaluation of general health of individual plants, the vegetation cover and the soil structure [7]. According to Kefa and Oche [15], major attributes such as vegetation cover, abundance, herbage yield, species composition, herbaceous layer as well as water availability are to be monitored to determine the condition of that range. These influence the presence of animals in rangelands and undoubtedly affect distribution and promotion of their survival.

The general view of range trend with date describing any vegetation attribute in a monitoring program is still theoretically valid, but today the term carries a more specific interpretation relating to the comparison of consecutive assessment of range condition in a monitoring program [16]. The major attributes that need to be monitored and inventoried to determine the condition of rangelands are vegetation cover, frequency, abundance or density and yield of herbage species composition [8], herbaceous layer (cover, density and frequency) and water availability [13]. Water availability influences the presence of animals in rangelands and undoubtedly affects distribution and promotion of their survival and production.

Therefore, animals tend to move away from areas with available forage to areas where the forage is overgrazed but there is water. The Ikwe forest reserve was established by the Benue State Government with the aim of conserving flora and fauna resources as well as eco-tourism activities. However, despite the biological value of the reserve, its future is not secured. This is because; the reserve is surrounded by communities with a high impact of human activities; namely farming, logging, hunting and bush burning [2,17]. This paper reviews the range condition of the Ikwe Forest Reserve with the aim of ascertaining the possibility of range improvement or deterioration.

2. MATERIALS AND METHODS

2.1 Study Area

The research was carried out at Ikwe Forest Reserve, Igbo, Gwer Local Government Area of Benue State, Nigeria which is located in the southern Guinea savanna belt on the hill area of Igbo and lies between latitude 7°27 ' and 7°30 'N and longitude 8°37 'E [2,17] as shown in Fig 1. It has an area of approximately 25 km^2 and it is about 40 km South of Makurdi along Makurdi – Aliade road. Three microhabitats of the reserve are; the woodland savannah, grassland savannah and cultivated land [2]. The reserve was created in 1980 by the Benue State Government with the aim of promoting ecotourism and biodiversity conservation. The mean annual rainfall of the area ranges from 1140 mm-1520 mm and evapotranspiration is between 0.40-0.70. Temperature is about 30°C and the relative humidity is between 60% and 80%. The topography is highly undulated ranging from 45 m to 800 m above sea-level. The soil is relatively fertile, shallow, well drained and sandy loam [18]. The dominant vegetation in the area is compose of grasses and woody plants and shrubs.
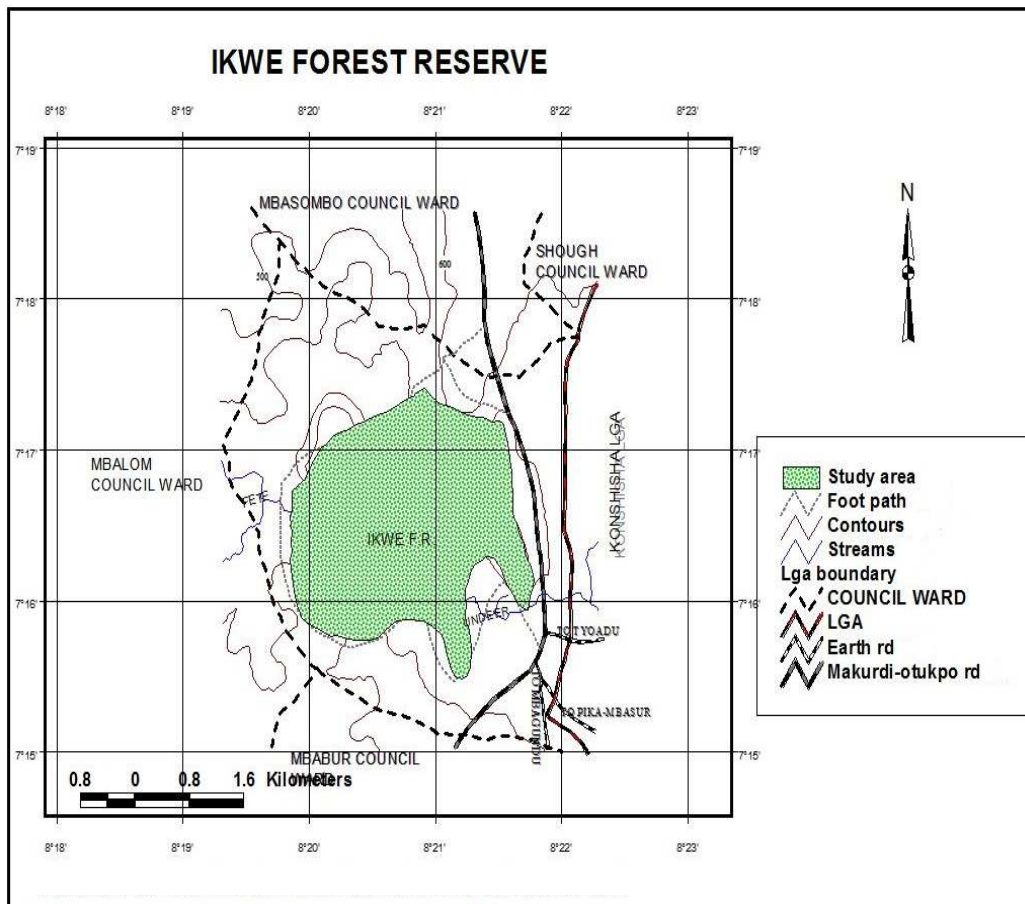

Fig. 1. Map of Ikwe Forest Reserve

2.2 Data Collection

The methods used for evaluating range condition and trend were those outlined by Kershaw, [19]; Akosim et al. [12]; Khobe et al. [11]; Mbaya et al. [13] and Khobe [8]. A reconnaissance survey was conducted for the purpose of identifying and delineating major range sites of the area. Three range sites (A, B and C) were delineated based on the habitat type and laid down division of the reserve (i.e three sites; site A= Ikwe hill (upper area), site B= Agertyav hill (middle core) and site C= River Fete (downward area)).

A survey of vegetation was conducted; covering grasses, forbs as well as trees and shrubs. Parameters measured were liter cover, plant vigor, erosion, number of trees/shrubs per hectare, relative density of plants species, perennials and annuals species. In each of the three range sites, a base line of 1000 m was established. A 18 x 20 m plot was marked out in each range site. Each plot contained 180 sub plots of 1x1 m each. Each plot represents about 5% or more of each range sites.

Herbaceous layer estimate was made using 1 m^2 quadrat frame. At each five step count (5.40 m) at a distance range of 100 m along the transect, the mapper located a sampling point by placing the quadrat in such a way that the stop point laid at the center of the quadrat. Estimate of green or dry herbaceous materials were considered. Litter cover was assessed by walking along a line transect of 100 m long and recording at every two steps (1.45), the presence or absence of litter. Only detached leaves and straws, weather green or dry, were considered as litter. Data were collected along two transect in each range site.

Assessment of erosion was done using the method modified by Akosim et al. [12]. No erosion is indicated by the lack of gullies and no exposures of sub-soil, slight erosion been is indicated by the signs of shallow fresh gullies and exposure of the sub-soil and severe erosion is indicated by many deep gullies and large scale exposure of sub-soil in the area. This was appreciated at the level of the plots as well as general observation on the site.

Plant vigor was measured using the method by Kershaw [19]. This involved evaluation using the color of the leaves, its arrangement and general plant appearance (greenish or yellowish color

and state of the plant stand). This was appreciated at the level of the plots. Along the transect. Density of trees/shrubs was assessed by the total number of trees and shrubs present in one hectare.

Relative density of herbaceous species was determined as:

Relative density = $\frac{number\ of\ individuals\ of\ a\ species}{total\ number\ of\ all\ species}$ X 100

Water availability was assessed through reports obtained from the support zone communities.

Tress: are woody perennial plants, typically having a single stem or trunk growing to a considerable height and bearing lateral branches at some distance from the ground while shrubs are woody plants that are smaller than a tree and having multiple permanent stems arising at or near the ground and shorter height, usually under 6 m (20 ft) tall. Herbaceous plants: refers to plants or parts of them including grasses, forbs and shrubs. Annual herbs are species that grow and complete their life cycle within a year while perennial species grow and complete their life cycle more than a year.

2.3 Data Analysis

Data was analyzed using the descriptive statistics tables, frequency, and Analysis of Variance (ANOVA).

3. RESULTS

The number of dominant herbaceous species in the Forest Reserve estimated at random using a 1 m^2 quadrat in the range site was as shown in Table 1. The result shows that 25 herbaceous species were dominant in the forest reserve with 18 species belonging to 13 families occurring in all the range sites at varying diversities. Equally site C had the highest occurrence of herbaceous species (176), site B with 170 and site A with the least number of individuals (165). The list of trees/shrubs species within the reserve is presented in appendix I. Site C had the highest number of trees/shrubs species (308), followed by site B (245) and the least site A (201). *Isoberlinia doka* was the dominant tree species across the rage sites, whilst *Sida rhombifolia* was the dominant shrub species across the rage sites. Among the tree species the family of Fabaceae was more and Malvaceae for shrub species.

Table 1. Dominant herbaceous species in the range sites estimated at random using 1m^2 quadrat

S/No	Species	Family	Ranges sites		
			A	**B**	**C**
1.	*Ludwigia decurrens*	Onagraceae	13	07	14
2.	*Ageratum coyzoides*	Asteraceae	10	14	16
3.	*Laggera aurita*	Asteraceae	17	10	15
4.	*Evolvulus alsinoides*	Convolvlaceae	07	06	06
5.	*Nelsonia caneseens*	Rubiaceae	12	13	11
6.	*Waltheria indica*	Stercieliaceae	06	10	08
7.	*Tephrosia linearis*	Papilionoideae	06	07	03
8.	*Mittracarpus villosus*	Rubiaceae	04	07	09
9.	*Euphorbia heterophylla*	Euphorbiaceae	10	04	12
10.	*Polycarpaea corymbosa*	Carryophyllaceae	07	00	08
11.	*Tridax procumbens*	Asteraceae	06	09	05
I2.	*Aspilia africana*	Asteraceae	03	00	07
13.	*Celosia leptostachya*	Amaranthaceae	08	06	04
14.	*Gomphrena celosiodes*	Amaranthaceae	07	02	08
15.	*Oldelandia herbacea*	Rubiaceae	06	10	08
16.	*Heterotis rotundifolia*	Melastaceae	08	07	04
17.	*Ecipla alba*	Asteraceae	05	06	02
18.	*Spermacoce verticillata*	Rubiaceae	07	10	00
19.	*Aspilia bussei*	Asteraceae	05	08	09
20.	*Stchytarpheta jamaicunsis*	Verbenaceae	04	08	03
21.	*Boerhavia diffusa*	Nyctagmaceae	00	09	00
22.	*Hibiscus asper*	Malvaceae	00	09	04
23.	*Sida acuta*	Maliaceae	07	00	10
24.	*Ludwigia hyssopfolia*	Onagrceae	07	08	03
25.	*Tephrosia bracteolate*	Papilionoideae	00	00	07
	Total		**165**	**170**	**176**

Source: Field survey, 2016

Table 2 showed the result of the analysis of variance (ANOVA) which indicates that there was no significant difference in the distribution of dominant herbaceous species for range sites [P > 0.05]. The result of relative densities of general herbaceous species and grass species presented in Table 3 and 4 revealed that, *Laggera aurita* had the highest percentage of 8.22%; whilst *Tephrosia bracteolata* had the least (1.37%) while for grass species; *Pennecetum pendicellatum* has the highest density (17.58) whilst *Mariscus alternifolius* had the least (1.21).

Results of plant vigor in Table 5 showed that the plants were stunted in all the sites; the incidence of erosion was slight in the entire reserve. The mean percentage litter cover and tress/shrubs/ha was 37.00% and 252.

Water was available in the reserve for over a period of 7 months. However, the total range condition rating point was 41.50% "Table 6" and the range condition of the game reserve was classified to be fair as "indicated in Table 7".

Table 2. Analysis of variance of the distribution of dominant herbaceous species in the range sites

Source of variance	DF	SS	MS	F.cal	F.tab
Treatment	2	27.13	13.57	1.65	3.15
Error	63	518.49	8.23		(ns)
Total	65	548.62			

Ns= Not significant at 0. 05

Table 3. Relative densities of herbaceous species in the forest reserve

S/No.	Species	No. of Individuals	Relative density/ha
1	*Laggera aurita*	42	8.22
2	*Ageratum conyzoides*	40	7.83
3	*Nelsonia canescens*	36	7.05
4	*Ludwigia decurrens*	34	6.65
5	*Euphorbia heterropylla*	26	5.09
6	*Waltheria indica*	24	4.69
7	*Oldenlandia herbacea*	24	4.69
8	*Aspillia bussei*	22	4.31
9	*Mitracarpus villosus*	20	4.91
10	*Tridax procumbens*	20	4.91
11	*Evolvulus alsinoides*	19	3.72
12	*Heterotis rotundifolia*	19	3.72
13	*Ludwigia hyssopifolia*	18	3.52
14	*Celosia leptostachya*	18	3.52
15	*Gomphrena celosioides*	17	3.33
16	*Spermacoce verticillata*	17	3.33
17	*Sida acuta*	17	3.33
18	*Tephrosia linearis*	16	3.13
19	*Polycarpaea corymbosa*	15	2.94
20	*Stachytarpheta jamaicensis*	15	2.94
21	*Hibiscus asper*	13	2.54
22	*Eclipla alba*	13	2.54
23	*Aspillia africana*	10	1.96
24	*Boerhavia diffusa*	09	1.76
25	*Tephrosia bracteolata*	07	1.37
	Total	**511**	**100**

Source: Field survey, 2016

Table 4. Relative densities of grass species in the study area

S/No.	Species	No. of Individuals	Relative density/ha
1	*Pennisetum pendicellatum*	320	17.58
2	*Loudetia annua*	170	9.34
3	*Andropogon tectorum*	96	5.27
4	*Seteria longista*	85	4.67
5	*Hyparrhenia rufa*	76	4.18
6	*Eragrostis ciliaris*	70	3.85
7	*Echinochloa colona*	67	3.63
8	*Eragrostis tremula*	65	3.57
9	*Pannicum maximum*	64	3.52
10	*Urelytrium maricatum*	63	3.46
11	*Digitaria horizontalis*	62	3.41
12	*Andropogon gayanus*	61	3.35
13	*Pennisetum purpureum*	60	3.30
14	*Pannicum subalbidum*	58	3.19
15	*Leersia hexandra*	56	2.91
16	*Imperata cylindrical*	52	2.86
17	*Oryza barthii*	50	2.75
18	*Kyllinga erecta*	45	2.47
19	*Sacciolepis africana*	42	2.31
20	*Axonopus compressus*	40	2.20
21	*Sporobolus pyramidalis*	37	2.03
22	*Perotis indica*	36	1.98
23	*Rottboellia cochinchinensis*	34	1.87

S/No.	Species	No. of Individuals	Relative density/ha
24	*Brachiaria falcifera*	33	1.81
25	*Elytrophorus spicatus*	30	1.65
26	*Ischaemum rugosum*	26	1.43
27	*Maricus alternifolis*	22	1.21
	Total	**1820**	**100**

Source: Field Survey, 2016

Table 5. Assessment of litter cover, plant vigor, erosion and density of trees/shrubs in the range sites

	Range sites			
Parameters	**A**	**B**	**C**	**Mean**
Plant Vigor	Stunted	Stunted	Stunted	
Erosion	Slight	Slight	Slight	
No. of Trees and Shrubs/ha	201	245	308	**252**
Litter Cover	35	31	45	**37.0**

Source: Field Survey, 2016

Table 6. Range condition score card

Factors	Quantity (%)	Scale of Score	Actual Score (%)
Percentage herbaceous cover	75 – 100		
	50 – 74		
	25 – 49	25-32	25
	6 – 24		
	0 – 5		
Botanical Composition			
Perennial Species	0-5		
	6-25		
	26-50	12-16	2.0
	51-75		
	76-100		
Annual Species	0-5		
	6-25		
	26-50	0-5	5.0
	51-75		
	76-100		
Plant Vigor	Healthy	2-1	1.0
	Stunted		
	Weak		
Soil Condition (Litter)	20% litter		
	20-50% litter	2-1	0.5
	100% litter		
Erosion: None	0-8% slope		
Slight	8-16% slope	2-1	1.0
Severe	16% slope		
Water Availability	All year round		
	9-11 months		
	6-8 months	1-5	4.0
	Less than 6 months		
Trees and Shrubs/ha	0-250/ha		
	251-500		
	501-1000	1-5	3.0
	1001-2000		
	2000/ha		
Total			**41.5**

Source: Field survey, 2016

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Table 7. Key for rating condition

S/no.	Range condition class	Total score (%)
1	Excellent	80 – 100
2	Good	60 – 79
3	Fair	40 – 59
4	Poor	20 – 39
5	Very Poor	0 – 19

4. DISCUSSION

The result of the range parameters in the reserve revealed that, plant vigor was stunted across the range sites. However, the number of trees/shrubs were high in site C compare to site A and site B respectively. This was a reflection on the litter cover being high also in the site C. This could be attributed to the fact that site C occupies major drainage tributaries of the reserve and did not support agricultural activities like farming because of the terrain. Erosion was observed to be slight across the range sites. Furthermore, the herbaceous layer of site C was also high in number (176) compare to the other sites of the reserve.

Analysis of the range and its rating indicates that the forest reserve was in a fair condition (41.50%). Like many primary forest and reserves in the tropical region of the world, the original vegetation of the study area has been extensively modified through human encroachment [2,17]. This may have been influenced by the degradation of the vegetation composition of the game reserve in line with the report of Khobe [8], that, a range in a fair condition may be deteriorating depending on the impact of illegal activities such as logging, burning pressure and nomadic pastoralists on the reserve.

The classification of the vegetation used in this study shows that, annuals are more desirable groups of forage which are classified as increasers or less desirable forest plant. This is in line with the findings of Mbaya et al. [13]. Result of the herbaceous composition analysis showed that annuals (61%) e.g *Pennisetum pendicellatum, Loudetia annua, Andropogon tectorum and Setaria longiseta* dominated the range sites. However, there was no significant difference in herbaceous species occurrence across the sites. The stunted plants and presence of slight erosion are in conformity with the report of Khobe [8]; as indications of deteriorating site. The reserve is on a downward trend because of the rapid succession of less desirable plants (annuals and weeds), stunted plants, and presence of slight erosion, illegal grazing and unplanned burning. This is similar to the findings of Khobe [8,12] in Jibiro Grazing Reserve Adamawa State. Khobe, [8] observed that indiscriminate and unplanned use of burning and grazing management have been the principal causes of deterioration in range condition.

5. CONCLUSION

The result of this study showed the overall condition of the range to be fair. However, results of the analysis of soil factors such as litter cover and erosion; and plant factor, such as vigour tend to suggest the range to be tilting towards a poor condition. This implies that the direction of the trend of the range depends on how the range is utilised subsequently and on other activities such as burning, logging and farming.

There is need to exercise caution in the utilization of the land of Ikwe Game Reserve to ensure the improvement of the area. This strongly points to the need for range manipulation and the use of improvement practices such as reseeding, fertilization, stock water and fencing. Government should also imbibe community participatory approach to enhance the success of managing the Game Reserve for upward improvement.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX 1

Table 8. List of tree species/shrubs present in the range sites

S/no	Species	Family	Site A	Site b	Site C
	Tree species				
1	*Lannea schimperi* (Hochst. ex A.Rich.)	Anacardiaceae	09	05	10
2	*Annona senegalensis* (pers.)	Annonaceae	01	05	00
3	*Kigelia africana* (Lam.) Benth	Bignoniaceae	06	06	02
4	*Bombax costatum (*Pellegr. & Vuillet)	Bombacaceae	03	06	11
5	*Burkea africana (*Hook. f. Home.)	Caesalpinioideae	04	05	10
6	*Isoberlinia doka* (Craib and Stapf)	,,	**16**	**10**	**14**
7	*Anogeissus leiocarpus* (DC.) Guill. & Perr	Combrataceae	08	10	05
8	*Terminalia* avicennioides Guill. & Perr	,,	01	00	01
9	*Bridelia ferruginea (*Benth)	Euphorbiaceae	02	03	00
10	*Uapaca togoensis* (pax.)	,,	04	06	10
11	*Afzelia africana* (Sm. ex Pers)	**Fabaceae**	06	05	06
12	*Detarium microcarpum (*Guill. & Perr.)	,,	05	05	13
13	*Piliostigma thonningii* (Schum.) Milne Redhead	,,	01	04	04
14	*Parkia biglobosa* (Jacq.) G.Don	,,	06	07	06
15	*Pterocarpus erinaceus (*Poir)	Leguminosae	05	06	10
16	*Pericopsis laxiflora* (Benth. ex Baker)	,,	06	04	11
17	*Khaya senegalensis* (Desr.) A Juss	Meliaceae	03	08	01
18	*Prosopis africana (*Guill. & Perr.)	Mimosaceae	05	02	09
19	*Syzygium guineense (*Willd.) DC	Myrtaceae	00	02	10
20	*Lophira lanceolata (*Tiegh. ex Keay)	Ochnaceae	06	07	09
21	*Sarcocephalus latifolius* (JE Sm.)	Rubiaceae	02	06	09
22	*Vitellaria paradoxa* (C.F. Gaertn)	Sapotaceae	07	03	10
23	*Hannoa undulate (*Guill. & Perr.)	Simaroubaceae	05	04	10
24	*Vitex doniana* (Brummitt & Powell)	Verbenaceae	07	05	10
	Shrubs species				
1	*Chromolaena odorata* (L) R.M and Robinson	Asteraceae	05	09	04
2	*Senna obtusifolia* (L.) Irwin and Barneby	Fabaceae	11	06	10
3	*Indigofera tinctoria* (L) Var.hirsuta	,,	02	04	08
4	*Cochlospermum planchonii* (Hook F)	Cochlospermaceae	11	06	04
5	*Alchornea laxiflora* (Benth.) Pax & K.Hoffm	Euphorbiaceae	04	07	10
6	*Alchornea cordifolia* (Schym. and Thonn.)	,,	02	05	03
7	*Malvastrum coromandelianum* (Linn.)	**Malvaceae**	00	06	05
8	*Sida acuta* (Burm F)	,,	05	08	03
9	*Sida cordifolia* (Linn.)	,,	05	07	09
10	*Sida corymbosa* (R. E Fries)	,,	03	08	00
11	*Sida rhombifolia* (L.)	,,	**12**	**10**	**14**
12	*Urena iobata* (L.)	,,	01	07	11
13	*Mimosa invisa* (Mart)	Mimosoideae	03	09	05
14	*Mimosa pigra* (L.)	,,	03	05	06
15	*Tephrosia bracteolate* (Guill and Perr)	Papilionoideae	05	03	04

16	*Eriosema psoraleoide* (Lam.) *Var.hirsuta*	,,	01	02	07
17	*Desmodium tortuosum* (S.W) D.C	,,	04	08	09
18	*Triumfetta cordifolia* (A. Rich)	Tiliaceae	02	09	06
19	*Triumfetta rhomboidea* (Jacq)	,,	03	02	09
	Total (∑Trees and Shrubs)		**201**	**245**	**308**

Peer-review history:
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