

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

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%). 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%) while *Tephrosia bracteolata* was the lowest (1.27%). Grass species shows that *pennisetum pendicellatum* had the highest relative density at 17.58% (320 species) while *Mariscus alternifolius* 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

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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.

Keywords :- Botanical composition, forest reserve, herbaceous plant, range sites, tree density

2. 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 and which can result in the high rate of extinction of plants and animals species [2 and 3]. Many factors that affect the biodiversity of any area of land or water are human induced [4 and 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 the 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 and 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 range land [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, frequency, 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.

Comment [SH1]: Frequency of what?

The general association 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 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; especially namely farming, logging, hunting and bush burning [2 and 17]. This paper reviews the range condition of the Ikwe Foreste Reserve with the aim of ascertaining the possibility of range improvement or deterioration.

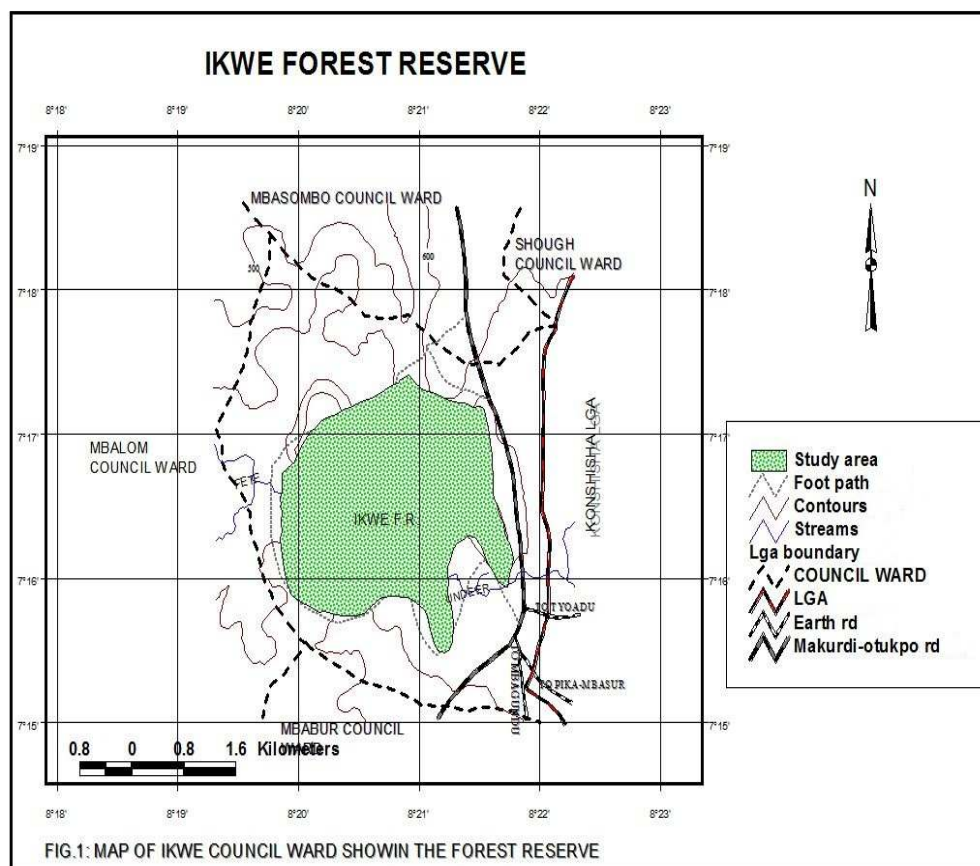
Comment [SH2]: Fragmented and unclear, suggest rewording

3. 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 and 17] as shown in Fig 1. It has an area of approximately 25km² and it is about 40km 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 1140mm-1520mm and evapotranspiration is between 0.40-0.70. Temperature is about 30⁰c and the relative humidity is between 60% and 80%. The topography is highly undulated ranging from 45m to 800m above sea-level. The soil is relatively fertile, shallow, well drained and sandy loam [18]. The dominant vegetation in the area is composed of grasses and woody plants and shrubs.



92

93 2.2 Data Collection

94 The methods used for evaluating range condition and trend were those outlined by Kershaw,
 95 [19]; Akosim *et al.*, [12]; Khobe *et al.*, [11]; Mbaya *et al.*, [13] and Khobe, [8]. A
 96 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 microhabitat 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)).

Comment [SH3]: What were the specific features you were looking for? An even coverage of micro habitats? What were these?

A survey of vegetation was conducted, these covering the 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 1000m was established. A 18 x 20m plot was marked out in each range site. Each plot contained 180 sub plots of 1x1m each. Each plot represents about 5% or more of each range sites.

Herbaceous layer estimate was made using 1m² quadrat frame. At each five steps count (5.40m) at a distance range of 100m 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 100m 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 ~~that by the lack of, there is no sign of~~ gullies and ~~no~~ exposures of sub-soil, slight erosion ~~been is slight~~ indicated ~~there are by the~~ signs of shallow fresh gullies and exposure of the sub-soil and ~~then if the severe~~ erosion is ~~severe~~, indicated ~~there are 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~~ leaf and general plant appearance (greenish or yellowish color and state of the plant stand). This was appreciated at the level of the plots. 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:

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

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

126 2.2 Data Analysis

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

129 4. RESULTS

130 The number of dominant herbaceous species in the Forest Reserve estimated at random using
131 a 1m² quadrat in the range site was as shown in Table 1. The result shows that 25 herbaceous
132 species were dominant in the forest reserve with 18 species belonging to 13 families
133 occurring in all the range sites at varying diversities. Equally site A had the highest
134 occurrence of herbaceous species (179), site B with 174 and site C with the least number of
135 individuals (158).

136 Table 2 shows the result of the analysis of variance (ANOVA) which indicates that, there is
137 no significant difference in the distribution of dominant herbaceous species for range sites [P
138 > 0.05]. Furthermore, when the result was subjected to follow-up test, it was found that the
139 mean number of the dominant herbaceous species per range site was not significantly
140 different from one another (Table 3).

141 The result of relative densities of general herbaceous species and grass species presented in
142 Table 4 and 5 revealed that, *Laggera aurita* had the highest percentage of 8.22%; while
143 *Tephrosia bracteolata* had the least (1.37%) while for grass species, *Pennecetum*
144 *pendicellatum* has the highest density (17.58) while *Mariscus alternifolius* had the least
145 (1.21).

146 Results of plant vigor in Table 6 showed that the plants were stunted in all the sites; the
147 incidence of erosion was slight in the entire reserve. The mean percentage litter cover and
148 tress/shrubs/ha was 37.00% and 252.

149 Water was available in the reserve for over a period of 7 months. However, the total range
150 condition rating point was 41.50% (Table 7) and the range condition of the game reserve was
151 classified to be fair as indicated in (Table 8).

Comment [SH4]: Not entirely sure why a follow up test was conducted on a test with an output showing no significant difference..... The results of the ANOVA show that there is no significant difference in the means.....

152 **Table 1: Dominant herbaceous species in the range sites estimated at random using 1m²**
153 **quadrat.**

S/no	Species	Family	Ranges sites		
			A	B	C
1.	<i>Ludwigia decurrens</i>	Onagraceae	13	07	14
2.	<i>Ageratum coyzooides</i>	Asteraceae	15	14	11
3.	<i>Laggera aurita</i>	Asteraceae	16	15	11
4.	<i>Evolvulus alsinoides</i>	Convolvaceae	07	06	06
5.	<i>Nelsonia canesens</i>	Rubiaceae	12	13	11
6.	<i>Waltheria indica</i>	Sterculiaceae	10	10	04
7.	<i>Tephrosia linearis</i>	Papilionoideae	06	07	03
8.	<i>Mitracarpus villosus</i>	Rubiaceae	09	07	04
9.	<i>Euphorbia heterophylla</i>	Euphorbiaceae	10	04	12
10.	<i>Polycarpaea corymbosa</i>	Carryophyllaceae	07	00	08
11.	<i>Tridax procumbens</i>	Asteraceae	10	03	07
12.	<i>Aspilia africana</i>	Asteraceae	03	00	07
13.	<i>Celosia leptostachya</i>	Amaranthaceae	08	06	04
14.	<i>Gomphrena celosiodes</i>	Amaranthaceae	07	07	03
15.	<i>Oldelandia herbacea</i>	Rubiaceae	06	10	08
16.	<i>Heterotis rotundifolia</i>	Melastaceae	08	07	04
17.	<i>Ecipla alba</i>	Asteraceae	05	06	02
18.	<i>Spermacoce verticillata</i>	Rubiaceae	07	10	00
19.	<i>Aspilia bussei</i>	Asteraceae	05	08	09
20.	<i>Stchytarpheta jamaicensis</i>	Verbenaceae	04	08	03
21.	<i>Boerhavia diffusa</i>	Nyctagmaceae	00	09	00
22.	<i>Hibiscus asper</i>	Malvaceae	00	09	04
23.	<i>Sida acuta</i>	Maliaceae	04	00	13
24.	<i>Ludwigia hyssopfolia</i>	Onagraceae	07	08	03
25.	<i>Tephrosia bracteolata</i>	Papilionoideae	00	00	07
Total			179	174	158

154 Source: Field Survey, 2016

155 **Table 2: Analysis of variance of the distribution of dominant herbaceous species in the**
 156 **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			

157 Ns= not significant at 0. 05

158 **Table 3: Follow-up test of mean number of dominant herbaceous species in the range**
 159 **sites.**

Range sites	Mean
B	8.29a
A	8.14a
C	6.89a

160 Mean number of dominant grass species in the range sites subjected to follow-up test using
 161 LSD at 0.05. The arrangement of values is in descending order and alphabet (a) indicates the
 162 same range in the condition at different site.

163 **Table 4: Relative densities of herbaceous species in the forest reserve.**

S/No.	Species	No. of Individuals	Relative density/ha
1	<i>Ludwigia decurrens</i>	42	8.22
2	<i>Ageratum conyzoides</i>	40	7.83
3	<i>Nelsonia canescens</i>	36	7.05
4	<i>Ludwigia decurrens</i>	34	6.65
5	<i>Euphorbia heterophylla</i>	26	5.09
6	<i>Waltheria indica</i>	24	4.69
7	<i>Oldenlandia herbacea</i>	24	4.69

Comment [SH5]: There is no need for post hoc testing when the ANOVA output is insignificant.... Listing the means is beneficial though. I suggest re-wording. Perhaps just state the list of means, rather than describe it as a follow up test.

8	<i>Aspillia bussei</i>	22	4.31
9	<i>Mitracarpus villosus</i>	20	4.91
10	<i>Tridax procumbens</i>	20	4.91
11	<i>Evolvulus alsinoides</i>	19	3.72
12	<i>Heterotis rotundifolia</i>	19	3.72
13	<i>Ludwigia hyssopifolia</i>	18	3.52
14	<i>Celosia leptostachya</i>	18	3.52
15	<i>Gomphrena celosioides</i>	17	3.33
16	<i>Spermacoce verticillata</i>	17	3.33
17	<i>Sida acuta</i>	17	3.33
18	<i>Tephrosia linearis</i>	16	3.13
19	<i>Polycarpaea corymbosa</i>	15	2.94
20	<i>Stachytarpheta jamaicensis</i>	15	2.94
21	<i>Hibiscus asper</i>	13	2.54
22	<i>Eclipla alba</i>	13	2.54
23	<i>Aspillia africana</i>	10	1.96
24	<i>Boerhavia diffusa</i>	09	1.76
25	<i>Tephrosia bracteolata</i>	07	1.37
	Total	511	100

164 **Source:** Field Survey, 2016

165 **Table 5: Relative densities of grass species in the study area.**

S/No.	Species	No. of Individuals	Relative density/ha
1	<i>Pennisetum pendicellatum</i>	320	17.58
2	<i>Loudetia annua</i>	170	9.34
3	<i>Andropogon tectorum</i>	96	5.27
4	<i>Seteria longista</i>	85	4.67
5	<i>Hyparrhenia rufa</i>	76	4.18
6	<i>Eragrostis ciliaris</i>	70	3.85
7	<i>Echinochloa colona</i>	67	3.63
8	<i>Eragrostis tremula</i>	65	3.57

9	<i>Panicum maximum</i>	64	3.52
10	<i>Urelytrium maricatum</i>	63	3.46
11	<i>Digitaria horizontalis</i>	62	3.41
12	<i>Andropogon gayanus</i>	61	3.35
13	<i>Pennisetum purpureum</i>	60	3.30
14	<i>Panicum subalbidum</i>	58	3.19
15	<i>Leersia hexandra</i>	56	2.91
16	<i>Imperata cylindrical</i>	52	2.86
17	<i>Oryza barthii</i>	50	2.75
18	<i>Kyllinga erecta</i>	45	2.47
19	<i>Sacciolepis africana</i>	42	2.31
20	<i>Axonopus compressus</i>	40	2.20
21	<i>Sporobolus pyramidalis</i>	37	2.03
22	<i>Perotis indica</i>	36	1.98
23	<i>Rottboellia cochinchinensis</i>	34	1.87
24	<i>Brachiaria falcifera</i>	33	1.81
25	<i>Elytrophorus spicatus</i>	30	1.65
26	<i>Ischaemum rugosum</i>	26	1.43
27	<i>Maricus alternifolis</i>	22	1.21
	Total	1820	100

166 **Source:** Field Survey, 2016

167 **Table 6: Assessment of litter cover, plant vigor, erosion and density of trees/shrubs in**
168 **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

169 **Source:** Field Survey, 2016

170 **Table 7: Range condition score card**

Factors	Quantity (%)	Scale Score	of Actual Score (%)
Percentage herbaceous cover	75 – 100 50 – 74 25 – 49 6 – 24 0 – 5	25-40	25
Botanical Composition			
Perennial Species	0-5 6-25 26-50 51-75 76-100	5-8	2.0
Annual Species	0-5 6-25 26-50 51-75 76-100	0-5	5.0
Plant Vigor	Healthy Stunted Weak	2-1	1.0
Soil Condition (Litter)	20% litter 20-50% litter 100% litter	2-1	0.5
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 Less than 6 months	1-5	4.0
Trees and Shrubs/ha	0-250/ha 251-500 501-1000 1001-2000 2000/ha	1-5	3.0
Total			41.5

171 **Source:** Field Survey, 2016

172 **Table 8: 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

5. DISCUSSION

Analysis of the range and its rating indicates that the forest reserve was in a fair condition (41.50%). Like many primary forests and reserves in the tropical region of the world, the original vegetation of the study area has been extensively modified through human encroachment [2 and 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 proportion of less-desirable and undesirable activities such as, logging and burning pressure by resident and nomadic pastoralists.

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, annual (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 and 12] in Jibiro

Comment [SH6]: Extremely poorly worded; suggested edit.

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193 Grazing Reserve Adamawa State. Khobe, [8] observed that indiscriminate and unplanned use
194 of burning and grazing management have been the principal causes of deterioration in range
195 condition.

196 6. CONCLUSION

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

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

Comment [SH7]: Separate as two sentences for clarity

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