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Habitat Variation and Avian Richness: Alpha Scale

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Abstract:
This study identified the interaction among bird communities, at each component unit of Okwangwo Range of Cross River National Park, Nigeria and ascertain the similarity indices. Ten transects were created along each of the existing trails at the low, mid and high altitudes of the study area. Each of the component units of the sampled plot represented a series of storage component linked by dynamical processes between sites. Data was obtained by simple observation of site characteristics, and using point and time-species count to obtain data on bird richness. The Jaccard's index was used to measure the coefficient of similarities between sites within the study area. Result show that the coefficient of similarity was generally low among the sample sites and highest similarity, 53 per cent, was recorded at the high altitude. Further, it was observed that the more adverse physical and biotic structure enhanced greater specialization among bird species richness. The low coefficient of similarity suggests that the study area is a good site for bird watching. This study is in consonance with the fact that nature parks as a geographical system have an inherently spatial structure around which transaction and interactions among avian communities take place. Work in the conservation planning needs improved techniques and tools for economic accounting of avian community by frameworks that facilitate the management within which development scheme function.

Keywords: *Habitat heterogeneity, Avian richness, Alpha scale, Okwangwo Range*

1. Introduction

Most geographical systems have an inherently spatial structure around which transaction and interactions take place. Distinct types of spatial structure can be recognized in geographical sphere; the heights of the land surface may vary across space. These variations create a surface either real or imaginary, in part create heterogeneity across, and further influence biodiversity richness. The arrangement of this facet brings to focus the architecture of geographical space for biodiversity to utilize in the wild. Bird species compositions and distribution in montane ecosystem is determine by physical and biological factors such as elevation, prevailing winds, slope, precipitation, humidity, and plant richness (Poulsen, 2002). Whereas physical factors have a predominant effect on the higher altitude, biological factors are often seen as the predominantly processes affecting diversity and distribution in the lower altitude. A crucial but often very difficult task was to understand the natural functioning of the montane ecosystem under study and its interrelationships with neighbouring systems. There was attempt to understand the functioning of the altitudinal gradients, cross-taxon relationships and ecological processes, as important drivers at different scales. Crawley and Haral (2001) suggest that at small scales (less than $1m^2$), ecological interactions are most important processes controlling plant diversity in a system but at larger scales, drivers such as topography, geology, climate and hydrology are more important because they influence habitat type.

There has been continuous demand from international communities on the need to protect plant and animal species, including the environment of the biodiversity. The focus on the priority area has been primarily on the abundance and species richness with little discussion on environmental influence. The effectiveness of this approach in capturing higher order manifestations of biodiversity in montane region in sub-Saharan region remains poorly understood. While the work of Obot and Barker (1996) highlight the action of climate on plant and morphology community that has direct influence on bird species diversity in the study area, it did not provide any evidence on whether short-term exposure to high or low altitude environmental gradient produced any permanent, heritable change in the plant morphology and community. Insights into this facet of habitat variability on bird community within the Okwangwo Range of Cross River National Park (CRNP), Nigeria provided a background for this research. Furthermore, the research investigated whether habitat preference can explain the reason for alteration in bird species richness within a defined nature reserve.

Bird species largely confirmed that habitat positively influences species diversity. The investigations of Poulsen (2002) show that upward positioning of resources and nesting sites support bird diversity in temperate Danish forest. At a spatial scale of between 1 hectare and $1km^2$, the result of the number of different habitat in an area on the number and variety of species living in an area is positive. Berry and Bock (1998) in the study of the grassland and forest ecosystems of the Colorado foothill shrub at the same spatial scale that Poulsen (2002) had, recorded a positive relationship between the effects of the different habitat in an area and the nature of the landscape on the breeding of birds. Debinski and Brussard (1994), assessed species-habitat relationships in Glacier National Park, Montana; the result show a positive relationship between bird and butterflies, and habitat heterogeneity. In contrast, Heaney (2001), from his study of small mammal's diversity along elevation gradients in the Philippines observed that at a spatial scale of above $1km^2$ there was no significant relationship. This result was in agreement with the finding of Johnsingh and Joshua (1994) at a spatial scale, above $1km^2$ on Mundanthurai Plateau, South India; that there is no significant relationship between Avifauna in three vegetation types of this ecosystem. Ralph (1985) in the study of birds of Northern Patagonia, Argentina at a spatial scale of 1 hectare – $1km^2$, observed a negative relationship; that as the composition of the different kind of environment according to the need and preference of birds increase, bird communities decrease. This however is at variance with habitat heterogeneity. According to Saunders, Hobbs and Margules (1991), negative effects of habitat heterogeneity may occur as consequence of fragmentation, causing the disruption and key biological processes such as dispersal and resource acquisition at alpha scale. However, Andrew (1994); Steffan-Dewenter and Tscharntke (2002) agree that not all plants and animals in an ecological system are equally linked by areal structure, depending on whether they cause heterogeneity or divided into fragments. The aim of this research is to examine the bird species richness between sampled sites in Okwangwo Range, Cross River National Park with the view of proffering suggestion to the conservation of montane bird communities.

2. Objectives

The objectives of the research are to:

1. delineate microhabitat variability in the study area,
2. identify bird species in each microhabitat, and
3. ascertain the similarity of bird species richness between sampled sites in the study area.

3. Scope and Significance of Study

The scope of this research is restricted to Okwangwo Range of Cross River National Park due to its high degree of naturalness, less anthropogenic activity, and the availability of appropriate environmental data needed for this research (Oka, 2014). The study fussed on conspicuous and vocal bird species and areas previously mapped as having natural ecosystems. This research will create more understanding of bird richness between sampled sites in the study area and further enhance the platform for effective planning, management and conservation of the avian community of Okwangwo Range for tourism promotion.

4. Study Area

Okwangwo Range is one of the two components of Cross River National Park, Nigeria. It lies South-East of Obudu with the eastern boundary extending along the Nigeria-Cameroon boundary; between longitudes $9°0^{/}$ - $9°27^{/}$E and latitudes $6°4^{/}$ - $6°29^{/}$ N (Fig 1), with an area of about $920Km^2$ representing about 32.48 per cent of Cross River National Park (Natural Resource Institute, 1990; Economic map of CRS resources, 2008).

The topography is hilly and rugged with many disjointed and connecting ridge systems; isolated peaks and rock out-crop (Igbozurike, 1975; Obot & Barker, 1996) with elevations of 150m, rising to about 1500m in Sankwala highlands and to peaks of up to 1700m at Obudu Plateau. Elevational variations distributed across Okwangwo Range are powerful test system for understanding biodiversity. Three main rivers; Oyi, Bemi, and Okorn, drain the park area. Oyi River is fed by Anyukwo River, which drains Obudu plateau at the Northern extremities of the park around Ochakwe, together with Mache, Asache and Magbe rivers that drain the eastern boundary of the park around Balegete. The Bemi drains the Boshi area of the park and flows south along its western boundary to join Okon River, which collects further drainage from Mbe highland before it crosses into the Cameroon.

The microclimate in Okwangwo is highly influenced by relief and is characterized by alternating dry and wet seasons (Udoh 1973). The mean annual temperature ranges between 25℃ and 28℃. The daily temperature range is between 14℃ and 25℃ with a daily minima range of 14℃ to 16℃ and 18℃ to 25℃ daily maxima on the highland areas of Obudu Plateau and Sankwala Mountains. Annual rainfall varies between 2,500mm - 3,500mm, distributed unevenly between March and November (Obot & Barker, 1996).

The richness of plant families in Okwangwo Range of the Cross River National Park is a driving factor that has listed the area as an important site to study; not just the cross-taxon congruence (Oka, 2014) but also creating room for the study of the impact that habitat heterogeneity have on biological diversity in this study.The Okwangwo Range is rich in different families of mammals, reptiles, insects, amphibians and birds (Obot & Barker, 1996). It is classified as an Important Bird Area (IBA) based on the premise that the area is known to hold a significant component of the group of species whose distribution are largely or wholly confined to this biome (Obot & Barker 1996). The importance that birds play as surrogate in assessing environment richness has given rise to the choice as an important variable among animals in this study. Hence, the plants and birds of Okwangwo Range are important topics to look closely into the interaction of species in this research. These plants and birds that transverse in all direction of the Range is among the richest forest reserves in southeastern Nigeria in plants and animal's communities.

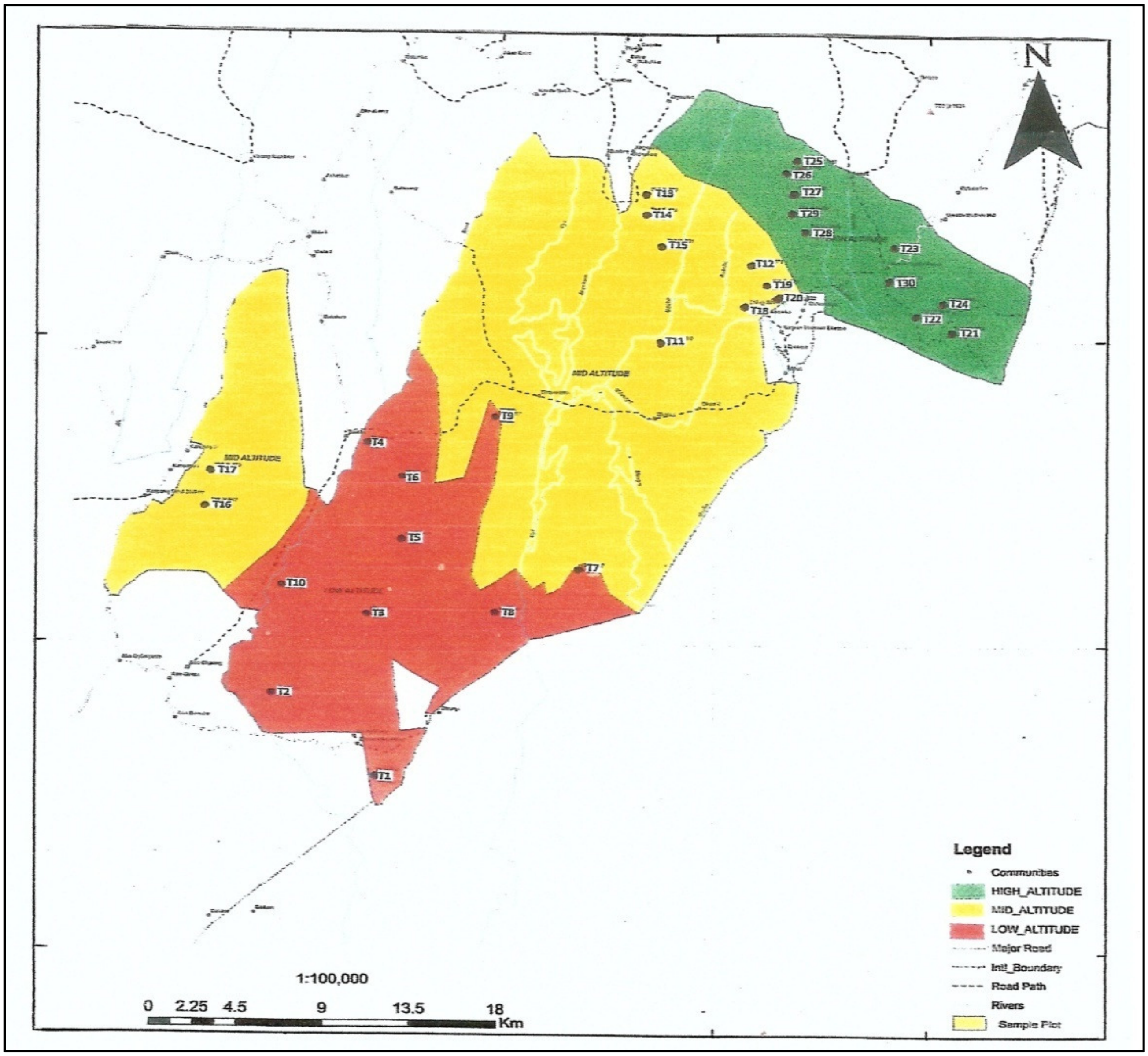

Figure 1: Okwangwo Range, Cross River National Park showing study transect locations

5. Method of Research

Relevant data for this study included data on site characteristics, conspicuous bird species sighted in the field. The 2003 Cross River State aerial photograph and topographic maps guided to trace vegetation types, landform and drainage features of sampled sites across the low, mid and high elevation of the study area. In addition, only those locations previously mapped as having natural ecosystems, retaining a high degree of relative naturalness and accessibility served as sources of data in the field. The study area was divided into three elevation ranges: low-altitude (122m-549m above sea level, a.s.l.), mid-altitude (549m-1,402m a.s.l.) and high-altitude (above 1,402m a.s.l.). These ranges further delineated in terms of blocks in line with Obot and Barker (1996) into the following, namely; Bemi block (low altitude), Okwangwo/Okwa block and Mbe mountain range (mid altitude), Cattle Ranch block and Buabre block (high altitude). Thirty (30) transects, 300m each, were established along the existing trails for each selected habitat which is homogeneous and typical of the site selected. Ten transects were laid in each altitudinal range; the orientations were based on accessibility and not directional. Due to the fragmented cover of natural ecosystems, only sites with a minimum of 95 per cent natural ecosystems, and accessibility served as areas for data collection. Ten transects were established in each of the three elevation zones along the existing trails for each of the selected habitat making a total of thirty (30) transects (3 X 10). Within transects created in each site, point and time-species count techniques were used in collecting data on birds. Also important are field marks such as bird crest, face pattern, eye lines, rings and spectacles, breast spot (kiln), tail marks and wing patterns. Flying formations and flight line were also used in identifying birds. At each point, counts of birds were conducted for 10 minutes interval between the periods of 7:00 – 11:00am (local time) as preliminary visits to the study sites show that most birds are surprisingly active during this time of the day. In each transect was a team of at least two observers used in identifying bird species. All observations were between August and October 2016. This is very significant because movement of birds is localized, with little or no migration; it also marks the beginning of the return of migrant birds that went in search of food during drought. All points were replicated two times; thus, total of two hundred and forty (240) point counts were conducted during the entire period of the field study. The Timed-Species count (TSC) identified bird species in the order seen within a period of one hour. The technique compared the bird species at different sites (30) within the studied area. A similar method has been used on a national scale to survey breeding birds in Britain and Ireland (Pomeroy, 1992), species richness define total number of species.

The Jaccard index expresses the number of common species of bird as a percentage of the total number of species found in two sampled sites. For the purpose of measuring the similarity between sites, Jaccard's similarity estimators were used to compare observed species compositions among different sites. This provided a value that expressed the extent of similarity between two sites and a value of 1 indicates identical sites. Thus,

$$j_i = \frac{c}{(a+b-c)}$$

Where,

j_i = Jaccard's index

a = Number of species unique in Site A

b = Number of species unique in Site B

c = Number of species in common.

Oka (2014) used the Jaccard index to examine the similarity between birds pesting on upland and lowland rice farms. The sites were compared based on the birds present and unique to the sites. The result obtained show that the similarity index was below 1 meaning that they were not identical. The species similarity coefficients used ignored the relative abundances of the species and were converted to percentage similarity. Nwadinigwe (2013) to compare sites based on plant species observed in each marked sites used similar method. The result obtained created room to know how viable sites can be assessed for conservation. Hence, this technique was used to measure the coefficient of similarity between different sites within the study area.

6. Data Presentation and Findings

The characteristics in bird species richness between sampled sites in the study area of this research, largely, showed increased differences between sites(Table 1). Table 1 shows the coefficient of similarity between sites. The greatest similarity between sites occurred between sampled sites 1, (201m a.s.l.) and 3, (143m a.s.l.)with coefficient of 0.52at the lower altitude. Between sites 12, (675m a.s.l.) and 17, (579m a.s.l.) with coefficient of 0.50 at the mid altitude; between sites 17, (579m a.s.l.) in the mid altitude and 22, (1517m a.s.l.) in the higher altitudewith coefficients of 0.51; and between sites 23, (1629m a.s.l.) and 24, (1548m a.s.l.) both in the higher altitude, with coefficients of 0.53. This revealed that the percentages of similarity between these pair of sites are in the order of 52, 50, 51 and 53 per cent. This further infers that sampled sites within the same elevation range recorded low similarity when compared to each other: lower altitude, 11 - 52 per cent; mid altitude, 12-50 per cent; and higher altitude, 0-53 per cent. Similarly, coefficients of between sites in different elevation ranges were also low: between lower and mid altitudes, 1 - 49 per cent; between lower and higher altitudes, 0 - 26 per cent; and between mid and higher altitudes, 0 - 51 per cent.

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	-	33	32	16	28	14	21	11	20	20	14	8	7	8	2	5	9	12	6	5	2	5	1	3	1	0	0	1	3	1
2		-	28	16	30	10	19	6	13	15	11	9	8	5	1	9	11	6	6	4	1	1	1	4	0	0	0	0	1	0
3			-	13	19	8	12	3	6	7	9	3	4	4	1	5	3	9	3	3	0	2	1	1	3	3	0	0	0	1
4				-	20	6	6	30	10	19	5	6	7	3	10	10	6	6	4	12	7	0	2	2	4	1	0	1	1	0
5					-	10	22	18	10	48	14	23	10	3	3	9	23	9	4	6	3	12	2	3	3	1	1	3	1	2
6						-	25	10	23	22	18	16	17	15	9	9	14	8	8	5	5	10	8	10	8	1	1	1	3	0
7							-	14	32	29	34	23	21	20	9	21	24	18	11	9	8	18	10	12	15	1	1	2	3	1
8								-	21	25	12	11	16	11	21	13	12	12	10	15	13	13	8	10	8	2	0	1	3	0
9									-	24	33	18	33	20	14	17	18	22	12	9	10	19	13	17	2	0	1	2	4	0
10										-	29	40	21	16	13	19	34	20	11	12	9	24	12	14	18	3	3	5	3	1
11											-	28	29	22	9	25	27	27	17	9	8	20	10	15	19	2	1	3	3	3
12												-	19	12	9	17	37	15	9	8	7	24	8	13	15	1	1	4	3	3
13													-	14	14	16	15	23	11	11	9	16	10	13	12	1	0	3	2	2
14														-	11	10	10	14	10	7	7	10	9	11	7	1	1	0	3	1
15															-	10	9	12	8	13	12	9	6	9	7	1	0	0	2	2
16																-	24	21	15	10	9	16	10	15	7	1	4	3	3	2
17																	-	20	14	9	10	34	14	16	16	2	2	6	4	2
18																		-	15	12	9	18	13	21	5	3	2	2	5	5
19																			-	10	10	12	12	14	0	2	0	1	5	1
20																				-	13	10	5	8	7	2	1	1	5	2
21																					-	13	7	9	8	1	0	1	5	3
22																						-	15	19	21	2	3	9	5	4
23																							-	16	13	1	0	0	1	0
24																								-	19	3	2	3	4	6
25																									-	1	0	0	0	1
26																										-	1	0	0	
27																											-	3	0	2
28																												-	1	2
29																													-	3
30																														-
No. of Species	57	51	37	51	77	36	60	50	54	79	60	55	46	30	27	50	56	45	24	21	18	45	17	29	33	4	6	11	8	10

Table 1:Number of bird species in common between sample sites in the study area.
Source: Researcher's fieldwork, 2016

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	-	0.44	0.52	0.17	0.26	0.18	0.22	0.11	0.22	0.17	0.14	0.08	0.07	0.08	0.02	0.05	0.09	0.13	0.08	0.07	0.03	0.05	0.01	0.04	0.01	0.00	0.00	0.01	0.05	0.02
2		-	0.47	0.19	0.31	0.13	0.21	0.06	0.14	0.11	0.11	0.09	0.09	0.07	0.01	0.16	0.11	0.07	0.09	0.06	0.01	0.01	0.01	0.05	0.00	0.00	0.00	0.00	0.02	0.00
3			-	0.17	0.20	0.12	0.14	0.04	0.07	0.06	0.10	0.03	0.05	0.06	0.02	0.05	0.03	0.12	0.12	0.05	0.00	0.03	0.02	0.02	0.04	0.08	0.00	0.00	0.00	0.02
4				-	0.19	0.07	0.06	0.42	0.11	0.17	0.05	0.06	0.08	0.04	0.15	0.11	0.06	0.07	0.06	0.20	0.11	0.00	0.03	0.03	0.05	0.02	0.00	0.02	0.02	0.00
5					-	0.10	0.19	0.17	0.08	0.44	0.11	0.21	0.09	0.03	0.03	0.08	0.21	0.08	0.04	0.07	0.03	0.11	0.02	0.03	0.03	0.01	0.01	0.04	0.01	0.02
6						-	0.40	0.13	0.34	0.24	0.23	0.21	0.26	0.29	0.17	0.12	0.18	0.11	0.15	0.10	0.10	0.14	0.18	0.18	0.13	0.03	0.02	0.02	0.07	0.00
7							-	0.15	0.39	0.26	0.40	0.25	0.25	0.29	0.12	0.24	0.26	0.21	0.15	0.13	0.11	0.21	0.15	0.16	0.19	0.02	0.02	0.03	0.05	0.01
8								-	0.25	0.24	0.12	0.11	0.19	0.15	0.35	0.14	0.12	0.14	0.15	0.25	0.22	0.15	0.13	0.14	0.10	0.04	0.00	0.02	0.05	0.00
9									-	0.22	0.41	0.20	0.49	0.31	0.22	0.20	0.20	0.29	0.18	0.14	0.16	0.24	0.22	0.26	0.02	0.00	0.02	0.03	0.07	0.00
10										-	0.26	0.43	0.20	0.17	0.14	0.17	0.34	0.19	0.12	0.14	0.10	0.24	0.14	0.15	0.19	0.04	0.04	0.06	0.04	0.01
11											-	0.32	0.38	0.32	0.16	0.29	0.30	0.35	0.25	0.13	0.11	0.24	0.15	0.20	0.26	0.03	0.02	0.04	0.05	0.04
12												-	0.23	0.16	0.12	0.19	0.50	0.18	0.13	0.12	0.11	0.32	0.13	0.18	0.21	0.02	0.02	0.06	0.05	0.05
13													-	0.23	0.24	0.20	0.17	0.34	0.13	0.20	0.16	0.21	0.19	0.21	0.18	0.02	0.00	0.06	0.04	0.04
14														-	0.24	0.14	0.13	0.23	0.19	0.16	0.17	0.15	0.24	0.23	0.13	0.03	0.03	0.00	0.09	0.03
15															-	0.15	0.12	0.20	0.19	0.37	0.36	0.14	0.16	0.19	0.13	0.03	0.00	0.00	0.06	0.06
16																-	0.29	0.28	0.25	0.16	0.17	0.20	0.18	0.23	0.09	0.02	0.08	0.05	0.05	0.03
17																	-	0.25	0.21	0.13	0.16	0.51	0.24	0.23	0.22	0.03	0.03	0.10	0.07	0.03
18																		-	0.28	0.22	0.17	0.25	0.27	0.40	0.07	0.09	0.04	0.04	0.10	0.10
19																			-	0.29	0.31	0.21	0.41	0.36	0.00	0.12	0.00	0.03	0.19	0.03
20																				-	0.50	0.18	0.15	0.19	0.14	0.09	0.04	0.03	0.21	0.07
21																					-	0.26	0.25	0.24	0.19	0.10	0.00	0.04	0.24	0.12
22																						-	0.32	0.36	0.37	0.02	0.06	0.19	0.10	0.08
23																							-	0.53	0.35	0.11	0.00	0.00	0.04	0.00
24																								-	0.44	0.10	0.06	0.08	0.12	0.18
25																									-	0.03	0.11	0.00	0.00	0.02
26																										-	0.11	0.00	0.00	0.00
27																											-	0.21	0.00	0.14
28																												-	0.06	0.11
29																													-	0.20
30																														-

Table 2: Coefficient of Similarity between sample sites in the study area
Source: Researcher's fieldwork, 2016

The number of bird species varied with difference in sites and a comparison between sites within the same altitude and sites in other altitudes revealed that despite changes in geographical location of sampled sites there were sites with common bird species. Data collected showed that bird species common to sites varied between one (the least) and 48 (the highest). There were sites within the study area that never had bird species in common with other sampled sites. This was particular observed between sampled sites in low altitude and high altitude. Similar observations recorded between thirteen (13) sites within the high altitude; four (4) sites between mid and high altitude; and 19 in common between sites in the low and high altitudes. The Jaccard's similarity estimator (coefficient of similarity) revealed that highest similarity between sites occurred between the sites located at 201m a.s.l. ($09^0 08^{/} 25^{//}$E, $06^0 05^{/} 42^{//}$N) and 143m a.s.l ($09^0 08^{/} 14^{//}$E, $06^0 10^{/} 57^{//}$N). Both sites are located in the low altitude and had a similarity coefficient of 0.52. At the mid altitude sites located at 675m a.s.l. ($09^0 03^{/} 50^{//}$E, $06^0 15^{/} 32^{//}$N) and 579m a.s.l. ($09^0 19^{/} 01^{//}$E, $06^0 22^{/} 21^{//}$N) in the mid altitude and 1517 m a.s.l. ($09^0 23^{/} 37^{//}$E, $06^0 20^{/} 49^{//}$N) in the high altitude had a similarity coefficient of 0.51. Increase bird richness at the low altitude is likely a product of higher foliage, more heterogeneous habitat and complex topography. Hence, a more diverse physical and biotic structure permits finer subdivision of limited resources and hence promotes greater specialization of species.

Result further show that turnover in species composition occurred over relative short distances but also that distance *per se* is not the sole cause of differences in species composition. Some sites with higher similarity in terms of species number were further apart. Variations in species composition from one transect to another reflect many factors that affect the distributional patterns of individual species. Factors such as changes in land use may operate over various temporal and spatial scales. Furthermore, changes in species composition because of changing patterns of land use likely will be an increasing important aspect of community dynamics and turnover along elevation gradient of Okwangwo Range.

Many changes in bird community composition along different sites reflect changes in the type of resources present. Species that primarily forage in epiphytes are more common at higher elevations, reflecting the greater importance of epiphytic plants at such elevation. In contrast, birds that primarily nest, roost or feed on woody plants are common at sites along lower elevation. Thus, temporal and spatial variations in resources exert a major influence on many assemblages and affect distribution patterns at different elevations.

7. Conclusion

This study examined the diversity index of bird species richness along the study area and the extent of similarity between sites. Further sampled sites within the same elevation range recorded low similarity index in bird richness and at alpha scale, the fewer the number of bird species, the higher the diversity index

Okwangwo Range of CRNP hosted exclusive species at the low elevation range, *Indicator indicatorCorocina agurea*; mid elevation range, *Poliolais lopezi*, *Terpsiphone rufiventer*, and *Terpsiphone rufocinerea*; and high elevation range, *Malacilla clara*, *Andropadus latirostris* and *Cisticola chubby*. These species and the environmental conditions that support them now clearly merit increase conservation concern. It should be a key management strategy to ensure that existing blocks of montane environment are protected from disturbance and inappropriate tourist infrastructure.

The disparity between the species exclusive to the mid elevation and low elevation is quite high. This suggests important conservation implication; sampled sites in the study should be conserved and the entire range should be given equal conservation attention. The mid altitude was not adequately covered due to poor accessibility into the terrain. This challenge should be solved by positioning closed circuit televisions (CCTVs) at strategic points as camera traps to enhance good observation and recording of bird species.

Laridae family is the most important avian vectors of disease, including fowl pest, ornithosis, intestinal parasites and food poisoning (Perrins and Harrison, 2008). Bird species in this avian family were not sighted during this study. If this suggests the absence of this bird family, poultry farming should be encouraged among local farmers for at least two reasons: (1) livelihood sustainability and (2) protection and preservation of niches of other biological diversities.

Work in the conservation planning needs to be accompanied by improved techniques and tools for economic accounting of avian community by frameworks that facilitates the management within which development schemes function. Among the priority research need is comparative work on the ecosystem function of the avian community, including an accelerated programme of comparative experimental studies to boost the scientific underpinning of conservation and management strategies.

8. References

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