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Research Article

Avifauna Species Diversity and Abundance in Kainji Lake National Park, Niger State, Nigeria

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Abstract

The dearth of understanding the importance of bird species diversity and abundance contributes to the low rate of conservation and distribution of wildlife species in the ecosystem. Diversity and abundance are equally important factors for improving the ecological system. This study examined bird species diversity and abundance in Borgu Sector of Kainji Lake National Park, Niger State, Nigeria. Line transect method was used to carry out birds' survey at five different tracks, namely: Hussaini Mashi, Gilbert Child, Bukar Shuaib, Shehu Shagari and Mahmud Lapai Tracks. Data were obtained on birds' species and abundance through the use of point count for bird survey. Frequency counts, percentages, means, Shannon-Weiner diversity Index, Simpson's Diversity Index, Analysis of variance (ANOVA) were used to analyse data. A total number of 70 bird species in 31 families were recorded during the survey. Shannon-Weiner diversity Index results showed that Mahmud Lapai track had the highest diversity (4.185) compared to Hussaini Mashi (3.726), Gilbert Child (3.928), Shehu Shagari (4.106) and Bukar Shuaib (4.135) tracks respectively. The results also indicated that bird species diversity was not equally distributed in the tracks. ANOVA showed that bird species abundance was normally distributed and varied significantly ($p < 0.05$) among the study sites. The study concluded that bird species diversity and abundance are key contributors to a healthy ecological system. Birds are good indicators of the biological network thereby revealing the status of the park environmental degradation. The study recommended that stakeholders should improve on the enactment, legislation and enforcement of laws that will safeguard areas where fauna and flora are effectively conserved.

Keywords: Biodiversity, conservation, ecology, wildlife.

Introduction

It has been observed that developing management strategies for conservation of wildlife species as well as the inventory of both fauna and flora resources to ensure proper monitoring required the knowledge of the population, abundance, distribution and migration of the species concerned (Child 1974). Similarly, wildlife inventory is with the aim to provide reliable information of management plan in order to guide the policy makers (park conservators) how best to conserve the fauna resource of the area for the sustainable development. There is a management concern about the decline in population and distribution of bird's species in some Nigeria National Parks. Arable crop production is widely practised in the adjacent communities of the study area. Besides, extensive grazing takes place within the support zone community areas of the study sites (Ijeoma and Ogbara 2013). This could constitute a serious threat to the survival of some birds as a result of the loss of habitat at the study sites. According to Neave *et al*. 1990), the physical structure of vegetation is considered an important habitat component

through the provision of food, shelter and nesting resources and also in providing potential clues about the onset of conditions suitable for successful breeding.

In addition, birds are often at risk, either directly or indirectly from pesticides spray treatments. These primarily affect birds' populations by reducing the availability of their arthropod prey. For example, changes in feeding rate of pied kingfishers (*Ceryl erudis*) and little bee-eaters (*Merops pusillus*) that prey on small fish and day-flying insects respectively had been affected by spray treatments (Smart 1997). Bird populations may be reduced by the consumption of contaminated insects with Fenitrothions. This causes the death of insectivorous birds through acute poisoning or causes sub-lethal effects which will affect their breeding success. Similarly, many insecticides are harmful to fish and thus piscivorous birds may also be at risk. Poisoning may occur when seeds dressed with insecticides are eaten (Smart 1997).

Birds generally are found in varied vegetation and are presently threatened by man's need for food, shelter and clothing. Birds are killed by poachers for sales and consumption. Farmers use agrochemicals to prevent birds from eating their grains and also crops that are germinating on the field especially around the buffer zones (Ajayi and Hall 1979, Ijeomah and Ogbara 2013). On the other hand, birds unite people around the world for conservation (BirdLife 2018). Insectivorous birds provide an important service in terms of pest control (Bullock 2018).

Birds are habitat specific and some can occupy more than one habitat type, however, because of land uses changes, most of the birds have been displaced from their original habitats (Burgess *et al*. 2002). The studies on bird diversity were confined into the forest emphasizing the general negative effects of forest conversion to human-dominated habitats (Burgess *et al*. 2002, Doggart *et al*. 2005, Frontier-Tanzania 2005, Yanda and Munishi 2007). Nevertheless, human-dominated and agricultural habitats vary a lot and therefore the effect on birds can be very different (Tworek 2002). Responses of birds to habitat changes differ depending on their strategies, some lifestyles benefit from habitat change, while for others it is a principal threat (Tworek 2002). Birds are very visible and integral part of the ecosystem occupies many trophic levels in a food chain ranging from consumers to predators. Their occurrences have been helpful as an environmental health indicator, plant pollinators and seed dispersal as well as pest controller (Hadley *et al*. 2012, Ramchandra 2013). Furthermore, they do add enjoyment to our lives because of their distinctive colours, the showy display also distinctive songs and calls.

The study on avifauna species diversity and abundance in Kainji Lake National Park, Niger State, Nigeria is important since it will provide an understanding on the avifauna diversity, distribution and abundance in a conservation centre aimed at promoting the biodiversity of Nigerian wildlife. However, the need to assess the species diversity and abundance of birds in a protected area will provide policymakers with reliable tools to formulate an appropriate policy framework that might reduce the consequences derivable from the ecosystem threat.

Materials and Methods

The Kainji Lake National Park (KLNP) is composed of two non-contiguous sectors: the Zugurma Sector and Borgu Sector (Fig. 1). The Borgu Sector of Kainji Lake National Park (Bs-KLNP) is made up of the former Borgu Game Reserve and the Doro River Forest Reserve. Both Game Reserves were constituted as wildlife conservation areas between 1962-1964 and 1964-1971 respectively. According to IUCN (1994, 2004) definition, Kainji Lake National Park is a Category II Protected Area (PA) managed mainly for ecosystem protection and recreation. Aside from these, the park protects watersheds, provides opportunities for education/research and has eco-tourism potential. It is the second largest of the seven National parks in Nigeria. The park covers a

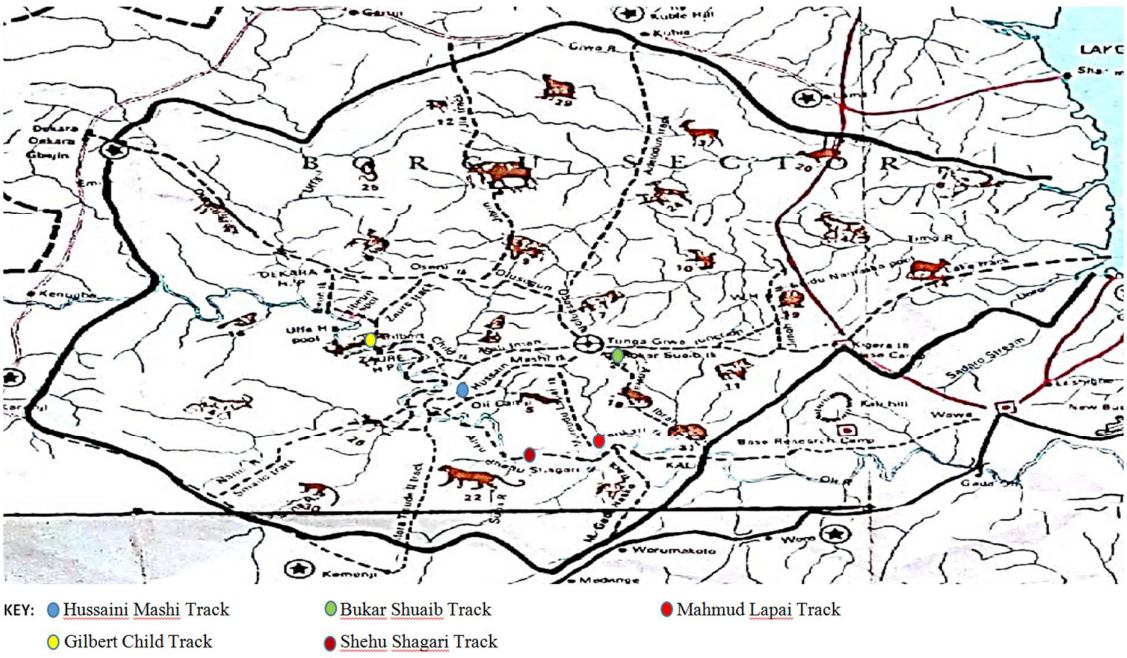

Figure 1. Map of Kainji Lake National Park, Niger State, Nigeria showing the study sites

total land area of 5340.82 km^2. The park lies between latitude 9^0 40' – 10^0 30'N and longitude 3^0 30' – 5^0 50'E. The park lies between latitude 9^0 40' – 10^0 30'N and longitude 3^0 30' – 5^0 50'E. The main vegetation type of the park is the Northern Guinea Savannah (Keay 1959,1989). However, there are seven identified vegetation sub-types in the park (Child 1974, Geerling 1976, Afolayan 1974, 1977, 1978, Chachu 1982). These are:

i. *Burkea africana* / *Detarium microcarpum* woodland
ii. *Afzelia africana* woodland
iii. *Isoberlinia tomentosa* woodland
iv. *Terminalia macroptera* woodland
v. *Diospyros mespiliformis* dry forest
vi. *Acacia* "complex" dry forest
vii. *Riparian* forest and woodlands.

Sampling and Data Collection Techniques

The study area was stratified according to its habitat type. The sampling unit within the habitat was determined, assigned on the basis of area coverage and vegetation type. A purposive random sampling technique was used for selecting the actual sites for sampling through line transects. It is is a non-probability sample that is on characteristics of a population and the objective of the study. This type of sampling is very useful in situations when the researcher needs to reach a targeted sample quickly, and where sampling for proportionality is not the main concern (Tongco 2007). Study Sites include tracks (Hussaini Mashi Track, Gilbert Child Track, Bukar Shuaib Track, Shehu Shagari Track and Mahmud Lapai Track) in Borgu Sector of Kainji Lake National Park.

Method of data collection

Point count

Points were selected at tracks (Hussaini Mashi Track, Gilbert Child Track, Bukar Shuaib Track, Shehu Shagari Track and Mahmud Lapai Track) in the Borgu Sector of Kainji Lake National Park to observe, count and identify bird species with the help of a pair of binoculars (Haldin and Ulfvens 1987). Surveys were conducted on foot and automobile along the tracks. In each site, bird observations were carried out twice daily (6 hours a day) for a

period of seven months (December to June) when the activities of the birds are prominent; morning between 6 a.m. to 10 a.m. and evening between 4 p.m. to 6 p.m. by moving slowly along the transects. The length of each transect was fixed at 5 km each and subdivided into 50 metres subsections to aid data collection and habitat assessment. In each site, transects were placed at 100 metres apart.

Birds were counted as bird seen and heard and birds in flight were also recorded. A pair of binoculars with magnification 7x50 was used in the identification of birds visually alongside two trained and experienced field guides (Ramsar Convention Bureau 2000). Photography of birds was done using a Digital camera with 300 and 500 zoom lenses. Videos were also taken to justify the species type for the species that would be difficult to identify. Inconspicuous bird species were identified based on their calls. The song and call records were used to relate with songs and calls of birds heard during the survey period.

Species diversity indices

Species diversity indices as Shannon-Wiener (Shannon and Weaver 1949) and Simpson Index (Simpson 1949) was used to evaluate the bird species diversity.

Shannon-Wiener Index assumes that individuals are randomly sampled from an independent large population and all the species are represented in the sample. Shannon diversity is a very widely used index for comparing diversity between various habitats (Clarke and Warwick 2001). It is is a measure of diversity that combines species richness (the number of species in a given area) and their relative abundances and it is calculated in order to know the species diversity in different habitat (Hutchison 1970) based on the abundance of the species by the following formula:

$$H = -\sum_{i=1}^{S} P_i \ln P_i$$

Where,

H = Diversity Index;

S = Total number of species of the community (number seen and heard).

P_i = Proportion of each or individual (i^{th}) species in the sample;

ln P_i = Natural logarithm of the species proportion..

Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4 to 4.5. A value near 4.6 would indicate that the numbers of individuals are evenly distributed between all the species (Magurran 2004, Bibi and Ali 2013) The Shannon index increases as both the richness and the evenness of the community increase. The fact that the index incorporates both components of biodiversity can be seen as both a strength and a weakness. It is a strength because it provides a simple, synthetic summary, but it is a weakness because it makes it difficult to compare communities that differ greatly in richness. The presence of one individual of a species is not necessarily indicative of the species being present in a large number.

Simpson Index assumes that a community dominated by one or two species is considered to be less diverse than one in which several different species have a similar abundance. Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so diversity increases.

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

n = the total number of organisms of a particular species.

N = the total number of organisms of all species.

D is a measure of dominance, therefore as D increases, diversity (in the sense of evenness) decreases. Thus, Simpson's index is usually reported as its complement 1-D (or sometimes 1/D or –lnD). Since D takes on values between zero and one and approaches one in the limit of a monoculture, (1-D) provides an intuitive

proportional measure of diversity that is much less sensitive to species richness. The value of D ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity (Magurran 2004).

Paleontological Statistics Software Package for Education and Data Analysis (PAST 3.22) was used to analyse the data.

Results

Checklist of bird species in the study area

Table 1 presents 31 families of birds observed and recorded in the five study sites. These includes Columbidae, Accipitridae, Phylloscopidae, Cistolidae, Lybidae, Meropidae, Pyconotidae, Sturnidae, Ardeidae, Bucerotidae, Muscicopidae, Nectariniidae, Phasianidae, Estrilididae, Plocidae, Upupidae, Picidae, Dicruridae, Cuculidae, Musophasidae, Indicatoridae, Psittacidae, Malaconotidae, Coracidae, Scopidae, Corvidae, Passeridae, Oriolidae, Paridae, Lanidae and Fringillidae. The result of the study showed that Estrilididae family recorded the highest number of species (6). This is closely followed by Plocidae (5), Columbidae (5), Lybidae (4), Phasianidae (4) and Cuculidae families respectively. Other bird species were recorded from the other families of birds as mentioned earlier.

The results of this study showed that bird species diversity indices indicated a normal distribution of bird species in all the sites (Table 2). A one-way ANOVA showed that bird diversity varies significantly ($p < 0.05$) between the five sites (Table 3). Mahmud Lapai track had the highest diversity (4.185) compared to Hussaini Mashi (3.726), Gilbert Child (3.928), Shehu Shagari (4.106) and Bukar Shuaib (4.135) tracks respectively. Thus, Mahmud Lapai had the highest diversity (Fig. 2). On the other hand, Fig.3 showed the bird species abundance distribution of the study sites.

Discussion

Majority of birds observed during the study were resident species, migratory and palearctic species. Afro-Palearctic migratory birds have suffered substantial declines over the past 30 years owing to reduced over-winter survival in Africa, habitat degradation in Europe, hunting and the effects of climate change **(**BirdLife International 2017**).** An important palearctic species recorded was *Phylloscopus trochilus* (Willow warbler). It is a very common and widespread leaf warbler and strongly migratory, with almost all of the population wintering in Sub-Saharan Africa (Baker 1997, Hoyo *et al*. 2006). Significant migrant and resident species observed included *Tockus nasutus* (African grey hornbill). It is a bird whose nesting habits are unique. The female seals herself in a tree cavity and leaves only a narrow slit through which the male will feed her and her chicks until they are nearly ready to fly away. Its curious nesting behavior is a defence against predators such as snakes and martens (Attica Park 2019). *Bucorvus abyssinicus* (Ground hornbill). They are large, with adults around a metre tall. The species are ground-dwelling, unlike other hornbills, and feed on insects, snakes, other birds, amphibians and tortoises (Kinnaird and O'Brien 2007). They are among the longest-lived of all birds (Wasser and Sherman 2010) and the larger southern species is possibly the slowest-breeding (triennially) and longest-lived of all birds (Brown 1988, Skutch and Gardner 1999). However, the absence of a proper nesting site may affect the abundance and diversity of these bird species. An important observation was that the bird abundance varied across sites (Tracks). This was influenced by various factors such as availability of food, types of vegetation, nesting sites and the need for cover from predators. Habitat is used as a predictor of bird species abundance. Variety of birds has developed preferences for habitat (Huston 1994, Lameed

2011). Birds select vegetation in a manner by which an individual habitat may have an important effect on its access to food, mating and/or its vulnerability to predators. This was ascertained by Manu (2000) in his work on the effect of habitat fragmentation on the distribution of forest birds in South-Western Nigeria. Therefore, the conservation of habitat will, therefore, be synonymous to the preservation and conservation of birds found in such habitat.

Table 1. Checklist of bird species in the study area

SN	Family	Common Name	Scientific Name
1		Red eyed dove	*Streptopelia semitorquatus*
2		Speckled pigeon	*Columba guinea*
3	*Columbidae*	Mourning dove	*Streptopelia decipens*
4		Vinaceous dove	*Streptopelia vinalea*
5		Laughing dove	*Streptopelia senegalensis*
6		Lizard buzzard	*Kaupofalco monogrammicus*
7	*Accipitridae*	Lanner falcon	*Falco biamicus*
8		Kestrel	*Falco tinnunculus*
9	*Phylloscopidae*	Willow warbler	*Phylloscopus trochilus*
10	*Cistolidae*	West African prinia	*Ptilostomus subflava*
11		Lemon rumped tinkerbird	*Pogoniulus bilineatus*
12	*Lybidae*	Bearded barbet	*Lybus dubius*
13		White headed barbet	*Lybius leucocephalus*
14		Tooth billed barbet	*Lybius bidentatus*
15		Black bee eater	*Merops gularis*
16	*Meropidae*	Blue cheeked bee eater	*Merops superciliosus*
17		Little bee eater	*Merops pusilius*
18	*Pyconotidae*	Common garden bulbul	*Pycnonotus barbatus*
19	*Sturnidae*	Blue eared glossy starling	*Lamprotormis purpereus*
20		Long tailed glossy starling	*Lamprotormis caudatus*
21	*Ardeidae*	Cattle egret	*Bubulus ibis*
22		Little egret	*Egretta garzetta*
23		African grey hornbill	*Tockus nasutus*
24	*Bucerotidae*	Ground hornbill	*Bucorvus abysinnicus*
25		Red billed hornbill	*Tockus eryhrorhynchus*
26	*Muscicopidae*	Black flycatcher	*Melaenornis edolides*
27		Black and white flycatcher	*Bias musicus*
28	*Nectariniidae*	Beautiful long tailed sunbird	*Nectarinia puchella*
29		Splendid sunbird	*Nectarinia coccinigaster*
30		Helmeted guinea fowl	*Numida meleagris*
31	*Phasianidae*	White throated francolin	*Francolinus albogularis*
32		Double spurred francolin	*Francolinus bicalcaratus*
33		Stone partridge	*Ptilopachus petrosus*
34		Black rumped waxbill	*Estrilda troglodytes*
35		Orange cheeked waxbill	*Estrilda melpoda*
36	*Estrilididae*	Seed cracker	*Pirenestes ostrinus*
37		Senegal fire finch	*Lagosnisticta senegala*
38		Streaky headed seed eater	*Serinus gularis*
39		Bronze manniken	*Lochura cucullata*
40		Red bishop	*Euplectes orix*
41		White billed buffalo weaver	*Bubalornis bibirostris*
42	*Plocidae*	Veilot's black weaver	*Ploceus nigerrimus*
43		Black headed weaver	*Spermestes cucullatus*
44		Blue billed malimbe	*Malimbus nitens*
45	*Upupidae*	Senegal wood hoopoe	*Phoeniculus purpreus*

Continuted Table 1. Checklist of bird species in the study area

SN	Family	Common Name	Scientific Name
46	*Picidae*	Cardinal woodpecker	*Dendropicos fuscencens*
47		Fire billed woodpecker	*Dendropicos pyrrhogaster*
48	*Dicruridae*	Glossy backed drongo	*Dicrurus adsimillis*
49	*Cuculidae*	Blue headed coucal	*Centropus monachus*
50		Senegal coucal	*Centropus senegalensis*
51		Great spotted cuckoo	*Clamator glandarius*
52		Leveillant's cuckoo	*Oxylophus levillantis*
53	*Musophasidae*	Grey plantain eater	*Crinifer piscator*
54		Violet plantain eater	*Musophaga vilacea*
55	*Indicatoridae*	Black throated honey guide	*Indicator indicator*
56		Cassien's sharp billed honeyguide	*Prodotiscus ingnis*
57	*Psittacidae*	Senegal parrot	*Poicephalus senegalus*
58	*Malaconotidae*	Black crowned tchagra	*Tchagra senegala*
59		Sooty boubou	*Laniarus leucorhynchus*
60	*Coracidae*	Abysinnia roller	*Coracias abysinnica*
61		Rufous crowned roller	*Coracias naevia*
62		Blue billed roller	*Coracias cyanogaster*
63	*Scopidae*	Hamerkop	*Scopus umbretta*
64	*Corvidae*	Pied crow	*Covus albus*
65	*Passeridae*	Grey headed sparrow	*Passer griseus*
66		Wire tailed swallow	*Hirundu smithii*
67	*Oriolidae*	African golden oriole	*Oriolus auralus*
68	*Paridae*	White shouldered black tit	*Parus guinemisis*
69	*Lanidae*	Barbary shrike	*Laniarius barbarous*
70	*Fringillidae*	Grey canary	*Serinus leucophygius*

Table 2. Bird species diversity in each site

Indices	Hussaini Mashi	Gilbert Child	Bukar Shuaib	Shehu Shagari	Mahmud Lapai
Individuals	614	622	949	1076	889
Dominance_D	0.03287	0.02629	0.01793	0.01923	0.01619
Simpson_1-D	0.9671	0.9737	0.9821	0.9808	0.9838
Shannon_H	3.726	3.928	4.135	4.106	4.185
Evenness_e^H/S	0.5933	0.7261	0.8929	0.8676	0.9385
Brillouin	3.536	3.725	3.979	3.966	4.019
Menhinick	2.825	2.807	2.272	2.134	2.348
Margalef	10.75	10.73	10.07	9.884	10.16
Equitability_J	0.8771	0.9247	0.9733	0.9666	0.9851
Fisher_alpha	20.35	20.25	17.43	16.76	17.81
Berger-Parker	0.07003	0.08199	0.0411	0.04461	0.027

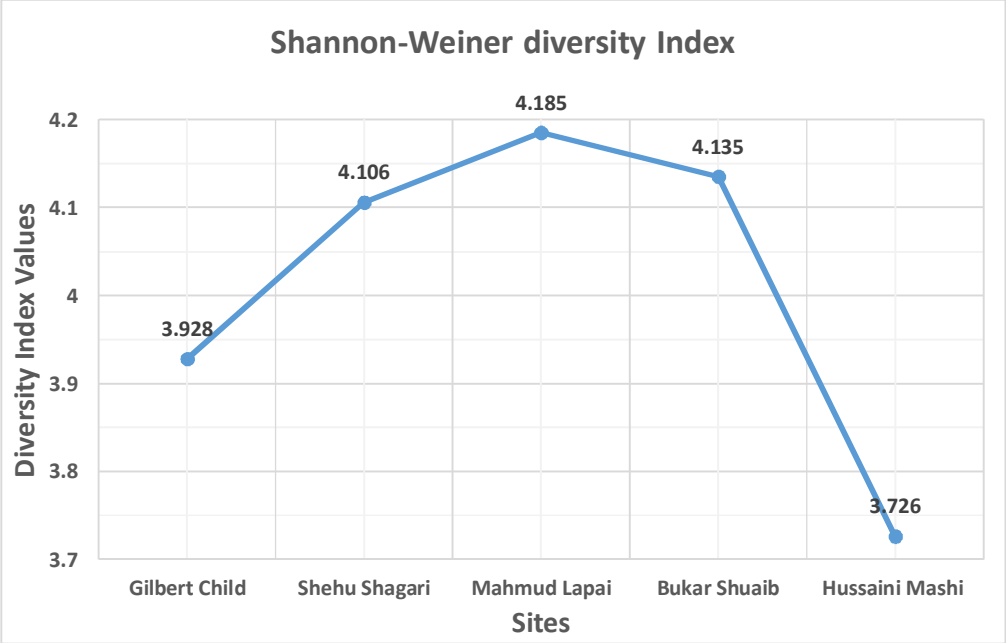

Figure 2. Bird species diversity of the study sites

Table 3. One-way Analysis of variance (ANOVA) Test for equal means of birds across the sites

	Sum of sqrs	Df	Mean square	F	P (same)
Between groups:	2401.11	4	600.279	9.346	3.51E-07
Within groups:	22159.7	345	64.2311		
Total:	24560.9	349			

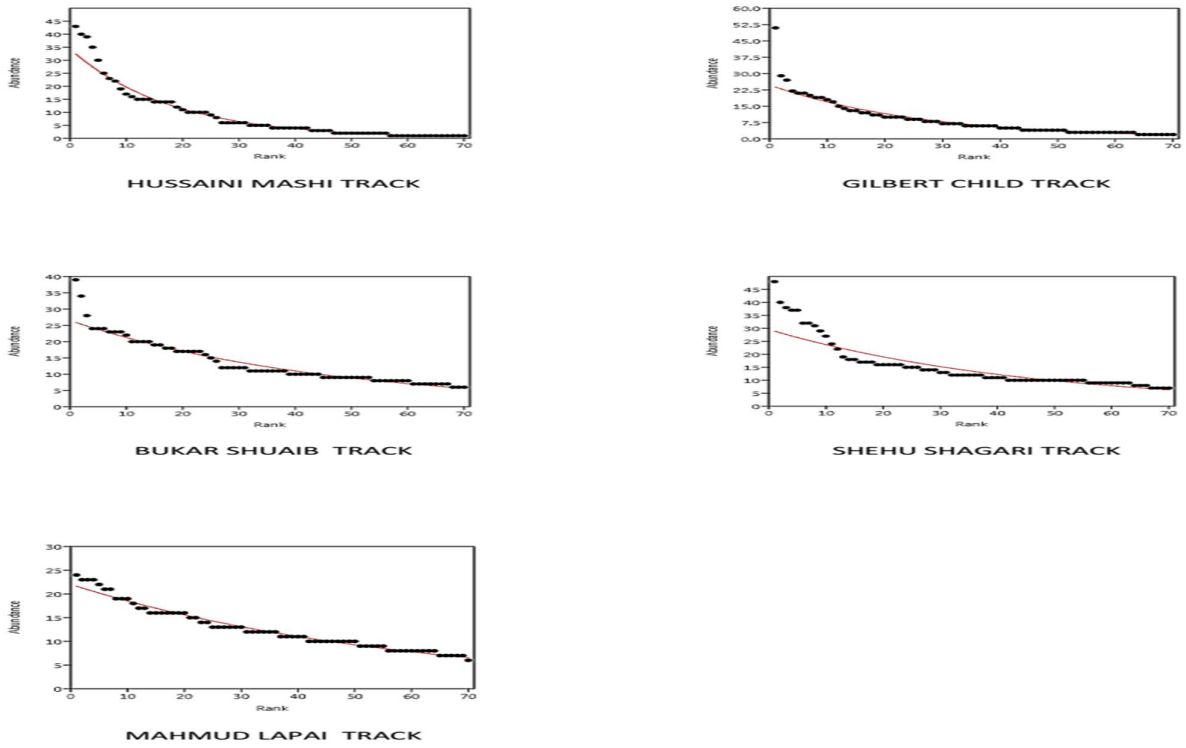

Figure 3. Distribution of bird species abundance of the study sites

Conclusion

Birds have been found to be indicators of environmental degradation. They could serve as indicators revealing the state of the environment, as dispersal agents in transferring nutrients and food from one vegetation during migration and local movements (BirdLife International 2008). A checklist of 70 species in 31 families was identified, therefore there is a need for proper monitoring of the sites (Tracks). Thus, protection of these sites will ensure better protection of resources richness (vegetation, water, soil etc.) thereby enable future sustainable utilization of the resources. If the park is under threat by the people and poorly managed by the policymakers, then it will send a serious signal to the viability of the park and invariably affect the general conservation of the park. Wildlife conservation is the ethical use of wildlife resources, allocation and its protection for future use. Its primary focus is upon maintaining the health of the natural world, habitats and biological diversity. Degradation of the natural environment is tantamount to man's extinction from the earth who depends on biodiversity in the wild hence their preservation and conservation. To protect wild animals from extinction would involve the legislation, enactment and enforcement of laws that will protect forest areas where avifauna are found and the diversity is almost infinite.

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