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Patterns of Species Richness and Abundance in Badingilo National Park in South Sudan

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ABSTRACT

The study was carried out to determine patterns of birds' species richness and abundance in Badingilo national park using a 10 m fixed-radius point count method. A total of 2670 individuals were recorded from 182 points in the park. The highest expected number of species (Jack1 estimator) was observed in the Riverine habitat and least was in the Agriculture and Human settlement habitat type. The total number of species observed in the park was 63; however Jack1 estimator indicated that there were 68 species in the park. The majority of the birds observed during the study were resident species, few migratory and Pa-laearctic bird species. Few birds observed in the park were abundant. The most abundant species was the village weaver (381 individuals), and the rarest species were black-bellied bustard, barn owl, black scimitar bill and tree pipit (one individual each).

1. Introduction

Avian community is an important component of all forest ecosystems. Birds play a major role as pollinators, consumers, and dispersers of plant seeds and predators of many invertebrates and small vertebrates^[24]. Research on birds' communities to design and strategize for biodiversity friendly development is of paramount importance^[10,22]. Community ecology is the study of grouping of species, their distribution and interactions between them and physical as well as biological components of the environment^[23,28]. According to Cody^[11] birds' community is directly associated with habitat; and as such can serve indicators of environmental changes. Likewise, Mills et al. 1989 found a strong relationship between breeding bird community structure and vegetation

in Arizona. Similarly, Ikin et al.^[21] reported a multi-scale association between vegetation cover and woodland bird communities in South-west Wales in Australia. Although compared to mammals and amphibians, birds are regarded as excellent conservation indicators, yet some species are classified as Data Deficient in the IUCN Red list^[8,19,32].

As yet birds are seriously threatened. These threats affect their distribution and diversity both locally and regionally. These threats arise from both natural factors and anthropogenic activities^[2,4,9,27]. Illegal activities such as fishing, logging, and agricultural practices within the park can be detrimental to birds' species diversity in the long term (Birds Life International 2010). Habitat destruction as a result of anthropogenic activities is the major problem affecting diversity, abundance and species richness

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of most birds [1,2,9,10,16]. Fahring [16] in a simulation study showed that habitat loss has a profound effect on extinction. Also, Zitske et al. [34] found that survival of migrant warblers in a forest mosaic was inversely proportional to habitat loss in New Brunswick in Canada. The objectives of this study were; first, to determine species richness of birds' in the park. Second, to determine abundance of birds in Badingilo National park and how this abundance is distributed across habitats.

2. Materials and Methods

2.1 Study Area

Badingilo National park is situated in South Sudan's equatorial region, within central equatorial state. The bordered by Bor in the north and Lafon to the east of White Nile. The Park was gazetted in 1986 and covers approximately an area of 8,400Km². The park is situated on a swamp 40 km east of Mongalla, and provides a dry season refuge for mammal populations [28]. It is surrounded by a large area of mostly waterless plains (Figure 1).

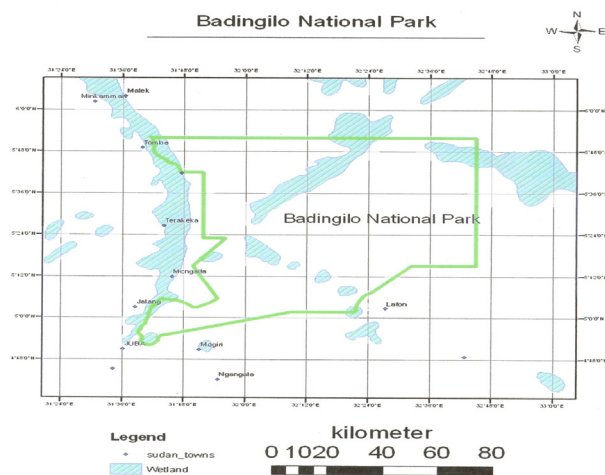


Figure 1. Map of Badingilo National Park (Green rectangle)

The climate of the area is characterised by two seasons wet and dry as it lies near the equator, temperature are hot throughout the year with the hottest maximum temperatures reaching 38°C. Total annual rainfall ranges between 1000 to 1,500mm [33]. The fauna of the park includes white-eared kob (*Kobus kob leucotis*), the tiang (*Damaliscus lunatus tiang*), the Mongalla gazelle (*Gazella rufifrons albonotata*), reticulated giraffe (*Giraffa camelopardalis*), zebra (*Equus burchelli*), Grant's gazelle (*Gazella granti*), lesser kudu (*Tragelaphus imberbis*), Beisa oryx (*Oryx beisa*), warthog (*Phacochoerus africanus*), Bohor reedbuck (*Redunca redunca*), lion (*Panthera leo*), spotted hyena

(*Crocuta crocuta*), wild dog (*Lycaon pictus*), leopard (*Panthera pardus*) and black-blacked jackal (*Canis mesomelas*) and several bird species [26,31]. The dominant tree species in the park includes white thorn (*Acacia seyal*), pod mahogany (*Azalia quanzensis*), desert dates (*Balanites aegyptiaca*), stink wood (*Celtis sp.*), Sodom apple (*Calotropis procera*), Bush-willow (*Combretum sp.*), African fan palm (*Borassus aethiopiun*), Bell-flowered mimosa (*Dichrostachys cinerea*), African ebony (*Diospyros mespiliformis*), Kaffir boom (*Erythrina sp.*), Fig (*Ficus sp.*), Sausage tree (*Kigelia africana*), Black plum (*Vitex doniana*), Christ thorn (*Ziziphus spina-christi*), Tamarind (*Tamarindus indica*), and Neem (*Azadirachta indica*) [5]. The main types of grasses found in the area consist of swamp meadow, with dense low growing stoloniferous grasses, antelope grass (*Echinochloa pyramidalis*), and thatching grass (*Hyparrhenia rufa*).

2.2 Sampling Design and Data Collection

Survey area was divided into five (5) different habitats based on the physiognomy and land use type as follows: first, mixed Woodland which is characterised by wooded landscapes with dominant woody layers about 50-90% canopy cover [4]. Mixed woodland habitat type is mostly dominated by white thorn (*A. seyal*), pod mahogany (*A. quanzensis*), desert dates (*B. aegyptiaca*), and bush-willow (*Combretum sp.*) among others [5]. Second, is Wetland/seasonal flooded grassland habitat type which is seasonally inundated by water from rivers and rain shed/ land where saturation of water is the dominant factor determining the nature of soil development and the types of plants and animals living in the soil and on its surface [4]. Wetland habitats are mostly dominated by the following grass species wild rice (*Oryza longistaminata*), Guinea grass (*Panicum sp.*), thatching grass (*H. rufa*) and antelope grass (*E. pyramidalis*). Third, is desert dates (*B. aegyptiaca*) and Christ thorn (*Z. spina-christi*) woodland habitats which is characterised by dense woody species mostly desert dates and Christ thorn as well as some grasses and shrubs adjacent to river courses [4]. Fourth, Riverine habitats is found along the riverside and its edge, these habitats are mostly dominated by nut-grass or water-grass (*Cyperus papyrus*), reed (*Phragmites sp.*) and reedmache (*Typha domingensis*) swamp among others [4]. Fifth, Agricultural and human settlement habitat is characterised by agricultural activities and human settlement. The area is dominated by open fields of most groundnuts, few maize and some beans. Within each habitat type 15-40 10 m radius circular plots were placed. Birds seen within the plots were identified to species and counted. Identification was done with the help of binoculars. Bird identification was done according

Nikolaus [28] and Sinclair & Ryan [31].

2.3 Data Analysis

To determine, species richness for the whole park and each habitat type, rarefaction curves were generated using 50 randomizations and sampling without replacement implemented in Estimate S v9 [13]. This was done using Jack-knife1 estimator chosen as the most applicable to our data. Rarefaction curve is a standardization procedure that calculates expected species accumulation curve and allows comparison of species richness among samples of different sites or habitats [13]. Avian species abundance in Badingilo National park and within each habitat type was assessed using species rank abundance curves. Here species are ordered from the most to least abundant. This enables the pattern of abundance to be discerned.

3. Results

3.1 Species Richness and Diversity

In total, 2857 birds were recorded from 182 point samples of 10 m radius across five different habitats in the park over the course of two weeks birding periods. The highest expected number of species (Jack 1 estimator) was observed in the Riverine habitat (51). The lowest was in the Agriculture and Human settlement habitat type (35) (Figure 2).

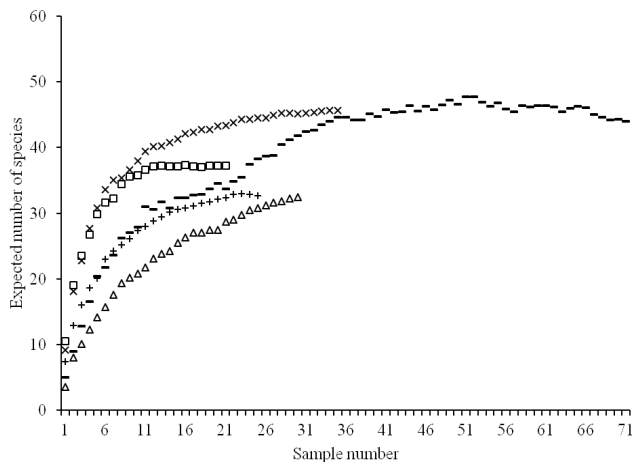


Figure 2. Rarefaction curves of birds in different habitat types (x RVRNE □ WTL + B & ZWL - MWL Δ AGRIC)

A total of 63 species was observed in the park. However, Jack 1 estimator puts the number of bird species in the park at 68 which is slightly higher than the observed number of bird species in the park (Figure 3).

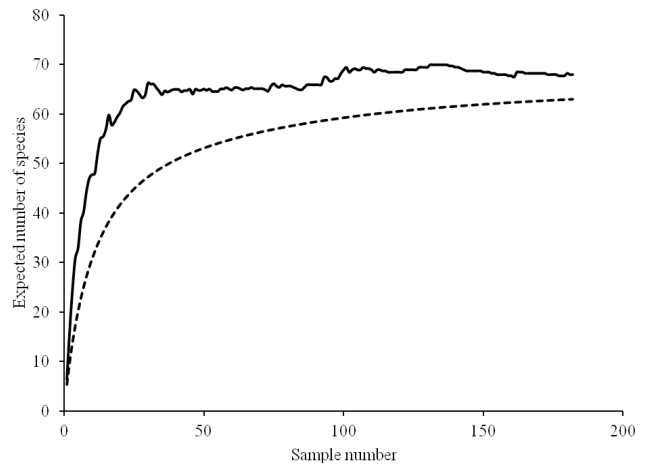


Figure 3. Species richness of birds in the park (----- observed number of species S(est) ———— estimated number of species (Jack1)

3.2 Bird Species Abundance

Most species of birds observed in each habitat type were rare (Figure 4).

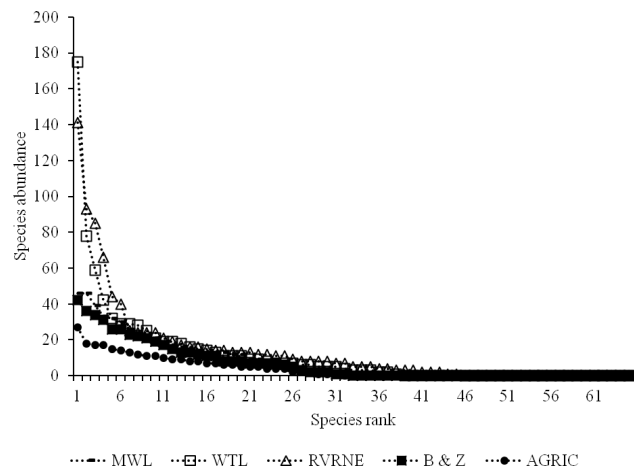


Figure 4. Species rank-abundance of birds in different habitat types in Badingilo National park (●●● MWL □●● WTL ●●● RVRNE ●●● B & Z WL ●●● AGRIC)

Likewise the global species rank-abundance curve of birds indicates that the number of rare species outnumbered that of abundant birds in Badingilo National Park. The village weaver was the most abundant bird species and each of black-bellied bustard, barn owl, black scimitar and tree pipit were rare (Figure 5).

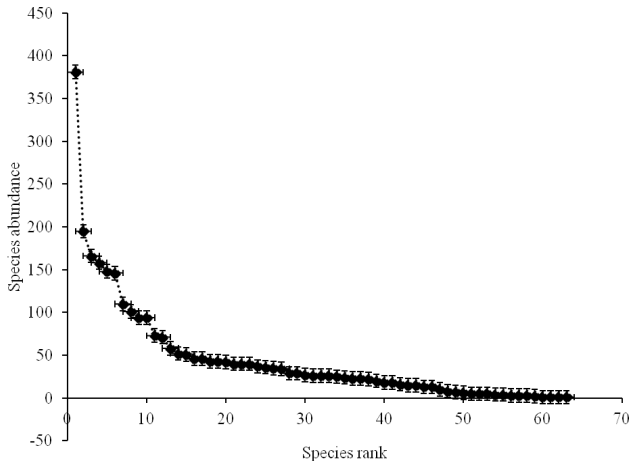


Figure 5. Species rank-abundance curve of birds in Badingilo National park

4. Discussion

Both the observed and estimated number of bird species in the park may represent a tiny fraction of birds found in Badingilo National Park in a relatively short sampling period. Nevertheless, it provides the first checklist of bird species recorded during the duration of this study in the National park. In addition, it indicates that Badingilo National Park may be harbouring a relatively rich avian community as has been reported by Evans and Fishpool [15].

Although, 63 bird species were observed in the park, Jack 1 estimator puts the figure at 68 indicating that the park may be harbouring more species. The underestimation may be due to the low sampling effort and thick vegetation present in some habitat types. Besides, the timing of sampling August may have contributed to low species richness. Evans and Fishpool put the number of birds in Badingilo National Park at 85. Although this species richness of birds may be higher than the 63 (74%) observed in this study, it suggests that the number of individuals observed in that study was higher than those in the current study. In spite of biases that may be associated with the sampling procedure, the Jack1 estimate is probably the correct estimate of the avian community in Badingilo National Park as it is considered a less bias estimator [14]. Moreover the Jack1 estimator has started to level off indicating that avian sampling over the two weeks has been exhausted. The occurrence of high number of species in the riverine habitat type [7,29] may be explained by the presence of several microhabitats thereby supporting many bird species [12,20,23,28]. For example, the riverine habitat type encompasses pockets of woodland, grasslands and plenty of water making it attractive to many bird species. The observed lowest species diversity of birds in the

agriculture and human settlement habitat may be due to high anthropogenic activity. For example, the bird survey period coincided with the harvest time for the groundnuts, thus there was a lot of activity in the agriculture and human settlement habitat type. In addition, this habitat type was mainly open with few scattered trees making it less attractive for many bird species as they may become exposed to predators [3,18].

The riverine habitat type had the highest number of individuals of birds dominated by the village weaver suggest that it is the main habitat type. The high number of rare species observed in this study is similar to that reported in other studies where many of the species found were rare and few were abundant [6,17,25,30]. This suggests many birds in Badingilo National Park occur in small numbers. In conclusion, the patterns of avian diversity observed in this study should be interpreted with caution because of the limited sampling effort. In addition, further research with sampling period extended over the dry and wet seasons should be undertaken to ascertain the species richness and abundance of birds in Badingilo National Park.

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Appendix

Table 1. List of birds observed in Badingilo National Park

Serial number	Local name	Scientific name	Status
1	Mourning dove	<i>Streptopelia semitorquata</i>	MB
2	Cape turtle dove	<i>Streptopelia semitorquata</i>	R
3	Village weaver	<i>Ploceus cucullatus</i>	RB
4	Rüppell's starling	<i>Lamprotornis purpuropterus</i>	RB
5	Sedge warbler	<i>Acrocephalus schoenobaenus</i>	PW
6	Red-cheeked cordon-bleu	<i>Uraeginthus bengalus</i>	RB
7	African pigmy kingfisher	<i>Ispidina picta</i>	MB
8	Malachite kingfisher	<i>Alcedo cristata</i>	R
9	Cat-throat finch	<i>Amadina fasciata</i>	RB
10	Tree pipit	<i>Anthus trivialis</i>	PW

11	Superb starling	<i>Lamprotornis superbus</i>	R
12	Common bulbul	<i>Pycnonotus barbatus</i>	RB
13	Lesser grey shrike	<i>Lanius minor</i>	P
14	Northern red bishop	<i>Euplectes franciscanus</i>	RB
15	Speckled mousebird	<i>Colius striatus</i>	RB
16	Senegal coucal	<i>Centropus senegalensis</i>	RB
17	Beautiful sunbird	<i>Cinnyris pulchellus</i>	RB
18	Pied kingfisher	<i>Ceryle rudis</i>	RB
19	Greyhooded kingfisher	<i>Halcyon leucocephala</i>	MB
20	Little bee-eater	<i>Merops pulchellus</i>	RB
21	Northern redbilled hornbill	<i>Tockus erythrorhynchus</i>	RB
22	Yellow-fronted canary	<i>Serinus mozambicus</i>	RB
23	Helmeted guinea-fowl	<i>Numida meleagris</i>	RB
24	Black-headed gonolek	<i>Laniarius erythrogaster</i>	RB
25	Purple glossy starling	<i>Lamprotornis purpureus</i>	RB
26	Black-bellied bustard	<i>Eupodotis melanogaster</i>	R
27	Red-billed quelea	<i>Quelea quelea</i>	MB
28	Tawny-flanked Prinia	<i>Prinia subflava</i>	RB
29	Cardinal quelea	<i>Quelea cardinalis</i>	R
30	Barn owl	<i>Tyto alba</i>	RB
31	Marsh owl	<i>Asio capensis</i>	M
32	Black kite	<i>Milvus migrans</i>	MB/PW
33	Pin-tailed whydah	<i>Vidua macroura</i>	RB
34	Eastern paradise whydah	<i>Vidua paradisaea</i>	R
35	Fork-tailed drongo	<i>Dicrurus adsimilis</i>	RB
36	Hadeda ibis	<i>Bostrychia hagedash</i>	R
37	White-faced whistling duck	<i>Dendrocygna viduata</i>	MB
38	Spotted flycatcher	<i>Muscicapa striata</i>	P
39	Bronze mannikin	<i>Spermestes cucullata</i>	RB
40	Great reed warbler	<i>Acrocephalus arundinaceus</i>	P
41	Eurasian reed warbler	<i>Acrocephalus scirpaceus</i>	PW/MB
42	Northern carmine bee-eater	<i>Merops nubicus</i>	MB
43	African paradise flycatcher	<i>Terpsiphone viridis</i>	MB
44	Black scimitarbill	<i>Rhinopomastus aterrimus</i>	RB
45	African golden oriole	<i>Oriolus auratus</i>	M
46	African fish eagle	<i>Haliaeetus vocifer</i>	RB
47	Lizzard buzzard	<i>Kaupifalco monogrammicus</i>	RB
48	Cattle egret	<i>Bubulcus ibis</i>	MB/P

49	Hammerkop	<i>Scopus umbretta</i>	RB
50	Goliath heron	<i>Ardea goliath</i>	RB
51	African yellow white eye	<i>Zosterops senegalensis</i>	RB
52	Copper sunbird	<i>Cinnyris cupreus</i>	RB
53	Jacobin cuckoo	<i>Clamator jacobinus</i>	M?
54	Rufous-rumped lark	<i>Pinarocorys erythropygia</i>	M
55	Lesser swamp warbler	<i>Acrocephalus gracilirostris</i>	RB
56	Swallowtailed bee-eater	<i>Merops hirundineus</i>	R
57	Namaqua dove	<i>Oena capensis</i>	MB
58	Dark chanting goshawk	<i>Melerax metabates</i>	RB
59	Village indigobird	<i>Vidua chalybeata</i>	RB
60	Flappet lark	<i>Mirafra rufocinnamomea</i>	RB
61	African thrush	<i>Turdus pelios</i>	RB
62	Red-backed shrike	<i>Lanius collurio</i>	P
63	Orange river francolin	<i>Scelopoptila levaillantoides</i>	R

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