

Impact of Seasonal Variation on Avian Species Diversity in Dagona Waterfowl Sanctuary, Yobe State, Nigeria

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ABSTRACT

Original research paper

A study was conducted at Dagona Waterfowl Sanctuary to examine the impact of seasonal variation on bird diversity. The research spanned six months and covered both the dry season (April to June) and the wet season (July to September). The objective was to evaluate seasonal fluctuations in bird diversity and species richness within the sanctuary. An initial reconnaissance survey was carried out to select suitable study locations and sampling points. Five distinct locations Zemo, Oxbow, Incheduwa, Maram, and Gustu Lakes were identified for sampling, and the point count method was used for bird census. Bird observations were conducted at each point twice a day: in the morning (6:00 AM to 10:00 AM) and in the evening (4:00 PM to 6:00 PM). Data were compiled using Microsoft Excel and analyzed with PAST version 3.26b software. Bird diversity was assessed using the Shannon-Wiener Diversity Index. The results revealed that the majority of birds observed were categorized as Resident (12,225 individuals), Migratory (8,186), and Palearctic Migrant species (10,876). Some of the resident birds recorded included the African Jacana, Long-tailed/Reed Cormorant, African Mourning Dove, Vinaceous Dove, Pied Kingfisher, and Common Moorhen. Migratory species observed included the Yellow Wagtail, African Marsh Harrier, Intermediate Egret, Red-billed Hornbill, and Garganey. Palearctic migrants such as the White-faced Whistling Duck, Squacco Heron, Fulvous Whistling Duck, Yellow-billed Kite, and Green Sandpiper were also recorded. The Shannon Diversity Index value was found to be 1.94 during the dry season and 3.63 in the wet season, indicating significantly greater bird diversity during the wet season. However, human activities such as overgrazing, fishing, and animal rearing pose serious threats to the avifaunal population and the ecological balance of the wetland ecosystem. Based on these findings, the study recommends continuous monitoring and the implementation of effective conservation strategies. Public awareness campaigns and better management practices are necessary to preserve Dagona Waterfowl Sanctuary as a vital habitat for both resident and migratory bird species.

Keywords: Seasonal, Migratory, Avifauna, Diversity, Reconnaissance, Survey, Sampling.

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Introduction

Birds are egg-laying, feathered vertebrates characterized by wings and belonging to the Kingdom *Animalia*, Phylum *Chordata*, and Class *Aves*. They are found across the globe, inhabiting diverse environments such as oceans, rivers, forests, and mountainous regions. Birds are among the most visible and recognized members of the animal kingdom, known for their vibrant plumage, unique vocalizations, and dynamic displays. These features not only enhance the natural environment but also bring enjoyment to bird watchers and nature enthusiasts.

Birds are highly social creatures that communicate through calls, songs, and visual signals. They also exhibit complex behaviors, including cooperative breeding, group hunting, flocking, and predator mobbing. Avian species occupy a wide range of habitats and can be found on every continent, including the harshest environments.

Nigeria hosts a rich diversity of bird species distributed across various ecological zones. Wetlands, in particular, play a critical role in supporting avifauna diversity. These ecosystems provide essential resources such as food and shelter. Birds feed on wetland vegetation, aquatic invertebrates, and small vertebrates. Some forage in water, others feed along the shores, while some exploit submerged or emergent vegetation for sustenance (Labe et al., 2018).

Previous research on bird diversity, such as studies by Burgess et al. (2002), Doggart et al. (2005), Frontier-Tanzania (2005), and Yanda & Munishi (2007), mainly focused on forest ecosystems and highlighted the negative impact of forest conversion to human-dominated landscapes. However, the effects of agricultural and human-modified habitats on birds are variable and species-specific (Tworek, 2002). While some birds adapt and even thrive under altered conditions, others suffer significant declines.

Birds play an important ecological role at various trophic levels, functioning as pollinators, seed dispersers, pest regulators, and indicators of environmental health (Hadley et al., 2012; Ramchandra, 2013). This study aims to identify the bird species (avifauna) present in the study area and assess their diversity in relation to seasonal variations.

Materials and Method

Study Area

The study was conducted at the Dagona Waterfowl Sanctuary, located in the Sahelian ecological zone of northeastern Nigeria. This wetland forms part of the Bade-Nguru Wetland sector and encompasses approximately 938 km². The sanctuary includes the legally recognized Gogoram and Zurgum Baderi Forest Reserves, established in 1966 under the jurisdiction of the Bade Native Authority.

Dagona Waterfowl Sanctuary lies between latitudes 12°13'N and 13°00'N and longitudes 10°00'E and 11°00'E. It spans across parts of Bade and Jakusko Local Government Areas in Yobe State. The vegetation in the area is predominantly

Sudan/Sahelian scrubland, though a portion of the wetland remains inundated year-round, providing a stable habitat for waterfowl and other wildlife.

The sanctuary holds international importance due to conservation efforts aimed at protecting Palearctic migratory bird species. It is managed as part of the Chad Basin National Park and forms a key section of the Hadejia Nguru wetlands. Although officially under a multiple-use management policy, unauthorized activities such as grazing and harvesting of natural resources (e.g., wild animals, fish, birds, fruits, and firewood) persist. These pressures underscore the urgent need for stricter enforcement of conservation laws and better protection strategies (Borrow and Demey, 2014).

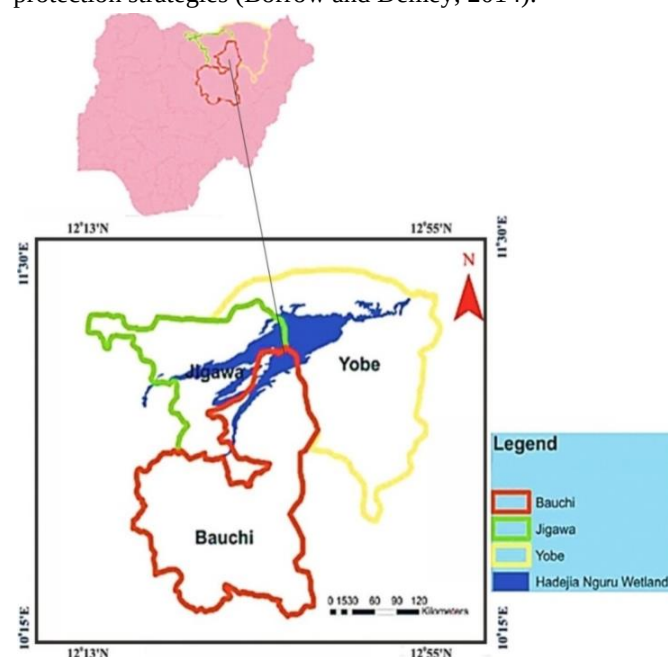


Figure 1: Map of Nigeria Showing the Study Area.

Source: (Ayeeni et al., 2019)

Below is a paraphrased, plagiarism-free, and academically polished version of the sections you provided: Research Design, Method of Data Collection, Data Analysis, and Results.

Research Design

A preliminary reconnaissance survey was conducted with the assistance of a topographic map and field personnel to identify appropriate sampling points within Dagona Waterfowl Sanctuary. Before fieldwork, permission was obtained from the relevant authorities overseeing the sanctuary. Based on this initial survey, five sampling locations were selected: Zemo, Oxbow, Incheduwa, Maram, and Gustu Lakes. The study was conducted over six months, comprising three months each during the dry (December to February) and wet (July to September) seasons.

Bird observations were carried out once per month during the study period. Counts included both visual and auditory detections of birds within a 100-meter radius. Birds observed in flight within this range were also recorded. Observations were facilitated using a pair of binoculars (model 750,

988,000m magnification) and a digital camera (Akomery 24MP) for photographic documentation. Bird identification was guided by the field manual *Birds of Western Africa* by Borrow and Demey (2014), following Ramsar Convention Bureau (2000) standards.

Method of Data Collection

Bird data were collected using the point count census method, in accordance with the procedures outlined by Bibby et al. (1992) and Ralph et al. (1993). For each of the five study sites (Zemo, Oxbow, Incheduwa, Maram, and Gustu Lakes), five points were selected randomly for observation.

At each observation station, birds were counted twice daily first in the morning from 6:00 AM to 10:00 AM and then in the evening from 4:00 PM to 6:00 PM. Upon arrival at each counting point, observers waited for five minutes to allow any disturbed birds to return to normal activity. Bird observation and identification lasted for 10 minutes per session using binoculars and the aforementioned field guide.

All observed and heard bird species were recorded on structured data forms specifically designed to capture relevant field information.

Data Analysis

All collected data were compiled using Microsoft Excel 2013 and analyzed using PAST version 3.26b (Paleontological Statistics Software). The following methods were used:

1. Tabular Presentation: Data on avifaunal species observed during the dry and wet seasons were presented in tables, following the approach by Lammeed (2011).
2. Diversity Analysis: Species diversity was quantified using the Shannon-Wiener Diversity Index (H'), calculated as:

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

Where:

- i. H' = Shannon-Wiener Diversity Index

- ii. S = Total number of species observed
- iii. P_i = Proportion of the i th species in the total sample
- iv. $\ln P_i$ = Natural logarithm of the proportion of the i th species (Source: Lammeed, 2011)

Results

Bird Species Identified During the Dry Season

During the dry season survey (December to February), a total of 23,284 individual birds were recorded over three visits:

- i. First visit: 4,976 individuals
- ii. Second visit: 2,991 individuals
- iii. Third visit: 15,317 individuals

These birds represented 31 avian families. The Ardeidae family recorded the highest species richness with 8 species. Anatidae and Ploceidae followed, each with 6 species, while Accipitridae and Columbidae had 5 species each. Families such as Rallidae, Scolopacidae, and Sturnidae had 4 species. Families with 2 species included Alaudidae, Alcedinidae, Bucerotidae, Charadriidae, Falconidae, Jacanidae, Passeridae, and Viduidae. A total of 15 families, including Ciconiidae, Coraciidae, and Cuculidae, had only 1 species each.

Bird Species Identified During the Wet Season

In the wet season (July to September), a significantly lower total of 1,287 individual birds were observed:

- i. First visit: 681 individuals
- ii. Second visit: 321 individuals
- iii. Third visit: 285 individuals

These birds belonged to 25 avian families. As in the dry season, the Ardeidae family had the highest species count with 6 species. Accipitridae, Columbidae, and Ploceidae followed with 5 species each. The Rallidae family had 4 species, while Anatidae and Sturnidae recorded 3 species each. Families such as Alaudidae, Bucerotidae, Charadriidae, Jacanidae, Passeridae, and Viduidae had 2 species each, whereas 11 families—including Alcedinidae, Ciconiidae, and Coraciidae—had only 1 species represented.

Table 1: Bird Species Identified in the Study Area (Dagona Waterfowl Sanctuary) for Dry Season

S/N	Family	Scientific Name	Common Name	Frequency			Total
				1 st Visit	2 nd Visit	3 rd Visit	
1.	Accipitridae	<i>Circus ranivorus</i>	African Marsh Harrier	6	1	2	9
	“	<i>Milvus migrans</i>	Black Kite	4	7	-	11
	“	<i>Elanus caeruleus</i>	Black-shouldered Kite	3	1	-	4
	“	<i>Circus macrourus</i>	Pallid Harrier	1	-	-	1
	“	<i>Milvus aegyptius</i>	Yellow billed Kite	-	4	69	73
2.	Alaudidae	<i>Galeridacristata</i>	Crested Lark	8	10	-	18
	“	<i>Ermmopterix leucotis</i>	Chestnut-backed Sparrow lark	2	5	-	7
3.	Alcedinidae	<i>Halcyon leucocephala</i>	Grey-headed Kingfisher	-	4	-	4
	“	<i>Cerylerudis</i>	Pied Kingfisher	-	4	20	24
4.	Anatidae	<i>Nettapus auritus</i>	African Pygmy Geese	-	-	28	28
	“	<i>Dendrocygna bicolor</i>	Fulvous Whistling Duck	301	30	-	331
	“	<i>Anas querquedula</i>	Garganey	105	40	-	145

	“	“	<i>Sarkidiornismelanotos</i>	Knob billed duck	29	21	-	50
	“	“	<i>Plectropterusgambensis</i>	Spur-winged Geese	38	34	-	72
	“	“	<i>Dendrocygnaviduata</i>	White Face Whistling Duck	830	272	13,450	14,552
5.	Ardeidae		<i>Egrettaaradesiaca</i>	Black Heron	114	53	30	167
	“	“	<i>Bubulcus ibis</i>	Cattle Egret	331	166	460	957
	“	“	<i>Ardea alba</i>	Greater Egret	11	3	25	39
	“	“	<i>Ardeacinerea</i>	Grey Heron	39	45	38	122
	“	“	<i>Egrettaintermedia</i>	Intermediate Egret	25	21	26	72
	“	“	<i>Egrettaazarzetta</i>	Little Egret	55	30	39	124
	“	“	<i>Ardeapurplea</i>	Purple Heron	48	43	49	140
	“	“	<i>Ardeolaralloides</i>	Squacco Heron	230	72	46	348
6.	Bucerotidae		<i>Tokunasutus</i>	African Grey Hornbill	2	12	2	16
	“	“	<i>Tockuserythrorhynchus</i>	Red-billed Hornbill	15	21	15	51
7.	Charadriidae		<i>Vanellustectus</i>	Black-headed Lapwing	28	14	-	42
	“	“	<i>Vanellusspinosus</i>	Spur-winged Lapwing	112	11	86	209
8.	Ciconiidae		<i>Anastomuslamelligerus</i>	African Openbill Stork	-	-	39	39
9.	Columbidae		<i>Streptopeliadecipiens</i>	African Mourning Dove	17	21	19	57
	“	“	<i>Streptopeliasenegalensis</i>	Laughing Dove	34	38	21	93
	“	“	<i>Oenacapensis</i>	Namaqua Dove	16	20	18	54
	“	“	<i>Columba guinea</i>	Speckled Pigeon	27	41	47	115
	“	“	<i>Streptopeliavinacea</i>	Vinaceous Dove	36	24	38	98
10.	Coraciidae		<i>Coraciasabyssinica</i>	Abyssinian Roller	13	21	28	62
11.	Cuculidae		<i>Centropussenegalensis</i>	Senegal Coucal	9	19	25	53
12.	Falconidae		<i>Falco naumanni</i>	Common Kestrel	1	1	-	2
	“	“	<i>Falco ardosiaceus</i>	Grey Kestrel	2	-	-	2
13.	Hirundinidae		<i>Hirundoaethiopica</i>	Ethiopian Swallow	-	11	-	11
14.	Jacaniidae		<i>Actophilornisafricanus</i>	African Jacana	123	102	179	404
	“	“	<i>Microparracapensis</i>	Lesser Jacana	14	21	38	73
15.	Motacillidae		<i>Motacillaflava</i>	Yellow Wagtail	261	355	9	625
16.	Muscicapidae		<i>Cercotrichaspodobe</i>	Black Scrub Robin	2	2	2	6
17.	Nectariniidae		<i>Cinnyrispulchellus</i>	Beautiful Sunbird	4	2	-	6
18.	Passeridae		<i>Passer griseus</i>	Northern Grey Headed Sparrow	10	16	-	26
	“	“	<i>Passer luteus</i>	Sudan Golden Sparrow	102	67	80	249
19.	Phalacrocoracidae		<i>Phalacrocoraxafricanus</i>	Longtail/Reed Cormorant	201	78	89	368
20.	Phoeniculidae		<i>Phoeniculuspurpureus</i>	Green Wood-hoopoe	7	3	-	10
21.	Ploceidae		<i>Bubalornisalbistrois</i>	Buffalo Weaver	67	14	11	92
	“	“	<i>Ploceusluteolus</i>	Little Weaver	3	-	23	26
	“	“	<i>Queleaquelea</i>	Red-billed Quelea	292	168	30	490
	“	“	<i>Sporopipesfrontalis</i>	Speckle Fronted Weaver	4	-	-	4
	“	“	<i>Ploceuscucullatus</i>	Village Weaver	32	45	2	79
	“	“	<i>Bubalornisalbistrois</i>	White Billed Buffalo Weaver	-	159	2	161
22.	Psittacidae		<i>Psittaculakrameri</i>	Rose-ringed Parakeet	27	33	53	113
23.	Pyconotidae		<i>Pycnonotusbarbatus</i>	Common Bulbul	8	24	19	51
24.	Rallidae		<i>Amaurornisflavirostris</i>	Black Crane	1	4	-	5
	“	“	<i>Gallinulachloropus</i>	Common Moorhen	13	13	-	26
	“	“	<i>Gallinulaangulata</i>	Lesser Moorhen	-	6	-	6
	“	“	<i>Porphyriomadagascariensis</i>	Purple Swampphen	-	3	-	3
25.	Recurvirostridae		<i>Himantopusnimantopus</i>	Black-winged Stilt	51	17	2	70
26.	Scolopacidae		<i>Tringaochropus</i>	Green Sandpiper	19	23	-	42

	“	“	<i>Philomachus pugnax</i>	Ruff	250	448	10	708
	“	“	<i>Tringa erythropus</i>	Spotted Red Shank	12	7	-	19
	“	“	<i>Tringaglareola</i>	Wood Sandpiper	5	5	-	10
27.	Sternidae		<i>Sterna nilotica</i>	Gull-billed Tern	4	3	-	7
28.	Sturnidae		<i>Lamprotornis pulcher</i>	Chestnut Bellied Starling	65	78	2	145
	“	“	<i>Lamprotornis chalybaeus</i>	Greater-blue eared Starling	26	15	54	95
	“	“	<i>Lamprotornis caudatus</i>	Longtail Glossy Starling	49	30	74	153
	“	“	<i>Buphagus africanus</i>	Yellow-bill Oxpecker	6	4	-	10
29.	Threskiornithidae		<i>Plegadis falcinellus</i>	Glossy Ibis	811	120	16	947
30.	Upupidae		<i>Upupa epops</i>	Hoopoe	4	-	2	6
31.	Viduidae		<i>Vidua orientalis</i>	Sahel Paradise Whydah	1	3	-	4
	“	“	<i>Vidua chalybeata</i>	Village Indigo	10	3	-	13
Total Number of Species in study area					4,976	2,991	15,317	23,284

Source: Field Survey, 2024

Table 2: Bird Species Identified in the Study Area (Dagona Waterfowl Sanctuary) for Wet Season

S/N	Family	Scientific Name	Common Name	Frequency			Total	
				1 st Visit	2 nd Visit	3 rd Visit		
1.	Accipitridae	<i>Circus ranivorus</i>	African Marsh Harrier	-	4	1	5	
	“	“	<i>Milvus migrans</i>	Black Kite	2	5	3	10
	“	“	<i>Elanus caeruleus</i>	Black-shouldered Kite	-	-	2	2
	“	“	<i>Circus macrourus</i>	Pallid Harrier	2	-	-	2
	“	“	<i>Milvus aegyptius</i>	Yellow billed Kite	16	6	7	29
2.	Alaudidae	<i>Galeridacristata</i>	Crested Lark	-	2	-	2	
	“	“	<i>Ermmopterix leucotis</i>	Chestnut-backed Sparrow lark	2	-	4	6
3.	Alcedinidae	<i>Cerylerudis</i>	Pied Kingfisher	14	5	2	21	
4.	Anatidae	<i>Nettapus auritus</i>	African Pygmy Geese	10	-	2	12	
	“	“	<i>Sarkidiornis melanotos</i>	Knob billed duck	2	5	5	12
	“	“	<i>Dendrocygna viduata</i>	White Face Whistling Duck	16	-	-	16
5.	Ardeidae	<i>Egretta ardesiaca</i>	Black Heron	19	5	10	34	
	“	“	<i>Bubulcus ibis</i>	Cattle Egret	41	13	12	66
	“	“	<i>Ardeacinerea</i>	Grey Heron	26	17	11	54
	“	“	<i>Egretta intermedia</i>	Intermediate Egret	12	-	-	12
	“	“	<i>Ardea purpurea</i>	Purple Heron	24	12	4	40
	“	“	<i>Ardeolaralloides</i>	Squacco Heron	22	17	13	52
6.	Bucerotidae	<i>Tokus nasutus</i>	African Grey Hornbill	13	7	12	32	
	“	“	<i>Tockus erythrorhynchus</i>	Red-billed Hornbill	11	9	12	32
7.	Charadriidae	<i>Vanellus tectus</i>	Black-headed Lapwing	3	2	5	10	
	“	“	<i>Vanellus spinosus</i>	Spur-winged Lapwing	27	7	9	43
8.	Ciconiidae	<i>Anastomus lamelligerus</i>	African Openbill Stork	9	-	5	14	
9.	Columbidae	<i>Streptopelia decipiens</i>	African Mourning Dove	13	9	12	34	
	“	“	<i>Streptopelia senegalensis</i>	Laughing Dove	17	12	16	46
	“	“	<i>Oenacampus</i>	Namaqua Dove	17	7	5	29
	“	“	<i>Columba guinea</i>	Speckled Pigeon	27	13	12	52
	“	“	<i>Streptopelia vinacea</i>	Vinaceous Dove	25	11	11	47
10.	Coraciidae	<i>Coracias abyssinica</i>	Abyssinian Roller	10	7	4	21	
11.	Cuculidae	<i>Centropus senegalensis</i>	Senegal Coucal	11	5	-	16	
12.	Jacaniidae	<i>Actophilornis africanus</i>	African Jacana	87	23	21	131	
	“	“	<i>Microparracampus</i>	Lesser Jacana	28	16	12	56
13.	Muscicapidae	<i>Cercotrichas podobe</i>	Black Scrub Robin	2	-	-	2	

14.	Nectariniidae	<i>Cinnyrispulchellus</i>	Beautiful Sunbird	4	3	-	7
15.	Passeridae	<i>Passer griseus</i>	Northern Grey Headed Sparrow	-	2	2	4
	“ “	<i>Passer luteus</i>	Sudan Golden Sparrow	15	4	-	19
16.	Phalacrocoracidae	<i>Phalacrocoraxafricanus</i>	Longtail/Reed Cormorant	24	11	11	46
17.	Ploceidae	<i>Bubalornisalbistrois</i>	Buffalo Weaver	6	9	9	24
	“ “	<i>Ploceusluteolus</i>	Little Weaver	16	8	3	27
	“ “	<i>Queleaquelea</i>	Red-billed Quelea	7	2	-	9
	“ “	<i>Ploceuscucullatus</i>	Village Weaver	2	4	2	8
	“ “	<i>Bubalomisalbistrois</i>	White Billed Buffalo Weaver	5	-	2	7
18.	Psittacidae	<i>Psittaculakrameri</i>	Rose-ringed Parakeet	5	3	2	10
19.	Pyconotidae	<i>Pycnonotusbarbatus</i>	Common Bulbul	7	7	-	17
20.	Rallidae	<i>Amauornisflavirostris</i>	Black Crake	2	4	3	9
	“ “	<i>Gallinulachloropus</i>	Common Moorhen	5	9	7	21
	“ “	<i>Gallinulaangulata</i>	Lesser Moorhen	6	7	9	22
	“ “	<i>Porphyriomadagascariensis</i>	Purple Swampen	4	4	-	8
21.	Scolopacidae	<i>Tringaachropus</i>	Green Sandpiper	4	2	-	6
22.	Sternidae	<i>Sterna nilotica</i>	Gull-billed Tern	-	2	-	2
23.	Sturnidae	<i>Lamprotornispulcher</i>	Chestnut Bellied Starling	5	2	5	12
	“ “	<i>Lamprotornischalybaeus</i>	Greater-blue eared Starling	28	15	10	53
	“ “	<i>Lamprotorniscaudatus</i>	Longtail Glossy Starling	21	-	-	21
24.	Upupidae	<i>Upupaepops</i>	Hoopoe	2	2	-	4
25.	Viduidae	<i>Viduaorientalis</i>	Sahel Paradise Whydah	3	-	-	3
	“ “	<i>Viduachalybeata</i>	Village Indigo	2	2	8	12
Total Number of Species in study area				681	321	285	1287

Source: Field Survey, 2024

Bird Species Diversity in the Study Area

The analysis of bird species diversity in Dagona Waterfowl Sanctuary during the dry season is presented in Table 3. Based on the Shannon-Wiener Diversity Index, the diversity value was 1.943, indicating a moderate level of species diversity during this period. Among the recorded species, *Dendrocygna viduata* (White-faced Whistling Duck) exhibited the highest relative abundance with a diversity proportion of 0.29376. In contrast, species such as *Circus macrourus* (Pallid Harrier), *Falco ardosiaecus* (Grey Kestrel), and *Falco naumanni* (Lesser Kestrel) had the lowest proportions, with values of 0.00043 and 0.0008, respectively. During the wet season, the results shown in Table 4 indicate a significantly higher Shannon Diversity Index of 3.62582,

suggesting a greater overall species diversity compared to the dry season. The species *Actophilornis africanus* (African Jacana) had the highest diversity value at 0.23257, making it the most dominant species during this period. Conversely, species such as *Cercotrichas podobe* (Black Scrub-Robin), *Circus macrourus* (Pallid Harrier), *Elanus caeruleus* (Black-winged Kite), *Gallinula cristata* (Lesser Moorhen), and *Sterna nilotica* (Gull-billed Tern) recorded the lowest diversity proportions, each with a value of 0.01005.

The comparative analysis highlights a clear increase in avian diversity during the wet season, which may be attributed to increased availability of food resources, favorable breeding conditions, and the arrival of migratory species.

Table 3: Bird Species Diversity in the Study Area (Dagona Waterfowl Sanctuary) for Dry Season

S/N	Species	Frequency	Pi	lnPi	Pi lnPi
1.	<i>Actophilornisafricanus</i>	404	0.017351	4.05411	0.07034
2.	<i>Amauornisflavirostris</i>	5	0.000215	8.44608	0.00181
3.	<i>Anasquerquedula</i>	145	0.006227	5.07879	0.03163
4.	<i>Anastomuslamelligerus</i>	39	0.001675	6.39196	0.01071
5.	<i>Ardea alba</i>	39	0.001675	6.39196	0.01071
6.	<i>Ardeacinerea</i>	122	0.00524	5.2515	0.02752

7.	<i>Ardeapurpurea</i>	140	0.006013	5.11388	0.03075
8.	<i>Ardeolaralloides</i>	348	0.014946	4.20332	0.06282
9.	<i>Bubalomisalbirostris</i>	161	0.006915	4.97412	0.03439
10.	<i>Bubalornisalbirostris</i>	92	0.003951	5.53373	0.02186
11.	<i>Bubulcus ibis</i>	957	0.041101	3.19172	0.13118
12.	<i>Buphagusafricanus</i>	10	0.000429	7.75294	0.00333
13.	<i>Centropussenegalensis</i>	53	0.002276	6.08523	0.01385
14.	<i>Cercotrichaspodobe</i>	6	0.000258	8.26376	0.00213
15.	<i>Cerylerudis</i>	24	0.001031	6.87747	0.00709
16.	<i>Cinnyrispulchellus</i>	6	0.000258	8.26376	0.00213
17.	<i>Circus macrourus</i>	1	0.000043	10.0555	0.00043
18.	<i>Circus ranivorus</i>	9	0.000387	7.8583	0.00304
19.	<i>Columba guinea</i>	115	0.004939	5.31059	0.02623
20.	<i>Coraciasabyssinica</i>	62	0.002663	5.92839	0.01579
21.	<i>Dendrocygna bicolor</i>	331	0.014216	4.2534	0.06047
22.	<i>Dendrocygnaviduata</i>	14552	0.624979	0.47004	0.29376
23.	<i>Egrettaardesiaca</i>	197	0.008461	4.77232	0.04038
24.	<i>Egrettaagarzetta</i>	124	0.005326	5.23524	0.02788
25.	<i>Egrettaintermedia</i>	72	0.003092	5.77886	0.01787
26.	<i>Elanuscaeruleus</i>	4	0.000172	8.66923	0.00149
27.	<i>Errmopterixleucotis</i>	7	0.000301	8.10961	0.00244
28.	<i>Falco ardosiaecus</i>	2	0.000086	9.36237	0.0008
29.	<i>Falco naumanni</i>	2	0.000086	9.36237	0.0008
30.	<i>Galeridacristata</i>	18	0.000773	7.16515	0.00554
31.	<i>Gallinulaangulata</i>	6	0.000258	8.26376	0.00213
32.	<i>Gallinulachloropus</i>	26	0.001117	6.79743	0.00759
33.	<i>Halcyon leucocephala</i>	4	0.000172	8.66923	0.00149
34.	<i>Himantopus himantopus</i>	70	0.003006	5.80703	0.01746
35.	<i>Hirundoaethiopica</i>	11	0.000472	7.65763	0.00362
36.	<i>Lamprotorniscaudatus</i>	153	0.006571	5.02508	0.03302
37.	<i>Lamprotornischalybaeus</i>	95	0.00408	5.50164	0.02245
38.	<i>Lamprotornispulcher</i>	145	0.006227	5.07879	0.03163
39.	<i>Microparracapensis</i>	73	0.003135	5.76506	0.01807
40.	<i>Milvusaegyptius</i>	73	0.003135	5.76506	0.01807
41.	<i>Milvusmigrans</i>	11	0.000472	7.65763	0.00362
42.	<i>Motacillaflava</i>	625	0.026842	3.61777	0.09711
43.	<i>Nettapusauritus</i>	28	0.001203	6.72332	0.00809
44.	<i>Oenacapensis</i>	54	0.002319	6.06654	0.01407
45.	<i>Passer griseus</i>	26	0.001117	6.79743	0.00759
46.	<i>Passer luteus</i>	249	0.010694	4.53807	0.04853
47.	<i>Phalacrocoraxafricanus</i>	368	0.015805	4.14744	0.06555
48.	<i>Philomachus pugnax</i>	708	0.030407	3.49308	0.10621
49.	<i>Phoeniculuspurpureus</i>	10	0.000429	7.75294	0.00333
50.	<i>Plectropterusgambensis</i>	72	0.003092	5.77886	0.01787

51.	<i>Plegadisfalcinellus</i>	947	0.040672	3.20222	0.13024
52.	<i>Ploceuscucullatus</i>	79	0.003393	5.68607	0.01929
53.	<i>Ploceusluteolus</i>	26	0.001117	6.79743	0.00759
54.	<i>Porphyriomadagascariensis</i>	3	0.000129	8.95691	0.00115
55.	<i>Psittaculakrameri</i>	113	0.004853	5.32813	0.02586
56.	<i>Pycnonotusbarbatus</i>	51	0.00219	6.1237	0.01341
57.	<i>Queleaquelea</i>	490	0.021044	3.86112	0.08126
58.	<i>Sarkidiornismelanotos</i>	50	0.002147	6.1435	0.01319
59.	<i>Sporopipesfrontalis</i>	4	0.000172	8.66923	0.00149
60.	<i>Sterna nilotica</i>	7	0.000301	8.10961	0.00244
61.	<i>Streptopeliadecipiens</i>	57	0.002448	6.01247	0.01472
62.	<i>Streptopeliasenegalensis</i>	93	0.003994	5.52292	0.02206
63.	<i>Streptopeliavinacea</i>	98	0.004209	5.47055	0.02303
64.	<i>Tockuserythrorhynchus</i>	51	0.00219	6.1237	0.01341
65.	<i>Tokusnasutus</i>	16	0.000687	7.28293	0.005
66.	<i>Tringaerythropus</i>	19	0.000816	7.11108	0.0058
67.	<i>Tringaglareola</i>	10	0.000429	7.75294	0.00333
68.	<i>Tringaochropus</i>	42	0.001804	6.31785	0.0114
69.	<i>Upupaepops</i>	6	0.000258	8.26376	0.00213
70.	<i>Vanellusspinosus</i>	209	0.008976	4.71319	0.04231
71.	<i>Vanellustectus</i>	42	0.001804	6.31785	0.0114
72.	<i>Viduachalybeata</i>	13	0.000558	7.49057	0.00418
73.	<i>Viduaorientalis</i>	4	0.000172	8.66923	0.00149
Total		23,284	1		1.94284

Source: Field Survey, 2024

Table 4: Bird Species Diversity in the Study Area (Dagona Waterfowl Sanctuary) for Wet Season

S/N	Species	Frequency	Pi	lnPi	PilnPi
1.	<i>Actophilornisafricanus</i>	131	0.101787	2.28487	0.23257
2.	<i>Amaurornisflavirostris</i>	9	0.006993	4.96284	0.03471
3.	<i>Anastomuslamelligerus</i>	14	0.010878	4.52101	0.04918
4.	<i>Ardeacinerea</i>	54	0.041958	3.17109	0.13305
5.	<i>Ardeapurpurea</i>	40	0.03108	3.47119	0.10788
6.	<i>Ardeolaralloides</i>	52	0.040404	3.20883	0.12965
7.	<i>Bubalomisalbirostris</i>	7	0.005439	5.21416	0.02836
8.	<i>Bubalornisalbirostris</i>	24	0.018648	3.98202	0.07426
9.	<i>Bubulcus ibis</i>	66	0.051282	2.97041	0.15233
10.	<i>Centropussenegalensis</i>	16	0.012432	4.38748	0.05455
11.	<i>Cercotrichaspodobe</i>	2	0.001554	6.46692	0.01005
12.	<i>Cerylerudis</i>	21	0.016317	4.11555	0.06715
13.	<i>Cinnyrispulchellus</i>	7	0.005439	5.21416	0.02836
14.	<i>Circus macrourus</i>	2	0.001554	6.46692	0.01005
15.	<i>Circus ranivorus</i>	5	0.003885	5.55063	0.02156
16.	<i>Columba guinea</i>	52	0.040404	3.20883	0.12965
17.	<i>Coraciasabyssinica</i>	21	0.016317	4.11555	0.06715

18.	<i>Dendrocygnaviduata</i>	16	0.012432	4.38748	0.05455
19.	<i>Egrettaaradesiaca</i>	34	0.026418	3.63371	0.096
20.	<i>Egrettaintermedia</i>	12	0.009324	4.67516	0.04359
21.	<i>Elanuscaeruleus</i>	2	0.001554	6.46692	0.01005
22.	<i>Errmopterixleucotis</i>	6	0.004662	5.36831	0.02503
23.	<i>Galeridacristata</i>	2	0.001554	6.46692	0.01005
24.	<i>Gallinulaangulata</i>	22	0.017094	4.06903	0.06956
25.	<i>Gallinulachloropus</i>	21	0.016317	4.11555	0.06715
26.	<i>Lamprotorniscaudatus</i>	21	0.016317	4.11555	0.06715
27.	<i>Lamprotornischalybaeus</i>	53	0.041181	3.18978	0.13136
28.	<i>Lamprotornispulcher</i>	12	0.009324	4.67516	0.04359
29.	<i>Microparracapensis</i>	56	0.043512	3.13472	0.1364
30.	<i>Milvusaegyptius</i>	29	0.022533	3.79277	0.08546
31.	<i>Milvusmigrans</i>	10	0.00777	4.85748	0.03774
32.	<i>Nettapusauritus</i>	12	0.009324	4.67516	0.04359
33.	<i>Oenacapensis</i>	29	0.022533	3.79277	0.08546
34.	<i>Passer griseus</i>	4	0.003108	5.77377	0.01794
35.	<i>Passer luteus</i>	19	0.014763	4.21563	0.06224
36.	<i>Phalacrocoraxafricanus</i>	46	0.035742	3.33143	0.11907
37.	<i>Ploceuscucullatus</i>	8	0.006216	5.08063	0.03158
38.	<i>Ploceusluteolus</i>	27	0.020979	3.86423	0.08107
39.	<i>Porphyriomadagascariensis</i>	8	0.006216	5.08063	0.03158
40.	<i>Psittaculakrameri</i>	10	0.00777	4.85748	0.03774
41.	<i>Pycnonotusbarbatus</i>	14	0.010878	4.52101	0.04918
42.	<i>Queleaqueuelea</i>	9	0.006993	4.96284	0.03471
43.	<i>Sarkidiornismelanotos</i>	12	0.009324	4.67516	0.04359
44.	<i>Sterna nilotica</i>	2	0.001554	6.46692	0.01005
45.	<i>Streptopeliadecipiens</i>	34	0.026418	3.63371	0.096
46.	<i>Streptopeliasenegalensis</i>	45	0.034965	3.35341	0.11725
47.	<i>Streptopeliavinacea</i>	47	0.036519	3.30992	0.12088
48.	<i>Tockuserythrorhynchus</i>	32	0.024864	3.69433	0.09186
49.	<i>Tokusnasutus</i>	32	0.024864	3.69433	0.09186
50.	<i>Tringaochropus</i>	6	0.004662	5.36831	0.02503
51.	<i>Upupaepops</i>	4	0.003108	5.77377	0.01794
52.	<i>Vanellusspinosus</i>	43	0.033411	3.39887	0.11356
53.	<i>Vanellustectus</i>	10	0.00777	4.85748	0.03774
54.	<i>Viduachalybeata</i>	12	0.009324	4.67516	0.04359
55.	<i>Viduaorientalis</i>	3	0.002331	6.06146	0.01413
Total		1,287	1		3.62582

Source: Field Survey, 2024

Table 5: Shannon-Weiner Indices for Bird Species Diversity in the Study Area (Dagona Waterfowl Sanctuary) for Dry and Wet Season

Indices	Dry Season	Wet Season
	(DS)	(WS)
Taxa_S	73	55
Individuals	23284	1287
Dominance_DM	0.3978	0.03502
Simpson	0.6022	0.965
Shannon_H	1.943	3.626
Evenness_e^H/S	0.0956	0.6828
Equitability_J	0.4528	0.9048

Source: Field Survey, 2024

Key: DS and WS – Dry Season and Wet Season

Discussion

The results of this study revealed a significant presence of resident (12,225), migratory (8,186), and Palearctic migrant (10,876) bird species in Dagona Waterfowl Sanctuary. Common resident species observed included *African Jacana*, *Long-tailed/Reed Cormorant*, *African Mourning Dove*, *Vinaceous Dove*, *Pied Kingfisher*, and *Common Moorhen*. Migratory birds recorded were *Yellow Wagtail*, *African Marsh Harrier*, *Intermediate Egret*, *Red-billed Hornbill*, and *Garganey*. Palearctic migrants such as *White-faced Whistling Duck*, *Squacco Heron*, *Fulvous Whistling Duck*, *Yellow-billed Kite*, and *Green Sandpiper* were also observed.

These findings are in alignment with the work of Osunsina et al. (2018) and Sabo (2016), who also reported the predominance of resident, migratory, and Palearctic migrant bird species in similar habitats. Likewise, Lameed (2011) found that wetlands are typically dominated by these three bird categories. In particular, the species *Dendrocygna viduata* (14,552 individuals), *Bubulcus ibis* (957), and *Plegadis falcinellus* (947) were most abundant in the study area, reinforcing the sanctuary's importance as a habitat for both local and migratory avifauna.

The analysis of bird diversity using the Shannon-Wiener Diversity Index further emphasizes seasonal variation. The index was 1.94 during the dry season and 3.63 during the wet season, indicating a notably higher species diversity in the wet season. This is consistent with findings by Bibi and Ali (2013), who stated that the Shannon index generally ranges between 1.5 and 3.5, rarely exceeding 4.5. The higher index during the wet season suggests greater species richness and more even distribution, likely due to increased availability of food, breeding conditions, and migratory arrivals.

This study also supports the conclusions of Mengesha and Bekele (2008), who asserted that avian diversity is a good indicator of habitat heterogeneity. The diversity of microhabitats within Dagona Waterfowl Sanctuary provides suitable niches for a wide variety of bird species, reflecting the ecological value and conservation significance of the area.

Conclusion

This study assessed the status and diversity of avifauna within Dagona Waterfowl Sanctuary over six months, covering both dry and wet seasons. Monthly observations provided insights into seasonal variations in bird populations. Although species richness was higher during the dry season, largely due to the influx of migratory and Palearctic migrant species, species diversity (evenness and distribution) was significantly greater in the wet season.

The increased abundance and diversity of birds in the study area may be attributed to the availability of food resources, favorable habitat conditions, and reduced human interference during certain periods. However, the study also noted that agricultural practices, such as livestock grazing and fishing, particularly during late hours, may disturb bird populations and pose a threat to their continued survival.

Recommendations

Based on the findings of this research, the following recommendations are proposed:

1. Implement effective monitoring and conservation strategies to protect and restore declining bird populations, particularly during critical breeding and migratory periods.
2. Promote public awareness and education among local communities about the ecological and economic importance of Dagona Waterfowl Sanctuary as a haven for both resident and migratory bird species.
3. Strengthen law enforcement and regulation of human activities, especially illegal grazing, fishing, and resource extraction, within the sanctuary boundaries.
4. Encourage community-based conservation initiatives that involve local stakeholders in sustainable wetland management and bird conservation.

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Plate 1: The Researcher Observing and Counting Birds Species in Dagona Waterfowl Sanctuary.
Source: Field Survey, 2024



Plate 2: Flock of White-faced Whistling Duck which is the most Diverse and Dominant Specie in the study Area.
Source: Field Survey, 2024