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Research Article

Assessment of Bird Species Composition, Relative Abundance, and Distributions in East Gojjam Wetland Habitats, Ethiopia

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Many bird species depend on wetlands and the surrounding habitats. However, the status of these wetlands, as well as their biodiversity, is poorly understood and maintained. From January to February 2021, we assessed the compositions, relative abundances, and distributions of bird species throughout five wetland habitats in the East Gojjam zone. In each study site, systematic random sampling techniques were applied at a 4 km interval along the wetland habitats. Bray–Curtis cluster analysis was conducted using PAST software. During the study period, Simpson's Index and Shannon–Wiener Index were also used to assess the diversity of bird species at various study sites. As a result, a total of 55 bird species from 20 families and 9 orders were identified. During the study period, 49 species were classified as least concern, two were critically endangered species, two were vulnerable species, two were endangered species, and one was an endemic species. During the study, overgrazing and agricultural expansion were identified as threats to biodiversity. To conserve the biological richness of these ecosystems, a wetland conservation strategy and a sustainable usage system are required.

1. Introduction

Wetlands are well-known as the world's most productive environments [1, 2]. They are important stores of plant genetic material and habitats for a wide range of species [3–6]. Wetlands provide food, breeding, nesting, and raising opportunities for a wide range of amphibians, birds, and mammals [3]. Wetland microhabitats offer avifauna populations with abundant and high-quality shelter and food all year [7]. Wetlands also provide important ecological and economic functions, such as water supply and pollution control [8, 9].

Mammals, birds (including migratory species), reptiles, amphibians, fish, and macro and micro invertebrate species all thrive in different wetland types. They also mitigate climate change and global warming by sequestering carbon [4]. Wetland environments in many areas have a lot of promise for biodiversity conservation [10]. On the contrary, mounting problems are threatening the wetlands' contribution to biodiversity protection [11, 12]. The rising population continues to put a strain on wetlands, and rates of degradation have accelerated across the world [13, 14]. Wetland disturbances, degradation, and loss result in the extinction of native plant species, the invasion of exotic species, and the decline of wetlands' ecological and economic importance [15, 16].

Many African bird species, including Ethiopian ones, depend on wetlands and their surroundings for foraging, breeding, resting, and mate-finding [17–19]. Because most birds are able to immediately respond to any change in habitat or climatic condition, the presence or absence of birds reveals the ecological conditions of wetlands and the link between the food web and the nutrient cycle [20, 21]. As wetland habitat structures and adjacent land use change, so do the composition and diversity of bird species. Information about a wetland's biodiversity is extremely useful in determining the habitat's status and developing appropriate conservation measures for long-term biodiversity conservation. However, the state of these wetlands, as well as their biodiversity, is poorly documented and maintained in these

wetland areas. Despite the fact that the wetlands in East Gojjam have a higher bird species composition and abundance, no scientific data has been collected in the study areas. To fill the gaps in existing knowledge, the current study was done to analyze the composition of bird species, relative abundance, and distributions throughout the five wetland habitats in the East Gojjam zone to show the potential of the areas for biodiversity conservation.

2. Material and Methods

2.1. Study Area Description. The research was carried out in five wetland habitats (Chemoga, Sentera, Yewula, Yebasan/Des, and Dechekes/Yejube woreda) in part of Blue Nile basin, East Gojjam zone, Ethiopia's Amhara Regional State (Figure 1). Debre Markos, the zone's administrative town, is located 290 kilometers northwest of Addis Ababa (the country's capital city) and 265 kilometers from Bahir Dar, the Amhara Region's capital city. The East Gojjam zone encompasses a variety of geographic features, and the highest mountain, Choke, with an elevation of 4100 meters above sea level (m.a.s.l) is found in this zone [22]. The current study sites are located in this zone, and Gozamin woreda covers the majority of the studied wetlands, accounting for nearly 90% of the total research area. The woreda, which covers 1217.8 km^2 [23], is bordered on the east by Aneded and Debay Telatgen woredas, on the west by Machakel and Debre Elias woredas, on the north by Sinan woreda, and on the south by Baso Liben woreda (Abay River) (Figure 1). Chemoga, Sentera, Yebasan, and Des are found in the Gozamin woreda administration, whereas Yewula and Dechekes/Yejube are found in the Baso Liben woreda. The wetlands under study can be found in a variety of landscape places and settings, such as floodplain channels used as lower catchment regions, springs, rivers, ponds, open shallow water bodies, and open grazing land plains. All of these wetlands are located between 5 and 20 kilometers from Debre Markos. The current study sites in the East Gojjam zone are geographically located between 10°10′-10°25′N and 37°35′-37°45′E, with an altitude ranging from 1159 to 2600 meters above sea level (m.a.s.l) (GPS reading during field work). The rainfall pattern is primarily unimodal, with annual rainfall ranging from 900 to 1800 mm on average. The zone's average temperature ranges from minus 7.5°C to plus 27°C [22].

2.2. Sampling Design. According to [24], a systematic random selection approach was applied to choose the actual sampling locations from a total of five study sites. A total of 15 line transects (35 percent) of the study sites (100 km^2) were sampled. Then, at every 4 km interval, a line transect method was used to count birds in open wetland habitats and agricultural fields adjacent to wetland habitats. A 3 km transect line was used to count birds in open wetland habitats and adjacent farm fields at 100–300 m sighting distance.

2.3. Data Collection Methods. Ornithological data was collected in each study site from January to February 2021, with four consecutive day surveys in a week. The start and end geographical coordinates of each transect were saved in a Garmin GPS 72 during the bird counting, and the bird species, number, and survey site were recorded. Bird species were kept at a safe distance from each other throughout the count to reduce disruption [24]. Bird species were identified based on the shape and color of their feathers, beaks, eye colors, legs, and body size. At each transect line, the number, type, and location of birds were recorded for a set amount of time.

The study was conducted in good weather from 6:30 a.m. to 10:00 a.m. and from 4:30 p.m. to 6.30 p.m., when bird activity is high [24]. Bird identification was based on morphological characteristics such as feather pattern, size, shape, color, sounds, and field guides [25], with Nikon binoculars assisting in observations. Photographs were also taken to help with the identification of the inconspicuous species.

2.4. Data Analysis. The information gathered in the field was first compiled in an Excel spreadsheet, and descriptive and inferential statistics were analyzed. Biodiversity indices and Bray–Curtis cluster analysis were conducted using Paleontological Statistics (PAST) software version 4.6b. It is a free statistical software tool for analyzing paleontological data that allows you to construct diversity measures [26]. During the study period, Simpson's Index (Simpson, 1949) and Shannon–Wiener Index (Shannon and Wiener, 1949) were employed to assess the diversity of bird species at various study sites.

$$H' = -\sum_{i=1}^{S} P_i \ln P_i,$$
$$D = 1 - \sum_{i=1}^{S} P_i^2, \quad (1)$$

where H' is the Shannon–Wiener Index, S is the number of species observed, P_i is the proportion of the total sample, ln is the natural logarithm, and D is Simpson's Index.

Relative abundance of avian species was determined using encounter rates following [24]. Encounter rate was calculated for each species by dividing the number of birds recorded by the number of hours spent searching, in order to get a figure of birds per hour for each species. It was calculated as follows:

$$\text{Encounter rate} = \frac{\text{Total number of individual birds observerd}}{\text{Period of observation in hours}} \times 100. \quad (2)$$

Abundance categories were <0.1, 0.1–2.0, 2.1–10.0, 10.1–40.0, and 40+. For each category, one of the following abundance scores was given: 1 (rare), 2 (uncommon), 3 (frequent), 4 (common), and 5 (abundant) [24].

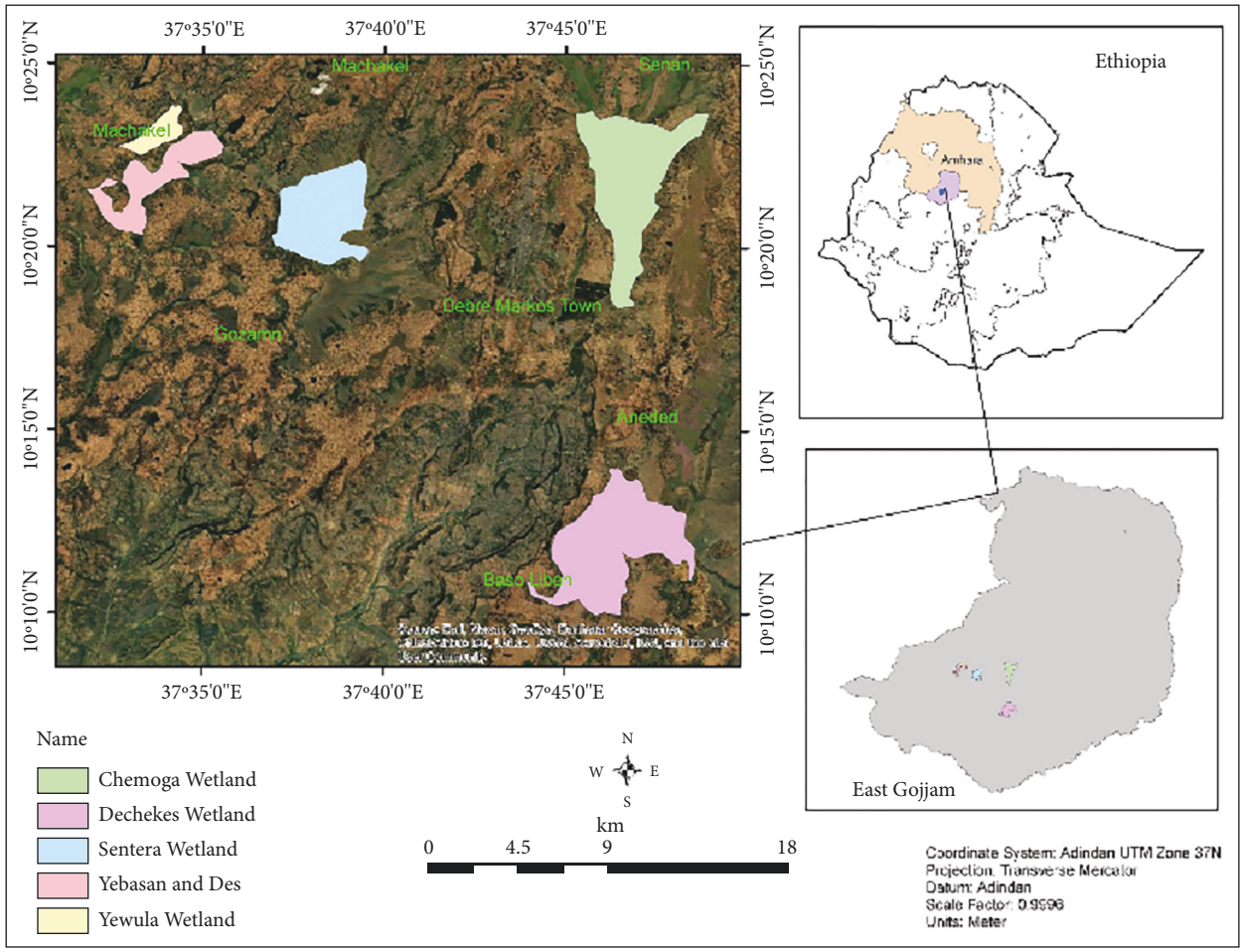

Figure 1: Location map of the study area.

3. Results

3.1. Species Composition. A total of 55 bird species belonging to 20 families and 9 orders were recorded in the studied sites (Figure 2). Passeriformes had the most families and species (7, 12, resp.) followed by Accipitriformes and Charadriiformes, which had nine species each and 1 and 4 families, respectively (Figure 2). The order Caprimulgiformes had the fewest species recorded (Figure 2). Among them, black-winged stilt (*Himantopus himantopus)*, black-headed gull (*Larus ridibundus*), and white stork (*Ciconia ciconia*) are Palearctic migrants. Black kite (*Milvus migrans*) and tawny eagle (*Aquila rapax*) are African migrants. Wattled ibis (*Bostrychia carunculata*), thick-billed raven (*Corvus crassirostris*), and white-collared Pigeon (*Columba albitorques*) are among the endemic Ethiopian and Eritrean species recorded in the studied area. An endemic bird species, the spot-breasted lapwing (*Vanellus melanocephalus*), was also recorded. 50 species were classified as least concern by the IUCN in 2021, but two species, the hooded vulture (*Necrosyrtes monachus)* and the white-backed vulture (*Gyps africanus*), were listed as critically endangered. The wattled crane (*Bugeranus carunculatus*), the black crowned crane (*Balearica pavonina*), and the tawny eagle (*Aquila rapax*) were all vulnerable. During the study period, the endangered lappet-faced vulture (*Torgos tracheliotus*) was also recorded.

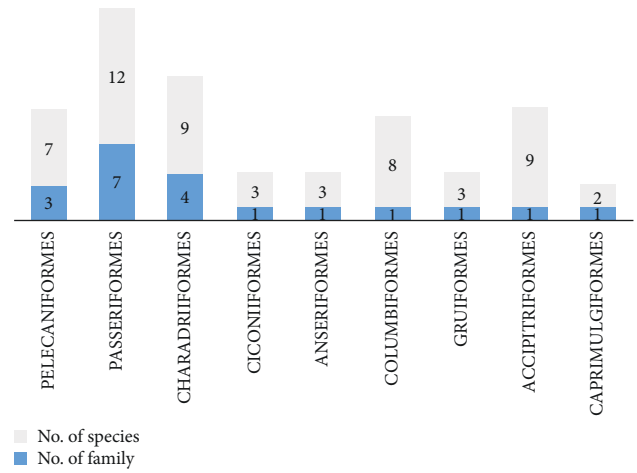

Figure 2: Family and species compositions of each order in the study sites during the study period.

3.2. Species Diversity, Evenness, and Dominance Index. Chemoga wetland habitat had the greatest Simpson's D species diversity index $(1 - D)$ (0.99). Yebasan and Des wetland habitats, on the other hand, had the lowest species diversity score (0.97). Yewula wetland habitat had the highest Shannon-Wiener Index ($H' = 3.45$) and evenness

($E = 0.50$). The highest dominance index ($D = 0.03$) was found in the Yebasan and Des wetland habitats (Table 1).

3.3. Avian Similarities in the Study Sites. The same bird species can be found in most wetland habitats. The cluster analysis (Figure 3) reveals the study sites' similarities, with Sentera and Yewula wetland belonging to the same clade, implying that they shared the same avifaunal species. In addition, the wetlands of Yebasan and Dechekes/Yejube constituted the first clade, indicating that these sites shared many of the same avifaunal species. The Chemoga wetland habitat is distinct from all other wetland habitats (Figure 3).

3.4. Relative Abundance. The relative abundance of birds varied throughout the study sites. The most numerous species were locally abundant in Chemoga, Sentera, Yewula, and Yebasan/Des wetland habitat, although a high number of locally common species were recorded in Dechekes/Yejube wetland (Table 2). Chemoga wetland has both uncommon and common birds, although it had a higher number of bird species (47) than any other wetland. The Dechekes/Yejube wetland area had the fewest bird species reported.

The Egyptian goose, *Alopochen aegyptiaca*; white stork, *Ciconia ciconia*; little egret, *Egretta garzetta*; wattled ibis, *Bostrychia carunculata*; hadada ibis, *Bostrychia hagedash*; Abdim's stork, *Ciconia abdimii*; and black-winged stilt, *Himantopus himantopus*, were the most abundant bird species in all study sites (Figure 4). The study sites had low populations of common buzzard, *Buteo buteo*; black-chested snake-eagle, *Circaetus pectoralis*; augur buzzard, *Buteo augur*; little swift, *Apus affinis*; and plain martin, *Riparia paludicola*.

3.5. Distribution of Species among the Study Sites. The distributions of bird species indicated a few differences across all of the sites surveyed. Pelecaniformes, Passeriformes, Charadriiformes, Ciconiiformes, Anseriformes, Columbiformes, and Accipitriformes were found at all of the study sites, out of a total of 55 bird species identified (Table 3). However, only the Gruiformes (wattled crane, *Bugeranus carunculatus*; black crowned crane, *Balearica pavonina*) were found in the Chemoga wetland habitat. Chemoga wetland habitat has the highest number of species (47) and individuals (2557) among the sites studied. Dechekes/Yejube has the fewest records at both the species (35) and individual level (Figure 5).

4. Discussion

A large number of bird species and individuals were found to be supported by the various habitat types and settings near to the study areas. Various researchers have reported that anthropogenic activity fluctuations and rates have an impact on bird species richness, distribution, and abundances, either directly or indirectly [27, 28]. During the study, habitat disturbance was identified as a result of anthropogenic activities such as overgrazing and agricultural development. Destruction, habitat degradation, and climate change can all lead to migration and extinction of bird species that live in that environment [29]. A total of 55 bird species were recorded from the entire surveyed sites in this study. The Chemoga wetland habitat is inhabited by 47 species, the largest number compared to any other habitat. This could be owing to the species' suitable habitats, the abundance of food, and the less disturbance level compared to other sites. In the Chemoga wetland, species such as the Gruiformes (wattled crane, *Bugeranus carunculatus*; black crowned crane, *Balearica pavonina*) were restricted. The Dechekes wetland has the fewest species among all the habitats studied. This may be somewhat accurate due to the significant agricultural expansion that encompasses the entire area when compared to other sites. Changes in species numbers among similar habitat types may be due to the differences in predation pressure, accessible food, disturbance, and particular habitat selection nature of birds [30–32]. Habitat size and quality, bird foraging strategies, and floristic composition may all have a role in avian species distribution in the above variables [31–33].

The highest diversity of species in the Chemoga wetland among the study sites could be attributed to favored breeding sites, availability of food in microhabitats that preferred certain bird species, predator protection, and fewer disturbances compared to other sites, according to the findings [34]. Floristic composition and vegetation structure are frequently mentioned as factors that influence the number of species found in a given area [35, 36]. This research backs up prior findings from other researchers [30–39]. It is possible that the habitat's high species evenness during the study in the Yewula wetland habitat is due to the habitat's ability to support a variety of habitat specialist and generalist bird species that can take advantage of the available resources [40]. The existence of numerous equally distributed species may be due to the fewer disturbances of humans and other animals in comparison to other areas. The highest species dominance index is found in the Yebasan and Des wetland habitats. Little egret (*Egretta garzetta*) was determined to be the dominating species with the highest dominance index ($D = 0.03$), which is likely due to the presence of a diverse range of habitats and favorable food availability for little egret in the area. Dominance occurs when one or more species exert control over the environment and conditions, as well as influencing other species [41]. The existence of a high abundance bird species in this area is indicated by a high dominance index value [41, 42]. Little egrets are friendly birds that eat a variety of items found in shallow marsh settings, particularly by following cattle [43], and there were many of them throughout the study period. Due to the large plain area and availability for foraging of different livestock animals, this species is highly opportunistic and contributes positively to their presence.

Sentera and Yewula wetlands are found in the same clade, according to cluster analysis. This suggests that the species found in these areas are similar. Because these sites share several bird species, the largest species similarity between the two habitats, which are physically closest, is

Table 1: Avian species diversity, evenness, and dominance during the study period.

Study sites	Richness	No. of individuals (abundance)	D	$(1-D)$	H'	H'max	H'/H'max
Chemoga	47	2557	0.01	0.99	3.05	7.85	0.39
Sentera	43	1267	0.02	0.98	3.17	7.14	0.44
Yewula	43	1051	0.02	0.98	3.45	6.96	0.50
Yebasan and Des	37	659	0.03	0.97	3.29	6.49	0.51
Dechekes/Yejube	35	388	0.02	0.98	3.23	5.96	0.54

H': Shannon-Wiener Index; H'/H'max: evenness; $(1-D)$: diversity index; H'max: ln(S).

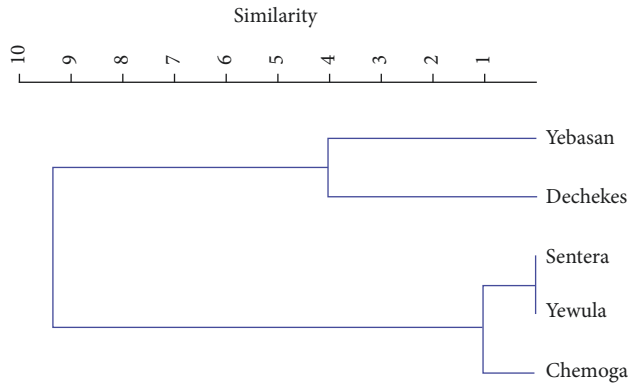

Figure 3: Similarity of species composition and their distributions of birds across the study sites (Bray–Curtis cluster analysis-paired group).

Table 2: Abundance rank of bird species along the study sites.

Study sites	No. of species				
	Uncommon	Frequent	Common species	Abundant species	Total recorded species
Chemoga	1	2	8	36	47
Sentera			7	36	43
Yewula			8	35	43
Yebasan and Des			14	23	37
Dechekes/Yejube			24	11	35

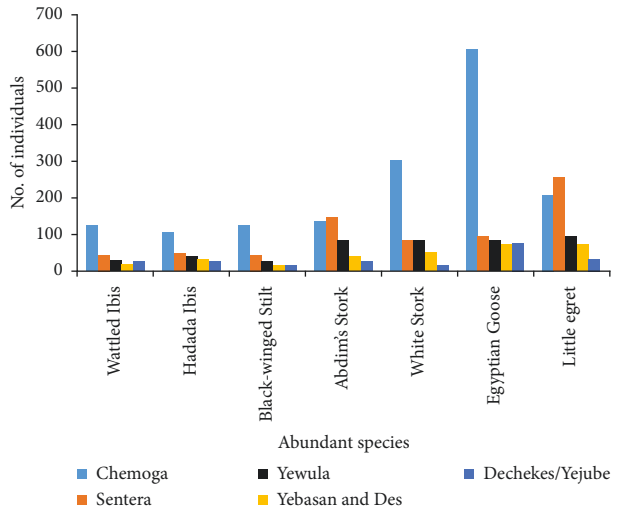

Figure 4: Spatial variations of the most dominant birds in the study sites.

expected. The similarity of bird species composition between habitats, according to [44], implies a tendency for similar habitats to have similar species composition. In this study, the two closest habitats, the Sentera and Yewula wetlands, had a higher similarity percentage, which supports the above finding.

The relative abundance of birds in the study area revealed that the majority of species were abundant. This could be due to the greater detectability of birds in open wetland habitats and agricultural fields, as opposed to places with dense forest growth, which results in poor visibility. This is consistent with [32, 45]. Species abundance scores differed among habitats. This could be attributed to differences in resource/food availability across study sites. The change in abundance of bird species among habitats is driven by food availability and nesting sites, according to [36, 39]. Baker et al. [46] also found that there was more change in bird species abundance between habitats than between seasons. The change in bird species abundance observed in different study sites could be caused by bird species' temporal and geographical movements in response to unique species requirements, such as nesting and breeding places for survival and reproduction [30, 31].

Most species types and individuals were not distributed evenly among survey sites, and most species populations showed changes in abundance. Variations in water or food

Table 3: Distribution of bird species among the study sites during the study period.

Species		Plain wetland habitats				
Common name	Scientific name	Chemoga	Sentera	Yewula	Yebasan and Des	Dechekes/Yejube
Sacred ibis	*Threskiornis aethiopicus*	+	+	+	+	+
Wattled ibis	*Bostrychia carunculata*	+	+	+	+	+
Hadada ibis	*Bostrychia hagedash*	+	+	+	+	+
Cape crow	*Corvus capensis*	+	+	+	+	+
Fan-tailed raven	*Corvus rhipidurus*	+	+	+	+	+
Thick-billed raven	*Corvus crassirostris*	+	+	+	+	+
Pied crow	*Corvus albus*	+	+	+	+	+
Black-winged stilt	*Himantopus himantopus*	+	+	+	+	+
Egyptian plover	*Pluvianus aegyptius*	+	+	+	+	+
Woolly-necked stork	*Ciconia episcopus*	+	+	+	+	+
Abdim's stork	*Ciconia abdimii*	+	+	+	+	+
White stork	*Ciconia ciconia*	+	+	+	+	+
Egyptian goose	*Alopochen aegyptiaca*	+	+	+	+	+
Knob-billed duck	*Sarkidiornis melanotos*	+				
Ruddy shelduck	*Tadorna ferruginea*	+				
Black-headed heron	*Ardea melanocephala*	+	+	+	+	+
Little egret	*Egretta garzetta*	+	+	+	+	+
Great egret	*Egretta alba*	+	+	+	+	+
Hamerkop	*Scopus umbretta*	+	+	+	+	+
Red-billed oxpecker	*Buphagus erythrorhynchus*	+	+	+	+	+
Greater blue-eared starling	*Lamprotornis chalybaeus*		+			
Rüppell's starling	*Lamprotornis purpuroptera*		+	+		
Lesser blue-eared starling	*Lamprotornis chloropterus*		+	+		
Speckled pigeon	*Columba guinea*	+	+	+	+	+
White-collared pigeon	*Columba albitorques*	+	+	+	+	
Blue-spotted wood dove	*Turtur afer*			+	+	+
Ring-necked dove	*Streptopelia capicola*	+	+	+		
Red-eyed dove	*Streptopelia semitorquata*	+	+	+	+	+
African mourning dove	*Streptopelia decipiens*	+	+	+	+	+
Dusky turtle dove	*Streptopelia lugens*	+	+	+	+	+
Laughing dove	*Streptopelia senegalensis*	+	+	+	+	+
Wattled crane	*Bugeranus carunculatus*	+				
Common crane	*Grus grus*	+				
Black crowned crane	*Balearica pavonina*	+				
Spot-breasted lapwing	*Vanellus melanocephalus*	+		+		
Long-toed lapwing	*Vanellus crassirostris*	+	+	+	+	
Spur-winged plover/lapwing	*Vanellus spinosus*	+	+	+	+	+
Black-winged plover	*Vanellus melanopterus*	+	+			+
Black-headed gull	*Larus ridibundus*	+	+			+
Gull-billed tern	*Sterna nilotica*	+	+	+	+	+
Whiskered tern	*Chlidonias hybrid*	+				
Yellow-billed kite	*Milvus (migrans) aegyptius*				+	
Black kite	*Milvus migrans*	+	+	+	+	+
Hooded vulture	*Necrosyrtes monachus*		+			
Lappet-faced vulture	*Torgos tracheliotus*		+			
White-backed vulture	*Gyps africanus*		+			
Black-chested snake-eagle	*Circaetus pectoralis*	+	+	+	+	+
Augur buzzard	*Buteo augur*	+	+	+	+	+
Common buzzard	*Buteo buteo*	+	+	+	+	+
Tawny eagle	*Aquila rapax*	+	+			
Little swift	*Apus affinis*	+	+	+	+	+
Nyanza swift	*Apus niansae*	+	+	+	+	+
Plain martin	*Riparia paludicola*	+				
Common bulbul	*Pycnonotus barbatus*	+	+	+	+	+
Village weaver	*Ploceus cucullatus*	+	+	+	+	+
Red-billed firefinch	*Lagonosticta senegala*	+	+	+	+	+

+ indicates the species presence in the area; blanks indicate the species absence.

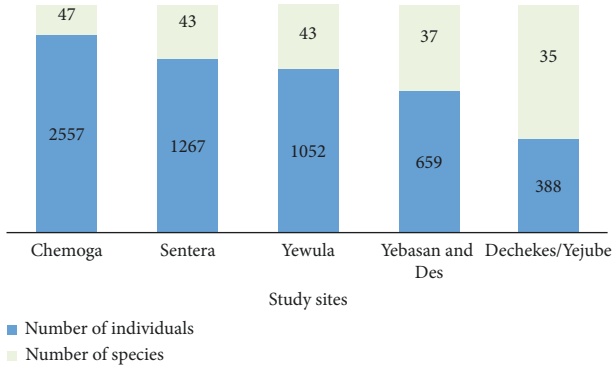

FIGURE 5: Species and abundance rank of bird species in the study sites during the study period.

supplies, individuals' ability to disperse to new locations, and species interactions such as predation or competition are all possible causes of variance [32, 47]. In terms of species diversity, the Chemoga wetland had the most. This could be linked to the habitat type that is best for a given species, as the Chemoga wetland has various grass layers, water ponds, and agricultural areas close to the wetland environment. The species' specialized requirements unique to each given habitat determine the differences in bird species preferences. Some species demand short grasses and little cover, while others require the opposite [37]. Bird distribution patterns often reflect the spatial structure of the environment and the habitat requirements of the bird species, according to [32, 48]. This is consistent with the findings of this study, which revealed habitat specificity and generalization. Pelecaniformes, Passeriformes, Charadriiformes, Ciconiiformes, Anseriformes, Columbiformes, and Accipitriformes, for example, were found in all of the study sites. However, only the Gruiformes (wattled crane, *Bugeranus carunculatus*; black crowned crane, *Balearica pavonina*) were found in the Chemoga wetland habitat. The highest number of bird species recorded across all of the sites studied requires conservation attention.

5. Conclusion

During the study, a high number of species and internationally endangered birds were recorded at the study sites. The presence of endemic, migrant, and globally threatened species emphasizes the importance of the study areas for bird conservation. The study sites differed in terms of bird species diversity, evenness, and similarities. The Chemoga wetland had the most diversity and richness of bird species, whereas the Dechekes wetland had the lowest diversity and richness. The Yewula wetland had the highest evenness index, while the Chemoga wetland had the lowest evenness. Sentera and Yewula wetland were found to be in the same clade, indicating that they shared the same avifaunal species; however, Chemoga wetland habitat was found to have a lower similarity percentage than all other wetland habitats. The avian species with the highest relative abundance value was locally abundant and common. All of the study sites had the majority of the species recorded. Domestic animal overgrazing, agricultural expansion, and habitat fragmentation have all been identified as serious threats to birds in the study areas.

6. Recommendations

(i) More research on biodiversity components, including the wet season, is required.

(ii) To conserve the biodiversity of the study sites, it is necessary to safeguard these wetland habitats through raising community awareness.

(iii) To limit the level of disturbance at the study sites, a controlled grazing system should be adopted.

(iv) A sound conservation approach and a wetland habitat management system should be implemented.

Data Availability

The raw data can be obtained from the first/corresponding author upon reasonable request.

Conflicts of Interest

There are no conflicts of interest stated by the authors.

Authors' Contributions

AG and YB conceived the study and assisted with data gathering at all studied sites. AG has organized the data and fed it into software for analysis, as well as writing the first draft of the manuscript. AG and YB interpreted and analyzed the data and read and approved the final paper for publishing consideration.

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