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Research Article

Composition and Diversity of Bird Community in the Chemoga Wetland and the Associated Human-Modified Landscapes, East Gojjam, Ethiopia

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Wetlands and their surrounding habitats are rich in avian communities. However, the desire for human needs has degraded these ecosystems. The current study was carried out in the Chemoga wetland and its associated human-modified landscapes in East Gojjam, Ethiopia, during both the dry and wet seasons from December 2020 to August 2021. The study aims to investigate the species composition and diversity of the bird community. A line transect sampling technique was used in the human-modified landscapes, whereas the total counting method was used to study the wetland habitat. PAST software and Microsoft Excel were used for data analysis. Using a paired diversity T-test, the effect of seasons and habitats on species richness and abundance was compared. In total, 3890 individuals, 76 species, 31 families, and 13 orders were recorded from the studied habitats. Our results showed that the Chemoga wetland with low human disturbance had a greater number of birds and abundance than the human-modified habitats at $P < 0.05$. Moreover, in both wet and dry seasons, the Chemoga wetland ($P < 0.05$) shows significant difference in the abundance of avian species. But, in the human-modified habitat, there is no significant difference in the abundance of avian species ($P > 0.05$). The majority of birds scored frequent and common on the ordinal scale in both habitats and seasons. This study confirms that the studied habitats are important for the conservation of birds. Conservation measures are thus required to limit disturbances and foster species survival in the area.

1. Introduction

Many wildlife species are currently facing population decline due to habitat degradation caused by land-use changes [1, 2]. Human population growth, in addition to increased demand for settlements, agricultural land, and wood products, is changing vital wildlife habitats around the world [3, 4]. The use and cover of natural habitats in wetlands have also been radically changed, with serious effects on the bird community [5, 6]. Failure to recognize the impact of changes in these natural habitats on wetland biodiversity is likely to increase human pressure on wetlands' natural resources, particularly on birds [7, 8]. Because birds are easy to observe and provide essential ecological services, they are frequently employed to assess or predict the effects of land-use change [9–12]. Furthermore, many birds have diverse and specialized feeding requirements, making them useful indicators of habitat change throughout the year. Seasonality has an impact on the availability of food and cover for bird populations, which has an impact on breeding success and, ultimately, the bird species survival [13]. The availability of different food items for birds is known to be affected by seasonal variations in rainfall and temperature, as well as spatiotemporal conditions [14]. These could change the richness, abundance, and distribution of birds in an area based on species sensitivity to the type of habitat. In particular, it has been revealed that processes happening in migratory bird species breeding and wintering habitats determine both patterns of habitat occupancy and seasonal abundance [15].

Anthropogenic disturbances and natural disasters such as intensive agriculture, livestock overgrazing, degradation of wetlands' natural resource, and climate change have impacted the size, quality, and structure of wetland habitats, reducing the composition and abundance of bird species [16, 17]. While evidence from many empirical researches suggests that disturbed and modified habitats harbor less avian biodiversity than natural habitats since the latter supplies more resources, this does not necessarily allow generalization across all ecosystems and areas [18, 19]. As a result, effective management techniques should attempt to restore these degraded habitats and simplified landscapes, particularly in the tropics, where data on bird population dynamics in connection to anthropogenic disturbances are scarce.

Wetland habitats in Ethiopia, like those in other developing countries, are increasingly threatened by overharvesting of wetland resources [20, 21], anthropogenic pollution [22], inappropriate land use in and around wetlands [21], undermined wetland values [21, 23], and invasive species [24]. Climate change and wetland fragmentation are also affecting Ethiopian wetlands [25–27].

Bird communities are reduced as a result of wetland area reduction or human modification. Due to the loss of wetland ecosystems, wetland-dependent biodiversity and wildlife populations are decreasing. According to [28], some wild animal species that exist in wetland areas, such as Aardvark (*Orycteropus afer*), African civet (*Civettictis civetta*), Cape bushbuck (*Tragelaphus scriptus*), Common duiker (*Sylvicapra grimmia*), Bushpig (*Potamochoerus larvatus*), and Crested porcupine (*Hystrix cristata*), are locally extinct due to the wetland ecosystem degradation in Bule Hora Woreda of the Borena zone in Southern Ethiopia. In the same way, there is a decrease in the diversity of water-bird species, their abundance, and distribution in the wetlands of Lake Ziway and in the surrounding habitats [29]. Bird species diversity and abundance declines have been linked to deforestation and livestock overgrazing, which reduce vegetation cover, nesting sites, food, and habitats [29].

The Chemoga wetland and the associated watershed form one of the headstreams of the Blue Nile. Besides, the Blue Nile Basin is recognized internationally as an Important Bird Area (IBA) in the criteria of 1 (globally threatened species), 2 (restricted range species), and SG (Sudan-Guinea Savannah Biome) [30]. Wetlands can be exploited as long as the usage is compatible with their ecological characteristics, and all uses are for sustainable development, according to the Ramsar wise use of wetland concept [31]. Uncontrolled human activities, such as unplanned settlement growth, intensive agriculture, and animal overgrazing, are increasing at the Chemoga wetland, contrary to the sustainable utilization concept [32, 33]. This has raised worries about the ecosystem's ecological integrity and long-term viability, and if not addressed with management interventions, the wetland ecosystem's structure and functions may be affected. Birds are widely recognized as ecological health indicators [13, 34], and their presence could help researchers better understand and forecast the effects of human disturbances on wetland biodiversity. Furthermore, changing rainfall patterns between wet and dry seasons have been shown to affect vegetation composition and structure, as well as bird diversity [15]. In this regard, research on the composition, abundance, richness, and diversity of bird species in wetland and the distinct human-modified habitats have not been conducted. As a result of the lack of these kinds of biological studies, effective restoration and biodiversity conservation efforts are hampered. Therefore, this research was aimed to gain a better understanding of bird composition and diversity in the area and seasonal bird community dynamics to propose mitigation methods.

2. Materials and Methods

2.1. Study Area Description. The study was conducted in the Chemoga floodplain wetland and the surrounding landscapes in East Gojjam zone, Amhara region, north-west Ethiopia. It is located between 10°18′–10°26′N and 37°44′–37°48′E (Figure 1), with an altitude ranging from 1159 to 2600 meters above sea level (GPS reading during field work). The Chemoga plain wetland is surrounded by four rural kebeles administration (Yegagina, Enerata, Chemboard, and Yenebrna), which have interfaced with this wetland. The climate of this area and the surrounding vicinities has a distinct seasonality with three seasons: summer: June–September (main rainy season), winter: October–February (dry season), and spring: March–May (short rainy season), and the mean annual temperature and rainfall of the study area are estimated at about 21°C and 1808 mm, respectively [35]. The wetland habitat, which is characterized by open water/pond and plain grasses that are intensively grazed by domestic animals, is located in the middle and surrounded by the human-modified landscapes. According to villagers who have lived in the area, the habitat has been impacted by various land use changes such as settlements and agricultural practices, as well as recent overgrazing. The human-modified habitats, on the other hand, due to the high anthropogenic effect, forests have been lost but remnant plants around church forests are left. The total land cover in the studied area is 7841 ha (Figure 1): 4815 ha of human-modified landscapes (farmland, settlement, and plantation trees) and 3026 ha of wetland habitat (grassland, open water/pond, and marshland of five blocks).

2.2. Sampling Design and Data Collection Methods. From the studied habitats, we employed a line transect sampling technique [29, 36, 37] to collect data on bird species composition and diversity, and the total count method was employed followed by [38]. We sampled twenty line transects and five block counts based on natural and artificial boundaries across the various land uses outlined above to assess bird species richness and abundance. Within a survey, all twenty line transects and five block counts were visited twice for a total of sixty-four hours, for four days in both seasons. The first study was conducted in January 2021, during the dry season, while the second survey was carried out in July 2021, during the wet season.

During the surveys, birds were identified early in the morning from 6:30 to 10:00 a.m. and in late afternoon from 4:30 to 6:00 p.m. when the temperature was relatively

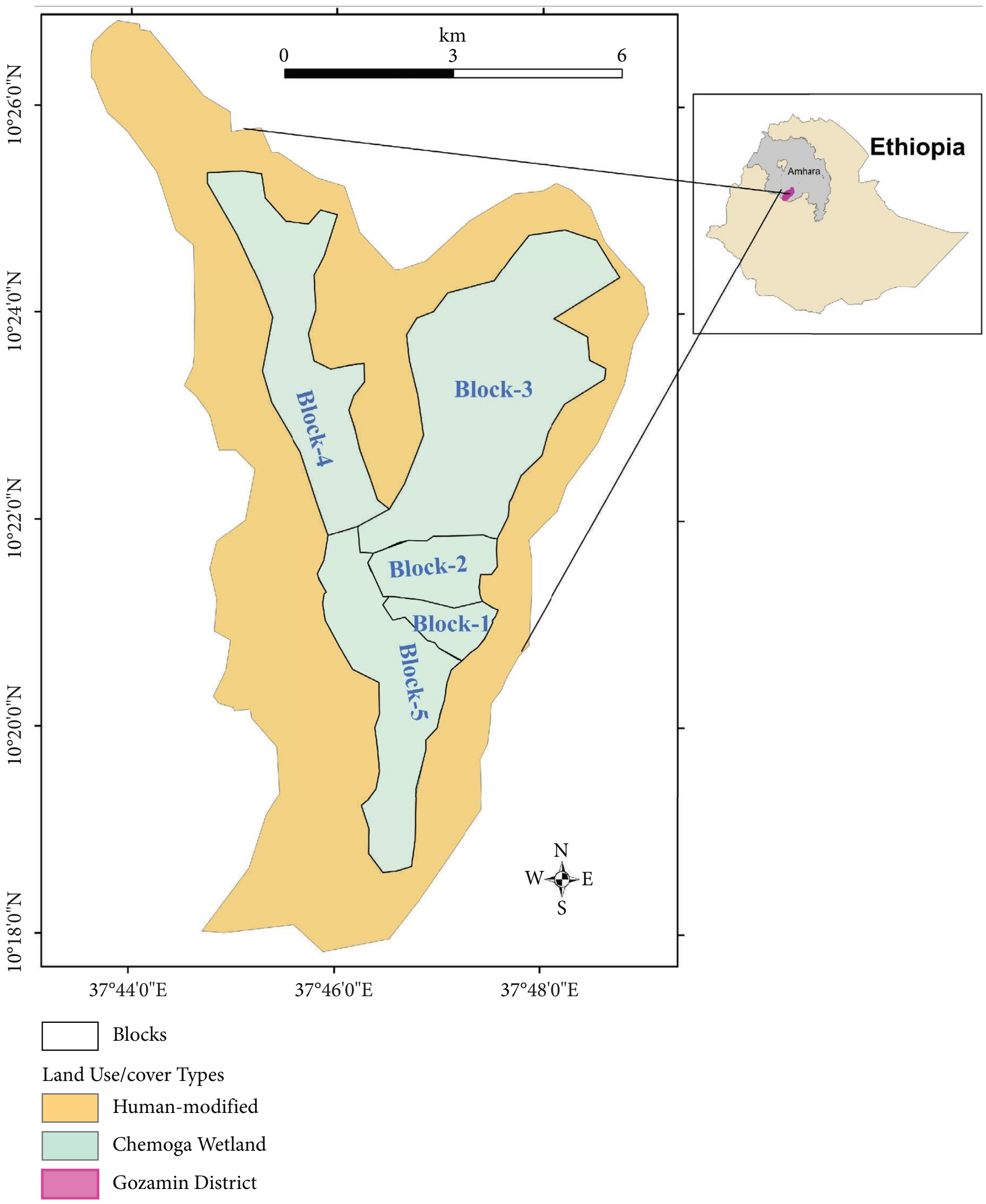

Figure 1: Location and delineation of the study area and the counting blocks.

moderate and the birds' activity was high. Birds were identified by experienced EBI staff members, with the aid of a field guide book [39], with binoculars assisting observations. For every sample, we recorded all birds seen or heard during 15 minutes. The first five minutes were used to wait until bird species were settled after arrival disturbances, and the remaining ten minutes were used to record all species observed or heard [4, 40]. The bird species, number of individuals, and survey site were recorded. To avoid repeated counting of birds, areas were divided based on their distribution and habitat types, and then the same counting method was used by the experts. Birds that flew overhead but did not land on the sites were not recorded.

2.3. Statistical Analysis. Paleontological Statistics (PAST) software, version 4.08, was used for analysis of diversity profile and individual rarefaction, and also Microsoft Excel was used to generate descriptive and inferential statistics. Species richness (S) was obtained by adding the number of species present. To obtain bird abundance in a habitat, we added the entire individual birds from all the samples in that particular habitat and seasons. Data were log transformed to improve the normality and homogeneity of variance. A diversity test was used to compare the richness and abundance of birds counted between two habitats and seasons.

The species diversity was calculated using the following formula [41]:

$$H^{'} = -\sum_{\mathrm{i}=1}^{S} P_{\mathrm{i}} \ln P_{\mathrm{i}}, \quad (1)$$

where H' is the Shannon–Weaver diversity index, P_i is the proportion of the total sample, and Ln is the natural logarithm.

Equitability or evenness index (the distribution of abundances among species) was calculated by using the ratio of observed diversity to the maximum diversity.

$$E = \frac{H^{'}}{H\max}, \quad (2)$$

where E is the evenness index, H' is the Shannon–Weaver diversity index, and $H_{\max}$ is the natural log of the total number of species.

The Simpson's index of diversity (D) was used to evaluate the relative abundance of avian species in each habitat type. The index measures the probability that two randomly selected individuals from a sample will be the same. The formula for calculating the value of the index (D) is as follows:

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)}\right), \quad (3)$$

where n is the number of individuals displaying one trait (e.g., the number of individuals of one species) and $N =$ the total number of all individuals.

The relative abundance of bird species was determined using encounter rates based on the assumption that the more frequently a species is seen, the more abundant it is [36]. The encounter rate was calculated for each species by dividing the total number of individuals observed by the period of observation hours spent searching, so that the number of individuals of each species per hour was determined. This encounter rate was used to give a crude ordinal scale of abundance [36]. Abundance categories used were <0.1, 0.1–2.0, 2.1–10.0, 10.1–40.0, and 40+, and the abundance score given for each category was given as 1 (rare), 2 (uncommon), 3 (frequent), 4 (common), and 5 (abundant), respectively.

$$\text{Encounter rate} = \frac{\text{Total number of individual birds observed}}{\text{Period of observation in hour}} \times 100. \quad (4)$$

3. Results

3.1. Bird Species Composition. During the study period, a total of 3890 individual birds of 76 species, belonging to 31 families and 13 orders, were recorded in the studied habitats (Table 1). The order Passeriformes has the most species (25), followed by Charadriiformes (9) and Phoenicopteriformes, Bucerotiformes, Musophagiformes, and Galliformes (Figure 2). The migratory status of birds revealed that, out of 76 species, 22 (29%) was migratory birds. The remaining (54) bird species (71%) were residents. According to the IUCN status (2022), 70 (94%) species were of least concern, and 6 (6%) were globally threatened species (Table 1).

3.2. Diversity, Richness, and Abundance. The Shannon–Weaver diversity index revealed that the highest avian species diversity index ($H' = 3.44$) was recorded in human-modified habitats during the wet season and ($H' = 3.33$) during the dry season, followed by the Chemoga wetland ($H' = 2.81$) in the same season. In both seasons, the highest species evenness was recorded in the human-modified habitat ($J' = 0.80$). The Chemoga wetland had the highest dominance indexes ($D = 0.11$) and ($D = 0.13$) during dry and wet seasons, respectively (Table 2).

The overall accumulation of species richness estimator and individual rarefaction curves showed that the Chemoga wetland had the highest curve during both the two seasons. However, the human-modified habitat has the lowest curve; this indicates fewer species and a lower number of individuals (Figure 3(a)). The species and diversity index that occurred during surveys was high in the Chemoga wetland as it indicates diversity profiles for both habitat types in two seasons (Figure 3(b)).

Out of the total number of species recorded in the area, 55 and 45 species were recorded from the wetland and human-modified habitat, respectively. Among them, 31 species were recorded only in the wetland, 22 species were recorded only in the human-modified, and 16 species were recorded in both habitats. The paired wise T-test analysis indicated that there was a statistically significant difference in the abundance of species between the two habitats ($P < 0.05$). Moreover, in both wet and dry seasons, the Chemoga wetland ($t = 3.7$, $P \leq 0.001$) shows significant differences in the abundance of avian species. But, in the human-modified habitat, there are no significant differences in the abundance of avian species ($t = -1.62$, $P > 0.05$) (Table 2).

3.3. Bird Species Relative Abundance. The abundance score and ordinal scale of birds varied depending on the studied habitats and the seasons. The most recorded species were locally frequent, common, and abundant in the Chemoga wetland habitat in both seasons. But in the human-modified habitat, the most ordinal scale of bird abundance was frequent. The abundant score was not recorded from this habitat (Table 3).

In total, 76 species were recorded in the study area; the highest relative abundance of bird species was counted in the Chemoga wetland. Out of the recorded top ten abundant species, the Egyptian goose (*Alopochen aegyptiaca*) counted for the highest percent of relative abundance in both dry and

Table 1: Bird species composition in the Chemoga wetland and the associated human-modified habitats during the study period.

Family	Scientific name	Common name	*Wetland*		*Human-modified*		IUCN 2022
			Dry	Wet	Dry	Wet	
Threskiornithidae	*Platalea alba*	African spoonbill	—	4	—	—	LC
	Threskiornis aethiopicus	Sacred ibis	80	120	—	—	LC
	Bostrychia carunculata	Wattled ibis[EB]	60	86	20	22	LC
	Bostrychia hagedash	Hadada ibis	73	26	14	18	LC
Ardeidae	*Ardea melanocephala*	Black-headed heron	6	4	—	—	LC
	Bubulcus ibis	Cattle egret	64	60	—	—	LC
	Egretta garzetta	Little egret	150	40	—	—	LC
	Egretta alba	Great egret	28	34	—	—	LC
Scopidae	*Scopus umbretta*	Hamerkop	4	9	—	—	LC
Ciconiidae	*Ciconia episcopus*	Woolly-necked stork	4	2	—	—	LC
	Ciconia abdimii	Abdim's stork	12	—	—	—	LC
	Ciconia ciconia	White stork	120	—	—	—	LC
Anatidae	*Alopochen aegyptiaca*	Egyptian goose	300	250	—	—	LC
	Sarkidiornis melanotos	African comb duck	8	—	—	—	LC
	Tadorna ferruginea	Ruddy shelduck	14	—	—	—	LC
	Dendrocygna viduata	White-faced whistling duck	—	40	—	—	LC
	Anas undulate	Yellow-billed duck	—	30	—	—	LC
Columbidae	*Columba guinea*	Speckled pigeon	40	20	18	12	LC
	Columba albitorques	White-collared pigeon[EB]	30	18	8	8	LC
	Streptopelia capicola	Ring-necked dove	—	—	6	8	LC
	Streptopelia semitorquata	Red-eyed dove	16	—	18	28	LC
	Streptopelia decipiens	African mourning dove	—	—	6	9	LC
	Streptopelia lugens	Dusky turtle dove	—	—	9	8	LC
	Streptopelia senegalensis	Laughing dove	—	—	8	6	LC
Gruidae	*Bugeranus carunculatus*	Wattled crane	8	2	—	—	VU
	Balearica pavonina	Black crowned crane	4	—	—	—	VU
Recurvirostridae	*Himantopus himantopus*	Black-winged stilt	50	4	—	—	LC
Charadriidae	*Vanellus melanocephalus*	Spot-breasted lapwing[E]	6	4	—	—	LC
	Vanellus crassirostris	Long-toed lapwing	12	28	—	—	LC
	Vanellus spinosus	Spur-winged lapwing	86	80	—	—	LC
	Vanellus senegallus	African wattled lapwing	34	43	—	—	LC
	Charadrius pecuarius	Kittlitz's plover	—	6	—	—	LC
	Charadrius asiaticus	Caspian plover	—	4	—	—	LC
Laridae	*Larus ridibundus*	Black-headed gull	20	8	—	—	LC
	Sterna nilotica	Gull-billed tern	20	—	—	—	LC
	Chlidonias hybrid	Whiskered tern	12	8	—	—	LC

Table 1: Continued.

Family	Scientific name	Common name	Wetland		Human-modified		IUCN 2022
			Dry	Wet	Dry	Wet	
Accipitridae	*Milvus (migrans) aegyptius*	Yellow-billed kite	8	—	8	—	LC
	Milvus migrans	Black kite	12	10	—	—	LC
	Necrosyrtes monachus	Hooded vulture	20	9	6	4	CR
	Torgos tracheliotus	Lappet-faced vulture	6	4	—	—	EN
	Gyps africanus	White-backed vulture	4	2	6	4	CR
	Circaetus pectoralis	Black-chested snake-eagle	2	1	—	—	LC
	Buteo augur	Augur buzzard	4	2	2	—	LC
	Buteo buteo	Common buzzard	2	—	2	—	LC
	Aquila rapax	Tawny eagle	4	—	—	—	VU
Apodidae	*Apus affinis*	Little swift	4	—	6	—	LC
	Apus niansae	Nyanza swift	6	—	7	—	LC
Hirundinidae	*Riparia paludicola*	Plain martin	14	16	2	4	LC
Pycnonotidae	*Pycnonotus barbatus*	Common bulbul	—	—	8	10	LC
Passeridae	*Passer swainsonii*	Swainson's sparrow	—	—	6	4	LC
Muscicapidae	*Cossypha semirufa*	Rüppell's robin-chat	—	—	14	12	LC
Turdidae	*Turdus abyssinicus*	Abyssinian thrush	—	—	20	14	LC
	Turdus pelios	African thrush	—	—	8	4	LC
Estrildidae	*Uraeginthus bengalus*	Red-cheeked cordon-bleu	—	—	18	10	LC
	Coccopygia quartinia	Yellow-bellied waxbill	—	—	6	2	LC
	Lagonosticta senegala	Red-billed firefinch	8	—	18	16	LC
Ploceidae	*Euplectes afer*	Yellow-crowned bishop	—	6	—	4	LC
	Euplectes hordeaceus	Black-winged red bishop	—	—	—	8	LC
	Ploceus cucullatus	Village weaver	—	—	8	12	LC
Viduidae	*Vidua chalybeate*	Village indigobird	—	—	—	14	LC
	Vidua macroura	Pin-tailed whydah	—	—	—	8	LC
	Vidua paradisaea	Eastern paradise whydah	—	—	—	12	LC
Motacillidae	*Motacilla aguimp*	African pied wagtail	—	8	—	4	LC
Leiothrichidae	*Turdoides leucopygia*	White-rumped babbler	—	6	—	20	LC
Buphagidae	*Buphagus erythrorhynchus*	Red-billed oxpecker	8	12	4	6	LC
Sturnidae	*Lamprotornis chalybaeus*	Greater blue-eared starling	—	—	12	10	LC
	Lamprotornis chloropterus	Lesser blue-eared starling	—	—	16	14	LC
Corvidae	*Corvus capensis*	Cape crow	30	18	4	2	LC
	Corvus rhipidurus	Fan-tailed raven	4	—	13	8	LC
	Corvus crassirostris	Thick-billed raven[EB]	12	6	8	10	LC
	Corvus albus	Pied crow	6	8	12	20	LC
Malaconotidae	*Laniarius aethiopicus*	Ethiopian boubou	—	—	4	8	LC
Monarchidae	*Terpsiphone viridis*	African paradise flycatcher	—	—	—	6	LC
Phoenicopteridae	*Phoenicopterus roseus*	Greater flamingo	—	4	—	—	LC
Bucerotidae	*Tockus hemprichii*	Hemprich's hornbill	—	—	—	9	LC

Table 1: Continued.

Family	Scientific name	Common name	*Wetland*		*Human-modified*		IUCN 2022
			Dry	Wet	Dry	Wet	
Musophagidae	*Tauraco leucotis*	White-cheeked turaco	—	—	—	4	LC
Phasianidae	*Pternistis clappertoni*	Clapperton's spurfowl	—	—	6	2	LC

Note. *E* = endemic^{E}; EB = endemic to both Ethiopia and Eritrea^{EB}; VU = vulnerable; NT = near threatened; LC = least concern; CR = critically endangered; +indicates with specific number recorded during the study; —, no recorded of species in the indicated season and habitat.

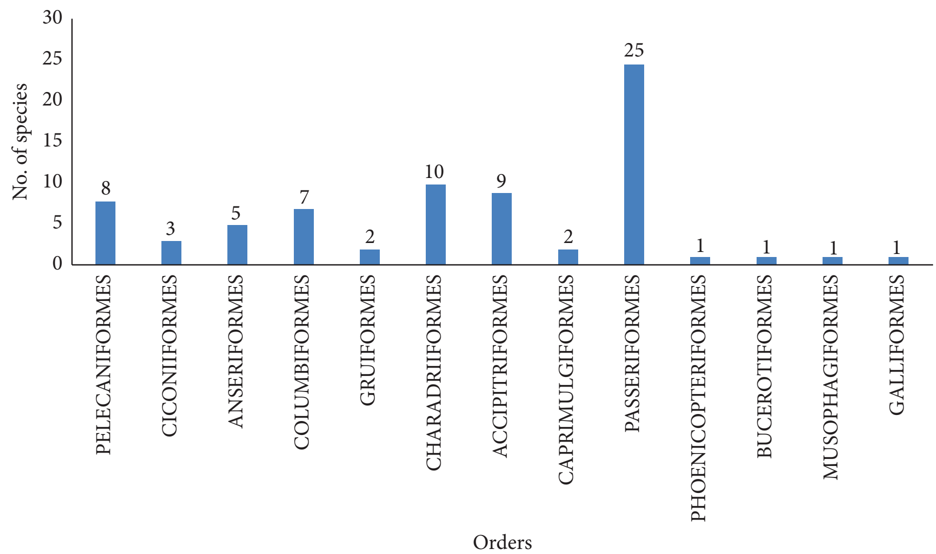

Figure 2: Species composition of birds by their respective order in the study area.

Table 2: Bird species diversity and evenness during wet and dry seasons.

Habitat types	Season	Abundance ($M \pm$ SE)	Species richness	(J')	(H')	(D')	D	T-value	P value
Chemoga wetland	Dry Wet	1415 1042	45 39	0.37 0.33	2.81 2.59	0.89 0.87	0.11 0.13	3.70	0.001
Human-modified	Dry Wet	331 384	35 40	0.80 0.80	3.33 3.44	0.96 0.96	0.04 0.04	−1.62	0.11

J' = evenness; H' = Shannon–Weaver index; D' = diversity index; D = dominance index.

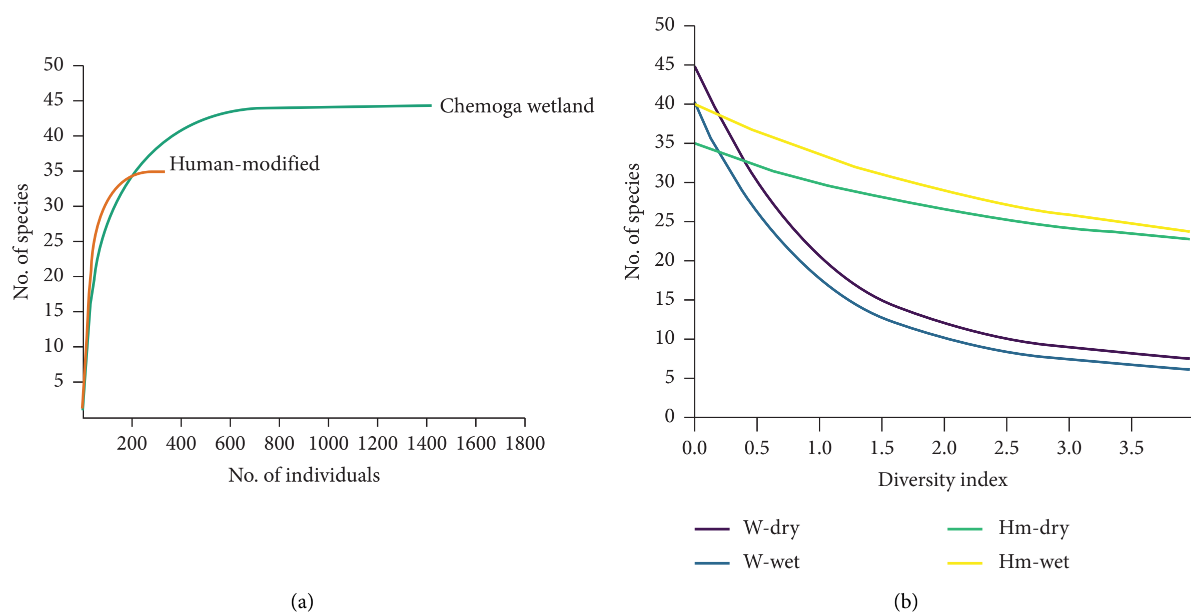

Figure 3: (a) Individual rarefaction curve and (b) diversity profiles for both habitat types in two seasons. For all panels, error bars represent 95% of confidence intervals and closed circles. Hm: human-modified; W: wetland.

wet seasons, followed by the sacred ibis (*Threskiornis aethiopicus*) and the little egret (*Egretta garzetta*) (Figure 4). The African spoonbill (*Platalea alba*), white-backed vulture (*Gyps africanus*), and lappet-faced vulture (*Torgos tracheliotus*) had low relative abundance scores of the total species recorded.

Table 3: Abundance rank of bird species in the two habitats during wet and dry seasons.

Habitat types	Season	No. of species					
		Uncommon	Frequent	Common	Abundant	Total recorded species	Abundance
Chemoga wetland	Dry		14	17	14	45	1415
	Wet	2	16	12	9	39	1042
Human-modified	Dry		28	7		35	331
	Wet		32	8		40	384

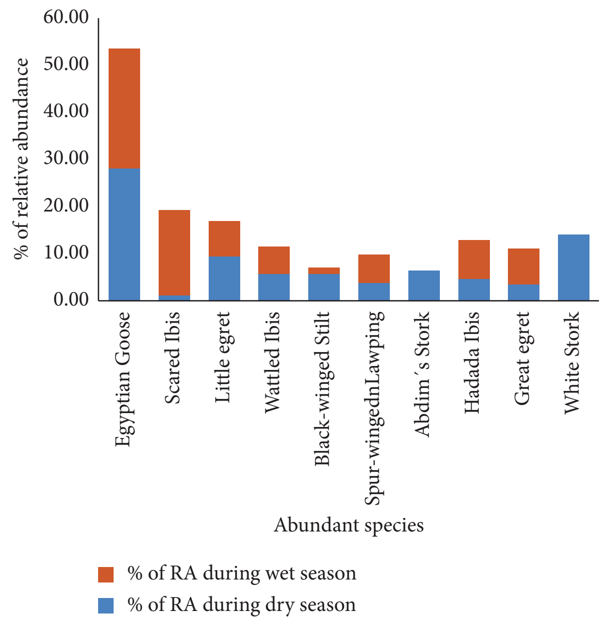

Figure 4: Percentage of relative abundance rank of top ten bird species during wet and dry seasons in the study area.

4. Discussion

This study revealed that both the Chemoga wetland and human-modified habitats provide important habitats that support a considerable number of bird species, including endemic species of spot-breasted lapwing and globally threatened bird species such as hooded vulture, white-backed vulture, lappet-faced vulture, tawny eagle, wattled crane, and black crowned crane. The record of bird species during this study was confirmed at 76 species, which is almost higher than the previous records reported from the surrounding area [42, 43]. In and around Zengo Forest, East Gojjam, a total of 42 avian species belong to 22 families were identified [42], and in Choke Mountains, East Gojjam, Ethiopia, a total of 55 bird species belonging to 11 orders and 27 families were identified [43] during the study period. This study revealed that the studied habitats support a significant number of bird species, which calls attention for conservation of birds in the area. The variation in the bird species composition among habitats may be due to the birds' nesting behavior, resource availability, and disturbance status of the habitats. Another study which is almost similar in its study design with this study conducted in Zege Peninsula forest patches and associated wetlands, Bahir Dar, Ethiopia, was recorded a total of 96 avian species belonging to 38 families [44]. Our results showed that the two different habitat types supported different bird species. About 72% and 59% of all birds recorded have occurred in the Chemoga wetland and human-modified habitats, respectively. Moreover, 16 species were found in both habitats, suggesting that they use a wide range of habitats, possibly because the rich dietary guilds help them with the distribution of generalist and opportunistic bird species in this system that can exploit the available resources [45, 46].

The number of species and number of individuals were significantly higher in the Chemoga wetland than in human-modified habitats. This may indicate that the number of species and individuals in human-modified habitats is declining as a result of numerous human activities in the area. The area's vegetation is decreasing due to agricultural, settlement, and urbanization purposes, which could have an impact on avian composition and abundance [44]. Differences in habitat characteristics and feeding habits of bird species in the study area are also most likely the reason for the variation in species diversity and the number of individuals of bird species across habitats [37, 44, 47]. This result is in line with a study in the Kilombero wetland, Tanzania, and in other African countries [4], reported that the high disturbance grassland has a lower number of species and abundance than the low disturbance habitats. Similar studies in Burdwan, West Bengal, India, also confirmed that agricultural landscapes in the surrounding area of natural habitats showed the lowest richness with the absence of the majority of the birds [48]. The diversity index result showed that the lowest diversity of bird species was recorded in the Chemoga wetland habitat ($H' = 2.59$) during the wet season, while the highest diversity of species was found in the human-modified habitat ($H' = 3.44$) in the same season. During both seasons, results show a higher species dominance index in the Chemoga wetland. Dominance results when one or several species control the environment and conditions influence the associated species, and a high dominance index implies that a dominant bird species exists in this habitat [49–51]. This might be due to the presence of large numbers of individuals of few species such as Egyptian goose, sacred ibis, wattled ibis, hadada ibis, little egret, great egret, black-winged stilt, and spur-winged lapwing in both seasons, which affects the Shannon–Weaver index values.

The highest individual rarefaction curves shown during both wet and dry seasons in the Chemoga wetland indicate that the species richness is highest in this habitat and that rigorous sampling in this habitat will only retrieve a few additional species [52]. However, the human-modified habitat had the lowest curve, which showed that species richness is lowest in this habitat. This means that more sampling effort in the habitat would likely retrieve more new species [53]. They reported that rarefaction allows comparison of species richness at a standardized sample size and avoids confusing genuine differences in species richness with differences in sampling effort.

The abundance and richness of bird species were significantly different between the two habitats, implying that human disturbance has a significant impact on the human-modified habitat. This finding agrees with the authors of [54], who found that the land in the high-density rural population landscape was subjected to intensive management practices on cropland, pasture land, and hay meadows, whereas the land in the low-density rural population landscape was primarily in native vegetation that was extensively managed with prescribed burning, herbicide application, and grazing management to increase native grass production for livestock grazing. This shows that human-induced disturbances and the possible presence of a variety of foraging sites contribute to the variation of abundance, composition, richness, and diversity of bird species in our area. This study showed that a highly disturbed habitat supported fewer bird species richness and diversity than a low-disturbed habitat. It is well understood that the disturbance of natural habitats leads to a reduction or loss of habitat-dependent species, with generalist species being the most likely to survive [4]. Anthropogenic disturbances have altered the conditions of the most disturbed habitats on a regular basis, either biologically or structurally. Consequently, these habitats support fewer bird species.

In the present study, the highest bird species richness was recorded during the dry season (45) [55] than during the wet season (39) in the Chemoga wetland, while in human-modified habitat, the dry season (35) had lower bird species richness than the wet season (40). The possible reason for this variation could be related to the availability of food, habitat condition, and breeding season of the species. The distinct seasonality of rainfall and seasonal variation in the abundance of food resources result in seasonal changes in the bird species abundance [56]. During the dry season, different bird feeding resources around human-modified landscapes may decline, and birds may concentrate in the more resourced Chemoga wetland habitat. During the wet season, however, the human-modified landscape (farm land and settlement) turns green and is used by various birds as food, nesting, and breeding grounds for different species. The high number of species in Chemoga wetland during the dry season may be attributable in part to the large number of migrating birds that winter in this wetland. Other reasons might be that, during dry season, the wetland habitat had better resource that could be utilized by birds.

The abundance score and ordinal scale of birds revealed that most avian species are found within the ordinal rank of "frequent and common" in both dry and wet seasons. In both habitats and seasons, rare species were not recorded. This finding contradicts the findings of [57], who reported rare bird species in the Ansas dam and the surrounding farmland site in Debre Berhan Town, Ethiopia, during the dry season. The presence of a high abundance of birds is probably due to the availability of food, habitat condition, and breeding season of the species and the high detectability of birds in open wetland and scattered trees in modified habitats compared to areas with high forest vegetation cover, which causes low visibility.

5. Conclusion

In this study, 76 species of birds were recorded, implying that the habitats are important for bird conservation. The wetland habitat had the highest species richness and number of individuals during both seasons. The differences in resource availability and disturbance levels between the two habitats were linked to seasonal fluctuation in bird species and numbers in the study area. Our results indicate that the abundance and richness of bird species differed statistically between the two habitats, indicating that the human-modified habitat is highly influenced by human disturbance and those habitats with better resource availability support better biodiversity than habitats with larger sizes. This indicates that the less disturbed wetland habitat supports more species richness and abundance than the more disturbed human-modified landscapes. The study sites are home to a variety of bird species with various abundance scores and ordinal scales. However, the majority of the bird species recorded was frequent and common in the area. The abundance of bird species in the wetland varies significantly depending on the season. However, there is no significant variation in the abundance of bird species in the human-modified habitat.

Considering the results of this study, we find it useful to make the following recommendations:

(i) Further research on breeding resident birds and monitoring activities on seasonal migrant birds is required to see the long-term spatiotemporal changes.

(ii) Resident birds are threatened by continued and expanding anthropogenic impacts such as settlement, agricultural expansion, overgrazing, and other livelihood activities of local residents, due to the lack of conservation effort put into the area. As a result, it is advised that responsible stakeholders implement conservation measures to maintain and conserve biodiversity of the wetland as well as the human-modified landscapes.

(iii) During the dry season, the Chemoga wetland used as a wintering ground for many migratory birds so that it needs special attention to protect these species from any disturbance.

(iv) There is an accelerated land use change in the area; therefore, it needs conservation of biological diversity and its habitat from degradation, habitat shrinkage, and extinction through raising community awareness.

(v) Conservation mechanisms on breeding bird species specific sites are established and the habitat is protected from human disturbances for long-term survivals in collaborative with stakeholders and local communities.

Data Availability

The data used to support the findings of the study are available from the corresponding author upon reasonable request.

Disclosure

This work was conducted as part of the authors' job.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

AG, YB, and TH designed the study and participated with data collection at all study sites. AG and TH organized the data, entered it into software for analysis, and wrote the first draft of the manuscript. The data were interpreted and analyzed by AG, YB, TH, and TF who read and approved the final work for publication.

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References

[1] S. A. V. Bael, R. Zambrano, and J. S. Hall, "Bird communities in forested and human-modified landscapes of Central Panama: a baseline survey for a native species reforestation treatment," *International Journal of Biodiversity Science, Ecosystem Services & Management*, vol. 9, no. 4, pp. 281–289, 2013.

[2] E. C. Ellis, "Ecology in an anthropogenic biosphere," *Ecological Monographs*, vol. 85, no. 3, pp. 287–331, 2015.

[3] V. Devictor, R. Julliard, and F. Jiguet, "Distribution of specialist and generalist species along spatial gradients of habitat disturbance and fragmentation," *Oikos*, vol. 117, no. 4, pp. 507–514, 2008.

[4] W. A. Ntongani and S. M. Andrew, "Bird species composition and diversity in habitats with different disturbance histories at Kilombero Wetland, Tanzania," *Open Journal of Ecology*, vol. 3, no. 7, pp. 482–488, 2013.

[5] S. E. Toogood, C. B. Joyce, and S. Waite, "Response of floodplain grassland plant communities to altered water regimes," *Plant Ecology*, vol. 197, no. 2, pp. 285–298, 2008.

[6] A. J. Wright, H. de Kroon, E. J. Visser et al., "Plants are less negatively affected by flooding when growing in species-rich plant communities," *New Phytologist*, vol. 213, no. 2, pp. 645–656, 2017.

[7] T. W. Da Silva, G. Dotta, and C. S. Fontana, "Structure of avian assemblages in grasslands associated with cattle ranching and soybean agriculture in the Uruguayan savanna ecoregion of Brazil and Uruguay," *The Condor: Ornithological Applications*, vol. 117, no. 1, pp. 53–63, 2015.

[8] M. G. Pretelli, J. P. Isacch, and D. A. Cardoni, "Species-area relationships of specialist versus opportunistic pampas grassland birds depend on the surrounding landscape matrix," *Ardeola*, vol. 65, no. 1, pp. 3–23, 2018.

[9] S. A. Chamberlain, J. L. Bronstein, and J. A. Rudgers, "How context dependent are species interactions?" *Ecology Letters*, vol. 17, no. 7, pp. 881–890, 2014.

[10] T. A. Gardner, J. Barlow, R. Chazdon et al., "Prospects for tropical forest biodiversity in a human-modified world," *Ecology Letters*, vol. 12, no. 6, pp. 561–582, 2009.

[11] C. H. Sekercioglu, "Increasing awareness of avian ecological function," *Trends in Ecology & Evolution*, vol. 21, no. 8, pp. 464–471, 2006.

[12] A. S. Mori, T. Furukawa, and T. Sasaki, "Response diversity determines the resilience of ecosystems to environmental change," *Biological Reviews*, vol. 88, no. 2, pp. 349–364, 2013.

[13] S. Aynalem and A. Bekele, "Species composition, relative abundance and distribution of bird fauna of riverine and wetland habitats of Infranz and Yiganda at southern tip of Lake Tana, Ethiopia," *Tropical Ecology*, vol. 49, no. 2, pp. 199–2009, 2008.

[14] G. Mengesha, Y. Mamo, and A. Bekele, "A comparison of terrestrial bird community structure in the undisturbed and disturbed areas of the Abijata Shalla lakes national park, Ethiopia," *International Journal of Biodiversity and Conservation*, vol. 3, no. 9, pp. 389–404, 2011, http://www.academicjournals.org/IJBC.

[15] Z. Girma, Y. Mamo, G. Mengesha, A. Verma, and T. Asfaw, "Seasonal abundance and habitat use of bird species in and around Wondo Genet Forest, south-central Ethiopia," *Ecology and Evolution*, vol. 7, no. 10, pp. 3397–3405, 2017.

[16] N. Burgess, T. M. Butynski, N. J. Cordeiro et al., "The biological importance of the eastern arc Mountains of Tanzania and Kenya," *Biological Conservation*, vol. 134, no. 2, pp. 209–231, 2007.

[17] A. Gibru and Z. Temesgen, "Diversity and threats of avifauna in cheleleka wetland, central rift valley of Ethiopia," *Research in Ecology*, vol. 2, no. 4, pp. 53–60, 2021.

[18] D. Palomino and L. M. Carrascal, "Threshold distances to nearby cities and roads influence the bird community of a mosaic landscape," *Biological Conservation*, vol. 140, no. 1-2, pp. 100–109, 2007.

[19] S. Bhatt, P. W. Gething, O. J. Brady et al., "The global distribution and burden of dengue," *Nature*, vol. 496, no. 7446, pp. 504–507, 2013.

[20] T. Ayenew and D. Legesse, "The changing face of the Ethiopian rift lakes and their environs: call of the time," *Lakes & Reservoirs: Science, Policy and Management for Sustainable Use*, vol. 12, no. 3, pp. 149–165, 2007.

[21] D. Mequanent and A. Sisay, "Wetlands potential, current situation and its threats in Tana Sub-Basin, Ethiopia," *World Journal of Agricultural Sciences*, vol. 1, no. 1, pp. 1–14, 2015, http://www.wjeas.com/.

[22] K. Hussien, B. Demissie, and H. Meaza, "Spatiotemporal wetland changes and their threats in North Central Ethiopian Highlands," *Singapore Journal of Tropical Geography*, vol. 39, no. 3, pp. 332–350, 2018.

[23] F. Dechasa, F. Senbeta, and D. D. Guta, "Economic value of wetlands services in the central rift valley of Ethiopia," *Environmental Economics and Policy Studies*, vol. 23, no. 1, pp. 29–53, 2021.

[24] D. U. Hooper, F. S. Chapin III, J. J. Ewel et al., "Effects of biodiversity on ecosystem functioning: a consensus of current knowledge," *Ecological Monographs*, vol. 75, no. 1, pp. 3–35, 2005.

[25] D. Thomas, *Poverty, Biodiversity and Local Organisations: Lessons from BirdLife International*, International Institute for Environment and Development (IIED), London, UK, 2011.

[26] M. Kasso and M. Balakrishnan, "Ex situ conservation of biodiversity with particular emphasis to Ethiopia," *Indian Social Responsibility Network Biodiversity*, vol. 2013, Article ID 985037, 11 pages, 2013.

[27] B. Bahilu and M. Tadesse, "Review on distribution, importance, threats and consequences of wetland degradation in Ethiopia," *International Journal of Water Resources and Environmental Engineering*, vol. 9, no. 3, pp. 64–71, 2017.

[28] A. Babu, "Assessment of challenges and opportunities of wetlands management in Bule Hora woreda, Borena zone, southern Ethiopia," *Science, Technology and Arts Research Journal*, vol. 4, no. 2, pp. 99–111, 2016.

[29] M. Girma, B. Afweork, F. Gail, and M. Yosef, "Land use, land cover and climate change impacts on the bird community in and around Lake Zeway, Ethiopia," *International Journal of Biodiversity and Conservation*, vol. 6, no. 3, pp. 256–270, 2014.

[30] Ethiopian Wildlife and Natural History Society (Ewnhs), *Important Bird Areas of Ethiopia*, Ethiopian Wildlife and Natural History Society, Addis Ababa, Ethiopia, 1996.

[31] Ramsar, *The Ramsar Convention*, Center, R. Rue Mauverney, Gland, Switzerland, 1971.

[32] W. Damtea, D. Kim, and S. Im, "Spatiotemporal analysis of land cover changes in the chemoga basin, Ethiopia, using Landsat and google earth images," *Sustainability*, vol. 12, no. 9, p. 3607, 2020.

[33] H. Desalegn, A. Mulu, and B. Damtew, "Landslide susceptibility region mapping using GIS, analytic hierarchy process model, and multi-criteria analysis at the chemoga watershed, upper Blue nile, Ethiopia," *Natural Hazards*, vol. 7, pp. 1–22, 2021.

[34] D. Ryan Norris and P. P. Marra, "Seasonal interactions, habitat quality, and population dynamics in migratory birds," *The Condor: Ornithological Applications*, vol. 109, no. 3, pp. 535–547, 2007.

[35] S. Tekleab, S. Uhlenbrook, H. H. Savenije, Y. Mohamed, and J. Wenninger, "Modelling rainfall–runoff processes of the Chemoga and Jedeb meso-scale catchments in the Abay/Upper Blue Nile basin, Ethiopia," *Hydrological Sciences Journal*, vol. 60, no. 11, pp. 1–18, 2015.

[36] C. J. Bibby, N. D. Burgess, D. A. Hill, and S. H. Mustoe, *Bird Census Techniques*, Academic Press, London, UK, 2000.

[37] G. Amare and M. Girma, "Species composition, seasonal abundance and distribution of avifauna in Lake Hawassa and part of the Eastern Wetland habitats, Southern Ethiopia," *International Journal of Biodiversity and Conservation*, vol. 13, no. 1, pp. 1–11, 2021.

[38] W. J. Sutherland, *Ecological Census Techniques: A Handbook*, Cambridge University Press, Cambridge, UK, 2006.

[39] N. Redman, T. Stevenson, and J. Fanshawe, *Birds of the Horn of Africa: Ethiopia, Eritrea, Djibouti, Somalia, and Socotra*, Princeton University Press, Princeton and Oxford, UK, 2009.

[40] L. O'Reilly, D. Ogada, T. M. Palmer, and F. Keesing, "Effects of fire on bird diversity and abundance in an East African savanna," *African Journal of Ecology*, vol. 44, no. 2, pp. 165–170, 2006.

[41] C. E. Shannon and W. Weaver, *The Mathematical Theory of Communication*, University of Illinois press, Urbana, IL, USA, 1949.

[42] D. Belay and M. Yihune, "Diversity, distribution and relative abundance of avian fauna in and around Zengo forest, East Gojjam, Ethiopia," *International Journal of Ecology & Environmental Sciences*, vol. 43, no. 4, pp. 287–293, 2017.

[43] T. Bewketu and A. Bezawork, "A preliminary study on species composition, relative abundance and distribution of bird species in Choke Mountains, East Gojjam, Ethiopia," *International Journal of Biodiversity and Conservation*, vol. 10, no. 12, pp. 517–526, 2018, http://www.academicjournals.org/IJBC.

[44] M. Mola, D. Ejigu, and Y. Yitayih, "Species composition, relative abundance, and habitat association of avifauna in zegie peninsula forest patches and associated wetlands, Bahir dar, Ethiopia," *International Journal of zoology*, vol. 2021, Article ID 9928284, 12 pages, 2021.

[45] U. S. Roy, A. Pal, P. Banerjee, and S. K. Mukhopadhyay, "Comparison of avifaunal diversity in and around Neora valley national park, West Bengal, India," *Journal of Threatened Taxa*, vol. 3, no. 10, pp. 2136–2142, 2011.

[46] W. D. Kissling, C. H. Sekercioglu, and W. Jetz, "Bird dietary guild richness across latitudes, environments and biogeographic regions," *Global Ecology and Biogeography*, vol. 21, no. 3, pp. 328–340, 2012.

[47] Y. Derebe, B. Derebe, M. Kassaye, and A. Gibru, "Species diversity, relative abundance, and distribution of avifauna in different habitats within Lewi Mountain, Awi zone, Ethiopia," *Heliyon*, vol. 9, no. 6, Article ID 17127, 2023.

[48] A. Hossain and G. Aditya, "Avian diversity in agricultural landscape: records from Burdwan, West Bengal, India," in *Proceedings of the Zoological Society*, vol. 69, pp. 38–51, Springer India, New Delhi, India, 2016.

[49] B. M. Cagod and O. M. Nuñeza, "Avian species diversity in oil palm plantations of agusan del sur and compostela valley, Philippines," *Advances in Environmental Sciences*, vol. 4, no. 2, pp. 85–105, 2012.

[50] G. E. Soka, P. K. Munishi, and M. B. Thomas, "Species diversity and abundance of avifauna in and around hombolo wetland in Central Tanzania," *International Journal of Biodiversity and Conservation*, vol. 5, no. 11, pp. 782–790, 2013.

[51] D. M. T. Calimpong and N. Om, "Avifaunal diversity of bega Watershed, prosperidad, agusan del Sur, Philippines," *Journal of Biodiversity and Environmental Sciences (JBES)*, vol. 6, no. 4, pp. 385–400, 2015.

[52] N. J. Gotelli and A. Chao, "Measuring and estimating species richness, species diversity and biotic similarity from sampling data," *Encyc Biodiver*, vol. 5, pp. 195–211, 2013.

[53] T. M. Ellis and M. G. Betts, "Bird abundance and diversity across a hardwood gradient within early seral plantation forest," *Forest Ecology and Management*, vol. 261, no. 8, pp. 1372–1381, 2011.

[54] J. Filloy, G. A. Zurita, J. M. Corbelli, and M. I. Bellocq, "On the similarity among bird communities: testing the influence of distance and land use," *Acta Oecologica*, vol. 36, no. 3, pp. 333–338, 2010.

[55] A. Gibru and Y. Biru, "Assessment of bird species composition, relative abundance, and distributions in East Gojjam wetland habitats, Ethiopia," *International Journal of Zoology*, vol. 2022, Article ID 2802998, pp. 1–9, 2022.

[56] T. J. Webb, D. Noble, and R. P. Freckleton, "Abundance-occupancy dynamics in a human dominated environment: linking interspecific and intraspecific trends in British farmland and woodland birds," *Journal of Animal Ecology*, vol. 76, no. 1, pp. 123–134, 2007.

[57] A. Shiferaw and D. Yazezew, "Diversity, distribution and relative abundance of avifauna at Ansas Dam and surrounding farmland site Debre Berhan Town, Ethiopia," *Avian Biology Research*, vol. 14, no. 1, pp. 8–17, 2021.