



Avifauna diversity and abundance in *Washa* and *Borale* Wetlands in Debre Berhan Town, Central Ethiopia

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Abstract

Birds are valuable indicators of both biodiversity and environmental health. However, increased agricultural activity has led to habitat loss and degradation, resulting in declining bird populations. This study examined the diversity and composition of bird species at *Washa* and *Borale* Dams/Wetlands in Debre Berhan Town, Ethiopia, from November 2019 to September 2020. The research design of the present study was total count survey method through transect lines. Data analysis was conducted using PAST software (version 3.26) and Microsoft Excel. Using the total count survey method along transect lines, researchers recorded a total of 38 bird species (38 in *Washa* and 20 in *Borale*) during the study period. Among the identified species, the Abyssinian long claw (*Macrinyx flavicollis*), Blue-winged goose (*Cyanochen cyanoptera*) and Spot-breasted lapwing (*Vanellus melanoccephalus*) are unique to Ethiopia. *Washa* Dam exhibited higher species diversity ($H'=1.9$) compared to *Borale* Dam ($H'=1.3$) based on the Shannon diversity index. However, the Simpson diversity index suggests relatively high avian species diversity in both dams ($D=0.7$). A crucial aspect of wildlife management should be the conservation of the various distinctive bird species in the study areas. By meticulously compiling bird species diversity, the value of the area as a tourist destination can be enhanced, generating revenue for the sustainable conservation of the wetlands and their biodiversity.

Key words/Phrases: Birds, endemic, species diversity, *Washa* and *Borale* wetlands.

1. INTRODUCTION

A biological community is a group of populations from different species that coexist in a specific geographic area. This community is characterized by its species diversity and the relative abundance of each species. Biodiversity is often used as a measure of the ecological health of a habitat, with more diverse communities indicating a healthier habitat from a conservation standpoint [9; 14]. Accordingly, species richness, which simply involves identifying the species present, is a relatively easy variable to study and is often used as an indicator of community diversity [13; 31].

Tropical mountains are recognized for their high diversity of bird species, with many different species sharing the same habitats [15]. Ethiopia, a land of stunning diversity, boasts a remarkable array of wildlife, particularly in its tropical mountains. With its unique geographical features, including the towering peak of Ras Dejen at 4620 meters above sea level and the lowest point in Africa at 126 meters below sea level in the Afar Depression, Ethiopia offers a diverse range of

habitats that support a rich tapestry of life. This diverse landscape has led to a high degree of endemism, with many species found nowhere else on Earth. The country's beautiful landscapes, from the rugged mountains to the lush lowlands, are home to iconic species of both fauna and flora. Notably, Ethiopia is home to approximately 9.5% of the world's bird species and more than half of Africa's bird species, making it a birder's paradise [2]. Ethiopia, a birdwatcher's paradise, is home to approximately 926 bird species, out of the 1850 species found in Africa [19]. Of these, a remarkable 665 species are resident, making Ethiopia a year-round destination for bird enthusiasts [21]. The country's unique biodiversity has given rise to 18 bird species endemic to Ethiopia alone. Additionally, another 14 species are shared with neighboring Eritrea, bringing the total number of endemic species in the region to 32. To protect these valuable bird populations, 73 Important Bird Areas (IBAs) have been identified across Ethiopia. These IBAs represent various ecosystems, with 30 of them being wetland sites [2].

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Different studies have shown that alterations in surface water bodies, caused by changes in land use, have had a significant negative impact on local biodiversity, including bird and other wildlife populations. Consequently, these changes have eroded local economies that depend on these natural resources [6; 28]. Birds, in particular, have been highly vulnerable to environmental changes, such as alterations in land use [17]. Human activities that destroy habitats often outpace the ability of birds to adapt or relocate [34]. Additionally, peoples' negative perceptions of birds as crop pests can further endanger their survival [33]. Deforestation, agricultural expansion, and overgrazing have significantly disrupted the environment, leading to the decline or extinction of numerous bird species [12]. Specifically, changes in land use that alter the environment of freshwater lakes have been shown to have a negative impact on the composition of water bird communities [12]. Birds are often considered excellent indicators of biodiversity and environmental health, as they are sensitive to changes in their environment, such as pollution levels and other human-induced impacts [8]. For example, many bird species that rely on farmland habitats for breeding and overwintering have experienced significant population declines in recent years [4]. Intensified agriculture, which often leads to the loss and degradation of breeding habitats, is a primary driver of bird population decline [23]. Ethiopia, with its diverse ecosystems, faces significant threats to its biodiversity, necessitating strong conservation efforts supported by legislation [24]. Amhara National Regional State, recognized as an Important Bird Area (IBA), encompasses a significant portion of the central Ethiopian highlands, making it a crucial region for endemic bird conservation [7].

Despite Ethiopia's rich diversity of bird species, many endemic and globally threatened birds face serious threats due to widespread habitat degradation, fragmentation, and loss [19]. Specifically, the expansion of agriculture, encroachment by livestock, deforestation, and uncontrolled fires, fueled by a growing human population, are frequently cited as the primary causes of habitat degradation, fragmentation, and loss for birds in Ethiopia, ultimately impacting their survival [2; 20]. It has been observed that threats to bird species in Ethiopia have been escalating in recent decades, mirroring the trend for other wildlife [2]. Different researchers at different parts of Ethiopia have studied the population ecology of birds [1; 2; 20; 29; 30]. However, the diversity and composition of bird species around Debre Birhan town such as at *Washa* and *Borale* Dams/reservoirs was not the subject of the study. Therefore, the aim of this study was to investigate the diversity and composition of bird species at the aforementioned

dams in North Shewa Zone, Amhara Regional State, Ethiopia.

2. MATERIALS AND METHODS

2.1. Study area

We conducted this study in *Washa/Ansas* and *Borale* Dams/ wetlands located around Debre Berhan town approximately 5 km and 10 km east of the center of the Town, in Atakilit Kebele, North Shewa, Amhara National Regional State, Ethiopia (Fig. 1). The study areas are located within a narrow altitudinal range, spanning from 2767 meters above sea level (m asl) at *Washa* to 2832 m asl at *Borale*. The geographical location of *Washa* is 9°39'45" latitude and 39°32'45" longitude whereas *Borale* is located at 9°39'62" latitude and 39°32'36" longitude. The study area is characterized by a temperature range, with a mean annual minimum temperature of 2.3°C and a mean annual maximum temperature of 22°C. Additionally, the area receives an average annual rainfall of 906 mm [26]. Regarding the area of the reservoirs/dams, *Washa* covers a total area of 15 ha while *Borale* covers 17 ha. *Washa* Dam was constructed in 1995 by a non-governmental organization known as Lutheran. *Borale* Dam, on the other hand, was built in 2007 by the Amhara Region Agriculture Bureau. Both dams were built primarily to supply water for fisheries, irrigation, and livestock. These reservoirs rely on seasonal floods and small streams, particularly during the rainy season (late June to early September). The maximum depth of both dams is 14 meters. *Washa/Ansas* Reservoir has a capacity of 91,875 cubic meters, whereas *Borale* Reservoir has a capacity of 280,000 cubic meters [22]. Excessive water extraction for irrigation, livestock, and construction, particularly during the dry season (November to May), significantly reduces water depth and causes deficits (Fig. 2).

2.2. Data Collection

The data collection was conducted at *Washa* and *Borale* dams from November 2019 to September 2020. Survey of the avian species was carried out in the morning (06:00-11:00 h) and in the afternoon (15:00-18:00 h) when most of the avian species can be active. Identification and recording of avian species were conducted by direct observations using binocular by walking along all parts of the study area, where birds can be located or heard [27].

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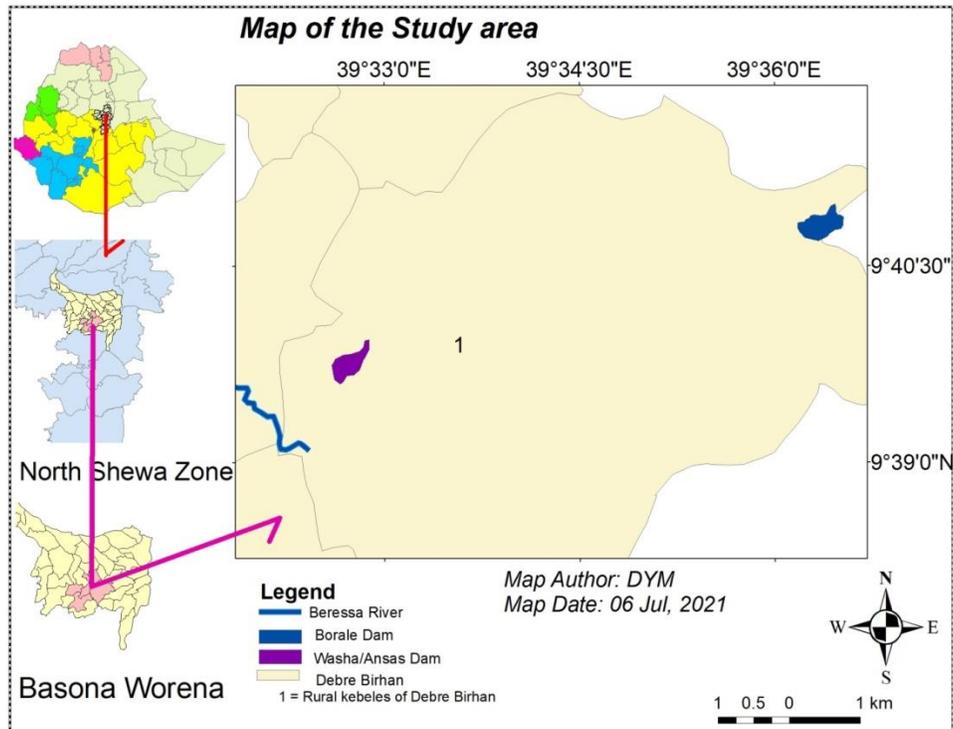


Figure 1. Map of the study area

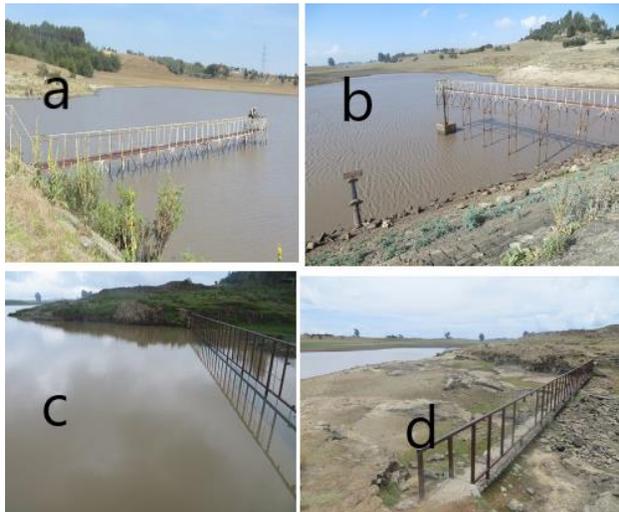


Figure 2. Depth of water level during wet and dry seasons (a-d)

To investigate the diversity and abundance of bird species, line transect counts were employed. Transects were randomly sited and oriented to ensure unbiased relative abundance estimates [3]. Birds inhabiting open water bodies were counted along both the eastern and western shores, progressing in a north-to-south direction. Birds crossing the approximate center of the dam in either direction were counted on the side of the dam they reached.

To minimize disturbance to the birds during the count, a waiting period of 3 to 5 minutes was implemented prior to commencing each count. Additionally, a movement rate of 2 km/h was maintained to prevent overlooking or double-counting individuals [5; 10; 27]. We identified bird species based on their specific structural features such as size of birds, color and pattern of plumage, shape and calls using bird field guidebooks [25]. Birds flying directly overhead or singing on the air were counted and observed using binoculars to identify species. Additionally, videos and photos were captured using a Canon digital camera to aid in the identification of challenging species [2]. Lastly, a taxonomic classification was assigned to each identified bird species.

Data Analysis

Data analysis was conducted using PAST 3.26 and Microsoft Excel. PAST was employed to calculate Shannon-Wiener diversity, evenness, and Simpson's diversity index (H'). Diversity t-tests were utilized to compare diversity indices between seasons. Evenness (E) or equitability was calculated as the ratio of observed diversity to maximum diversity using the equation:

$$E = H' / H_{\max}, \text{ Where: } H_{\max} = \ln S,$$

H' is Shannon-Wiener's diversity index, Hmax is the maximum value of H' and S is Species richness. Evenness was used to quantify the unique representation of a species against a given hypothetical community in which all species are equally common[18].

Simpson index of similarity: Simpson's similarity index was used to quantify the similarity between different habitats in relation to the composition of species. This index was calculated using the formulas: $S_I = \frac{2C}{(a+b)}$, where C is the number of common species for both habitats, a is the number of species occurring at site 1, and b is the number of species occurring at site 2 [16]. Coefficients range from 0 to 1 with zero representing no species shared

(no similarity) and one representing all species shared (complete similarity).

3. RESULTS

3.1. Species Composition

A total of 38 bird species were recorded from both *Washa* and *Borale* Dams during the study period. Out of the total number 38 bird species recorded in the study area, all 38 species were recorded in *Washa* Dam while 20 Species were recorded in *Borale* Dam. Most of the birds in the study area were observed throughout the study period. Out of the species recorded in the area, three species (7.9%) were endemic to Ethiopia and eight (21.1%) species were endemic to Ethiopia and Eritrea (Table 1).

Table 1. Bird species recorded during the study period in the study area(♥= Endemic to Ethiopia, ♣ = Endemic to Ethiopia and Eritrea)

NO.	Scientific name	Common name	Abundance	
			Washa Dam	Borale Dam
1	<i>Milvus aegypticus</i>	Yellow-billed kite	1	-
2	<i>Haliaetus vocitor</i>	African fish eagle	2	-
3	<i>Alopochen aegyptiaca</i>	Egyptian goose	373	301
4	<i>Cyanochen cyanoptiera</i>	♥Blue-winged goose	129	18
5	<i>Charadrius tricollaris</i>	Three banded plover	5	5
6	<i>Anas undulta</i>	Yellow-billed duck	7	6
7	<i>Vanellus melanocephalus</i>	♥Spot-breasted lapwing	19	10
8	<i>Vanellus spinosus</i>	Spur-winged lapwing	6	3
9	<i>Calidris minuta</i>	Little stint	9	3
10	<i>Tringa glareola</i>	wood sand piper	9	-
11	<i>Calidris ferruinea</i>	Curlew sand piper	7	6
12	<i>Anas erythrorbynchos</i>	Red-billed duck	2	-
13	<i>Recuriro straovosetta</i>	Pied avocet	2	-
14	<i>Threskiorniss ethiopicus</i>	African sacred ibis	3	-
15	<i>Bostychia carunculata</i>	♣Wattled ibis	15	5
16	<i>Columba albitoques</i>	♣White-collored pigeon	25	9
17	<i>Columba pigeon</i>	Speckled pigeon	5	4
18	<i>Ralbus rougetii</i>	♣Roget rail	2	-
19	<i>Macrinyx flavicollis</i>	♥Abyssinian long claw	3	4
20	<i>Mymecocichia semirufa</i>	♣White-winged cliff-chat	2	3
21	<i>Melaenoris chocolatinus</i>	♣Abyssinian slaty flycatcher	3	6
22	<i>Myrmecacichia melaena</i>	♣Rupell's black chater	2	-
23	<i>Corvus crassirostris</i>	♣Thick-billed raven	2	-
24	<i>Corvus albus</i>	♣Pied crow	9	5
25	<i>Lagonosticta senegala</i>	Red-billed fire finch	3	-
26	<i>Bubulcus ibis</i>	Cattle egret	6	-

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27	<i>Charadrius marginatus</i>	White-fronted plover	4	4
28	<i>Ploceus intermedius</i>	Lesser masked-weaver	2	3
29	<i>Passer domesticus</i>	House sparrow	6	5
30	<i>corvus capensis</i>	Cape crow	3	3
31	<i>Neophron Percnopterus</i>	Egyptian vulture	5	-
32	<i>Gyps africanus</i>	White-back vulture	6	-
33	<i>Phoenicurus sphaenicurus</i>	European redstart	3	2
34	<i>Scopus umbretta</i>	Hamerkop	1	-
35	<i>Gallinula chloropus</i>	Common moorhen	1	-
36	<i>Limosa lapponica</i>	Bar-tailed Godwit	4	-
37	<i>Tringa erythropus</i>	Spotted Redshank	12	-
38	<i>Actitis hypoleucos</i>	Common Sandpiper	2	-
Species Richness			38	20

3.2. Species Diversity and Evenness

Statistical differences were observed in species diversity between the two dam habitats during the study period. The lowest diversity of bird species was

recorded in the *Borale* dam ($H'=1.3$) while the highest diversity of species was found in *Washa* dam ($H'=1.9$). Evenness was the same value ($E=0.18$) in both dams (Table 2).

Table 2. Bird species diversity and evenness indices in the two dam habitats

Habitat	Species richness	Abundance	H'	Hmax	E=H'/Hmax	Dominance
<i>Washa</i> Dam	38	700	1.9	3.43	0.18	0.3
<i>Borale</i> Dam	20	405	1.3	3.22	0.18	0.6

Note: H' = Shannon-Weiner Index; H'/H_{max} = Evenness; Dominance = $\sum ni (ni-1) / N (N-1)$

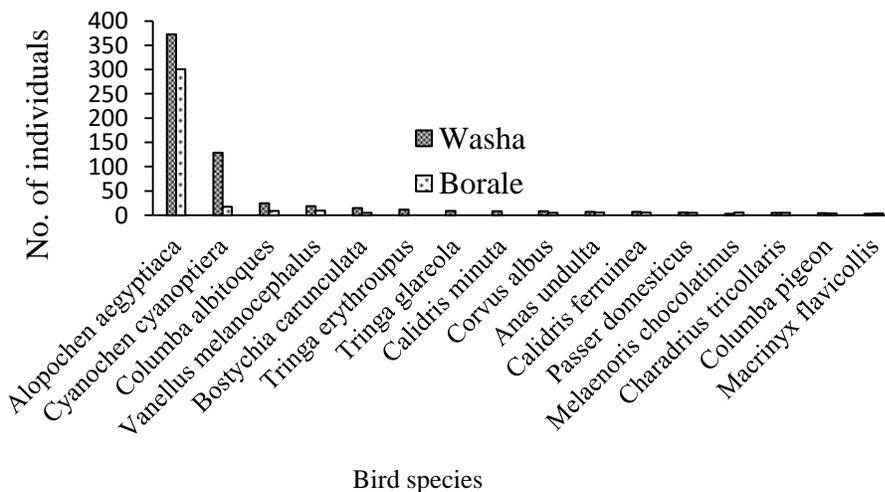


Figure 3. Species of birds with their relative abundance records in both *Washa* and *Borale* dams

3.3. Simpson Similarity Index

Out of the total 38 bird species observed during the study period, 20 species of birds were recorded from both dams while 18 more species were recorded only from *Washa* Dam. The similarity index of the two dams was 0.7 (20 of 38 species).

3.4. Bird species abundance

Out of the total 38 species recorded in the study area, three bird species *Alopochen aegyptiaca*, *Cyanochen cyanoptera* and *Columba albitoques* accounted the highest abundance in respective manner in both *Washa* and *Borale* dams (Fig. 3; Appendix I).

4. Discussion

Although birds are considered a good source of environmental indicators, studies regarding birds' species diversity and behavior are patchy with a single census in *Washa* Dam [26]. Accordingly, this study is a pioneering endeavor regarding a comparative study of bird species diversity in the two dams in north Shewa. Moreover, the findings of this study have been compared with studies elsewhere in the country. A total of 38 and 20 bird species were recorded in *Washa* and *Borale* dams, respectively although both dams faced several anthropogenic pressures (Table 1). The number of species recorded in the present study was significantly lower than that reported in several studies conducted in other localities in Ethiopia, indicating a lower avian diversity in this particular area. For instance, Aynalem and Bekele [2] reported 129 bird species from riverine and wetland habitats of Infranz and Yiganda at southern tip of Lake Tana, Ethiopia which is a very high diversity. Moreover, several studies also confirmed higher bird species diversity contrary to this study: 124 avian species from Dhati Walel National Park [32]; 474 birds species from Kafa Biosphere Reserve [29]; 95 avian species from Apini and Dikuma forest patches, Awi Administrative Zone [10]; 68 bird species from Mekelle University Endayesus campus [1]. The possible reason for the lower avian species diversity in the present study may be the influence of habitat types, area coverage and high anthropogenic disturbance on both dams (*Washa* and *Borale*) and surrounding areas. More specifically, the utilization of dam water for livestock marched with intensive irrigation practices and human-bird conflict may be the reason for lower species diversity in this study though no data were collected to support this argument. The relatively low avian species diversity (20) observed at *Borale* Dam could be attributed to the restricted range of habitat types within the area. These limited habitats may offer fewer opportunities for foraging and nesting, coupled with a lower level of protection compared to *Washa* Dam [11].

Out of the 38 bird species recorded in both dams three species, Blue-winged goose (*Cyanochen cyanoptera*), Spot-breasted lapwing (*Vanellus melanocephalus*) and Abyssinian long claw (*Macrinyx flavicollis*) are endemic species to Ethiopia and eight species, Wattled ibis (*Bostrychia carunculata*), Thick-billed raven (*Corvus crassirostris*), White-collared pigeon (*Columba albitorques*), Roget rail (*Ralbus rougetii*), Abyssinian slaty flycatcher (*Melaenorhis chocolatinus*), Rupell's black chater (*Myrmecocichia melaena*), Pied crow (*Corvus albus*) and White-winged cliff-chat

(*Myrmecocichia semirufa*) are shared endemic species between Ethiopia and Eritrea. This is comparable with Genet and Ejigu [10] and Shiferaw and Yazezew [26] who identified four species endemic to Ethiopia and ten species endemic to both Ethiopia and Eritrea, six of which are included in this study. The Diversity Index indicated that *Borale* Dam had the least bird species diversity ($H'=1.3$), while *Washa* Dam had the highest diversity ($H'=1.9$). The similarity analysis of bird species between the two dams showed that a high species similarity was observed ($SI=0.7$).

When comparing the bird species relative abundance recorded in the two wetlands, Egyptian goose (*Alopochen aegyptiaca*) accounted the highest relative abundance (53%) followed by Blue-winged goose (*Cyanochen cyanoptera*) (75%). This is in line with the report made by Shiferaw and Yazezew [26] for *Washa* wetland. Moreover, Hamerkop (*Scopus umbretta*), Common moorhen (*Gallinula chloropus*) and Yellow-billed kite (*Milvus aegypticus*) are the least abundant species in *Washa* wetland and are not recorded in *Borale* wetland.

Conclusion

The present study at *Washa* and *Borale* Dams revealed that the area supports relatively diverse species of birds. The research confirmed the presence of 38 bird species in the area, three of which are endemic to Ethiopia. These results further emphasize the role of the two dams in conserving a diverse range of bird species, which could significantly attract tourists and researchers. Although only 20 bird species were recorded from *Borale* dam, out of the total 38 species, the area is important as alternative habitat of birds in the area and supplement conservation of these birds. The limited conservation efforts in the area jeopardize the long-term survival of range-restricted bird species. The ongoing and expanding anthropogenic pressures, such as urbanization, agricultural expansion, and livestock watering, present significant conservation bottlenecks. Therefore, the local government bodies and conservation stakeholders should take appropriate conservation measures to mitigate the diverse anthropogenic impacts so as to ensure avifauna diversity and abundance in both wetlands/dams and the surrounding areas before the total elimination of these patchy habitats. To that end, the conservation of avian species in the area necessitates awareness-raising initiatives among local communities and the implementation of participatory conservation strategies. The sustainability of the dams should also be a center of gravity for biodiversity conservation in line with high tendency of pollution due to agricultural inputs and the expansion of the town encircling *Washa* Dam and its

surroundings. In this regard, *Borale* dam could be a good backup of birds endangered in *Washa* dam. Moreover, Debre Berhan town tourism office should aspire to enhance the value of the area as a tourist destination site.

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Conflicts of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

References

1. Alelign A, Alemayehu Y, Hans B, Yonas M: Abundance and diversity of birds around Mekelle Airport, Ethiopia, and their threat to aviation safety. *Journal of Zoology Studies* 2017, **4**(3): 29-36.
2. Aynalem S, Bekele A: 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* 2008, **49**(2): 199.
3. Bibby CJ, Johnes M, Marsden S: *Expedition Field Techniques. Bird Surveys* London: The expedition Advisory Center Royal Geographic Society 1998.
4. Donald PE, Sanderson FJ, Burfield IJ, van Bommel FP: Further evidence of continent-wide impacts of agricultural intensification on European farmland birds, 1990–2000. *Agric Ecosyst Environ* 2006, **116**: 189–196.
5. Esayas K, Bekele A: Species Composition, Relative Abundance and Distribution of the Avian Fauna of Entoto Natural Park and Escarpment, Addis Ababa *SINET: Ethiopian Journal of Science* 2011, **34**(2): 113-122.
6. Esikuri EE. (1998). *Spatio-temporal effects of land use changes in a savanna wildlife area of Kenya*. Virginia Tech.
7. Ethiopian Wildlife and Natural History Society: *Important Bird Areas of Ethiopia. A First Inventory*. Addis Ababa: Ethiopian Wildlife and Natural History Society 1996.
8. Furness RW, Greenwood JJD: *Birds as monitors of environmental change*. London: Chapman & Hall 1993.
9. Gaston K: *Biodiversity: A biology of numbers and difference*. London, UK: Blackwell Science 1996.
10. Genet Y, Ejigu D: Community composition, relative abundance and habitat association of avian species in Apini and Dikuma forest patches, Awi Administrative Zone, Ethiopia. *Ethiopian Journal of Science and Technology* 2017, **10**(1): 33-50.
11. Girma Z, Mamo Y, Mengesha G, Verma A, Asfaw T: Seasonal abundance and habitat use of bird species in and around Wondo Genet Forest, south-central Ethiopia. *Ecology and Evolution* 2017, **7**(10): 3397-3405.
12. Hilli-Lukkarinen M, Kuitunen M, Suhonen J: The effect of changes in land use on waterfowl species turnover in Finnish boreal lakes. *Ornis Fennica* 2011, **88**(4): 185.
13. Hopton ME, Mayer AL: Using self-organizing maps to explore patterns in species richness and protection. *Biodivers Conserv* 2006, **15**(14): 4477-4494.
14. Huston MA: *Biological diversity: the coexistence of species*: Cambridge university press 1994.
15. Jankowski JE, Ciecka AL, Meyer NY, Rabenold KN: Beta diversity along environmental gradients: implications of habitat specialization in tropical montane landscapes. *Journal of Animal Ecology* 2009, **78**(2): 315-327.
16. Kent M, Coker P: *Vegetation Description and Analysis. A practical approach* New York: : John Wiley and Sons. Inc. 1992.
17. Kolecek J, Reif J: Differences between the predictors of abundance, trend and distribution as three measures of avian population change. *Acta ornithologica* 2011, **46**(2): 143-153.
18. Krebs CJ: *Ecological Methodology*. England: Longman Inc., Harlow 1999.
19. Lepage D: Avibase. *The worldwide database. Recuperado el* 2016, **29**.
20. Mengesha G, Bekele A, Fraser G, Mamo Y: Land use, land cover and climate change impacts on the bird community in and around Lake Zeway, Ethiopia. *International Journal of Biodiversity and Conservation* 2014, **6**(3): 256-270.
21. Mengesha G, Mamo Y, Kefyalew S, Elphick C, Bekele A: Effects of Land-use on Birds Diversity in and around Lake Zeway, Ethiopia. *Journal of Science & Development* 2014, **2**: 2.
22. Moges A, Mebrate T: Ecological Conditions and Ecosystem Services of Artificial Wetlands in Semiarid Ethiopian Highlands. *International Journal of Ecology* 2024, **2022**: 7667611.
23. Nagy S, Nagy K, Szép T: Potential impact of EU accession on common farmland bird populations in Hungary. *Acta Ornithologica* 2009, **44**(1): 37-44.
24. Pol JLV: *A Guide to Endemic Birds of Ethiopia and Eritrea* (2nd ed.). Addis Ababa.: Shama Books, 2006.
25. Redman N, Stevenson T, Fanshawe J: *Birds of the Horn of Africa: Ethiopia, Eritrea, Djibouti, Somalia, and Socotra-Revised and Expanded Edition* (Vol. 107): Princeton University Press 2016.
26. Shiferaw A, Yazezew D: Diversity, distribution and relative abundance of avifauna at Ansas Dam and

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- surrounding farmland site Debre Berhan Town, Ethiopia. *Avian Biology Research* 2020, **14**(1): 8-17.
27. Sutherland WJ: *Ecological Census Techniques: A Hand book* Cambridge Cambridge University Press 2006.
28. Tenalem A: Recent changes in the level of Lake Abijata, Central Main Ethiopian Rift. *Journal of Hydrological Science* 2001, **47**: 493-503.
29. Tesfahunegny W: A catalogue for endemic birds of Ethiopia. *Journal of zoology* 2016, **3**(4): 109-133.
30. Tesfahunegny W, Mulualem G: Impact of Climatic Change on Avian Populations: Implication for Long Term Conservation in Wildlife Genetic Resources. *American Journal of Bioscience and Bioengineering* 2017, **5**(1): 23-33.
31. Thomson JR, Fleishman E, MacNally R, Dobkin DS: Comparison of predictor sets for species richness and the number of rare species of butterflies and birds. *Journal of Biogeography* 2007, **34**: 90-101.
32. Tsegaye M, Gadisa T, G/Micchael G: Avian Diversity in Dhati Walel National Park of Western Ethiopia. *International Journal of Molecular Evolution and Biodiversity* 2016, **6**(1): 1-12.
33. Viveropol JL: *A Guide to Endemic Birds of Ethiopia and Eritrea*. Addis Ababa: Shama Books 2001.
34. Wilson BW: *Birds*. San Francisco: W. H. Freeman and Company 1980.

Appendix I: Images of some bird species in *Washa* and *Borale* Dams/wetlands



Spot-breasted lapwing (*Vanellus melanocephalus*)



spur winged lapwing (*Vanellus spinosus*)



Red-billed fire finch (*Lagonosticta senegala*)



Spotted Redshank (*Tringa erythropus*)



Red-billed duck (*Anas erythrorhynchos*)



Pied avocet (*Recuriro straavosetta*)



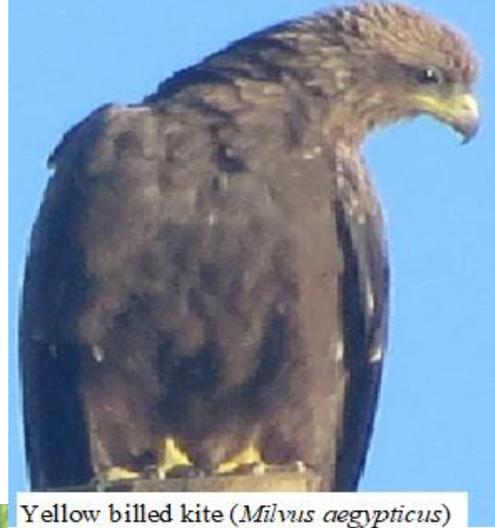
African sacred ibis (*Threskiornis ethiopicus*)



Speckled Pigeon (*Columba pigeon*)



Yellow billed duck (*Anas undulata*)



Yellow billed kite (*Milvus aegypticus*)



Wattled Ibis/ *Bostychia carunculata*



Hamerkop (*Scopus umbretta*)





Blue-winged goose/ *Cyanochen cyanoptera*



Cattle egret (*Bubulcus ibis*)



Egyptian Goose/ *Alopochen aegyptiaca*



Cape crow/*Corvus capensis*



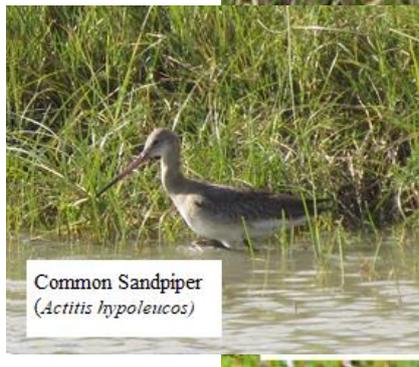
Three banded plover/*Charadrius tricollaris*



African Fish eagle/ *Haliaeetus vocifer*



Bar-tailed Godwit/*Limosa lapponica*



Common Sandpiper
(*Actitis hypoleucos*)



Curlew sandpiper/*Calidris ferruginea*
Raibus rougetii



Egyptian Vulture (*Neophron Percnopterus*)



Common Moorhen/*Gallinula chloropus*



Pied Crow/*Corvus albus*



White-backed vulture (*Gyps africanus*)



White-collared Pigeon/*Columba albitoques*



House sparrow/*Passer domesticus*