



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 fragmentation and deterioration, resulting in declining bird populations. This study examined species richness and composition of birds 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 Microsoft Excel and PAST software (version 3.26). Using the total count survey method along transect lines, researchers recorded 38 bird species (38 in Washa and 20 in Borale) in this study. Of the species identified, Abyssinian long claw (*Macrinyx flavicollis*), Blue-winged goose (*Cyanochen cyanoptera*) and Spot-breasted lapwing (*Vanellus melanocepalus*) 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 set of populations representing different species that coexist within a specific geographic area. This community is characterized by its species richness and relative proportions of each species. Biodiversity is frequently regarded as an indicator of a habitat's ecological health, where communities are more diverse indicating a more resilient habitat in terms of conservation standpoint [9; 14]. Accordingly, species richness, which simply involves identifying the species present, is a variable that can be studied with relative ease 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

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nowhere else on Earth. The country's beautiful landscapes, from the rugged mountains to the lush lowlands, are home to symbolic species of in terms of animals and plants. Notably, Ethiopia is home nearly to 9.5% of global bird species with over half of Africa's bird fauna, making it a birder's paradise [2]. Ethiopia, a birdwatcher's paradise, is home to approximately 926 bird species, among 1850 species recorded 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 number of endemic birds within this geographic area to 32. To protect these valuable bird populations, a total of 73 Important Bird Areas (IBAs) have been recognized across Ethiopia. These IBAs represent various ecosystems, with 30 of them being wetland sites [2].

Different studies have shown that alterations in surface water bodies, caused by changes in land use patterns, have exerted a notable negative effect on biodiversity of the area, including bird and remaining 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 detrimental effects 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, considered to be an Important Bird Area (IBA), encompasses significant portion in 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 as a result of widespread habitat destruction and loss [19]. Specifically, agricultural expansion, livestock encroachment, habitat destruction, and uncontrolled fires, fueled by a growing human population, are frequently referred as the primary causes of habitat destruction and loss for birds in the country, eventually impacting their existence [2; 20]. Studies have shown that challenges to bird conservation in Ethiopia have been escalating in recent decades, mirroring this 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, species richness and composition of bird around Debre Birhan town such as at *Washa* and *Borale* Dams/reservoirs was not the subject of the study. Therefore, we aimed to investigate the diversity and composition of birds at the aforementioned dams in North Shewa Zone, Amhara Region, Ethiopia.

2. MATERIALS AND METHODS

2.1. Study area

We conducted this research 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 Region, Ethiopia (Fig. 1). We conducted this study 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" N and 39°32'45" E while *Borale* is located at 9°39' 62" N and 39°32'36" E. The area experiences a temperature range, with a mean annual minimum of 2.3°C and a mean annual maximum 22°C. The region also receives approximately 906 mm rainfall annually [26].

Regarding the area of the reservoirs/dams, *Washa* covers a total area of 15 ha while *Borale* covers 17 ha. *Washa* Dam was made in 1995 by non-governmental body 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 were collected at *Washa* and *Borale* dams from November 2019 to September 2020. Survey of the avian species was carried out at morning (06:00-11:00 h) and afternoon (15:00-18:00 h) when most of the birds 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].

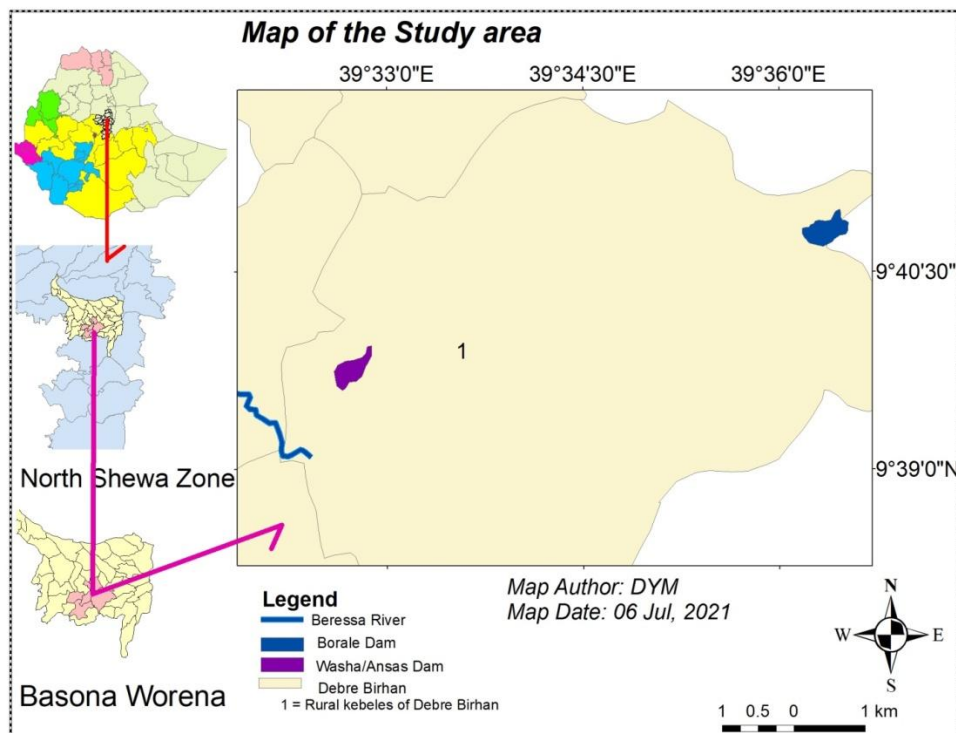


Figure 1. Map of the study area

either direction were recorded on the side of the dam they reached.

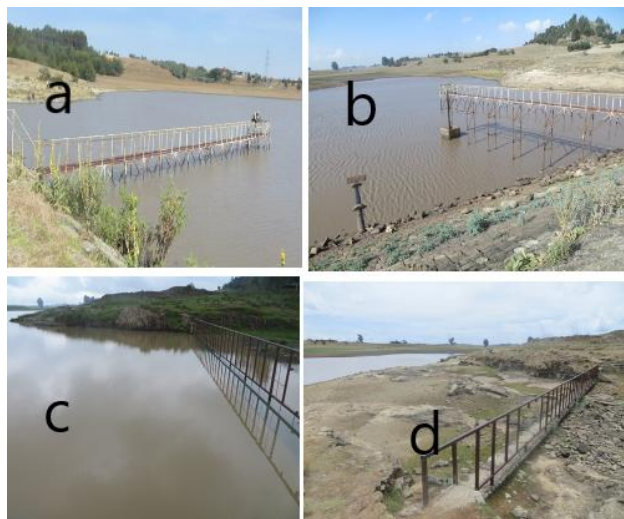


Figure 2. Depth of water level during wet and dry seasons (a-d)

Line transect counts were employed to collect data on the diversity and abundance of bird species. 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 traversing near the center of the dam in

To minimize disturbance to the birds while recording, a pause lasting 3 to 5 minutes was implemented before commencing each count. Additionally, a movement rate of 2 km/h was maintained to prevent no individuals are missed or no individuals counted multiple times [5; 10; 27]. We identified bird species based on their specific structural features such as size of birds, pattern of plumage, shape and calls deploying bird's field guidebooks [25]. Birds flying directly overhead or singing on the air were observed and recorded using binoculars. 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 Microsoft Excel and PAST 3.26. Shannon-Wiener diversity, evenness, and Simpson's diversity index (H') were calculated employing PAST. Diversity indices between seasons were

compared using Diversity t-tests. Evenness (E) was computed as the ratio of observed diversity to maximum diversity following the equation:

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

H' is Shannon-Wiener's diversity index, H_{max} is the maximum value of H' and S is Species richness. Evenness was used to assess 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 evaluate the similarity among different habitats in terms of composition of species. This index was calculated following 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

inhabiting at site 1, and b is the number of species inhabiting at site 2 [16]. Coefficients range from 0 to 1 with zero signifying no species shared (no similarity) and one representing all species shared (complete similarity).

3. RESULTS

3.1. Species Composition

The study revealed 38 bird species from both *Washa* and *Borale* Dams. Out of 38 birds recorded in this study, all 38 species were observed in *Washa* Dam while 20 Species were observed in *Borale* Dam. The majority of birds in the study area were observed throughout the study period. 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	
			<i>Washa Dam</i>	<i>Borale Dam</i>
1	<i>Milvus aegypticus</i>	Yellow-billed kite	1	-
2	<i>Haliaetus vocifer</i>	African fish eagle	2	-
3	<i>Alopochen aegyptiaca</i>	Egyptian goose	373	301
4	<i>Cyanochen cyanoptera</i>	♥Blue-winged goose	129	18
5	<i>Charadrius tricollaris</i>	Three banded plover	5	5
6	<i>Anas undula</i>	Yellow-billed duck	7	6
7	<i>Vanellus melanoccephalus</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 ferruginea</i>	Curlew sand piper	7	6
12	<i>Anas erythrorhynchos</i>	Red-billed duck	2	-
13	<i>Recuriro straavosetta</i>	Pied avocet	2	-
14	<i>Threskiornis ethiopicus</i>	African sacred ibis	3	-
15	<i>Bostychia carunculata</i>	♣Wattled ibis	15	5
16	<i>Columba albitarses</i>	♣White-collared pigeon	25	9
17	<i>Columba pigeon</i>	Speckled pigeon	5	4
18	<i>Rallus roulei</i>	♣Roget rail	2	-
19	<i>Macropygia flavirostris</i>	♥Abyssinian long claw	3	4
20	<i>Mymecocichia semirufa</i>	♣White-winged cliff-chat	2	3
21	<i>Melaenopsis chocolatinus</i>	♣Abyssinian slaty flycatcher	3	6
22	<i>Myrmecocichia 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	-
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 phoenicurus</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 erythroupus</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	$E=H'/H_{max}$	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 = $\sum n_i(n_i-1)/N(N-1)$

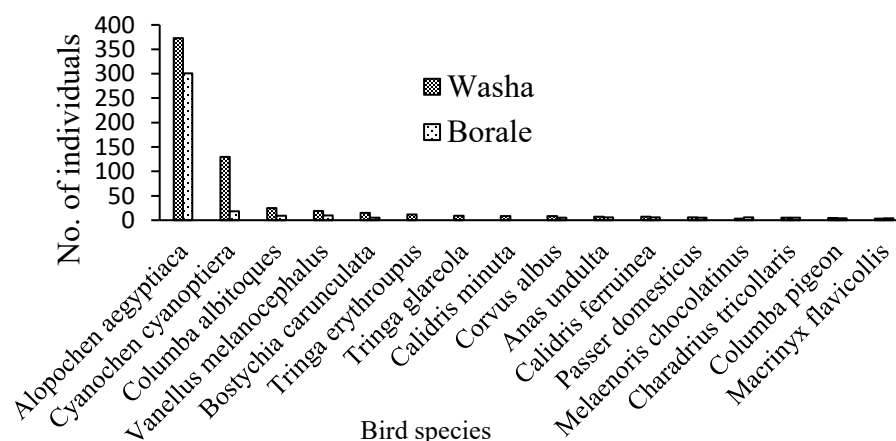


Figure 3. Species of birds with their relative abundance records in both *Washa* and *Borale* dams

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 albitorques* 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 (*Rallus rougetii*), Abyssinian slaty flycatcher (*Melaenoris chocolatinus*), Rupell's black chater (*Myrmecacichia 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.

5. 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.

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



Spot-breasted lapwing (*Vanellus melanopterus*)



spur winged lapwing (*Vanellus spinosus*)



Red-billed fire finch (*Lagonosticta senegala*)



Red-billed duck (*Anas erythrorhynchos*)



Spotted Redshank (*Tringa erythropus*)



Pied avocet (*Recuriro straavosetta*)



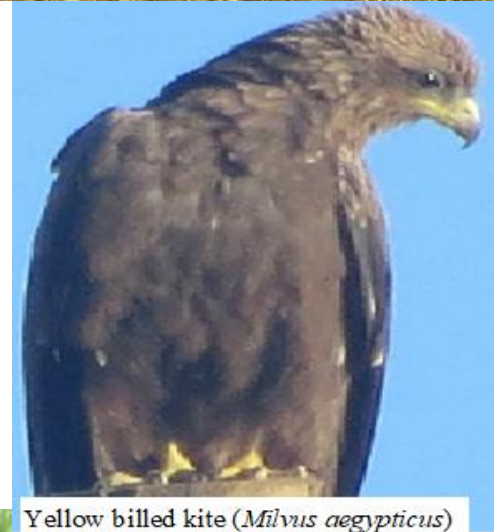
African sacred ibis (*Threskiornis ethiopicus*)



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*
Ralbus rougetii

