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***RESEARCH ARTICLE***

# AVIAN COMMUNITY ASSEMBLAGE AND DIVERSITY IN CHELEKLEKA WETLAND, CENTRAL ETHIOPIA

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**ABSTRACT**: Wetlands are one of the most bird-rich ecosystems on earth. However, they are also one of the systems that face human-induced threats. This study aimed at investigating the avian community assemblage and diversity of the highly degraded Chelekleka wetland, Ethiopia. Avian community diversity and composition in the wetland was investigated using vantage point and strip transect method. Data on post rainy, dry, pre rainy and rainy seasons were collected from November 2020 to October 2021 in four habitat types in and surrounding the wetland. A total of 24,653 individuals belonging to 246 species were identified. This wetland supported 11 Abyssinian endemic birds of which two were endemic to Ethiopia. Among bird species recorded in the wetland, 39% of them are either migrants and/or visitors to the area. Seasonally, 175, 193, 159 and 148 bird species were recorded during post rainy, dry, pre rainy and rainy seasons, respectively while 108 species were recorded in all seasons. A significantly high species abundance (17,523 individuals) and richness (193 species) were recorded during dry season, whereas highest diversity ($H' = 3.93$) and evenness ($E = 0.76$) were observed during the post rainy season. Species diversity between habitats and seasons showed a significant difference. The seasonal community similarity among the four habitat types was significantly different. Chelekleka wetland is ecologically important in supporting high assemblage of resident, migratory as well as endemic bird species and hence an ideal location for ecotourism activities. However, anthropogenic threats such as farming, pollution, residential encroachment, wetland diversions and direct disturbances should be curtailed for sustainability of the wetland and its avian community.

**Key words/phrases**: Birds, Chelekleka wetland, Diversity index, Species similarity.

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## INTRODUCTION

Ethiopia has various freshwater wetland ecosystems distributed in most parts of the country. These wetlands are productive ecosystems that can play an important role in ecological processes and socio-economic developments if they are effectively utilized on a sustainable way. Their ecological role can be seen from the 73 Important Bird Areas identified in Ethiopia (EWNHS, 1996) of which 30 comprise wetlands that support a variety of bird species.

Ethiopian avifauna is estimated to be 881 bird species (Clements *et al*., 2022; Lepage, 2023) and 65% are located in the Rift Valley ecosystem (Lemlem Sisay, 2003; Amare Gibru and Girma Mengesha, 2019). This ecosystem is also known for its several wetlands harboring millions of resident and migratory water birds (Amare Gibru and Girma Mengesha, 2019), among which Chelekleka wetland is one.

The Chelekleka wetland, which is part of the Ethiopian Rift Valley ecosystem, attracts several water birds following the winter migration time from September to February (EWNHS, 2010). The wetland is also recognized as one of an Important Bird Area (IBA) (EWNHS, 1996) though it is a highly degraded wetland (Berhan Gessesse and Woldeamlak Bewket, 2014). At the study area a variety of birds have been recorded such as groups of storks, herons, ducks, geese, waders, ibises, and the birds of prey. The wetland is shallow and seasonally inundated (EWNHS, 1996; 2010) and it is ecologically important as roosting sites for common cranes (*Gurus gurus*) (Shimelis Aynalem *et al*., 2020).

Though wetlands are known as “biological supermarkets”, they are frequently degraded and destroyed (Rajpar and Zakaria, 2011; Luo *et al*., 2019). Unlike rural wetlands, urban wetlands provide extended recreational opportunities and visual aesthetics, but they are subject to urban developmental pressures, resulting in profound and extensive damage, loss and degradation (Luo *et al*., 2019). During the past century, over 50% of wetlands around the globe have been lost, and the remaining wetlands have been degraded to different degrees because of the adverse influences of human activities (Ma *et al*., 2010; Rajpar and Zakaria, 2011; Luo *et al*., 2019).

At present, many of the Ethiopian Rift Valley lakes and wetlands face multiple threats (Shimelis Aynalem *et al*., 2020). According to Amare Gibru and Girma Mengesha (2019), many of these sites face threats and there is incomplete knowledge about the ecology, taxonomy, species diversity,

abundance and distribution of most aquatic species. Therefore, studies on the importance of wetlands to support diversified aquatic species are of paramount importance to provide information on the resource that is contained in the ecosystem and mitigate potential threats. Despite the dynamic nature of the wetland, the anthropogenic pressures and being an Important Bird Area, scientific reports on Chelekleka wetland community ecology are limited. Hence, the present study aimed to identify the avian community assemblage and diversity in Chelekleka wetland.

## MATERIALS AND METHODS

### Description of the study area

Chelekleka wetland is unprotected area located at 8° 45′ 50″ to 8°48′ 20″ North and 38° 45′ 40″ to 39° 0′ 50″ East, 50 km southeast of Addis Ababa (Fig. 1). According to BirdLife International (2021) the wetland covers an area of 24,000 ha. However, currently its area coverage is reduced to 714.7 ha consisting of 329.9, 165.65, 147.53 and 71.62 ha of open water, grassland, farmland and forest land use types, respectively. It is in a shallow pan, which seeps and flows from the cultivated slopes surrounding the pan and the two highland range catchments from Teltele and Sofa, on its northeast (EWNHS, 1996). The topographic feature of the study area is a rugged topography with an altitude of 1,800–1,900 m.a.s.l (BirdLife International, 2021). The monthly annual rainfall of the area ranges from 5 to 232 mm and the annual mean temperature ranges from 8.5°C to 28.3°C.

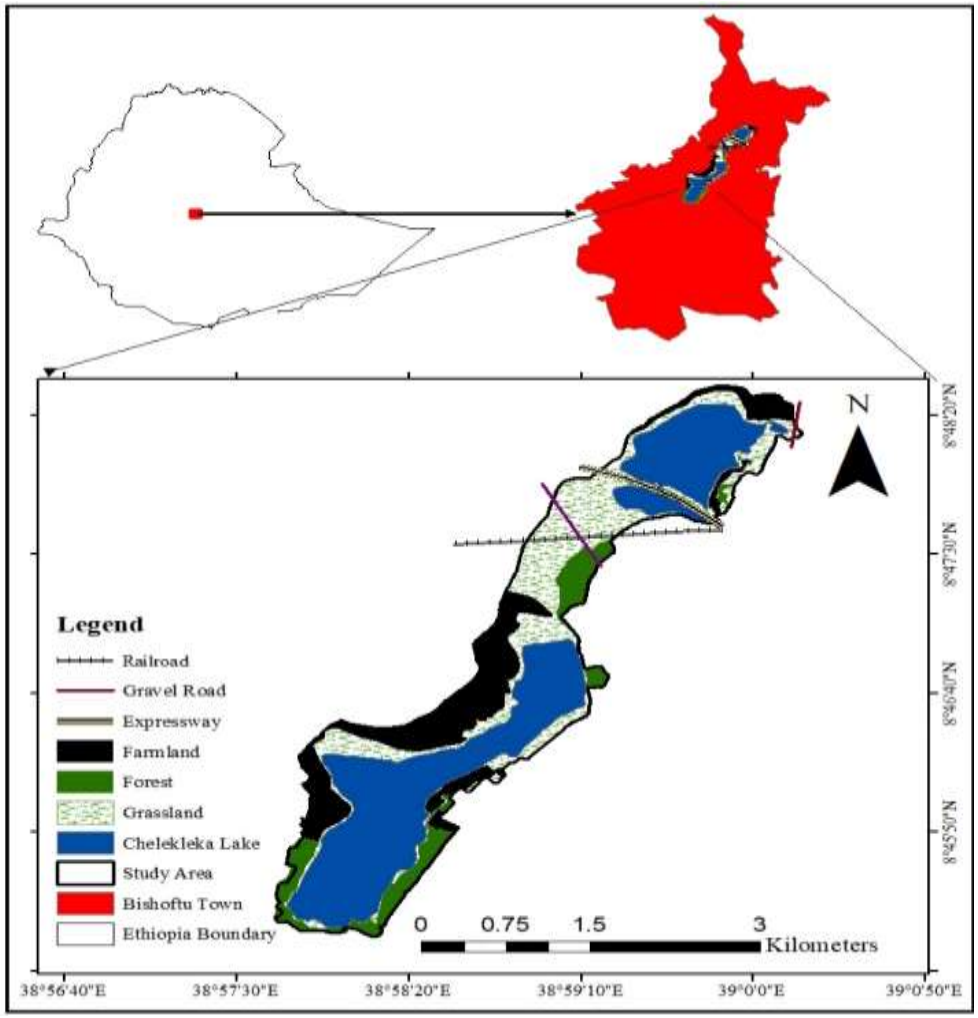


Fig. 1. Map of Chelekleka wetland, Ethiopia.

## Data collection

Avian community composition was collected in and surrounding Chelekleka wetland in four different habitats namely; forest (natural and planted), farmland, grassland, and open water. Data were collected from these habitats early in the morning from 6:30–10:00 a.m. and late afternoon from 3:30–6:00 p.m. twice a week for 12 months during November 2020 – October 2021. A total of 96 days i.e., 24 observation days each during the post rainy, dry, pre rainy and rainy seasons were carried out.

Bird identification and count was conducted by two observers using point count (James *et al*., 2017; Khaing *et al*., 2019) in the forest habitat whereas, strip transect count was employed in the farmland, grassland, and open water habitats. Eight 15-min point counts were conducted in a single day during a "loop-walk" in the forest habitat of the wetland with stops at pre-selected locations 150–200 m apart from each other. A waiting period of 3 minutes was applied to minimize disturbance during counts (Debebe Dana and Selemon Thomas, 2019). A variable-width transect line with a maximum of 250 m on either side was used since the farmland, grassland, and open water habitats are open fields with good visibility (Azhar *et al*., 2008). All individuals seen or hovering over the site were counted and group-counting was used for large flocks (Luo *et al*., 2019). To avoid double-counting, both observers were organized to count the bird species simultaneously and birds that fly over the site quickly (usually taking less than 10 s) were not recorded. Additionally, the counting was not conducted during heavy rains and cloudy days (Khaing *et al*., 2019).

Bird identification was based on different morphological features such as plumage pattern, size, shape, colour and sounds (Hossain and Baki, 2015; Kassahun Abie *et al*., 2019) and using a field guide (Redman *et al*., 2009). The observations were assisted by Nikon binoculars. Photographs and videos were taken to justify the species type for those species which were difficult to identify. The avian species of Chelekleka wetland was listed as per Clements *et al*. (2022) and various literature were used for confirmation of their respective distribution (Ash and Atkins, 2009; Redman *et al*., 2009; Gedeon *et al*., 2022).

## Data analysis

Data were analyzed using R 4.2.1 (R Core Team, 2022). Vegan package was used to determine the diversity measures of avian community in the study area (Oksanen *et al*., 2018). All multivariate analyses were performed using the Vegan package (Oksanen *et al*., 2018; Oksanen, 2021). A comparison of the different avifauna Orders associations relative to each habitat type was performed using multivariate community analyses of Hellinger distances. Hellinger transformation of avian community data was employed to reduce the influence of dominant species in the analysis (Kindt and Coe, 2005). The Hellinger distance was subsequently used to differentiate between habitat types through ordination techniques (using nonmetric multidimensional scaling) (Oksanen *et al*., 2018; Oksanen, 2021). Distances are restricted within the range of zero to one and when the distance is zero, two habitats

are completely similar for every species, whereas, if the distance equals one they are completely dissimilar (they do not share any species) (Kindt and Coe, 2005). Additionally, Euclidean distance based on hierarchical agglomerative clustering was employed to classify avian orders based on their respective species richness. Orders that group together are believed to have similar species richness (Oksanen *et al*., 2018).

Variations in the diversity indices of bird community (abundance, richness, and diversity) were assessed using Chi square-test between the months. One-way ANOSIM using Simpson similarity index was also employed to measure the similarity of species between seasons and habitats.

## RESULTS

### Species composition

A total of 24,653 individuals (Table 1), 246 species, and 62 families belonging to 20 orders were recorded from the Chelekleka wetland (Appendix 1). Among the records, 175, 193, 159 and 148 species were identified during the post rainy, dry, pre rainy and rainy seasons respectively; of which 108 species were common for all seasons (Table 1).

Table 1. Bird community and diversity measures of Chelekleka wetland in different seasons.

| Parameters | Post rainy season | Dry season | Pre rainy season | Rainy season | Total | Common in all seasons |
|---|---|---|---|---|---|---|
| Number of individuals* | 15,299 | 17,523 | 11,595 | 8,562 | 24,653 | 5,130 |
| Species richness | 175 | 193 | 159 | 148 | 246 | 108 |
| Shannon diversity | 3.93 | 3.88 | 3.03 | 3.34 | 4.02 | 3.0 |
| Evenness | 0.76 | 0.74 | 0.60 | 0.67 | 0.73 | 0.64 |

* Significant difference was observed ($p<0.001$)

Order Passeriformes had the highest bird species, 102 species (41.5%), whereas the lowest number of species, one species each (0.4%) was recorded for Order Strigiformes and Suliformes (Fig. 2 and Appendix 1). Out of the total bird species recorded, Family Anatidae had the highest number of species (26 species, 41.5%) whereas; the lowest number of species (2%) belonged to the families: Burhinidae, Jacanidae, Picidae, Oriolidae, Platysteiridae, Zosteropidae, Monarchidae, Macrosphenidae, Phylloscopidae, Pycnonotidae, Turdidae, Glareolidae, Scopidae, Tytonidae, Phalacrocoracidae, Phasianidae and Numididae, which were represented by a single species (Appendix 1).

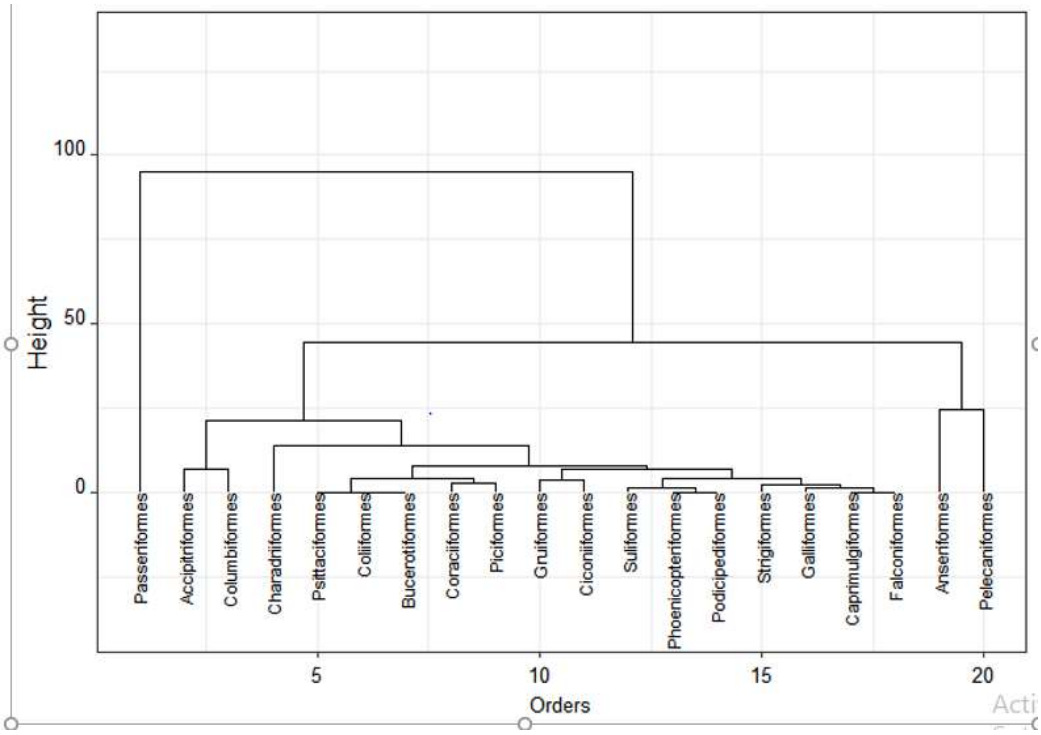


Fig. 2. Dendrogram of the avian orders using Euclidean distance and ggplot2 based on their respective species richness.

In this study two endemic birds, the Yellow-fronted Parrot (*Poicephalus flavifrons*) and Blue-winged Goose (*Cyanochen cyanopterus*) were recorded. Nine species among the identified birds, Erlager's Lark (*Calandrella erlangeri*), Wattled ibis (*Bostrychia carunculata),* White-winged Cliff Chat (*Thamnolaea semirufa*), Blue-breasted Bee-eater (*Merops variegatus*), Banded Barbet (*Lybius undatus*), Black-billed Barbet (*Lybius guifsobalito*), Black-winged lovebird (*Agapornis taranta*), Black-eared Wheatear (*Oenanthe hispanic*), and White-collared Pigeon (*Columba albitorques*) are endemic to Ethiopia and Eritrea (Appendix 1).

About 39% of Chelekleka wetland birds were migratory of which 33 (13.42%) species are Palearctic and/or passage migrants, 5(2.03%) intra and Afro-tropical migrants, 6(2.43%) intra-African migrants, 15(6.08%) partial migrants, and 37 (15.04%) Palearctic and/ or winter visitors. The remaining 61% of bird species were residents (Appendix 1).

## Avian species abundance, richness and distribution

Chelekleka wetland and its periphery farmland, grassland and forest supported different bird species (Fig. 3). The highest number of bird species were recorded in grassland (189 species) and forest (157 species) habitats followed by open water (108 species) habitat. Farmland habitat supported the lowest (99 species) number of birds (37 species) (Fig. 3 and Appendix 2).

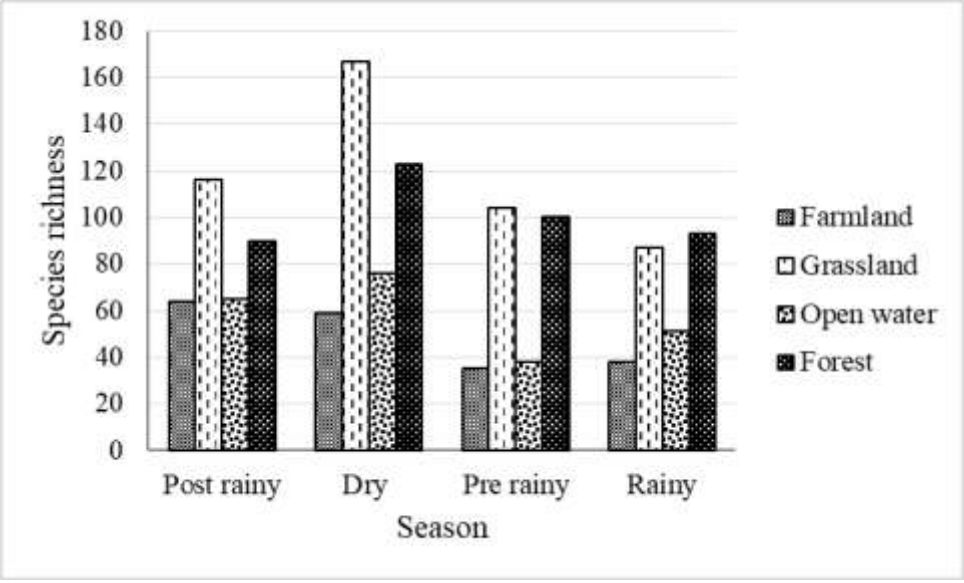


Fig. 3. Richness of avian species among the habitats of Chelekleka wetland in different seasons.

Seasonally, avian abundance showed a significant difference ($\chi^2$ = 3,561.65, df = 3, p<0.001) where the highest individuals were recorded during the dry season (Table 1). However, species richness among the seasons were statistically similar ($\chi^2$ = 6.85, df = 3, p>0.05). There was a significant difference in the monthly abundance ($\chi^2$ = 15484.8, df = 3, p<0.001) and richness ($\chi^2$ = 33.18, df = 3, p<0.001) of the species in the study area. Species abundance (13,378 individuals) and richness (157 species) were highest during February whereas, the lowest species abundance (3,612 individuals) and richness (108 species) were recorded during April and October, respectively (Appendix 3).

## Species diversity and similarity

Seasonally, avian Shannon diversity showed a significant difference where the highest diversity measures were recorded during the post rainy and dry seasons (Fig. 4b). The species were evenly distributed during the post rainy season, whereas the lowest evenness was recorded during pre-rainy season (Fig. 4a). Monthly species diversity of Chelekleka wetland showed that there was no significant difference between the study months ($\chi^2 = 0.96$, df =11, $p>0.05$). Among habitat types, the highest species diversity was recorded in grassland habitat during the dry season ($H' = 3.88$) while the lowest was in the farmland habitat during the pre-rainy season ($H' = 2.36$). Forest ($H' = 3.99$) and grassland ($H' = 3.79$) habitats in the study area supported highest species diversity compared to farmland ($H' = 3.41$) and open water ($H' = 3.6$) habitats (Appendix 2).

A one-way ANOSIM showed that species similarity was significantly different among the seasons ($R = 0.52$, $p<0.05$) and habitats ($R = 0.69$, $p<0.001$). There was a relatively high similarity (79%) of species on both grassland and open water habitats during the study season. The avian orders similarity between habitats (Fig. 5) indicated that highest similarity was observed between grassland and open water habitats whereas the avian community in forest and open water habitats were relatively dissimilar. In addition, overlapping of different orders were investigated in all habitats except in farmlands (Fig. 5).

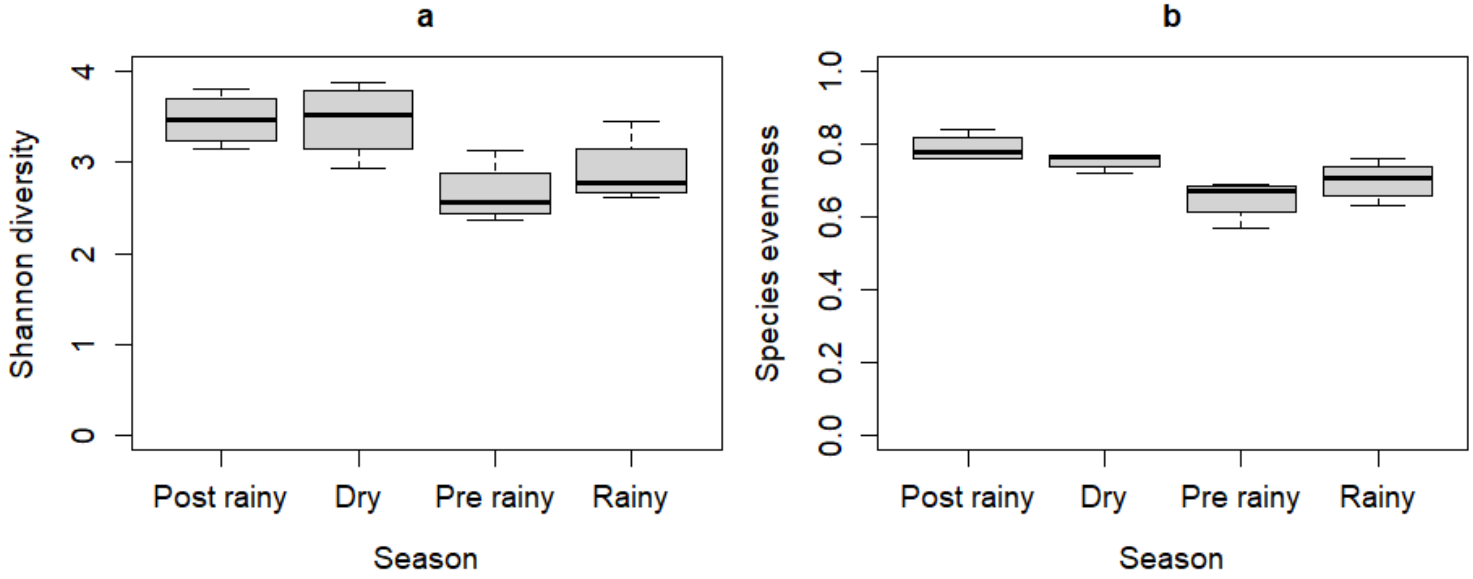


Fig. 4. Seasonal variations in the avian diversity measures (a) species evenness and (b) Shannon diversity at different habitats in Chelekleka wetland. If the boxes of the box plots do not overlap, it suggests a significant difference between the medians of the different groups ($P<0.05$). Conversely, if the boxes of the box plots overlap, it suggests that there is no significant difference between the groups ($P>0.05$).

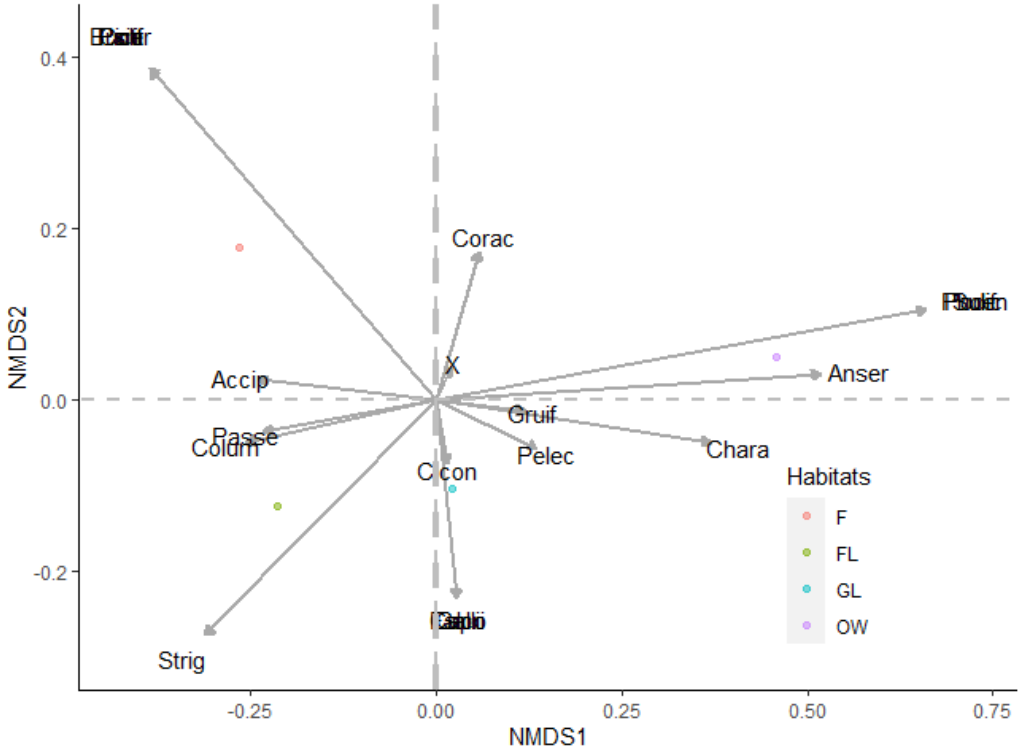


Fig. 5. The dissimilarity of the avian orders based on the species richness along the habitat types using Hellinger distance through non-metric multidimensional scaling (NMDS). The 20 orders (Anser; Pelec; Accip; Colum; Capri; Passe; Phoen; Strig; Gruif; Podic; Cicon; Colii; Bucer; Corac; Chara; Picif; Falco; Psitt and Galli = Galliformes) occurred in four habitats (F = forest; FL = farmland; GL = grassland and OW = open water). Except in FL, the dissimilarity of orders overlapped in their occurrence habitat; (Suli, Phoen and Podic in OW; Colii, Bucer, Psitt and Picif in F; Falco, Capri and Galli in GL).

## DISCUSSION

Chelekleka wetland supports high diversity and composition of bird community. The present study identified 246 bird species in the area. This is by far much greater number of bird species compared to Mengistu Wondafrash (2003) who recorded 74 species and Steiner and Measho Legesse (2018) who identified 37 species in a single day observation in the wetland. Kalkidan Esayas (2017) also recorded 54 species in Chelekleka wetland in a two years survey. The higher number of species record in the present study may be due to a continuous weekly navigation of the study area over a period of one year that gave researchers more time for detection of different species of birds in this ever-changing wetland habitat.

Chelekleka wetland is ecologically important in that it recorded 46% of the 538 birds recorded in the Ethiopian Rift Valley's ecosystem (Lemlem Sisay, 2003; Amare Gibru and Girma Mengesha, 2019). The reason for the existence of these different species of avian fauna in the wetland might be due to the presence of varied habitat types surrounding the wetland and its dynamic ecosystem characteristics with seasonal inundation and drying which may provide a different range of foraging opportunities and nesting and resting sites for birds.

The current study showed that Chelekleka wetland is ecologically important in that two fifth of the recorded bird species are either migrants or visitors. Chelekleka wetland is used as an important stopover site for millions of migratory birds crossing the Sahara Desert (Şekercioğlu *et al*., 2012) for wintering or for passage migrant birds (Weldemariam Tesfahunegny, 2016; Ayalew Demeke *et al*., 2019; Teklay Girmay *et al*., 2020). Chelekleka wetland is also home to, two endemic and nine near endemic bird species shared with Eritrea. This indicated that the area has a unique potential to support Abyssinian endemic species.

Chelekleka wetland recorded high species diversity with high Shannon diversity index, greater than 4, which occurs rarely in ecological studies, indicating that the richness and the evenness of the community are very high (Magurran, 2004 cited in Teklay Girmay *et al*., 2020).

The wetland supported high species diversity during the post-rainy and dry seasons than the pre-rainy and rainy seasons. This variation of species diversity among the seasons might be due to the arrival of migratory and visitor birds at the end of rainy season and their leaving at the end of dry season, when Chelekleka wetland attracts many water birds following the Palaearctic migration during the months from September to February (EWNHS, 2010).

Among the different families, the highest species richness was recorded under Family Anatidae. This might be due to the potential of the wetland to harbour many migratory and resident species of geese and ducks. A variety of ducks and geese are among the recorded wetland birds of Chelekleka wetland by EWNHS (1996) and BirdLife International (2021) as well.

Species richness and abundance in Chelekleka wetland varied throughout the study months. In fact, the highest abundance and species richness were recorded during February, the abundance of bird species can be affected by anthropogenic factors (Girma Mengesha *et al*., 2011; Bewketu Takele and

Bezawork Afework, 2018; Amare Gibru and Girma Mengesha, 2019) and seasonal fluctuation of migrant and resident bird species. Teklay Girmay *et al*. (2020) also reported similar finding in Kafta Sheraro National Park. Arrival of migratory birds and utilization of the wetland as an alternative habitat for the resident birds during the dry season can contribute to such high abundance. April on the other hand, supported the lowest species abundance in Chelekleka wetland. This might be due to the dryness of the wetland during this month that results in the abandonment of almost all the wetland-dependent birds.

Habitat factors can affect species composition, diversity, and abundance of birds. Surrounding Chelekleka wetland, there are grasslands and remnant forest patch habitats that supported a higher number of bird species compared to open water and farmland habitats. These areas were mainly used as foraging, nesting, resting, and roosting sites for many bird species due to the quality and quantity of foraging opportunities and nesting sites (Shimelis Aynalem and Afework Bekele, 2008; Zerihun Girma *et al*., 2017; Ayalew Demeke *et al*., 2019; Teklay Girmay *et al*., 2020). On the other hand, farmlands and open water habitats were highly disturbed and there is a rapid inundation and dryness in these habitats associated with rainfall and intensive irrigation along the fringe of Chelekleka wetland. Farmlands supported the lowest avian diversity among other habitats due to monoculture, high human disturbance and harassment of birds while guarding nearby crops and vegetables. In fact, intensity of disturbance and availability of food (Kalkidan Esayas and Afework Bekele, 2011), habitat size and quality, foraging modes of birds, and floristic composition (Shimelis Aynalem and Afework Bekele, 2008; Bewketu Takele and Bezawork Afework, 2018) are among the key factors influencing the distribution of avian species.

Interestingly, bird species similarity among seasons was low. This might be attributed to the wetland being mostly a stopover sit for migratory birds and the deterioration of the wetland's capacity to sustain those bird species due to the dynamic changes in its land use types. Habitat wise, grassland and open water showed high species similarity that may be due to the local movement of wetland-dependent bird species between foraging and resting sites. In addition, the adjacent occurrence of the two habitat types can lead to sharing of the same species as was reported by Zerihun Girma *et al*. (2017), Yenew Genet and Dessalegn Ejigu (2017) and Ayalew Demeke *et al*. (2019).

Overall, Chelekleka wetland supported high abundance of birds throughout the year. Some fifteen years ago more than 20,000 water birds were recorded seasonally (EWNHS, 1996) and still the wetland supports considerably large aggregations of birds despite the different anthropogenic threats it is facing. Habitat degradation due to different anthropogenic factors such as disturbance, horticulture expansion, intensive irrigation, pollution, residential encroachment, diverting feeder streams flow and channelling Bishoftu town's run off were some of the threats witnessed in the area.

## CONCLUSION

Despite its small size and anthropogenic threats, Chelekleka wetland is a dynamic habitat and an important destination to diversified migratory and resident bird community. The area is also home to Ethiopian endemic bird species as well as several Abyssinian endemic birds. The wetland is also vital for various migratory and resident birds and can be considered a potential wetland for avian tourism. The wetland is surrounded by different land use types that contributes to the high diversity of bird species. The bird composition also showed high abundance of migratory birds emphasizing the significance of the wetland for these birds. However, anthropogenic activities going on in and around the wetland lead to shrinking of the available habitats for birds. Hence, urgent conservation measures are inevitable to conserve the wetland and its inhabitants.

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Appendix 1. Avian community composition from Chelekleka wetland.

| **Order** | **Family** | **Common name** | **Scientific name** |
|---|---|---|---|
| Accipitriformes | Accipitridae | Tawny eagle | *Aquila rapax* |
| | | Wahlberg's Eagle ◄ | *Hieraaetus wahlbergi* |
| | | Steppe Eagle ▄● | *Aquila nipalensis* |
| | | Long crested Eagle | *Lophaetus occipitalis* |
| | | African Fish-Eagle | *Haliaeetus vocifer* |
| | | Augur Buzzard | *Buteo augur* |
| | | Pallid Harrier | *Circus macrourus* |
| | | Eurasian Marsh-Harrier ♠▲ | *Circus aeruginosus* |
| | | Hooded Vulture | *Necrosyrtes monachus* |
| | | White-backed Vulture | *Gyps africanus* |
| | | Eurasian Vulture ♣ | *Gyps fulvus* |
| | | Egyptian Vulture | *Neophron percnopterus* |
| | | Rüppell's Griffon | *Gyps rueppelli* |
| | | Black Kite ♠▲ | *Milvus migrans* |
| | | Scissor-tailed Kite ◄ | *Chelictinia riocourii* |
| | | Yellow billed Kite | *Milvus migrans aegyptius* |
| | | Dark Chanting-Goshawk | *Melierax metabates* |
| | | Eastern Chanting-Goshawk | *Melierax poliopterus* |
| | Cuculidae | Diederik Cuckoo ► | *Chyrysococcyx caprius* |
| Anseriformes | Anatidae | Egyptian Goose | *Alopochen aegyptiaca* |
| | | African Pgymy-Goose | *Nettapus auratus* |
| | | Spur-winged Goose Φ | *Plectropterus gambensis* |
| | | Blue-winged Goose ⸸ | *Cyanochen cyanoptera* |
| | | Fulvous Whistling-Duck Φ | *Dendrocygna bicolor* |
| | | White-faced Whistling-Duck Φ | *Dendrocygna viduata* |
| | | Ruddy Shelduck ♣ | *Tadorna ferruginea* |
| | | White-backed Duck | *Thalassornis leuconotus* |
| | | African Black Duck | *Anas sparsa* |
| | | Ferruginous Duck ▲ | *Aythya nyroca* |
| | | Tufted Duck ♥ | *Aythya fuligula* |
| | | Maccoa Duck, | *Oxyura maccoa* |
| | | Knob-billed Duck▼ | *Sarkidiornis melanotos* |
| | | Hottentot Teal | *Spatula hottentota* |
| | | Cape Teal | *Anas capensis* |
| | | Eurasian Teal♥ | *Anas crecca* |
| | | Northern Shoveler | *Spatula clypeata* |
| | | Southern Pochard | *Netta erythrophthalma* |
| | | Common Pochard | *Aythya farina* |
| | | Northern Pintail♥ | *Anas acuta* |
| | | Garganey♥ | *Spatula querquedula* |
| | | Yellow-billed Duck | *Anas undulata* |
| | | Red-billed Duck | *Anas erythrorhyncha* |
| | | Gadwall ♠ | *Mareca strepera* |
| | | Mallard ▲ | *Anas platyrhynchos* |
| | | Eurasian Wigeon▲ | *Mareca Penelope* |
| Charadriiformes | Charadriidae | Spur-winged Lapwing | *Vanellus spinosus* |
| | | Little Ringed Plover ▄ Δ | *Charadrius dubius* |
| | | Black winged Lapwing | *Vanellus melanopterus* |

| Order | Family | Common name | Scientific name |
|---|---|---|---|
| | | Three-banded Plover | *Charadrius tricollaris* |
| | | Kittlitz's Plover | *Charadrius pecuarius* |
| | | Kentish plover | *Charadrius alexandrines* |
| | Burhinidae | Senegal Thick-knee | *Burhinus senegalensis* |
| | Jacanidae | African Jacana | *Actophilornis africanus* |
| | Laridae | White-winged Tern ■ Δ | *Chlidonias leucopterus* |
| | | Black Tern ♣ | *Chlidonias niger* |
| | | Common Tern ♠▲ | *Sterna hirundo* |
| | | Arctic Tern ♣ | *Sterna paradisaea* |
| | | Gull-billed Tern ▲■ | *Gelochelidon nilotica* |
| | | Grey-headed Gull | *Larus cirrocephalus* |
| | Recurvirostridae | Black-winged Stilt | *Himantopus himantopus* |
| | | Pied Avocet ◄ | *Recurvirostra avosetta* |
| Ciconiiformes | Ciconiidae | Marabou Stork | *Leptoptilos crumenifer* |
| | | White Stork ♠▲ | *Ciconia Ciconia* |
| | | Yellow-billed Stork | *Mycteria ibis* |
| | | Saddle-billed Stork Φ | *Ephippiorhynchus senegalensis* |
| | | Abdim's Stork ► | *Ciconia abdimii* |
| | | African Woolly-necked Stork► | *Ciconia microscelis* |
| Suliformes | Phalacrocoracidae | Long-tailed Cormorant | *Microcarbo africanus* |
| Coliiformes | Coliidae | Blue-naped Mousebird | *Urocolius macrourus* |
| | | Speckled Mousebird | *Colius striatus* |
| Bucerotiformes | Upupidae | Eurasian Hoopoe | *Upupa epops* |
| | Bucerotidae | Hemprich's Hornbill | *Lophoceros hemprichii* |
| Coraciiformes | Alcedinidae | Woodland Kingfisher | *Halcyon senegalensis* |
| | | African Pygmy Kingfisher | *Ispidina picta* |
| | | Grey-headed Kingfisher ■ | *Halcyon leucocephala* |
| | | Pied Kingfisher | *Ceryle rudis* |
| | Meropidae | Northern Carmine bee-eater | *Merops nubicus* |
| | | Blue-breasted Bee-eater ♦ | *Merops variegatus* |
| | | Little Bee-eater | *Merops pusillus* |
| Columbiformes | Columbidae | Ring-necked Dove | *Streptopelia capicola* |
| | | Red-eyed Dove | *Streptopelia semitorquata* |
| | | African Collared Dove | *Streptopelia roseogrisea* |
| | | Mourning Collared Dove | *Streptopelia decipiens* |
| | | Namaqua Dove | *Oena capensis* |
| | | Laughing Dove | *Spilopelia senegalensis* |
| | | Dusky Turtle-Dove | *Streptopelia lugens* |
| | | Speckled Pigeon | *Columba guinea* |
| | | White-collared Pigeon♦ | *Columba albitorques* |
| Piciformes | Lybiidae | Yellow-fronted Tinkerbird | *Pogoniulus chrysoconus* |
| | | Banded Barbet ♦ | *Lybius undatus* |
| | | Black-billed Barbet ♦ | *Lybius guifsobalito* |
| | Picidae | African Gray Woodpecker | *Chloropicus goertae* |
| Falconiformes | Falconidae | Eurasian Kestrel | *Falco tinnunculus* |
| | | Lesser Kestrel ♣▲ | *Falco naumanni* |
| Psittaciformes | Psittaculidae | Black-winged lovebird ♦ | *Agapornis taranta* |
| | Psittacidae | Yellow-fronted parrot ⧫ | *Poicephalus flavifrons* |
| Passeriformes | Oriolidae | Eurasian Golden Oriole ♠ | *Oriolus oriolus* |

| Order | Family | Common name | Scientific name |
|---|---|---|---|
| | Platysteiridae | Gray-headed Batis | *Batis orientalis* |
| | Malaconotidae | Black-crowned Tchagra | *Tchagra senegalus* |
| | | Ethiopian Boubou ● | *Laniarius aethiopicus* |
| | Zosteropidae | Heuglin's White-eye | *Zosterops poliogastrus* |
| | Monarchidae | African paradise-Flycatcher | *Terpsiphone viridis* |
| | Laniidae | Isabelline Shrike ▲ | *Lanius isabellinus* |
| | | Gray-backed Fiscal | *Lanius excubitoroides* |
| | | Northern Fiscal | *Lanius humeralis* |
| | Alaudidae | Singing Bush Lark | *Mirafra cantillans* |
| | | Erlager's Lark ♦ | *Calandrella erlangeri* |
| | | Chestnut-headed Sparrow-Lark Φ | *Eremopterix signatus* |
| | | Thekla's Lark | *Galerida theklae* |
| | Macrosphenidae | Red-faced Crombec | *Sylvietta whytii* |
| | Cisticolidae | Buff-billed Warbler | *Phyllolais pulchella* |
| | | Green-backed camaroptera | *Camaroptera brachyura* |
| | | Tawny-flanked Prinia | *Prinia subflava* |
| | | Pale Prinia | *Prinia somalica* |
| | | Red-fronted Prinia/Warbler | *Prinia rufifrons* |
| | | Stout Cisticola | *Cisticola robustus* |
| | | Rattling Cisticola | *Cisticola chiniana* |
| | | Boran Cisticola | *Cisticola bodessa* |
| | Acrocephalidae | Marsh Warbler | *Acrocephalus palustris* |
| | | Common Reed Warbler ♠ | *Acrocephalus scirpaceus* |
| | Phylloscopidae | Willow Warbler ♠ | *Phylloscopus trochilus* |
| | Hirundinidae | Plain Martin | *Riparia paludicola* |
| | | Common House Martin | *Delichon urbicum* |
| | | Bank Swallow♠▲ | *Riparia riparia* |
| | | Mosque Swallow | *Cecropis senegalensis* |
| | | Barn Swallow ♥ | *Hirundo rustica* |
| | Leiothrichidae | Brown Babbler | *Turdoides plebejus* |
| | | Rufous Chatterer | *Argya rubiginosa* |
| | Pycnonotidae | Common Bulbul | *Pycnonotus barbatus* |
| | Buphagidae | Red-billed Oxpecker | *Buphagus erythrorynchus* |
| | | Yellow-billed Oxpecker | *Buphagus africanus* |
| | Sturnidae | Wattled Starling | *Creatophora cinerea* |
| | | Greater Blue-eared Starling | *Lamprotornis chalybaeus* |
| | | Lesser Blue-eared Starling Φ | *Lamprotornis chloropterus* |
| | | Rüppell's Starling | *Lamprotornis purpuroptera* |
| | Turdidae | African Thrush | *Turdus pelios* |
| | Muscicapidae | African Dusky Flycatcher | *Muscicapa adusta* |
| | | Rufous-tailed Rock Thrush | *Monticola saxatilis* |
| | | Ruppell's Robin Chat | *Cossypha semirufa* |
| | | Common Redstart ♣▲ | *Phoenicurus phoenicurus* |
| | | Siberian Stonechat ▲ | *Saxicola maurus* |
| | | White-winged Cliff Chat ♦ | *Thamnolaea semirufa* |
| | | Brown-tailed Chat | *Oenanthe scotocerca* |
| | | Whinchat ♠▲ | *Saxicola rubetra* |
| | | Familiar Chat | *Oenanthe familiaris* |

| Order | Family | Common name | Scientific name |
|---|---|---|---|
| | | Mocking Cliff Chat | *Thamnolaea cinnamomeiventris* |
| | | Pied Wheatear ■ Δ | *Oenanthe pleschanka* |
| | | Northern Wheatear ■ Δ | *Oenanthe Oenanthe* |
| | | Cyprus Wheatear | *Oenanthe cypriaca* |
| | | Western Black-eared Wheatear ♦ | *Oenanthe hispanica* |
| | | Isabelline Wheatear ■ Δ | *Oenanthe isabelline* |
| | Nectariniidae | Hunter's Sunbird | *Chalcomitra hunter* |
| | | Scarlet-chested Sunbird | *Chalcomitra senegalensis* |
| | | Tacazze Sunbird | *Nectarinia tacazze* |
| | | Beautiful Sunbird | *Cinnyris pulchellus* |
| | | variable Sunbird | *Cinnyris venustus* |
| | | Collared Sunbird | *Hedydipna collaris* |
| | Ploceidae | White-browed Sparrow-weaver | *Plocepasser mahali* |
| | | Vitelline Masked Weaver | *Ploceus vitellinus* |
| | | Village Weaver | *Ploceus cucullatus* |
| | | Little Weaver | *Ploceus luteolus* |
| | | Chestnut Weaver Φ | *Ploceus rubiginosus* |
| | | Baglaficht Weaver | *Ploceus baglafecht* |
| | | Red-billed Quelea | *Quelea quelea* |
| | | Northern Red Bishop | *Euplectes franciscanus* |
| | | Yellow Crowned Bishop Φ | *Euplectes afer* |
| | | Black-winged Bishop | *Euplectes hordeaceus* |
| | | Yellow-mantled Widowbird | *Euplectes macroura* |
| | | Fan-tailed Widowbird | *Euplectes axillaris* |
| | Estrildidae | Red-cheeked Cordonbleu | *Uraeginthus bengalus* |
| | | Red-billed Firefinch | *Lagonosticta senegala* |
| | | Cut-throat | *Amadina fasciata* |
| | | Quailfinch | *Ortygospiza atricollis* |
| | | Bronze Mannikin | *Spermestes cucullate* |
| | Viduidae | Straw-tailed Waydah | *Vidua fischeri* |
| | | Pin-tailed Waydah | *Vidua macroura* |
| | | Village Indigobird | *Vidua chalybeate* |
| | Passeridae | Swainson's Sparrow ≈ | *Passer swainsonii* |
| | | Chestnut Sparrow | *Passer eminibey* |
| | Motacillidae | White Wagtail ▲ | *Motacilla alba* |
| | | Western Yellow Wagtail ♣ | *Motacilla flava* |
| | | African Pipit | *Anthus cinnamomeus* |
| | | Tree Pipit ♣▲ | *Anthus trivialis* |
| | | Red-throated Pipit ♣▲ | *Anthus cervinus* |
| | | Plain-backed Pipit | *Anthus leucophrys* |
| | Fringillidae | Yellow-fronted Canary | *Crithagra mozambica* |
| | | Northern Grosbeak Canary | *Crithagra donaldsoni* |
| | | Yellow-crowned Canary | *Serinus flavivertex* |
| | | African Citril | *Crithagra citrinelloides* |
| | | Southern Citril | *Crithagra hyposticta* |
| | | White-rumped Seedeater ≈ | *Crithagra leucopygia* |
| | | Streaky Seedeater | *Crithagra striolata* |
| | | Richenow's Seedeater | *Crithagra reichenowi* |

| Order | Family | Common name | Scientific name |
|---|---|---|---|
| | Corvidae | Pied Crow | *Corvus albus* |
| | | Brown-necked Raven ♦ | *Corvus ruficollis* |
| | | Pan-tailed Raven | *Corvus rhipidurus* |
| | Emberizidae | Cinmamon-breasted Bunting | *Emberiza tahapisi* |
| | | Ortolan Bunting | *Emberiza hortulana* |
| Pelecaniformes | Areidae | Little Bittern► | *Ixobrychus minutus* |
| | | Gray Heron Δ | *Ardea cinerea* |
| | | Black Heron | *Egretta ardesiaca* |
| | | Black-headed Heron | *Ardea melanocephala* |
| | | Squacco Heron ♣ | *Ardeola ralloides* |
| | | Black-crowned Night Heron | *Nycticorax nycticorax* |
| | | Little Egret ■ | *Egretta garzetta* |
| | | Great Egret | *Ardea alba* |
| | | Cattle Egret ► | *Bubulcus ibis* |
| | | Intermediate Egret | *Ardea intermedia* |
| | Scolopacidae | Black tailed Godwit | *Limosa limosa* |
| | | Common Sandpiper ♠▲ | *Actitis hypoleucos* |
| | | Marsh Sandpiper | *Tringa stagnatilis* |
| | | Wood Sandpiper ♠▲ | *Tringa glareola* |
| | | Terek Sandpiper | *Xenus cinereus* |
| | | Dunlin | *Calidris alpina* |
| | | Little Stint ♠▲ | *Calidris minuta* |
| | | Ruff ♠▲ | *Calidris pugnax* |
| | | Sanderling ♠▲ | *Calidris alba* |
| | | Temminck's Stint ▲ | *Calidris temminckii* |
| | | Common Snipe▲ | *Gallinago gallinago* |
| | | African Snipe Φ | *Gallinago nigripennis* |
| | | Common Redshank | *Tringa tetanus* |
| | | Spotted Redshank | *Tringa erythropus* |
| | Glareolidae | Collared Pratincole | *Glareola pratincole* |
| | Pelecanidae | Great White Pelican ► | *Pelecanus onocrotalus* |
| | | Pink-backed Pelican | *Pelecanus rufescens* |
| | Scopidae | Hamerkop Φ | *Scopus umbrette* |
| | Threskiornithidae | Hadada Ibis | *Bostrychia hagedash* |
| | | African Sacred Ibis | *Threskiornis aethiopicus* |
| | | Wattled Ibis ♦ | *Bostrychia carunculata* |
| | | Glossy Ibis | *Plegadis falcinellus* |
| | | African Spoonbill | *Platalea alba* |
| | | Eurasian Spoonbill ▲ | *Platalea leucorodia* |
| Phoenicopteriformes | Phoenicopteridae | Greater Flamingo Φ | *Phoenicopterus roseus* |
| | | Lesser Flamingo Φ | *Phoeniconaias minor* |
| Strigiformes | Tytonidae | African Grass Owl | *Tyto capensis* |
| Gruiformes | Gruidae | Common Crane ▲ | *Grus grus* |
| | | Black-crowned-Crane | *Balearica pavonine* |
| | Rallidae | Red-knobbed Coot | *Fulica cristata* |
| | | Lesser Moorhen | *Paragallinula angulata* |
| | | Eurasian Moorhen | *Gallinula chloropus* |
| | | Allen's Gallinule | *Porphyrio alleni* |
| Podicipediformes | Podicipedidae | Little Grebe | *Tachybaptus ruficollis* |

| Order | Family | Common name | Scientific name |
|---|---|---|---|
| | | Great Crested Grebe | *Podiceps cristatus* |
| Galliformes | Numididae | Helmeted Guineafowl | *Numida meleagris* |
| | Phasianidae | Crested Francolin | *Ortygornis sephaena* |
| Caprimulgiformes | Apodidae | Common Swift ♠ | *Apus apus* |
| | | White-rumped Swift | *Apus caffer* |

(Φ resident with local movement, ♠ Palearctic passage migrant, ♣ Palearctic migrant, ♥ Palearctic visitor, ▲ Palearctic winter visitor, Δ winter visitor, ▄ Passage Migrant, ► Intra-African Migrant, ◄ Intra-Tropical Migrant, ▼ Afro-Tropical Migrant, ● Near Endemic, ⸸ Endemic, ♦ Endemic to Eritrea and Ethiopia, ≈ Near Endemic to Horn of Africa, and unmarked species are common resident birds

Appendix 2. Seasonal and per habitat avian diversity measures of Chelekleka wetland; F = Forest; FL = Farmland; GL = Grassland and OW = Open water habitats.

| Season | Habitat | Abundance | Species richness | Shannon-Wiener diversity | Evenness |
|---|---|---|---|---|---|
| Post rainy | FL | 2592 | 64 | 3.14 | 0.76 |
| | GL | 7369 | 116 | 3.61 | 0.57 |
| | OW | 8068 | 65 | 3.34 | 0.63 |
| | F | 2322 | 90 | 3.80 | 0.76 |
| Dry | FL | 1970 | 59 | 2.94 | 0.76 |
| | GL | 12454 | 167 | 3.88 | 0.66 |
| | OW | 10045 | 76 | 3.34 | 0.72 |
| | F | 3463 | 123 | 3.71 | 0.72 |
| Pre rainy | FL | 1548 | 35 | 2.36 | 0.80 |
| | GL | 6911 | 104 | 2.62 | 0.69 |
| | OW | 2910 | 38 | 2.51 | 0.69 |
| | F | 2598 | 100 | 3.13 | 0.77 |
| Rainy | FL | 1089 | 38 | 2.61 | 0.84 |
| | GL | 4544 | 87 | 2.83 | 0.68 |
| | OW | 3174 | 51 | 2.71 | 0.76 |
| | F | 2420 | 93 | 3.45 | 0.77 |
| Overall | FL | 3931 | 99 | 3.41 | 0.74 |
| | GL | 14546 | 189 | 3.79 | 0.72 |
| | OW | 13695 | 108 | 3.6 | 0.77 |
| | F | 4905 | 157 | 3.99 | 0.79 |

Appendix 3. Species abundance, richness and diversity of birds in different months.

| Months | Abundance | Mean Abundance (± SD) | Species richness | Shannon diversity |
|---|---|---|---|---|
| January | 12388 | 50 (181) | 144 | 3.63 |
| February | 13378 | 55 (198) | 157 | 3.6 |
| March | 9142 | 37 (114) | 155 | 3.79 |
| April | 3612 | 15 (75) | 120 | 3.25 |
| May | 7904 | 32 (177) | 114 | 2.79 |
| June | 8688 | 34 (268) | 121 | 2.59 |
| July | 6239 | 24 (169) | 115 | 2.87 |
| August | 4503 | 18 (74) | 111 | 3.44 |
| September | 3766 | 15 (45) | 109 | 3.89 |
| October | 6777 | 28 (177) | 108 | 3.01 |
| November | 11937 | 49 (171) | 151 | 3.82 |
| December | 11148 | 45 (149) | 149 | 3.88 |
| P-value | <0.001 | | <0.001 | 0.99 |