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THE ORNITHOLOGICAL VALUE OF THE URBAN WETLAND CHOTT EL OUED (NORTH-EASTERN ALGERIAN SAHARA)

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Abstract. Aquatic ecosystems in hot arid environments can support a high level of biodiversity worldwide, particularly birds. This study focused on the evaluation of the ecological importance of the urban wetland Chott El Oued in north-eastern Algerian Sahara as a critical habitat for bird communities. Bi-monthly monitoring was conducted between September 2023 and August 2024 to assess avian community composition, phenological patterns, protection statutes, and populations dynamic of waterbirds. A total of 71 bird species (39 waterbirds and 32 terrestrial birds) were documented in our study area, belonging to 15 orders and 29 families. Four Near Threatened species (IUCN Red List) and 21 protected species under Algerian law were identified. Among the 12460 recorded individuals, waterbirds dominated (77.28%, 9926 individuals), with 11 key species such as the Near Threatened, resident-breeding Marbled Duck. Phenologically, 17 are breeding species, whereas 54 are non-breeding with 38 being passage visitors and 16 winterers. These findings highlight the contribution of Chott El Oued in maintaining the regional biodiversity despite ecological and anthropogenic challenges and consolidating the urgent need for comprehensive conservation strategies to protect its biodiversity. Safeguarding this vital urban wetland is essential not only for sustaining endangered species but also for maintaining regional and global ecological balance.

INTRODUCTION

Wetlands are highly productive ecosystems that provide ecosystem services and essential ecological functions critical to sustaining biodiversity worldwide (Alikhani et al. 2021; Green and Elmberg 2014; Perennou et al. 2020). In addition, wetlands provide essential ecological services to benefit human populations, including water supply and purification, erosion control, recreational activities (Boyer and Polasky 2004; Crosby et al. 2024; Das and Basu 2020; Quin et al. 2015; Verhoeven et al. 2006), and habitat for wildlife, with particular emphasis on maintaining waterbird species (Bezzalla et al. 2025). The assessment of their ecosystem services is mainly influenced by their size. The total value of their services increases proportionally with their surface area, as well as other factors such as their types and their socio-economic context (Zhou et al. 2020). Wetlands are widely recognized as significant biodiversity hotspots (Bennett and Mulongoy 2006). Despite their ecological value (Bassi et al. 2014), they are classified as one of the most endangered ecosystems on the planet due to their inherent environmental vulnerability (Zhou et al. 2020). Their distinctive diversity stems from differences in origin, geographic location, water chemistry, species composition and soil properties, which collectively create complex and dynamic habitats (Finlayson and Davidson 1999).

Although regional factors contributing to wetland loss

and degradation vary considerably across regions, agricultural expansion and urban growth are universally recognized as the primary direct causes worldwide (Asselen et al. 2013). In fact, the surrounding urban growth has threatened wetlands and has posed numerous issues, including direct habitat loss, altered water regimes, wastewater contamination, and biodiversity decline (Ramsar Convention Secretariat 2004). However, the presence and creation of lakes and wetlands in urban environments are critical for biodiversity conservation as urban areas continue to expand and natural wetlands decline (Zedler 2000).

As the largest country in North Africa, Algeria hosts a bioclimatic gradient from the Mediterranean coastline to hyper-arid Saharan zones, characterized by longitudinal and latitudinal rainfall gradients (increasing from west to east and decreasing from north to south, respectively) (Bouaoune and Dahmani-Megrerouche 2010; Chenchouni et al. 2025) fostering a mosaic of ecosystems sustaining rich biodiversity (Samraoui and Samraoui 2008). Among these ecosystems, natural and artificial wetlands play a pivotal role as critical staging and wintering grounds for migratory birds travelling from the Palearctic to Sub-Saharan Africa (Isenmann and Molaï 2000; Samraoui et al. 2011).

Previous studies conducted on many wetlands in north-eastern Algerian Sahara have shown that these scarce water resources act as crucial stopover sites for migratory and threatened bird species despite extreme environmental conditions, offering abundant food resources, wintering refuges, expanding range sites and critical breeding grounds for avian species, particularly waterbirds traversing transcontinental flyways (Laabed et al. 2021; Khirani-Betrouche and Moulaï 2021, 2022; Chedad 2021a; Chedad et al. 2020; Chedad et al. 2021b, 2021c, 2022, 2023a, 2023b; Bouzid et al. 2023a, 2023b; Adamou et al. 2023; Gueddoul et al. 2024). Nevertheless, several wetlands along the southern Mediterranean border in North Africa, particularly those in inland regions including Chott El Oued in the northeast of the Algerian Sahara, have been poorly studied, and insufficient data exists to characterize these ecosystems comprehensively (Hamza and Selmi 2018). Notably, our study area remains entirely unexamined, with no prior research addressing its ornithological potential.

This article underscores the critical role of Chott El Oued, an urban wetland, as a vital habitat for birds. Based on bi-monthly monitoring conducted over an annual cycle, we provide the first comprehensive assessment of this ecosystem capacity to sustain avian biodiversity, especially waterbirds by analyzing bird community composition and focusing on waterbirds diversity, population dynamic and structure, as well as by establishing their phenological statuses and identifying the protection status of the inventoried species based on national and international treaties and laws.

MATERIALS AND METHODS

Study area

The present study was carried out throughout the annual cycle from September 2023 to August 2024. We collected data and studied the diversity of avian species in the Chott El Oued wetland in El Oued province located in the north-eastern Sahara of Algeria (Figure 1), which is characterized by a Saharan climate with dry summers and mild winters (Khezzani et al. 2022). The study site is an unprotected natural permanent wetland situated adjacent to an urban area in central El Oued province (33°23'3.24"N, 6°51'39.51"E) and extends across 46 hectares. The wetland maintains its consistent water presence through rising groundwater and wastewater inflow (Diaf et al. 2024). However, the water levels in this wetland vary seasonally, rising in winter and declining in summer. In addition, the Chott El Oued wetland is characterized by an interconnected mosaic of habitats, including reed beds surrounding the perimeter and flooded zones and abundant vegetation such as halophytes (*Tamarix gallica* trees*, Halocnemum strobilaceum, Zygophyllum album*, and *Phragmites australis*). A paved road divides the region, fragmenting its area, as landfilling operations on both sides encroach upon the wetland. These operations involve the dumping of human-generated waste, including construction debris and other solid materials.

Bird data collection and statistical analysis

The present study employed a comprehensive birds dataset assembled from bi-monthly censuses conducted during the annual cycle from September 2023 to August 2024. The diversity of avian species in the Chott El Oued wetland was investigated across both migratory and non-migratory periods. The observed bird species were categorized into two groups: waterbirds and landbirds. We employed an exhaustive counts method for flocks under 200 individuals and visual estimation for larger or distant groups for monitoring waterbird populations. On the other hand, we used the point count method with unlimited distance (Echantillonage frequential progressif) with documenting the presence/absence of species recorded at dawn throughout transect lines for landbirds survey (Blondel 1975; Blondel et al. 1981). We identified species by using binoculars (10 × 50), a spotting scope (20 × 60), and a Nikon P1000 camera (125× optical zoom). Identifications were supported by using the ornithological guide (Svensson 2010).

A checklist of documented bird species was compiled, including orders, families, scientific names, common

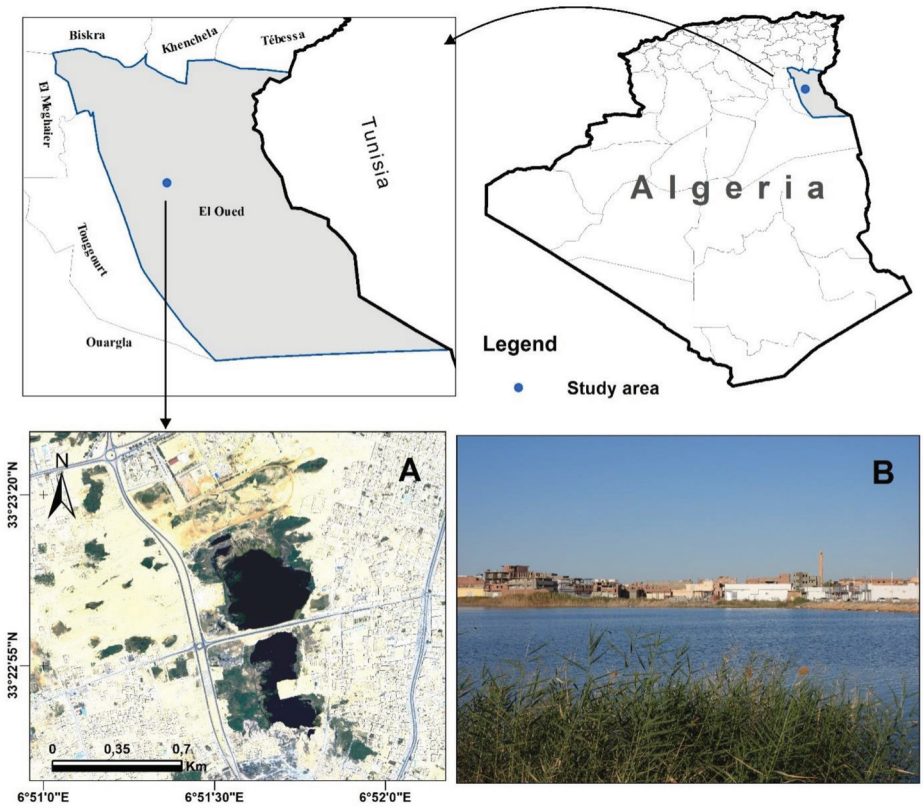

Figure 1. Geographic location of the study area in El Oued province, north-eastern Algerian Sahara: location (A) and view (B) of urban wetland Chott El Oued.

names, monthly distribution, protection and phenological status. Bird species were classified following the taxonomic orders defined by the IOC World Bird List, ensuring conformity with the most current nomenclatural and taxonomic revisions (Gill et al. 2025). Species were classified in six categories based on their phenological status (Chedad et al. 2023a).

The protection status of bird species was guided by two frameworks: National Regulations: Executive Fiat 12–235 (24 May 2012), which identifies protected non-domestic animal species, and Ordinance n° 06–05 (15 July 2006), focused on safeguarding critically endangered animals, and International Standards using the IUCN Red List criteria to assess global conservation status for species (IUCN 2025).

The frequency of occurrence was derived for each species obtained by dividing the number of censuses containing the species by the total number of censuses realized (two censuses/month). Birds frequency was classified into five categories according to Muller (1985): (1) omnipresent (OM), Occ = 100%, (2) constant (CN), 75% ≤ Occ < 100%, (3) regular (RE), 50% ≤ Occ < 75%, (4) accessory (AC), 25% ≤ Occ < 50%, and (5) rare (RA) having an occurrence less than 25%.

The R software was used in statistical analysis (R Core Team 2025). The vegan package was used for computing diversity indices such as monthly specific richness, Shannon-Wiener, evenness, Simpson and Margalef. For visualizing datasets, ggplot2 and ggstream packages were used for creating graphs and charts.

RESULTS

Avian community composition and Diversity

During the study period, a total of 71 bird species belonging to 15 orders and 29 families were documented in our study area (Table 1). The avian community was dominated by Passeriformes, representing 22 species across 10 families, followed by Charadriiformes with 20 species from 5 families. Other notable orders included Pelecaniformes and Anseriformes, with eight and six species, respectively, which contributed significantly to species diversity (Figure 2A).

Among the documented species, 32 landbird species were identified and distributed across 8 orders and 17 families, with Passeriformes comprising the majority (68.8%) of all landbirds (Figure 2B). On the other hand, 39 waterbird species (54.92%) were recorded, belonging to 7 orders and 12 families. Charadriiformes (shorebirds) dominated the waterbird community with five families, representing 51.3%, followed by Pelecaniformes (gulls) and Anseriformes (ducks) with one family each, representing 20.5% and 15.4%, respectively (Figure 2C).

Protection status of bird species

Among recorded bird species, our study area offered a crucial habitat and a refuge for four Near Threatened species (Ferruginous Duck *Aythya nyroca*, Curlew Sandpiper *Calidris ferruginea,* and Woodchat Shrike *Lanius senator*) and an essential breeding habitat for the Marbled Duck *Marmaronetta angustirostris*. 94.36% of species are Least Concern according to the IUCN Red List (IUCN 2025). Notably, 10 successfully breeding pairs with chicks ranging from 10 to 14 chicks/pair were documented during April, May and June (Figure 3). In addition, 21 species (29.51%) have been given protection status according to the Algerian Executive Fiat 12–235 of 24 May 2012, establishing the list of protected non-domestic animal species.

Phenological status

We documented 17 breeding species (nine waterbirds and eight landbirds), of which 14 are resident breeders,

Table 1. Checklist of birds in Chott El Oued, north-eastern Algerian Sahara, from September 2023 to August 2024.

Order-Family		Monthly distribution												Eco.	RA	Nat.	UICN.	Ph. St	Occ
Scientific name	Common name	S	O	N	D	J	F	M	A	M	J	J	A	Cat	(%)	St	St		
Accipitriformes – Acciptiridae																			
Circus aeruginosus	Western Marsh Harrier	■	■	■	■	■	■	■	■	■	■			L		√	LC	RB	CN
Hieraaetus pennatus	Booted Eagle									■				L		√	LC	PV	RE
Anseriformes – Anatidae																			
Marmaronetta angustirostris	Marbled Duck	■	■	■	■	■	■	■	■	■	■	■	■	W	14.4	√	NT	RB	OM
Spatula clypeata	Northern Shoveler		■	■	■	■	■	■	■					W	4.93		LC	W	RE
Anas platyrhynchos	Mallard		■			■	■	■	■	■	■			W	0.76		LC	W	AC
Marecastrepera	Gadwall					■	■	■						W	0.12		LC	PV	RA
Tadorna ferruginea	Ruddy Shelduck							■	■	■	■			W	0.23	√	LC	RB	AC
Aythya nyroca	Ferruginous Duck									■	■			W	0.06	√	NT	PV	RA
Apodiformes – Apodidae																			
Apus apus	Common Swift									■				L			LC	PV	RA
Bucerotiformes – Upupidae																			
Upupa epops	Eurasian Hoopoe								■					L		√	LC	PV	RA
Caprimulgiformes – Caprimulgidae																			
Caprimulgus aegyptius	Egyptian Nightjar	■											■	L		√	LC	PV	RA
Charadriiformes – Charadriidae																			
Anarhynchus alexandrinus	Kentish Plover	■	■	■	■	■	■	■	■	■	■	■	■	W	11,3		LC	RB	OM
Charadrius hiaticula	Common Ringed Plover	■	■	■						■				W	0.22		LC	W	AC
Charadrius dubius	Little Ringed Plover				■	■	■	■	■	■	■	■	■	W	0.87		LC	MB	RE
Charadriiformes – Glareolidae																			
Glareola pratincola	Collared Pratincole								■	■				W	0.06		LC	PV	RA
Charadriiformes – Laridae																			
Chroicocephalus ridibundus	Black-headed Gull			■										W	0.01		LC	PV	RA
Chroicocephalus genei	Slender-billed Gull						■							W	0.01		LC	PV	RA
Chlidonias hybrida	Whiskered Tern								■	■			■	W	0.16		LC	PV	AC
Chlidonias niger	Black Tern									■				W	0.03		LC	PV	RA
Charadriiformes – Recurvirostridae																			
Himantopus himantopus	Black-winged Stilt	■	■	■	■	■	■	■	■	■	■	■	■	W	26.1	√	LC	RB	OM
Charadriiformes – Scolopacidae																			
Calidris minuta	Little Stint	■	■	■	■	■	■	■		■			■	W	3.67		LC	W	RE
Calidris pugnax	Ruff	■	■	■	■	■	■	■	■	■			■	W	1.65		LC	W	RE
Tringa ochropus	Green Sandpiper				■	■		■	■	■				W	0.24		LC	W	AC
Tringa glareola	Wood Sandpiper				■	■	■	■	■	■		■	■	W	0.57		LC	W	RE
Gallinago gallinago	Common Snipe					■		■	■					W	0.04		LC	W	RA
Actitis hypoleucos	Common Sandpiper							■	■	■		■	■	W	0.32		LC	W	AC
Lymnocryptes minimus	Jack Snipe								■					W	0.03		LC	W	RA
Calidris ferruginea	Curlew Sandpiper								■				■	W	0.07	√	NT	PV	RA
Arenaria interpres	Ruddy Turnstone									■	■			W	0.04		LC	PV	RA
Tringa erythropus	Spotted Redshank									■	■			W	0.03		LC	PV	RA
Tringa nebularia	Common Greenshank												■	W	0.05		LC	PV	RA
Ciconiiformes – Ciconiidae																			
Ciconia ciconia	White Stork								■				■	W	0.07	√	LC	PV	RA
Columbiformes – Columbidae																			
Columba livia	Rock Pigeon	■	■	■	■	■	■	■	■	■	■	■	■	L			LC	RB	OM
Streptopelia decaocto	Eurasian Collared-Dove	■	■	■	■	■	■	■		■	■	■	■	L			LC	RB	RE

Order-Family		Monthly distribution												Eco. Cat	RA (%)	Nat. St	UICN. St	Ph. St	Occ
Scientific name	Common name	S	O	N	D	J	F	M	A	M	J	J	A						
Coraciiformes – Meropidae																			
Merops persicus	Blue-cheeked Bee-eater	■							■	■	■			L		√	LC	PV	AC
Merops apiaster	European Bee-eater								■					L		√	LC	PV	RA
Falconiformes – Falconidae																			
Falco tinnunculus	Eurasian Kestrel	■	■					■	■	■	■	■		L		√	LC	RB	AC
Gruiformes – Rallidae																			
Fulica atra	Eurasian Coot	■	■	■	■	■	■	■	■	■	■	■	■	W	7.39		LC	RB	CN
Gallinula chloropus	Common Moorhen	■	■	■	■	■	■	■	■	■	■	■	■	W	7		LC	RB	OM
Passeriformes – Acrocephalidae																			
Acrocephalus scirpaceus	Common Reed Warbler					■	■	■	■	■	■	■	■	L			LC	MB	RE
Acrocephalus schoenobaenus	Sedge Warbler								■					L			LC	PV	RA
Passeriformes – Cisticolidae																			
Cisticola juncidis	Zitting Cisticola	■	■	■	■	■	■	■	■	■	■	■	■	L			LC	RB	OM
Passeriformes – Emberizidae																			
Emberiza schoeniclus	Reed Bunting					■	■							L			LC	W	RA
Passeriformes – Hirundinidae																			
Hirundo rustica	Barn Swallow	■	■					■	■	■	■			L			LC	PV	AC
Riparia riparia	Bank Swallow							■	■	■	■			L			LC	PV	AC
Passeriformes – Laniidae																			
Laniusexcubitor	Great Gray Shrike	■	■	■	■	■	■	■	■	■	■	■	■	L			LC	RB	CN
Lanius senator	Woodchat Shrike								■	■				L		√	NT	PV	RA
Passeriformes – Leiothrichidae																			
Argya fulva	Fulvous Chatterer						■	■	■	■	■	■		L			LC	RB	AC
Passeriformes – Motacillidae																			
Motacilla flava	Western Yellow Wagtail	■						■	■	■	■			L			LC	PV	AC
Motacilla alba	White Wagtail			■	■	■	■	■	■					L			LC	W	RE
Anthus spinoletta	Water Pipit							■						L			LC	PV	RA
Anthus pratensis	Meadow Pipit								■					L			LC	PV	RA
Anthuscervinus	Red-throated Pipit								■					L			LC	PV	RA
Anthus trivialis	Tree Pipit								■					L			LC	PV	RA
Passeriformes – Muscicapidae																			
Cercotrichas galactotes	Rufous-tailed Scrub-Robin									■				L			LC	PV	RA
Oenanthe oenanthe	Northern Wheatear		■						■					L			LC	PV	RA
Saxicola rubicola	European Stonechat						■							L			LC	PV	RA
Saxicola rubetra	Whinchat								■	■				L			LC	PV	RA
Passeriformes – Phylloscopidae																			
Phylloscopus collybita	Common Chiffchaff				■	■	■	■	■	■				L			LC	W	AC
Phylloscopus sibilatrix	Wood Warbler								■					L			LC	PV	RA
Passeriformes – Sylviidae																			
Curruca melanocephala	Sardinian Warbler	■	■	■	■	■	■	■	■					L			LC	W	RE
Pelecaniformes – Ardeidae																			
Egretta garzetta	Little Egret	■	■	■	■	■	■	■	■	■	■	■	■	W	2.81	√	LC	OB	OM
Ardea cinerea	Gray Heron		■					■					■	W	0.18	√	LC	PV	RA
Ardea ibis	Western Cattle Egret					■	■	■						W	1.82	√	LC	PV	RA
Nycticorax nycticorax	Black-crowned Night Heron								■	■	■			W	0.61	√	LC	PV	AC
Ardeola ralloides	Squacco Heron								■	■	■	■	■	W	0.38	√	LC	PV	AC
Ardea purpurea	Purple Heron								■	■				W	0.19		LC	PV	RA
Botaurus minutus	Little Bittern									■	■		■	W	0.03		LC	PV	RA
Pelecaniformes –Threskiornithidae																			
Plegadis falcinellus	Glossy Ibis					■	■	■	■	■	■			W	0.11	√	LC	W	AC
Phoenicopteriformes – Phoenicopteridae																			
Phoenicopterus roseus	Greater Flamingo	■	■	■	■	■	■	■	■	■	■	■	■	W	0.79	√	LC	W	CN
Podicipediformes – Podicipedidae																			
Tachybaptus ruficollis	Little Grebe	■	■	■	■	■	■	■	■	■	■	■	■	W	12.6		LC	RB	OM

Eco.Cat: ecology categories (W: waterbirds, L: landbirds); RA%: relative abundance; Nat.St: national status (√: protected); IUCN status (LC: Least Concern; NT: Near Threatened); Ph. St: phenological status (W: winterer, RB: resident breeder, MB: breeding migrant, OC: occasional breeder, PV: passage visitor); Occ: occurrence frequency category (OM: omnipresent, CN: constant, RE: regular, AC: accessory, RA: rare).

two are migratory breeders and one is a casual breeder. The non-breeding birds (54 species) are composed of 38 passage visitors and 16 wintering species (dominated by waterbirds with 12 species).

Waterbirds species composition and diversity indices

Species richness

The monthly species richness data analysis indicates clear seasonal patterns in waterbird diversity, underscoring vital periods of ecological importance (Figure 4). Throughout the study period, species richness exhibited significant fluctuations among months, ranging from 10 to 25 species, with notable peaks in late summer (August, 19 species) and mid-winter (January, 19 species) and the highest species richness in spring (April, 25 species). Conversely, a sharp decline in richness was observed from June to July.

Relative abundance and frequency of occurrence

During the study period, a total of 12460 individuals of birds were recorded. Waterbirds were mostly abundant during all months with 9926 individuals (77.28% of total counts), especially during wintering and breeding periods (Figure 5).

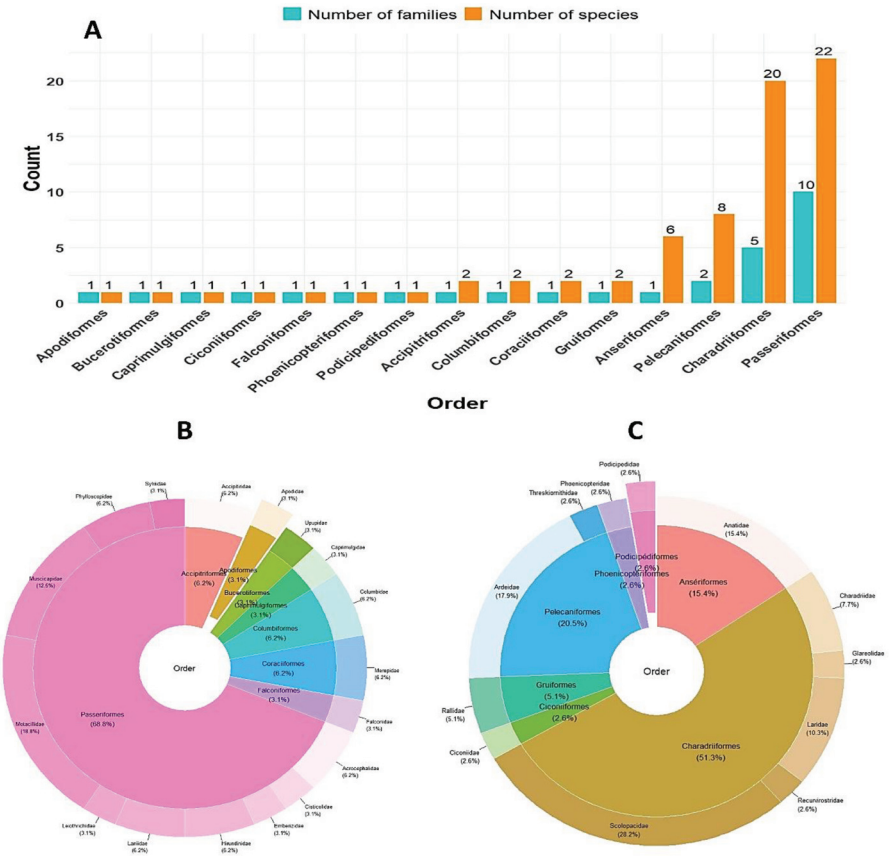

Figure 2. Avian community composition in the study area: Number of avian families and species (A), Pie-Donut Chart showing the percentage of orders and families for landbirds (B) and waterbirds categories (C).

Figure 3. Marbled Duck *Marmaronetta angustirostris* with chicks in Chott El Oued, northeast of Algerian Sahara.

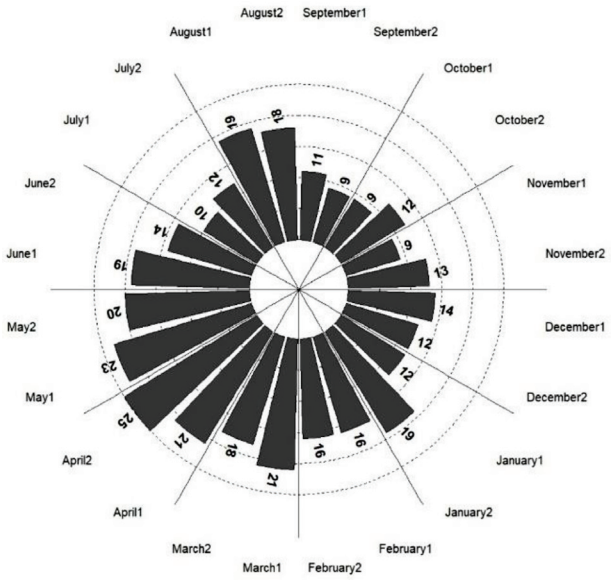

Figure 4. Monthly waterbirds species richness values for annual cycle (September 2023 – August 2024) in Chott El Oued, northeast of Algerian Sahara.

The relative abundance showed seasonal or monthly fluctuations between species populations (Figure 6). The avian community was dominated by four species with more than 10% of relative abundance, representing 64.42% of total abundance. The Black-winged Stilt had the highest relative abundance (26.06%) followed by Marbled Duck (14.44%), Little Grebe (12.61%) and Kentish Plover (11.32%). Seven species contribute significantly with moderate relative abundance (1%–10%) and might collectively represent 29.25% of total abundance, such as Eurasian Coot (7.39%), Eurasian Moorhen (7%), Northern Shoveler (4.93%), Little Stint (3.66%), Little Egret (2.81%), Western Cattle Egret (1.81%), and Ruff (1.65%). The other 28 species accounted for 6.33% of individuals with a relative abundance less than 1%. In terms of frequency of occurrence, the rare species were the most recorded with 33 species followed by accessory, regular and omnipresent species with 16, 10 and 8 species, respectively, whereas constant species marked the lowest richness with four species.

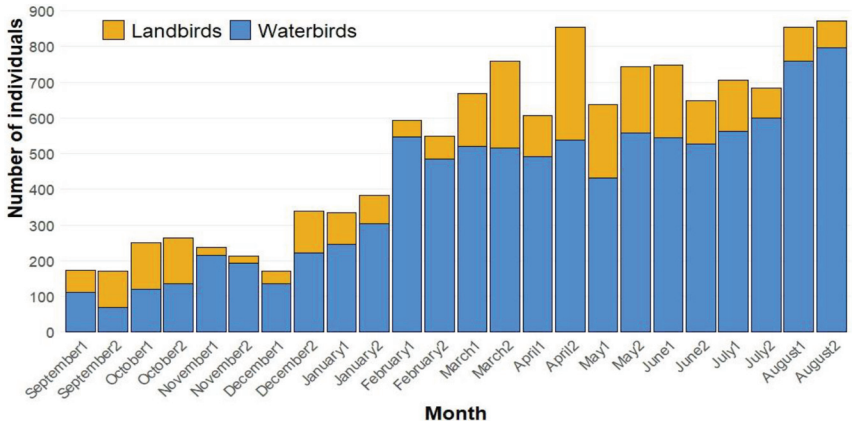

Figure 5. Bi-monthly bird abundance distribution of both waterbirds and landbirds in Chott El Oued, northeast of Algerian Sahara.

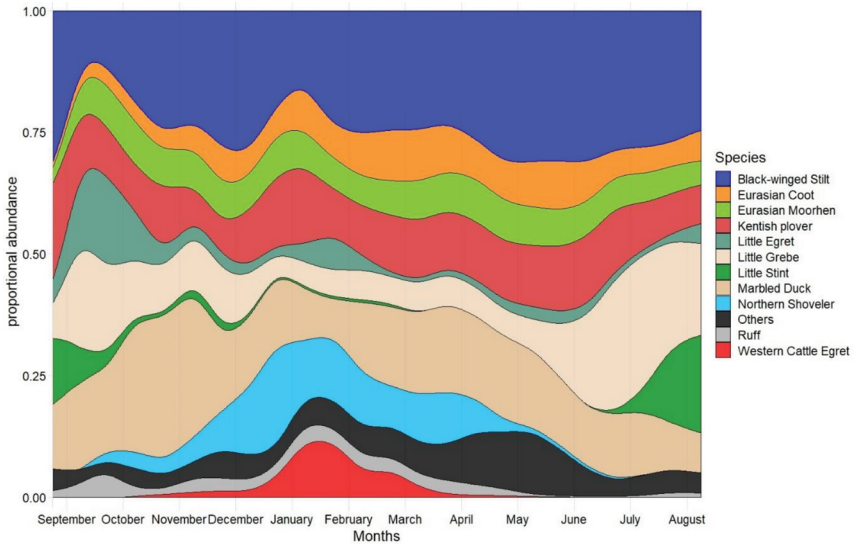

Figure 6. Stream graph representing the proportional abundance of species across months in Chott El Oued, north-eastern Algerian Sahara.

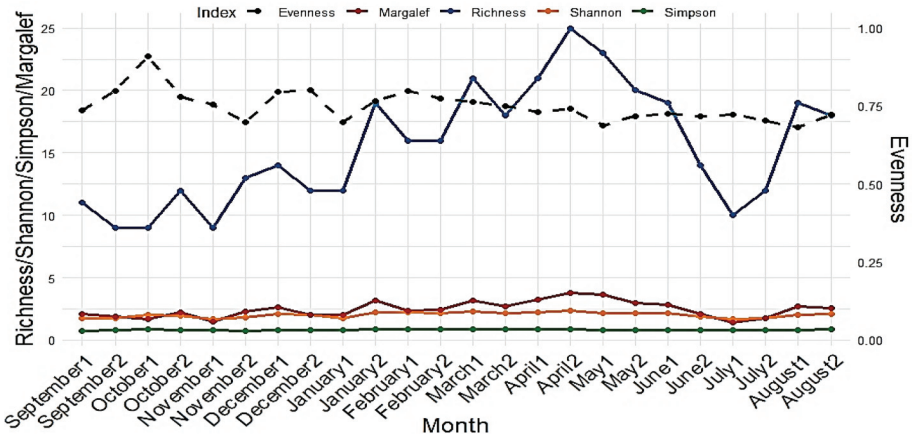

Figure 7.Variation in diversity indices values across months of waterbird communities in Chott El Oued, northeastern Algerian Sahara.

Diversity indices and statistical relationships

Figure 7 shows fluctuations and seasonal trends in diversity metrics across the months. Species richness and Margalef index peaked in April and May with the highest species richness in April2 (25) and May1 (23), and Margalef Index of 3.8 in April2, indicating the breeding activity or migratory influx arriving in the study area. In addition, a remarkable decline in species richness was observed in July and August with the lowest richness (10 in July1) and in Margalef index of 1.4 in July, corresponding to post-breeding dispersal and extreme summer temperatures (heat stress) or the end of migration. The Shannon and Simpson indices peaked in spring in April2 (2.38) and March1 (0.87), respectively, which suggests a more balanced community (high diversity with no single dominant species). The evenness index was relatively stable, floating around 0.66 in August and 0.91 in October with a clear dropping in May. This indicates the dominance of certain species during autumn migration (September, October, and November) and corresponds with a high richness during the breeding period (April and May).

DISCUSSION

The El Oued region in northeastern Algerian Sahara encompasses several natural water bodies, includi ng Chott Melghir and Chott Merouane (designated as Ramsar sites), as well as the urban wetland of Chott El Oued. It also features artificial water bodies such as wastewater treatment plants (four facilities) and treated wastewater discharge sites like Chott Dhiba and Taleb Larbi. These areas hold a significant ecological value by hosting several waterbird species, including both resident and migratory populations.

This work is the first study to document the role played by the urban wetland Chott El Oued for maintaining bird species diversity, especially waterbirds. The location of this wetland along the Palearctic-trans-Saharan migrant flyway highlights its significance in supporting a large and diverse community of migratory and resident bird species. The 71 species recorded represents 17.48% of the Algerian avifauna (406 species) reported by Isenmann and Molaï (2000). In addition, the wetland hosts 34.97% of the avifauna documented by Chedad et al. (2023a) in the M'zab region (province of Ghardaïa) and 52.2% of the Ziban avifauna (province of Biskra) in northern Algerian Sahara (Farhi and Blhamra 2012; Farhi 2014). Furthermore, our findings are higher than the bird diversity obtained during the survey conducted from January to December 2019 by Aouadi et al. (2021) in the peri-urban wetland of Boussedra marsh, located in the province of Annabain northeast of Algeria and comparable with the richness (42 waterbirds) obtained during the monitoring of aquatic avifauna carried out from September 2015 to August 2018 (three years) by Draidi et al. (2023) in the same area.

In the North African Saharan regions, our results were higher than the richness found by Hamza and Selmi (2018) in the Saharan wetland complex of Douz in south-western Tunisia (34 species). They were also similar to the ornithological diversity (41 species) reported by Biad et al. (2022) at Lake El-Golea in Ghardaïa province in the northern Sahara of Algeria and to the 42 species found by Khirani-Betrouche and Moulaï (2021) in Oued Righ wetlands. However, they are lower than the waterbirds found by Bensaci (2013) in the eco-complex of Oued Righ (53 species) and by Bouzid (2017) in Chott El Beidha, Ouargla province (67 species). These comparisons highlight the relative ecological significance of our study site within the broader Saharan wetland network and contribute to understanding regional biodiversity patterns. Numerous factors drive the fluctuations in species richness and population dynamics between wetlands across years, including wetland size, variation in water depth, water characteristics (salinity levels), vegetation cover, food

resource availability, anthropogenic impacts, human disturbances, and climate change (Hamza and Selmi 2018; Khirani-Betrouche and Moulaï 2021, 2022; Triplet et al. 2024).The specific geographic location of our study site, which is situated close to urban agglomerations with dense vegetation cover dominated by reeds and halophytic plants, has made it a crucial habitat for many migratory and resident birds, especially waterbirds. In addition, the human modified environments, such as anthropogenic discharges, attract generalist species, predominantly urban birds.

The Chott El Oued wetland serves as an essential stopover site for migratory birds during their southward journey in autumn and northward return in spring to arrive at their breeding grounds. This is supported by the fact that 38 recorded species are classified as passage visitors, which is indicated by the particular richness and the more balanced abundance during the breeding period, correlated with migratory influxes and breeding activity. In addition, this wetland represents an important wintering site for 16 species, of which a large majority are waterbirds. Furthermore, the diversity of habitats, including reedbeds (*Phragmites*) and mudflats, facilitates the nesting of nine waterbird species that inhabit the wetland, especially the Blackwinged Stilt, Marbled Duck and Kentish Plover.

Notably, the wetland serves as a crucial breeding habitat for the Near Threatened Marbled Duck, one of the most abundant waterbird species recorded. This species exhibits consistent annual breeding activity with fluctuations of population varies ranging from 9 to 103 individuals across survey periods. In addition, the presence of other Near Threatened and nationally protected species found in our study area underscores their ecological importance and conservation value within the regional wetland network.

CONCLUSION

The urban wetland of Chott El Oued plays an essential role in sustaining regional bird diversity. The geographical location in a hot arid environment makes it a necessary site for migratory and non-migratory birds, particularly endangered species. However, the wetland faces threats from urbanization, human activities, and climate change. The study emphasizes the critical need for ongoing ecological monitoring and targeted conservation efforts to protect these distinct bird communities' continued existence due to the potential threats associated with resource limitations, habitat degradation, and fragmentation. Our findings serve as a call to action for conservationists and policymakers, detailed data for any conservation strategy, emphasizing the importance of preserving these vulnerable ecosystems for future generations. Prioritizing this wetland as a key stopover, breeding, and wintering site improves ecological resilience and fosters sustainable coexistence between development and nature conservation.

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