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Cover: A gravid praying mantis just before she laid her ootheca—digital art on procreate. © Aakanksha Komanduri.



Ecological values of Ourkiss wetland (Oum El Bouaghi province - Algeria), an overview of waterbirds diversity and richness

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Abstract: The monitoring of waterbirds' abundance and richness serves as the primary method for scientists to characterize the ecological values and diversity profile of wetlands. This survey was specifically conducted in Ourkiss wetland, situated in the Oum El Bouaghi province of East Algeria, spanning from January to May 2013. The study aimed to elucidate the ecological significance of Ourkiss wetland by analyzing various parameters, including the abundance, richness, diversity profile, and conservation status of its waterbird population. A total of 23 species, representing 11 families, were documented during the survey period, with Anatidae and Rallidae emerging as the most prevalent taxa. Notably, Ourkiss wetland exhibited two distinct populations: the “wintering population” and the “breeding population,” with significant waterbird activity observed during migration between the northern and southern regions. The presence of the endangered species *Oxyura leucocephala* further underscores the ecological importance of this wetland. Noteworthy peaks in waterbird diversity were particularly observed in April, as indicated by richness and Shannon indices. To safeguard the ecological integrity of Ourkiss wetland, it is strongly recommended to intensify conservation efforts and implement effective management plans.

Keywords: Abundance, conservation, diversity profile, endangered species, management, monitoring, wintering

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Author contributions: RA—sampling, the conception of the study, editing the first draft; MB—data analysis, editing first draft, reviewing.

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INTRODUCTION

Animal population dynamic depends on many intra- and inter-species-specific factors (Mukherjee & Roy 2021). The bio-monitoring of these factors (such as air temperature, rainfall, prey-predator relationship, and trophic availability) is fundamental for understanding ecology, population dynamics, and conservation of animals (Kitahara et al. 2022). Many studies reported that birds are used as bioindicators of ecosystems and their population is significantly influenced by habitat structure and foraging availability (Norris & Marra 2007; Carnicer et al. 2009; Byju et al. 2023a). Moreover, adaptive radiations and ecological niches are widely recommended for birds' expansion and diversity (Cooney et al. 2017). Also, VASQUEZ et al. (2007) emphasize that bird expansion and diversity result from the distribution of abundance and richness among individuals.

Green & Elmberg (2014) said that the waterbird species are protected effectively as much as the services and values of ecosystems are identified. This ecological balance of ecosystems (i.e., ecosystems values and services) is indicated throughout avifaunal diversity studies (Byju et al. 2023b; Gyeltshen et al. 2023). It is well known that biodiversity within ecosystems and landscapes is influenced and regulated by the assemblage of birds (Kumar & Sahu 2020).

The distribution of abundance, richness and diversity profile of waterbirds in semi-arid wetlands are little studied in Algeria, and all data published previously were focused on northeastern wetlands (mainly in SKIKDA and ELTARF provinces) (Merzoug et al. 2015; Merzoug et al. 2021; Boubekour et al. 2020; Loucif et al. 2020; Draïdi et al. 2023; Ouarti et al. 2023).

In this study, we aim to describe the waterbird population in Ourkiss wetland (Oum El Bouaghi province). Our approach was focused on a description of the ecological value of Ourkiss wetland by using 1) ecological indices (Shannon, Simpson, Evenness, and Berger-Parker), 2) monthly variation of abundance and richness, and 3) the diversity profile of these waterbirds' population. The survey was initiated based on the geographical location of Ourkiss, situated within the primary migratory flyway "North-South" that connects the northern and southern regions of the country.

MATERIALS AND METHODS

Study area

Ourkiss wetland (35.8759°N, 6.9387°E) (Figure 1), is a freshwater dam flooded by Oued Ourkiss. It covers a total surface of 36 ha at an altitude of 930 m above sea level. Under the authority of the Ain Fakroun district (Oum El Bouaghi province - Eastern Algeria), it was built in 2004 by an Algerian hydraulic agency to maintain rainfall water (the irrigation of neighboring lands, arboriculture, and cereal crops). In some parts of this dam, we can observe the emergent aquatic plants "hydrophytes" such as *Typha* sp. and *Phragmites* sp. (Aissaoui, R. pers. obs. 2013). The climate is semiarid, with an annual mean temperature of 15.56°C (minimum 6.53°C recorded in January and maximum 26.13°C recorded in August). The annual rainfall average never exceeds 400 mm (Data provided from ONM). This wetland is not classified as a protected area. It is not cited in the national protected area database.

Sampling and data analysis

Waterbird counts were conducted three times per month from January to May 2013. The observations were made using an ornithological telescope Konus (60 x 25) during the twilight period of the day from a concealed observation point to minimize disturbance (Lumpkin & Pearson 2013). The punctual abundance indices (PIA) method, recommended by Bara & Segura (2019), was utilized for assessing abundance and richness, as it significantly reduces observer movement and disturbance (Ochando 1988). Observers remained stationary at one point for 15–20 minutes, tallying the abundance of waterbirds (Blondel 1985).

Four ecological indices (Shannon-Weaver, Simpson, evenness, and Berger-Parker) were calculated as per the methods described by Shannon & Weaver (1949), Pielou (1975), and Caruso et al. (2008). The conservation status of species was determined based on the IUCN Red List criteria (<https://www.iucnredlist.org/resources/birdlife2021>). A statistical analysis, including the Kruskal-Wallis test, was conducted to compare waterbird abundances. A diversity profile was generated to compare the composition of waterbird families, with α values set at $\alpha = 0$ for richness, $\alpha = 1$ for the Shannon index, $\alpha = 2$ for the inverse Simpson index (1/D), and $\alpha = a$ a higher value approximating the Berger-Parker index.

The principal component analysis (PCA) was performed to examine the correlation between waterbirds' abundance and their monthly distribution (Pearson, 1901). The selection of two independent

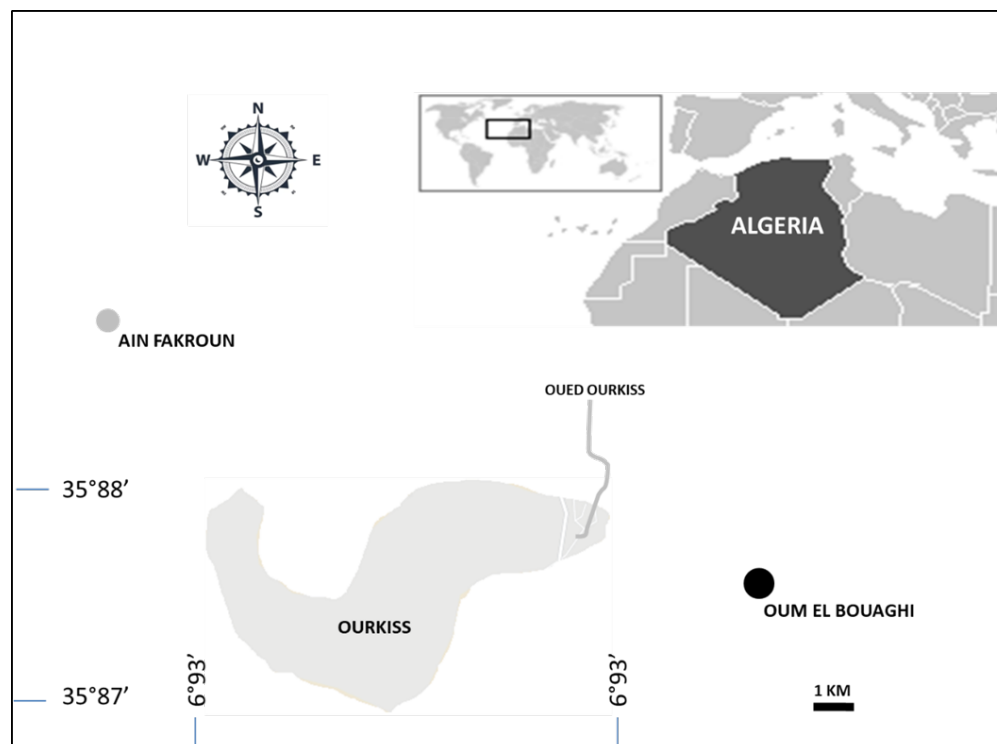


Figure 1. Geographical situation of Ourkiss wetland (Ain Fakroun – Oum El Bouaghi province).

components, labelled “PC1” and “PC2,” aids in focusing attention on the primary proportion of information (Litvak & Hansell 1990; Janžekovič & Novak 2012). The high variance explained by these first principal components (PCs) facilitates computational procedures and enhances analysis reporting (Vaughan & Ormerod 2005). Thus, PCA enables the analysis of species abundance and their monthly variation (Blanck et al. 2007).

A statistical matrix of size 6×15 was constructed. Waterbird taxa absent ('0') in more than five sampling data points were excluded from the analysis. All statistical analyses and tests, including Kruskal-Wallis, ecological indices, diversity profile, and PCA, were conducted using PAST 4.11 software (Hammer et al. 2012).

RESULTS

Waterbird's abundance and richness

During the survey, 23 waterbird species from 11 families were recorded. All recorded waterbirds are classified as Least Concern in the IUCN Red List status, except for the White-headed Duck *Oxyura leucocephala*, which is endangered. The maximum richness (number of species, S) was observed in April (towards the end

of the month), while the abundance of the waterbird population peaked in early January (first week, 221 individuals per 36 ha) (Figure 2). Subsequently, the number of individuals decreased to a minimum recorded in mid-May (44 individuals) (Figure 2). A significant monthly difference was observed in the abundance of waterbird families (Kruskal-Wallis: H (chi-2) = 94.09, P (same) = 1.855 E-17). The abundance of Rallidae was higher or significantly higher than other waterbird families, except between “Rallidae/Anatidae”, “Rallidae/Podicipididae”, and “Rallidae/Ciconidae” (Table 1).

Ecological indices

In mid-April, the maximum values of Simpson and Shannon indices were recorded (0.79 and 1.9, respectively). The evenness reached a maximum in the end of January (0.76). Berger-Parker index reached the maximum in early January (0.71).

Figure 3 summarizes the monthly trending of four ecological indices. The Berger-Parker index decreased substantially in February (0.32) whereas the abundance corresponded to 160 individuals and the dominance corresponded to 0.23. Except in May where the abundance and dominance of waterbird population noted 44 individuals and 0.32, respectively, the Berger-Parker was 0.52.

Table 1. Dunn's post hoc test comparing the monthly variation of abundance intra waterbirds families. Bonferroni corrected p values.

	Anatidae	Podicipedidae	Ardeidae	Ciconidae	Gruidae	Ralidae	Recurvirostridae	Sternidae	Accipitridae	Scolopacidae	Corvidae
Anatidae		1	1	1	***	1	0.06	***	0.69	***	***
Podicipedidae	1		1	1	***	1	0.39	***	1	***	**
Ardeidae	1	1		1	0.49	**	1	0.42	1	0.30	1
Ciconidae	1	1	1		*	0.09	1	*	1	*	0.10
Gruidae	***	***	0.49	0.04		***	1	1	0.94	1	1
Ralidae	1	1	**	0.09	***		***	***	**	***	***
Recurvirostridae	0.06	0.39	1	1	1	***		1	1	1	1
Sternidae	***	***	0.42	*	1	***	1		0.81	1	1
Accipitridae	0.69	1	1	1	0.94	**	1	0.81		0.59	1
Scolopacidae	***	***	0.3	*	1	***	1	1	0.59		1
Corvidae	***	**	1	0.1	1	***	1	1	1	1	

*p < 0.05, ** p < 0.01, ***p < 0.001

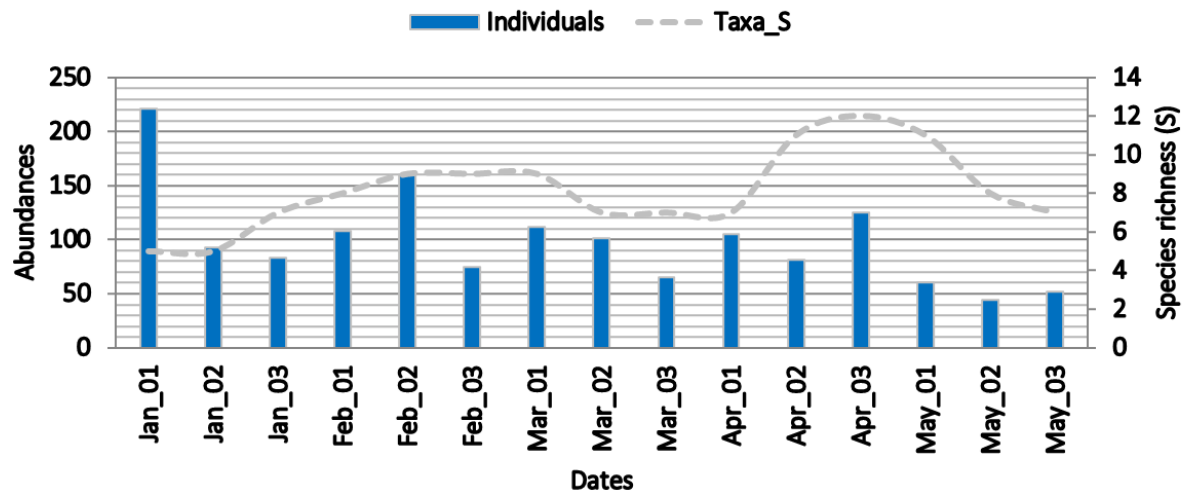


Figure 2. Trend of waterbird abundance and richness in Ourkiss wetland (Oum El Bouaghi province).

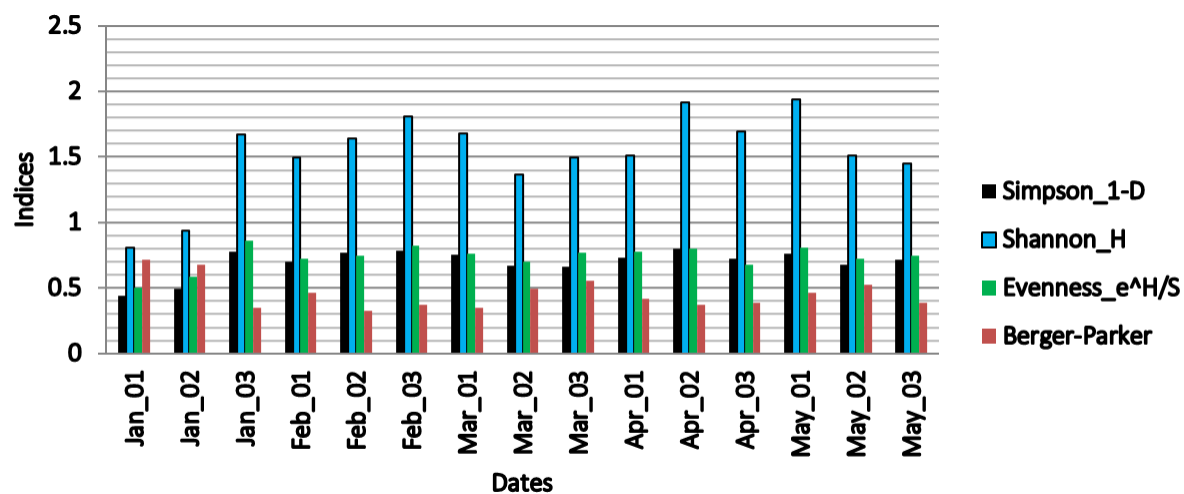


Figure 3. Monthly variability of Shannon, Simpson, evenness, and Berger-Parker indices in Ourkiss wetland (Oum El Bouaghi province).

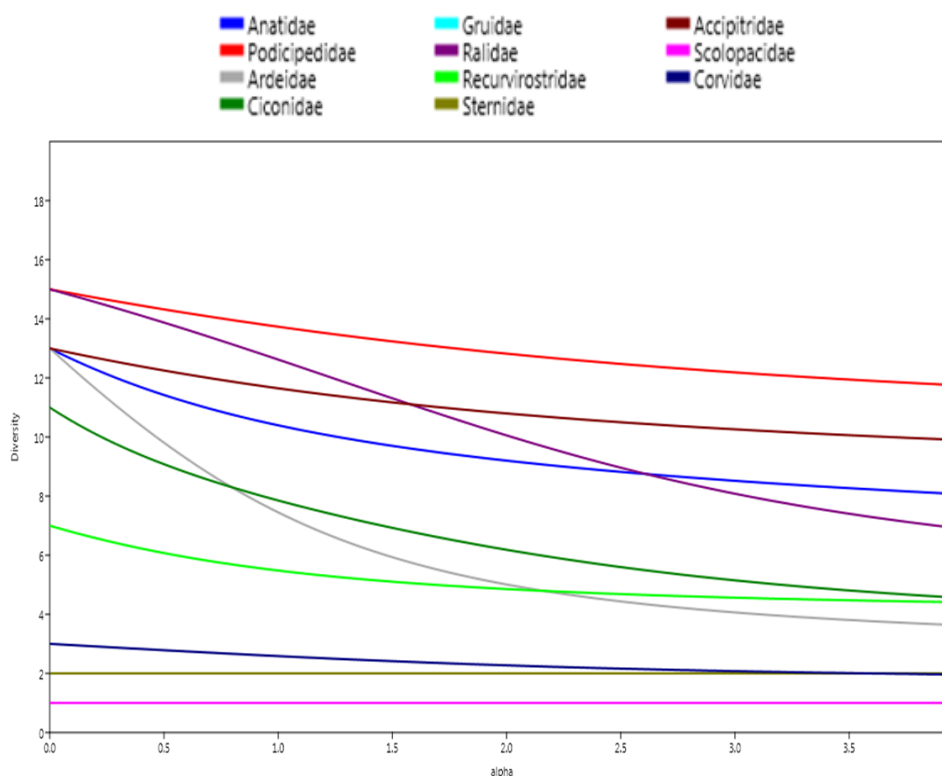


Figure 4. An overview of the alpha diversity profile in Ourkiss wetlands (Oum El Bouaghi province).

Diversity profile

Figure 4 exposed the template of alpha diversity according to waterbird families. Rallidae, Anatidae, and Podicipedidae were the most abundant families according to the diversity profile (higher values when $\alpha = 0$) (Figure 4). Indeed, the total abundance of these three families was 684, 384, and 107, respectively. The podicipididae abundance decreases substantially and shows a fallen curve (Figure 4).

The diversity profile of Gruidae, Corvidae, Scolopacidae, and Sternidae show a steady shape with low values of abundance (40, 10, six, and four respectively) along an alpha axis (Figure 4). The curve representing Ciconidae and Recurvirostridae was smoother along the profile (total abundance reached 152 and 47 individuals, respectively).

The monthly variation of abundance

The monthly variation of waterbird abundance was reported by PCA components with Eigenvalues, % variance and plots provided in Table 2 and Figure 5. The primary information was reported by PC1 and PC2 which collectively accounts for 94% of the variance. PC1 (85%) effectively distinguished between Rallidae/Anatidae and other families (Podicipedidae, Ciconidae, Accipitridae,

Table 2. Principal component analysis describing the monthly variation of waterbird abundance in Ourkiss (Oum el Bouaghi province).

PC	Eigenvalue	% variance
1	6703.4	85.02
2	713.257	9.0464
3	394.493	5.0034
4	43.9466	0.55738
5	29.3746	0.37256

Ardeidae). PC2 (9%) indicated that Anatidae were predominantly associated with Ourkiss wetland during the winter period (from late January to early April), while the remaining waterbird families were observed in early January (first and second weeks) and from April to May. Additionally, the abundance of Rallidae and Anatidae exhibited a negative correlation with the rest of the waterbird families (refer to Figure 5).

DISCUSSION

The richness of waterbirds was less than other neighboring wetlands in northeast Algeria (in Lake

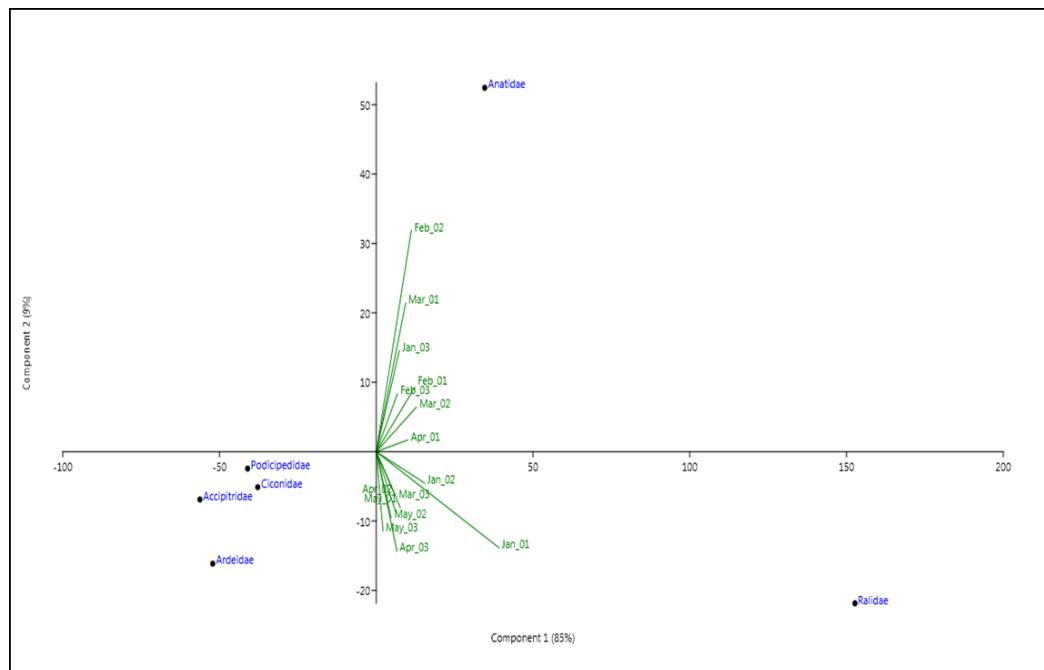


Figure 5. Projection of the waterbirds' families on the PCA map according to monthly trending in Ourkiss wetland (Oum El Bouaghi province).

TONGA (Loucif et al. 2020) and in Garaet HADJ TAHAR (Bara et al. 2020) both reported 35 species. While the number of species in Ourkiss reaches 23 species in spite of the restricted area in Ourkiss (36 ha). The number of species here represented 65% of the total richness reported in the Algerian avifauna database. Also, according to the total area, Ourkiss wetland is smaller than Lake Tonga (2,400 ha) and Garaet Hadj Tahar (100 ha). This data shows that the size of wetlands is not a deterministic factor of waterbird richness.

The Rallidae and Anatidae were the most dominant waterbirds (noted during the study period). The only species of Podicipedidae (The little Grebe *Tachybaptus ruficollis*) showed a preference for open shallow wetlands (Mukherjee & Roy 2021), and recorded during the entire study period

The Accipitridae (mainly the Western Marsh Harrier *Circus aeruginosus*) never exceeded five individuals but were recorded throughout the study period. This species is known as a predator in open wetlands and a wintering species in the Mediterranean region (Agostini & Panuccio 2010). The birds of families Corvidae, Sternidae, Gruidae, Scolopacidae, and Recurvirostridae were recorded as irregular birds (with a low abundance, they are observed as sporadic or occasional birds). The waterbirds' abundance is limited by conditions encountered in migration. Mainly, the food supply can reduce the number of individuals (Newton 2006).

Now it is unclear to what extent different waterbird species overlap in their roles as vectors and how robust this pattern is to changes in the waterbird population (Green & Elmberg 2014). However, this abundance is recognized as an asymmetric interaction network. This pattern suggests that bottom-up processes have a greater influence than top-down processes in these networks (Shurin et al. 2002). Kumar & Sahu (2020) reported that the complexity of food resources can organize the trophic guilds of birds. Also, the habitat structure (such as water level) can be a deterministic factor in the distribution pattern of aquatic birds (Malik & Joshi 2013; Kumar et al. 2016). However, recent waterbird abundance and distribution data have shown a notable increase related to these deterministic factors (mostly the draught in Ourkiss induced by low rainfall and intensive agriculture).

The ecological indices reached the maximum in April and January. We observed that during these two months, the waterbirds changed their phenology status (wintering versus breeding). The Anatidae associated with the wintering period (i.e., Northern Shoveler *Spatula clypeata* and Common Shelduck *Tadorna tadorna*) are known as wintering birds in Algeria (Loucif et al. 2020). Except for the White-headed Duck which is a sedentary in Ourkiss it is known as a breeding bird in Lake Tonga (Chettibi et al. 2013).

The Shannon and Simpson indices reached a

maximum in April-May, this period corresponded to breeding. But, the Evenness and Berger-Parker indices reached their maximum in January. On the other side, under disturbance waterbird population can share a dominant pattern (Caruso et al. 2008) and this population was dominated by some sedentary species (such as ducks, coots, and grebes), it results a high value of the Berger-Parker index in January. The rest of the species were opportunistic and did not record in the first week of January.

The number of waterbirds decreasing significantly in this dam (many ducks recorded previously, were not observed) was recorded, this observation can be explained by a large scale of agricultural activities (which use a high quantity of water) and water deficiency (caused by a little rainfall level recorded this decade).

Also, many wetlands lose their ecological functions and values (by losing richness and abundance) (Sekercioglu et al. 2004). Many studies reported that waterbirds' dynamics and number of individuals were influenced by the seasonal interactions, "The seasonal interactions will depend on the degree of migratory connectivity between periods of the year" (Norris & Marra 2007).

It is known that the monthly distribution of waterbirds was related to the behavior and the phenology of each species. A large part of Anatidae had a wintering status (observed during the winter). The variables clustering shown in our PCA map gives an easier way to explain this assembling (see PCA map).

An urgent conservation plan for Ourkiss wetland is strongly recommended, along with a comprehensive survey of the site to potentially classify it as an Important Bird Area (IBA), particularly considering the possible breeding of the White-headed Duck as suggested by many scientists. Besides this, various threats such as the intensive agriculture that assigns the ecological integrity of Ourkiss. This survey can allow the classification of Ourkiss wetland as a protected area. In this context, a global bird conservation perspective by regular long-term monitoring can accelerate this classification.

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