Waterbird diversity at the Sebkhet of Aures wetlands complex, North East Algeria

Imene Benzina, Abdelkrim Si Bachir, Christian Perennou

We collected a database on wintering waterbirds in the Sebkhet of Aures wetlands complex (SAWC), based on surveys during the period 1978–2019 as well as on a bibliographic search of theses, dissertations, and other reports. The main data are from 12 Ramsar wetlands within the SAWC. We found 57 waterbird species from 9 orders and 14 families. The most abundant species were Greater Flamingo, Pied Avocet, Common Crane, and several anatidae. The Gareat El Taref wetland hosted the highest waterbird diversity, with 31 species and a Shannon index H' = 3.30. The lowest waterbird diversity was found in Chott Tinsilt (8 species, H' = 1.56). 77% of the waterbird species were winter guests. Out of 12 biogeographical regions, species classified as Palearctic were the most common (41% of species). Out of six trophic categories, polyphagous species were the most common (44%). Among the 57 species, 21 are protected at a national level. According to the IUCN Red List, 48 species are of «least concern», whereas the Slender-billed Curlew is classified as «critically endangered» species; the White-headed Duck is «endangered»; three species are considered «vulnerable» (Marbled Teal, Common Pochard, Audouin's Gull); and four species are considered «near threatened» (Northern Lapwing, Red Knot, Black-tailed Godwit, Eurasian Curlew). The collected data should be used as a basis for the conservation of key species and of sites of great ornithological value.

Wetlands are one of the most productive ecosystems in the world and are home to a wide variety of flora and fauna, including migratory birds (Bonnet et al. 2005, Papayannis 2008). They are ecologically rich habitats, in which bird species find sufficient resources for feeding as well as sites for reproduction (Taylor et al. 2021).

The Mediterranean region comprises different types of wetlands, including salt marshes and lagoons, temporary sebkhas (an Arab term used in North Africa, meaning floodable and salty depressions), oases in North Africa, freshwater lakes, karstic cave systems, artificial wetlands such as salinas and rice paddies, and small and scattered peatlands (Payne 2018). Through its wealth of wetlands, the Mediterranean basin has great ecological, social, and economic values and represents one of the most important biodiversity hotspots with a very high rate of endemism (Adloff et al. 2015). The wetlands host more than 30% of vertebrate species of the Mediterranean area (MWO 2018).

Algeria is the largest country in Africa – it covers 2.38 million km^2 and has 2375 listed wetlands, composed of 2056 wetlands of natural origin and 319 of artificial origin (DGF 2016). These wetlands are among the most valuable resources in terms of biological diversity and natural productivity; they play an important role in fundamental processes, hosting an important number of fish fauna and migratory birds (Gherzouli 2013).

From 1983 to date, Algeria has classified 50 Ramsar wetlands. In 2016, it implemented the action plan of the national wetlands strategy, which emphasizes the establishment of national observatories to facilitate monitoring and management of wetlands (DGF 2016). Unfortunately, this seemed a difficult challenge, given the vastness of the national territory and the lack of resources and of management experience.

This study aims to fill some of these gaps and was carried out as part of a project coordinated by the Research Institute for the Conservation of Mediterranean Wetlands, Tour du Valat (France), funded by the Agence Française du Développement (AFD) and the Fond Français pour l'Environnement Mondial (FFEM). The project aims to create the first regional wetlands observatory in Algeria: the regional observatory of the Sebkhet of Aures wetlands complex (SAWC) that covers a floodplain of 1 019 446 ha (10 194 km^2), including 12 Ramsar sites. The SAWC plays an important role in the vital processes maintaining hydrological cycles, hosting thousands of migratory and breeding waterbirds (Bougoudjil 2016).

In order to better understand the composition, structure, distribution and diversity of waterbird communities of the SAWC, we collected a pluri-annual and inter-operational database of aquatic bird species, to assess their bio-ecological status (using phenological,

faunistic, trophic and protection information), with a particular focus on the Ramsar sites of the SAWC. This allows us to suggest a monitoring program and conservation actions for waterbirds and wetlands.

1. Materials and methods

1.1. Study area

The SAWC is located in the Algerian Eastern highlands at an elevation of 800 to 1200 m a.s.l., extending over 300 km from east to west and including many natural wetlands (garaets, sebkhets and chotts). The majority of these sites are salty and shallow, ranging from a few hectares to hundreds of thousands of hectares (Fig. 1; Bensizerara 2014). The region is characterized by vegetation that is resistant to salinity and drought. The immediate surrounding of flooded areas is occupied by belts of vegetation dominated by halophytic plants such as *Atriplex halimus*, *Suaeda fruticose*, *S. vermiculata*, and *Salicornia fruticosa*. These environments are often grazed by sheep and cattle. The majority of the sites are surrounded by cereal crops (Bensizerara et al. 2013).

The climate at the study area is semi-arid with wet-cold winters and dry-hot summers. There is a long period of drought, drying out streams and water bodies (Boukerker and Si Bachir 2015). Over the past 20 years, the mean of daily maximum temperatures (± SD) were 36.9 ± 2.04 °C, and minima were 8.94 ± 0.38 °C. Annual precipitation varies enormously from year to year (160.8 to 362.2 mm), with a very irregular seasonal distribution. The dry period generally lasts from May to November, and sometimes, dry winters result in the drying up of water bodies (Bentrcia 2022).

The majority of the hydrosystems, whose water content is dependent on rainfall, dries up starting from the month of May. The dominant soil substrate is rich in magnesium chloride, accommodating a specific flora consisting mainly of halophile species (Adjal and Mouici 2004). The 12 Ramsar sites of the SAWC are under the governance of the Directorate of Forest Conservation, the Directorate of Hydraulics, and the Regional Inspection of the Environment of the Wilaya (administrative department) of Oum-El-Bouaghi (DGF 2016; Fig. 2, Table 1).

Figure 1. Some of the Ramsar sites in the Sebkhet of Aures wetlands complex, highlighting the impact of drought: (a) Chott Tinsilt, (b) Sebkhet Ezzmoul, (c) Garaet Guellif, (d) Garaet Timerganine.
Einige der Ramsargebiete im Feuchtgebietskomplex von Sebkhet of Aures, welche die Auswirkungen der Dürre verdeutlichen: (a) Chott Tinsilt, (b) Sebkhet Ezzmoul, (c) Garaet Guellif, (d) Garaet Timerganine.

1.2. Database collection and biodiversity assessment

Our main data are on an inventory of waterbird species, their distribution by site, and numbers of individuals. Data collection was based (1) on a bibliographic search on more than 150 references (theses, dissertations, scientific publications, reports), with data reported as species lists or censuses on aquatic birds, in particular on summer visitors and resident species; and (2) on surveys of wintering waterbirds (1978–2019) reporting waterbird lists with the number of individuals counted at each site. Based on these surveys of wintering waterbirds, we calculated the diversity index for each site and according to years of counts. Diversity was evaluated as total species richness (total number of species recorded by site) and as Shannon diversity index H' (Magurran 2004), which takes into account both the number of species and how numerous the individuals of a species are. The Shannon index was calculated for each of the 12 sites, taking into consideration only data from the years in which all 12 sites were surveyed. We only considered birds identified to the species level. We also used the equitability or Pielou's evenness index E (Blondel 1979), which indicates how close in numbers of individuals (how even) the different species in a community are. The Shannon and Pielou indices are among the most used when evaluating the diversity of birds in a given community (Blondel 1979, Magurran 2004).

1.3. Phenological status

The phenological status of the observed bird species was assigned according to Isenmann and Moali (2000) and Heinzel et al. (2004). We used four categories: (1) Winter migrant: species observed during the wintering season; (2) Occasional visitor: species observed only a few times; (3) Summer migrant breeding, and (4) Summer migrant probably breeding: migratory species observed in the region during spring and summer seasons.

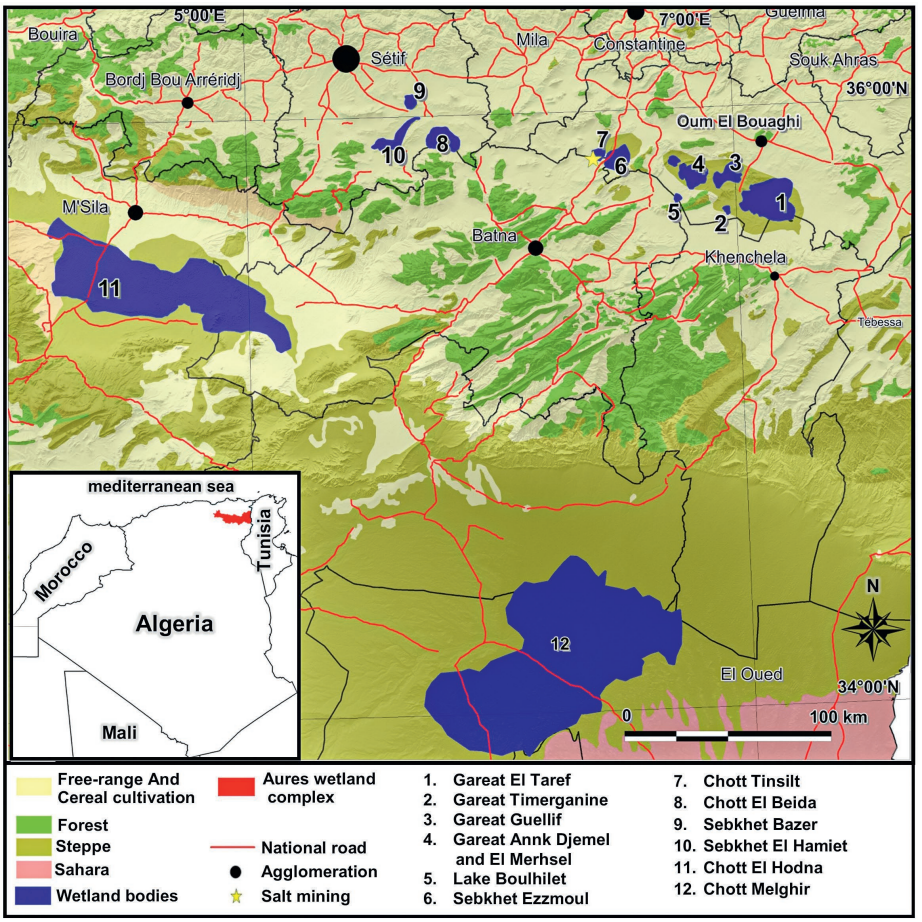

Figure 2. Location of the Sebkhet of Aures wetlands complex and its 12 Ramsar sites.
Lage des Feuchtgebietskomplexes von Sebkhet of Aures und seiner 12 Ramsargebiete.

Table 1. Characteristics of the 12 Ramsar sites at the Sebkhet of Aures wetlands complex.
Merkmale der 12 Ramsargebiete im Feuchtgebietskomplex von Sebkhet of Aures.

Site number (see Figure 1)	International Code*	Name	Date of designation	Elevation (m) Area (ha)	Ramsar criteria** IBA criteria***
1	1DZ034	Garaet El Taref	12 December 2004	830 33460	2, 6 A4i
2	1DZ043	Garaet Timerganine	18 December 2009	843 1460	2, 3, 4 A1, A4i
3	1DZ035	Garaet Guellif	12 December 2004	890 24000	2, 3, 4, 6 A4i
4	1DZ033	Garaet Annk Djemel & El Merhsel	12 December 2004	844 18140	4, 5, 6 A4i
5	1DZ047	Lac Boulhilet	18 December 2009	843 856	2, 4, 6 A1
6	1DZ045	Sebkhet Ezzmoul	18 December 2009	800 6765	3, 4, 6 A4i
7	1DZ031	Chott Tinsilt	12 December 2004	792 2154	4 A1
8	1DZ028	Chott El Beida	12 December 2004	887 12223	4 unclassified
9	1DZ040	Sebkhet Bazer Sakra	12 December 2004	917 4379	2, 6 A1
10	1DZ041	Sebkhet El Hamiet	12 December 2004	902 2509	4 unclassified
11	1DZ005	Chott El Hodna	2 February 2001	392 362000	1, 3, 7 A1
12	1DZ017	Chott Melghir	4 June 2003	−24 551500	1, 2, 3 unclassified

* Code adapted by Wetlands International.
** Codification according to Ramsar classification criteria (see Appendix 1): nine criteria based on originality and number of rarities for identifying wetlands of international importance.
*** Important Bird Areas by BirdLife International: areas identified according to an internationally agreed set of criteria as being globally important for the conservation of bird populations.

1.4. Trophic status

The trophic status of the observed bird species was assigned according to Heim de Balzac and Mayaud (1962) and Dubois and Olioso (2003). We used six classes: Carnivorous: species feeding mainly on animals, including small vertebrates and occasionally invertebrates; Piscivorous: feeding mainly on fish; Invertebrate consumer: consuming a wide variety of aquatic and/or terrestrial invertebrate prey; Mainly insectivorous: feeding mostly on insects; Polyphagous: a diet of several categories depending on food accessibility; and Granivorous: feeding mainly on seeds.

1.5. Biogeographical status

To investigate the biogeographical origin of the bird species, the faunal type was determined according to Voous (1960). Thus, waterbird species were assigned to one of twelve categories: Old World, Arctic, Cosmopolitan, Mediterranean, Holarctic, Palearctic, Turkesto-Mediterranean, Sarmatic, Paleoxeric, Indo-African and Ethiopian.

1.6. Protection status

The protection status of the observed birds was assigned according to the national list of species protected by Decrees N° 12-236 issued on 24 May 2012 in Algeria legislation (OJAR 2012), and according to the international Red List of the IUCN (International Union for Conservation of Nature; IUCN 2017).

2. Results

2.1. Waterbird diversity

A total of 57 species from 14 bird families and 9 bird orders were listed. The systematic list was assembled according to a classification established by BirdLife/HBW (2022; Table 2). The most abundant family were the Scolopacidae and the Anatidae with 13 species each. The least abundant families were Phoenicopteridae, Gruidae, Ciconiidae, Threskiornithidae, Phalacrocoracidae and Accipitridae, represented by one species each. Regarding frequency of waterbird sightings over time, Greater Flamingo, Pied Avocet, Common Crane, several anatidae (Eurasian Wigeon, Common Teal, Mallard, Northern Shoveler, Common Shelduck) and Black-headed Gull were the most constant species (present in more than 50% of reports). Little Grebe, Great White Egret *Egretta alba*, Cattle Egret, European Herring Gull and Jack Snipe *Lymnocryptes minimus* were very rare species. The frequency of all other species was low (less than 10% of reports).

The results (Table 3) showed that Garaet El Taref was the wetland most frequented by different waterbird species (31 species; H' = 3.30), whereas Chott Tinsilt had the lowest diversity indices (8 species; H' = 1.56). Garaet El Taref also hosted the largest number of birds with more than 35 000 individuals. Sebkhet Bazer Sakra had the highest evenness of numbers of individuals among species (Pielou's evenness index, E = 0.73), whereas Timerganine had the lowest evenness (E = 0.42).

Table 2. Checklist of waterbirds found at the 12 Ramsar wetlands of the Sebkhet of Aures wetlands complex.
* = species protected in Algeria.
Checkliste der Wasservögel, die in den 12 Ramsar-Feuchtgebieten des Feuchtgebietskomplexes von Sebkhet of Aures vorkommen.
** = in Algerien geschützte Arten.*

Species		Site number (see Figure 1)
White-headed Duck*	*Oxyura leucocephala*	5
Greylag Goose*	*Anser anser*	3, 6, 7
Common Shelduck*	*Tadorna tadorna*	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Ruddy Shelduck*	*Tadorna ferruginea*	1, 6, 8
Marbled Teal*	*Marmaronetta angustirostris*	10, 11
Common Pochard	*Aythya ferina*	5
Tufted Duck	*Aythya fuligula*	5, 9
Northern Shoveler	*Spatula clypeata*	1, 2, 4, 5, 6, 7, 8, 9, 10, 12
Gadwall	*Mareca strepera*	5, 8
Eurasian Wigeon	*Mareca penelope*	1, 2, 4, 5, 6, 7, 8, 9, 10, 11
Mallard	*Anas platyrhynchos*	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12
Northern Pintail	*Anas acuta*	9, 4, 5, 6, 8, 10
Common Teal	*Anas crecca*	1, 2, 5, 6, 8, 9, 10
Little Grebe	*Tachybaptus ruficollis*	5, 8
Great Crested Grebe	*Podiceps cristatus*	5, 8
Black-necked Grebe	*Podiceps nigricollis*	5, 8
Greater Flamingo*	*Phoenicopterus roseus*	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Western Water Rail*	*Rallus aquaticus*	12
Common Moorhen	*Gallinula chloropus*	12
Common Coot	*Fulica atra*	5, 6

Species		Site number (see Figure 1)
Common Crane*	*Grus grus*	2, 3, 4, 5, 7, 8, 9, 10, 11
White Stork*	*Ciconia ciconia*	8, 9, 12
Glossy Ibis*	*Plegadis falcinellus*	6
Squacco Heron*	*Ardeola ralloides*	8
Cattle Egret	*Bubulcus ibis*	1, 6, 8, 12
Grey Heron	*Ardea cinerea*	1, 4, 5, 8
Little Egret*	*Egretta garzetta*	3, 5, 8
Great Cormorant*	*Phalacrocorax carbo*	3, 5
Pied Avocet*	*Recurvirostra avosetta*	1, 3, 5, 7, 8, 10, 11
Black-winged Stilt*	*Himantopus himantopus*	1, 2, 6, 7, 15, 10, 11, 12
Grey Plover	*Pluvialis squatarola*	8, 10
Eurasian Golden Plover	*Pluvialis apricaria*	9, 10
Eurasian Dotterel	*Eudromias morinellus*	1, 2, 9
Common Ringed Plover	*Charadrius hiaticula*	1, 5, 6, 8, 12
Little Ringed Plover	*Charadrius dubius*	1, 2, 3, 5, 6, 10, 11, 12
Kentish Plover	*Charadrius alexandrinus*	1, 5, 6, 7, 8, 10, 11, 12
Northern Lapwing	*Vanellus vanellus*	1, 2, 5, 7, 8, 10, 12
Slender-billed Curlew*	*Numenius tenuirostris*	2, 11
Eurasian Curlew*	*Numenius arquata*	2, 5, 6, 7, 8, 9, 10
Black-tailed Godwit	*Limosa limosa*	2, 5, 8
Red Knot	*Calidris canutus*	9
Ruff	*Calidris pugnax*	1, 3, 6, 7, 10
Dunlin	*Calidris alpina*	5, 6, 10, 12
Little Stint	*Calidris minuta*	5, 6, 7, 8, 9, 11, 12
Common Snipe	*Gallinago gallinago*	1, 2, 5, 8, 9, 10, 11
Green Sandpiper	*Tringa ochropus*	1, 12
Spotted Redshank	*Tringa erythropus*	1, 5, 8, 9, 10
Common Greenshank	*Tringa nebularia*	8, 10
Common Redshank	*Tringa totanus*	5, 23, 37
Wood Sandpiper*	*Tringa glareola*	1, 12
Slender-billed Gull	*Larus genei*	2, 11
Black-headed Gull	*Larus ridibundus*	1, 2, 5, 6, 7, 8, 10, 11
Audouin's Gull*	*Larus audouinii*	2, 5, 12
European Herring Gull	*Larus argentatus*	10, 11
Caspian Gull	*Larus cachinnans*	1
Little Tern*	*Sternula albifrons*	1, 12
Western Marsh-harrier*	*Circus aeruginosus*	1, 5, 6, 8, 9, 10, 12

Table 3. Waterbird diversity in the 12 Ramsar sites of the Sebkhet of Aures wetlands complex.
Vielfalt der Wasservögel in den 12 Ramsargebieten des Feuchtgebietskomplexes von Sebkhet of Aures: Anzahl der beobachteten Wasservogelarten, Shannon-Diversitätsindex (H') und Pielou's Evenness-Index (E).

Ramsar wetland	Number of observed waterbird species	Shannon diversity index (H')	Pielou's evenness index (E)
Garaet El Taref	31	3.30	0.67
Timerganine	22	1.64	0.42
Garaet Guellif	16	2.52	0.63
Garaet Annk Djemel & El Merhsel	14	2.18	0.57
Lac Boulhilet	15	1.91	0.49
Sebkhet Ezzmoul	25	2.94	0.63
Chott Tinsilt	8	1.56	0.52
Chott El Beida	19	2.00	0.47
Sebkhet Bazer Sakra	17	2.99	0.73
Sebkhet El Hamiet	15	2.35	0.60
Chott El Hodna	13	2.63	0.71
Chott Melghir	18	2.83	0.68
Total	57	3.68	0.63

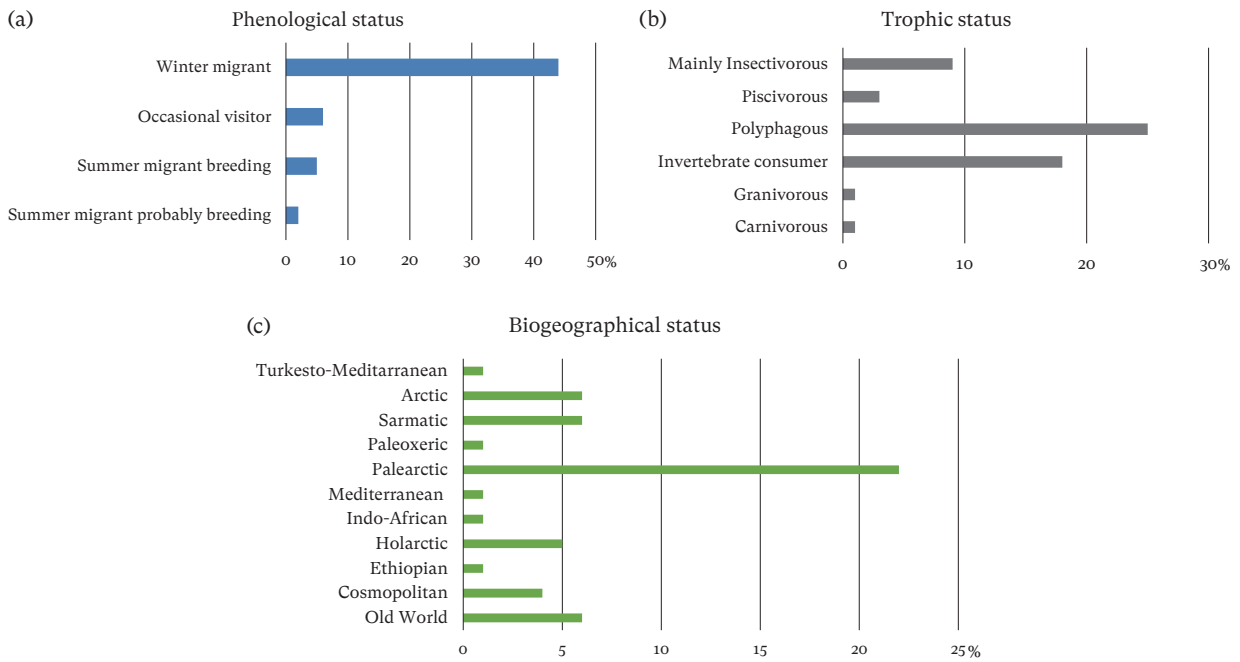

Figure 3. Phenological status (a), trophic status (b), and biogeographical status (c) of waterbird species recorded at the Sebkhet of Aures wetlands complex, in % of all observed species.
Phänologischer Status (a), trophischer Status (b) und biogeografischer Status (c) der Wasservogelarten, die im Feuchtgebietskomplex von Sebkhet of Aures erfasst wurden, in % aller beobachteten Arten. Phänologischer Status: Wintergast, Durchzügler, brütender Sommergast und wahrscheinlich brütender Sommergast. Trophischer Status: hauptsächlich Insekten, Fisch, polyphag, Wirbellose, Körner, Fleisch. Biogeografischer Status: turkestanisch-mediterran, arktisch, sarmatisch, paläoxerisch, paläarktisch, mediterran, indo-afrikanisch, holarktisch, äthiopisch, kosmopolitisch, altweltlich.

2.2. Ecological status

Phenological status: Winter migrant species represented 77% of the recorded waterbird species, followed by Occasional visitors (11%). Summer migrant probably breeding species were the least frequent, with only two species (4%; Fig. 3a).

Trophic status: Polyphagous species were the most common species, with 44% (25 species), followed by Invertebrate consumers with 32% (18 species). Carnivorous and Granivorous waterbird species were the least common, with only one species each (2%; Fig. 3b).

Biogeographical status: Most waterbird species were classified as Palaearctic fauna (41%), followed by Arctic, Sarmatic, and Old world (11%). Turkesto-Mediterranean, Paleoxeric, Mediterranean, Indo-African and Ethiopian were the least common (Fig. 3c).

Protection status: Of 57 species recorded, 21 species are protected in Algeria (Table 2). According to the IUCN Red List, 48 species (84%) are of «least concern» (LC); 4 species are «near threatened» (NT): Eurasian Curlew, Black-tailed Godwit, Red Knot and Northern Lapwing; 3 species are «vulnerable» (VU): Marbled Teal, Common Pochard and Audouin's Gull. One species is «endangered» (EN): White-headed Duck, and one species is «critically endangered» (CR): Slender-billed Curlew.

3. Discussion

Despite gaps in our survey data that are mainly due to the absence of regular annual data, the number of bird species recorded at the Sebkhet of Aures wetlands complex (SAWC) was 57, which represents 76% of the total waterbird species listed for Algeria. Better knowledge of the identification of species and more regular monitoring of the sites, also during periods of partial drying-out of the sites, would be a valuable contribution to enriching the obtained inventory and the knowledge of the distribution of the species.

The observed species richness is important and justifies the classification of the majority of the SAWC wetlands as Important Bird Areas (IBA; BirdLife International 2004). However, there are other large wetlands with relatively high species numbers that are not classified Ramsar sites in the Eastern Hauts Plateaux, such as the Sebkhet Djendli wetland (51 bird species, 3700 ha; Bensizerara 2014), and in the Sahara, such as the Oued Righ depression wetland complex (53 species, 900 000 ha; Bensaci et al. 2013).

Our results highlight the importance of the SAWC for bird diversity, in providing wintering sites and resting sites for autumnal or spring passage of waterbirds. While only few waterbirds visit the sites in summer or breed there, the SAWC represents a highly important wintering area for a large number of species. The wintering populations are especially important for certain species such as the Greater Flamingo with 7627 individuals recorded in 2005, the Pied Avocet and the Black-winged Stilt with 12 000 individuals, and the Rallidae with 10 500 individuals recorded in 1988.

Similar results were found for the Moutas Cynegetic Reserve near Tlemcen in Western Algeria (Mostefai 1997), the Tamentit Oasis in the central Sahara (Cherifi 2003), and the South Constantine region (Bacha and Bechim 2005). According to Coulthard (2001), the El Kala and Oum El Bouaghi (named here SAWC) wetland complexes are classified as the two major regions of international importance for migratory and resident waterbirds in Algeria. This reveals that the SAWC region contains varied food resources for several waterbird species both in winter and during migration. The abundance of polyphagous waterbirds reflects the range of food resources that the SAWC offers, such as cereal crops (durum wheat, barley, oat), shellfish, molluscs and worms. The presence of invertebrate-feeding waterbirds reflects the importance of habitats harbouring many insect species. Granivorous birds such as the Eurasian Teal are the least common waterbirds; they feed on the seeds of herbaceous and bushy plants located around wetlands.

The dominance of Palearctic birds shows how the avifauna of the northern part of North Africa is linked to the western Palearctic (Voous 1960). Similarly, many studies in Algeria and in other North African countries have shown high proportions of bird species mainly linked to the northern Palearctic (Isenmann and Moali 2000, Isenmann et al. 2005, Bendjoudi et al. 2013, Bensizerara et al. 2013, Bezzalla et al. 2019).

The SAWC is home to some worldwide threatened species: nine species out of 57 are currently threatened, four near threatened, three vulnerable, one endangered (White-headed Duck), and one critically endangered (Slender-billed Curlew). The allocation to those categories was according to the criteria defined by the IUCN, based on various biological factors (Vié et al. 2008). However, these criteria are international; they are not based on a national or local Red List. The global IUCN Red List only includes information on species, subspecies or populations that have been globally assessed. Regional and national assessments are currently not included unless these are also global assessments (for example, a species that is only found in one country (i.e., is endemic) and therefore has the same Red List status nationally and internationally; Vié et al. 2008). National or local Red Lists would be needed to improve the assessment of the actual threats to the waterbirds of the SAWC. The reason is that the local conservation status of a species usually does not equal its international pro-

tection status, and a better understanding of the local population status would be needed to ensure better protection – hence the importance of implementing local or national Red Lists, taking into account surveys such as those on which our study is based.

In the SAWC area, we expect negative changes that may affect the habitats used by waterbirds. Recent climate warming and the increase in anthropogenic pressure (pollution, habitat fragmentation, agriculture, hunting, pumping) have led to conspicuous changes in the quality of habitats and of the water regime of the fragile wetlands (Bouras 2019). Since the studied sites are already classified as Ramsar sites (Appendix 1), it should be possible to envisage more specific conservation measures within the framework of a management plan. Currently, there is no special management other than the monitoring of the sites by the forest conservation services of the neighbouring wilayas (administrative sectors) and the annual winter surveys of waterbirds.

Acknowledgements

This study was carried out thanks to the technical contribution of the Research Institute for the Conservation of Mediterranean Wetlands, Tour du Valat (France) and to funding by the Agence Française du Développement (AFD) and the Fond Français pour l'Environnement Mondial (FFEM). We thank Abdelkrim Arar for the creation of the map. We also thank the laboratory of Ecology and environment (Faculty of nature and life sciences, Batna 2 University) for bibliographic documentations.

Zusammenfassung

Benzina I, Si Bachir A, Perennou C (2022) Wasservogelvielfalt im Feuchtgebietskomplex von Sebkhet of Aures, Nordostalgerien. Ornithologischer Beobachter 119: 318–329.

Wir haben eine Datenbank über überwinternde Wasservögel im Feuchtgebietskomplex von Sebkhet of Aures (SAWC) zusammengestellt, die auf Erhebungen im Zeitraum 1978–2019 sowie auf einer bibliografischen Suche in Diplomarbeiten, Dissertationen und anderen Berichten beruht. Die wichtigsten Daten stammen aus 12 Ramsar-Feuchtgebieten innerhalb des SAWC. Wir fanden 57 Wasservogelarten aus 9 Ordnungen und 14 Familien. Die häufigsten Arten waren Rosaflamingo, Säbelschnäbler, Kranich und mehrere Entenarten. Das Feuchtgebiet Gareat El Taref beherbergte mit 31 Arten und einem Shannon-Index H' = 3,30 die höchste Wasservogelvielfalt. Die geringste Vielfalt an Wasservögeln wurde in Chott Tinsilt festgestellt (8 Arten, H' = 1,56). 77 % der Wasservogelarten waren Wintergäste. Von den 12 biogeografischen Regionen waren paläarktische Arten am häufigsten (41 %). Von den sechs trophischen Kategorien dominierten die polyphagen Arten (44 %). 21 der 57 Arten sind auf nationaler Ebene geschützt. Nach der Roten Liste der IUCN sind 48 Arten «nicht gefährdet», während der Dünnschnabelbrachvogel als «vom Aussterben bedroht» eingestuft wird; die Weisskopfruderente ist «stark gefährdet»; drei Arten gelten als «verletzlich» (Marmelente, Tafelente, Sturmmöwe) und vier Arten als «potenziell gefährdet» (Kiebitz, Knutt, Uferschnepfe, Grosser Brachvogel). Die gesammelten Daten sollten als Grundlage für die Erhaltung von Schlüsselarten und ornithologisch wertvollen Gebieten dienen.

References

Adjal M, Mouici S (2004) Cartographie de la végétation et éco-éthologie de Tadorne de Belon dans la Sebkhat de Djendli (Batna). Ingineer Dissertation, University Batna.

Adloff F, Somot S, Sevault F, Jordà G, Aznar R, Déqué M, Herrmann M, Marcos M, Dubois C, Padorno E, Alvarez-Fanjul E, Gomis D (2015) Mediterranean Sea response to climate change in an ensemble of twenty first century scenarios? Climate Dynamics 45: 2775–2802.

Bacha B, Bechim L (2005) Approche bio-écologique des zones humides et des oiseaux d'eau de la région Sud-Constantinoise. Dissertation, University El Hadj Lakhdar Batna.

Bendjoudi D, Chenchouni H, Doumandji S, Voisin J-F (2013) Bird species diversity of the Mitidja Plain (Northern Algeria) with emphasis on the dynamics of invasive and expanding species. Acrocephalus 34: 13–26.

Bensaci E, Saheb M, Nouidjem Y, Bouzegag A, Houhamdi M (2013) Biodiversité de l'avifaune aquatique des zones humides Sahariennes: cas de la dépression d'Oued Righ (Algérie). Géographie Physique et Environnement 7: 211–222.

Bensizerara D (2014) Ecologie des oiseaux de Sebkhet Djendli (Batna, l'Est algérien). Dissertation, University of Biskra.
Bensizerara D, Chenchouni H, Si Bachir A, Houhamdi M (2013) Ecological status interactions for assessing bird diversity in relation to a heterogeneous landscape structure. Avian Biology Research 6: 67–77.
Bentrcia L (2022) Atlas des zones humides classes Ramsar du complexe des Sebkhates des Aurès (Nord-Est Algérien). Dissertation, University of Batna.
Bezzalla A, Houhamdi M, Chenchouni H (2019) Bird ecological status of two internationally important wetlands «Ramsar sites and IBA» in Algeria. Estuarine, Coastal and Shelf Science 227: 106308.
BirdLife/HBW (2022) Handbook of the Birds of the World and BirdLife International digital checklist of the birds of the world, Version 6b.
BirdLife International (2004) Threatened birds of the world 2004. CD-ROM. BirdLife International, Cambridge.
Blondel J (1979) Biogéographie et écologie. Masson, Paris.
Bonnet B, Aulong S, Goyet S, Lutz M, Mathevet R (2005) Integrated management of Mediterranean wetlands. Conservation of Mediterranean Wetlands N° 13. Tour du Valat, Arles.
Bougoudjil S (2016) Ecologie des *Tadorna casarca* et *Tadorna ferruginea* dans l'éco-complexe de zones humides des hautes plaines de l'Est algérien. Dissertation, University of Annaba.
Boukerker H, Si Bachir A (2015) Biodiversity of xylophagous insects and their role in the Cedrus atlantica forests decline in the national park of Belezma, Batna (Algeria). Courier du Savoir 20: 79–90.
Bouras N (2019) Ecologie des oiseaux d'eau des zones humides de la région d'Oum El Bouaghi. Dissertation, University of Oum El Bouaghi.
Cherifi T (2003) Bird diversity of Tamentit oasis (central Sahara). Oral presentation at 7th ornithological conference, 10 March 2003. National Agronomical Institute, El Harrach, Algiers.
Coulthard ND (2001) Algeria. Page 51–70 in Fishpool LDC, Evans MI (editors) Important Bird Areas in Africa and associated islands: priority sites for conservation. BirdLife Conservation Series No. 11. Pisces Publications, Newbury, and BirdLife International, Cambridge.
DGF (2016) Stratégie nationale de gestion écosystémique des zones humides d'Algérie. Direction Générale des Forêts, Ben Aknoun.
Dubois PJ, Olioso G (2003) Guide des oiseaux de France. Sélection du Reader's Digest.
Gherzouli C (2013) Anthropisation et dynamique des zones humides dans le nord-est-algérien: apport des études palynologiques pour une gestion conservatoire. Thèse de doctorat, Université Toulouse le Mirail.
Heim de Balsac H, Mayaud N (1962) Les oiseaux du Nord-Ouest de l'Afrique. Paul Lechevalier, Paris.
Heinzel H, Fitter R, Parslow J (2004) Oiseaux d'Europe, d'Afrique du Nord et du Moyen Orient. Delachaux et Niestlé, Neuchâtel.
Isenmann P, Moali A (2000) Oiseaux d'Algérie – Birds of Algeria. Societé d'Etudes Ornithologiques de France, Paris.
Isenmann P, Gaultier T, El Hili A, Azafzaf H, Dlensi H, Smart M (2005) Oiseaux de Tunisie – Birds of Tunisia. Societé d'Etudes Ornithologiques de France, Paris.
IUCN (2017) The IUCN Red List of threatened species. Version 2017-3. www.iucnredlist.org.
Magurran AE (2004) Measuring biological diversity. Blackwell Publishing, Malden.
Mostefai N (1997) Test of ecological analysis of the avifauna of Moutas hunting reserve (Tlemcen, Algeria). Oral presentation at 2nd ornithological conference. 15–17 March 1997. National Agronomic Institute, El Harrach.
MWO (2018) Mediterranean Wetland Outlook 2: Solutions for sustainable Mediterranean Wetlands. Tour du Valat, Arles. https://medwet.org/publications/med-wetlands-outlook-2-2018/
OJAR (2012) Legislative decree of May 8th 2012 complementary of decree 12-236 related to non-domestic animal species protected in Algeria. Official Journal of Algerian Republic.
OZHA (2020) Atlas des zones humides Algériennes classées Ramsar. Direction Générale des Forêts, Alger.
Papayannis T (2008) Action for culture in Mediterranean Wetlands. Med-INA, Athens.
Payne R (2018) Peatlands of the Mediterranean region. Page 1155–1165 in: Finlayson CM, Milton GR, Prentice RC, Davidson NC (editors) The wetland book: II: distribution, description, and conservation. Springer Netherlands, Dordrecht.
Taylor NG, Grillas P, Al Hreisha H, Balkız Ö, Borie M, Boutron O, Catita A, Champagnon J, Cherif S, Çiçek K, Costa LT, Dakki M, Fois M, Galewski T, Galli A, Georgiadis NM, Green AJ, Hermoso V, Kapedani R, Lange MA, Mateljak Z, Osta M, Papastergiadou E, Papazoglou C, Sabater S, Samraoui B, Samraoui F, Si Bachir A, Tankovic E, Thévenet M, Troya A, Sutherland WJ (2021) The future for Mediterranean wetlands: 50 key issues and 50 important conservation research questions. Regional Environmental Change 21: 33.
Vié JC, Hilton-Taylor C, Pollock C, Ragle J, Smart J, Stuart SN, Tong R (2008) The IUCN Red List: a key conservation tool. In: Vié JC, Hilton-Taylor, Stuart SN (editors) The 2008 Review of The IUCN Red List of Threatened Species. IUCN, Gland.
Voous KH (1960) Atlas of European birds. Nelson, New York.

Manuscript received 1 May 2022

Authors

Imene Benzina is a University senior lecturer, interested in studying the ecology of benthic macroinvertebrates and conservation of continental hydrosystems. Professor Abdelkrim Si Bachir works on ornithology, entomology and conservation, in particular of continental aquatic ecosystems. Christian Perennou is a project leader with the Tour du Valat Research Institute for the Conservation of Mediterranean Wetlands, working for the Mediterranean Wetlands Observatory.

Imene Benzina, Abdelkrim Si Bachir, Department of Ecology and Environment, Faculty of Natural and Life Sciences, University Mostefa Benboulaid Batna 2, 05078, Algeria, e-mail i.benzina@univ-batna2.dz, a.sibachir@univ-batna2.dz; Christian Perennou, Institut de Recherche pour la Conservation des Zones Humides Méditerranéennes, Tour du Valat, Le Sambuc, 13200 Arles, France, e-mail perennou@tourduvalat.org

Appendix 1. Ramsar classification criteria of the Sebkhet of Aures wetlands complex (OZHA 2020, www.ramsar.org, www.wetlands.org).
Ramsar-Klassifizierungskriterien für den Feuchtgebietskomplex Sebkhet of Aures (OZHA 2020, www.ramsar.org, www.wetlands.org).

Wetland	Ramsar classification criteria *IBA criteria (status of sites qualified as Important Bird Area)
Gareat El Taref	*Criteria 4.* The wetland is an important wintering site especially for Common Crane, Greater Flamingo, Common Shelduck. *Criteria 6.* More than 1% of the North African regional population of Common Shelduck, nearly 27 000 individuals, and Greater Flamingo, around 12 000 individuals. **A4i* Greater Flamingo.
Gareat Timerganine	*Criteria 2.* The site hosts species of high heritage value and listed as vulnerable on the IUCN Red List: White-headed Duck, Marbled Teal, and Ferruginous Duck *Aythya nyroca*. *Criteria 3.* The site is characterized by lacustrine vegetation, which remain ideal shelter for Anatidae and grebes that winter regularly. A total of 22 waterbird species have been recorded. *Criteria 4.* This site is one of the few in Algeria that serve as a refuge and at the same time for nesting of three species (criteria 2) with high numbers in comparison with the rest of their populations in the country. **A1* Marbled Teal, Ferruginous Duck, White-headed Duck. **A4i* Ruddy Shelduck.
Garaet Guellif	*Criteria 2.* The site is home to the Marbled Teal, a vulnerable species as classified on the IUCN Red List. *Criteria 3.* The area has at least 115 plant species, which are important for the wintering and nesting of migratory and sedentary birds. *Criteria 4.* The site is a refuge and wintering area for Greater Flamingo, Common Crane, Common Shelduck, and Common Teal. *Criteria 6.* More than 1% of the regional Mediterranean population of the Common Shelduck is recorded at the site level, with an average of 3117 individuals. **A4i* Common Shelduck, Pied Avocet, Black-winged Stilt, Slender-billed Gull, Gull-billed Tern.
Garaet Annk Djemel & El Merhsel	*Criteria 2.* The site hosts Marbled Teal, a vulnerable species on the IUCN Red List. *Criteria 6.* The site hosts more than 1% of the regional population of Shelduck and Greater Flamingo. **A4i* Greater Flamingo.
Lac Boulhilet	*Criteria 2.* The site is home to several endangered bird species listed on the IUCN Red List, such as White-headed Duck and Marbled Teal, classified as vulnerable. *Criteria 4.* An important number of waterbirds frequent the site during the wintering period. *Criteria 6.* The number of individuals of Common Crane recorded represents more than 1% of the total population of North Africa. The site is also home to nearly 4% of the White-headed Duck population of North Africa. **A1* Marbled Teal, White-headed Duck.
Sebkhet Ezzmoul	*Criteria 3.* The site hosts a large population of wintering and passing waterbirds (Anatidae, Greater Flamingo). *Criteria 4.* Ezzmoul is one of the most important sites for Greater Flamingo wintering (10 000 individuals) and nesting in the western Mediterranean basin. *Criteria 6.* The site hosts a large breeding population of Greater Flamingo (15 000 individuals, 7% of Mediterranean population) and wintering population of Common Shelduck (4000 individuals, 6% of Mediterranean population). **A4i* Greater Flamingo, Egyptian Vulture *Neophron percnopterus*.
Chott Tinsilt	*Criteria 4.* The site is an important wintering area for waterbirds, in particular for Common Shelduck. *Criteria 6.* The Chott Tinsilt hosts a bird population greater than 1% of the regional population of Common Shelduck. **A1* Marbled Teal, Ferruginous Duck, Egyptian Vulture.

Wetland	Ramsar classification criteria *IBA criteria (status of sites qualified as Important Bird Area)
Chott El Beida	*Criteria 4.* This wetland is a habitat for wintering birds, located on the migratory route linking Europe to Africa. The site is home to 15 species protected by Algerian law, including two breeding species: Common Shelduck and European Bee-eater *Merops apiaster*. *Criteria 6.* The site hosts more than 1% of the populations of Common Shelduck and Greater Flamingo of the Mediterranean region.
Sebkhet Bazer Sakra	*Criteria 2.* Several species recorded at the site, including White-headed Duck, Marbled Teal and Greater Flamingo. *Criteria 4.* The site hosts sedentary and migratory birds. Birds benefit from favorable conditions for resting, wintering, and breeding. *Criteria 6.* The site is home to 1% of the individuals of Common Shelduck and Greater Flamingo of the Mediterranean region. **A1* Marbled Teal, Ferruginous Duck.
Sebkhet El Hamiet	*Criteria 4.* The site is a transit, refuge and wintering area for birds. It is also a relay for migratory birds coming from northern Europe and the southern Sahel. The site hosts 24 waterbird species, 11 of which are protected by Algerian law, such as Common Shelduck, Ruddy Shelduck, Greater Flamingo, Pied Avocet, Black-winged Stilt, White Stork, Green Sandpiper, Greylag Goose, and Common Ringed Plover. *Criteria 6.* The site is of international importance for wintering waterbirds, in particular for Common Shelduck and Greater Flamingo, of which it usually shelters more than 1% of the populations of the North African region.
Chott El Hodna	*Criteria 1.* The site is located in an arid zone and is another asset with very little human-modified natural environments. The chott is a representative model on the pedological, bioclimatic and biological level. *Criteria 2.* The site is home to a vulnerable species that declined due to the decrease of its natural habitat: the Marbled Teal. *Criteria 3.* The site is of extreme importance for Marbled Teal, protected in Algeria and listed on the IUCN Red List. *Criteria 5.* The site hosts a large population of waterbirds, approaching 20 000 individuals per year. The population of waterbirds counted in some years exceeded 30 000 individuals from about twenty species. *Criteria 6.* The site hosts waterbird populations whose numbers are more than 1% on an international scale, with an average of more than 2300 individuals recorded for Greater Flamingo, 1120 individuals for Ruddy Shelduck, and 4600 individuals for Common Shelduck. *Criteria 7.* The hydrographic network hosts a large population of fish such as the Common Barbel *Barbus barbus*. **A1* Ruddy Shelduck, Marbled Teal.
Chott Melghir	*Criteria 1.* Semi-permanent wetland, located in the northern Saharan region, at lower than sea level. *Criteria 2.* Several endemic and vulnerable plant species have been identified on the site. About ten plant species are restricted to the region, 6 of which are found only in Algeria, Tunisia and Morocco. The most notable are *Fagonia microphylla*, *Oudneya africana* and *Ammosperma cinerea*, all endemic to Algeria.