

An ornithological survey of Algerian wetlands: Important Bird Areas, Ramsar sites and threatened species

BOUDJÉMA SAMRAOUI & FARRAH SAMRAOUI

Laboratoire de Recherche des Zones Humides, Département de Biologie,
University of Guelma, 4 rue Hassi-Beïda, Annaba, Algeria.
Email: bsamraoui@yahoo.fr

Abstract

Surveys were undertaken of 100 major wetlands across ten distinct regions of Algeria in 2002–2008, to determine the numbers of wetland birds using these sites, to provide new data on wetlands of international importance, and thus to indicate priorities for conservation action. Ninety-nine wetland birds were recorded and 41 sites met one or more of the criteria required for an Important Bird Area (IBA). This brought the total number of sites qualifying as IBAs in Algeria to 53 of which 21 are not currently listed as part of the IBA network. Fourteen of Algeria's current IBAs qualify as Ramsar sites, and all 21 of the potential IBAs also qualify for designation as wetlands of international importance under the Ramsar Convention. The sites visited during the surveys were spread across the Tell, the Hauts Plateaux and the Sahara and most held over 1% of a threatened waterbird species. Many of the sites included in the surveys were found to be more important for breeding and migratory waterbirds than had previously been recognised, and their locations along three north–south corridors make them particularly vital as staging areas before or after crossing the Sahara desert. We focused on sites used by wetland birds for breeding and found that Lake Fetzara was particularly important, hosting 23 of the 36 species known to breed in northeast Algeria. Building upon previous work, the present study provides a thorough assessment of the ornithological importance of Algerian wetlands. Many of the internationally important sites and ornithological hot-spots are under heavy pressure from man and are in urgent need of protection and other conservation measures.

Key words: breeding, conservation status, migration, North Africa, ornithological hot-spots, stopover, waterbirds, winter quarters.

The bird fauna of Algeria is relatively well known, due to data collected by dedicated ornithologists over the past two centuries (Heim de Balsac & Mayaud 1962; Ledant *et al.* 1981; Isenmann & Moali 2000). Yet there are major gaps in knowledge of the birds' status, distribution, seasonal movements and habitat use, particularly for wetland species. Algeria houses a great diversity of wetlands which are important staging posts and wintering grounds for migrating Palearctic birds (Stevenson *et al.* 1988; Coulthard 2001; Boulkhssaim *et al.* 2006). The country also includes important breeding sites for several rare, endangered or biome-restricted species including Audouin's Gull *Larus audouinii*, White-headed Duck *Oxyura leucocephala*, Ferruginous Duck *Aythya nyroca*, Marbled Teal *Marmorenetta angustirostris* and Eleonora's Falcon *Falco eleonora* (Spaans *et al.* 1976; Jacob & Jacob 1980). However, lack of data on distribution, breeding and population trends has made it difficult to draw firm conclusions about the conservation status of some species and to develop action plans for species threatened by human pressure on Algerian wetlands.

The Important Bird Areas (IBA) programme of BirdLife International is a global initiative aimed at identifying and protecting a network of critical sites for the conservation of the world's birds (Fishpool & Evans 2001). The IBA programme in Africa, which commenced in 1993, identified 31 IBAs in Algeria, of which 22 were wetlands (Coulthard 2001). In the light of continued threats to waterbirds through global climate change and anthropogenic pressures, we undertook further surveys of Algerian

wetlands in the early 21st century to identify additional potential IBAs, and also sites that would qualify for designation as wetlands of international importance under the Ramsar Convention. Current and pending threats to the integrity of these sites were recorded, together with potential measures for ensuring their effective conservation.

Study sites

With a total area of 2,381,741 km², Algeria is the second largest country in Africa and has a typical Mediterranean climate characterised by alternating wet and dry seasons. There is a distinct latitudinal gradient in the climate, from sub-tropical in the coastal northeast part of the country to semi-arid in the Hauts Plateaux and an arid climate across the Sahara.

The surveys were made across ten distinct regions within three broad climatic belts: the coastal wetlands and the Atlas Mountains (collectively known as the Tell), the Hauts Plateaux, and the Sahara. Environmental conditions varied between the climate belts due to different combinations of rainfall, latitude and altitude. The Tell is also more densely inhabited with major towns (Algiers, Oran and Annaba) concentrated on the coastal plains. There were six regions in the Tell: (1) Eastern Numidia (EN), (2) Western Numidia (WN), (3) Guelma wetlands (G), (4) the Jijel complex (JC), (5) the Algiers region (AR), and (6) the Oran complex (OC); three regions in the Hauts Plateaux: (7) Eastern High Plateaux (EHP), (8) Central High Plateaux (CHP), (9) Western High Plateaux (WHP), and (10) Sahara (S) was treated as a single zone (Fig. 1). Surveys in the Sahara

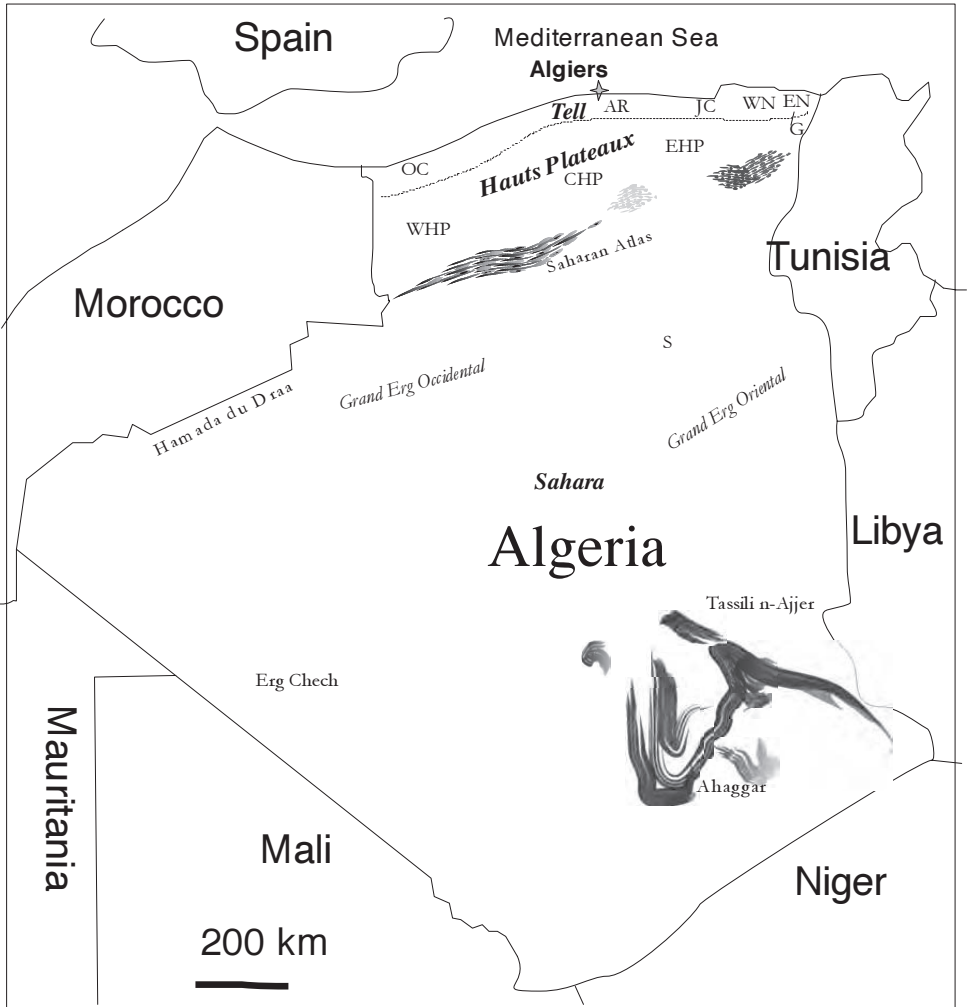


Figure 1. The location of the ten regions surveyed across Algeria. The six regions in the Tell are: Eastern Numidia (EN), Western Numidia (WN), Guelma wetlands (G), the Jijel complex (JC), the Algiers region (AR), and (6) the Oran complex (OC). The three regions in the Hauts Plateaux are: Eastern High Plateaux (EHP), Central High Plateaux (CHP), and Western High Plateaux (WHP). The Saharan region (S) covers a wide area, south of the Saharan Atlas Mountains to the middle of the Sahara desert.

were mainly in the Oued Righ valley and at El Goléa.

Methods

Between 2002 and 2008, attempts were made to survey all major wetlands within the three climatic belts. Many of the wetlands visited were known from previous surveys (Samraoui & Menaï 1999; Samraoui & Corbet 2000). Some new areas were located from maps and a few were introduced to us by conservationists. Phenological data were recorded simply as the presence or absence of species seen at each site during surveys made half-monthly in Numidia and monthly for the Eastern Hauts Plateaux region in each year of the study, although the birds were also often counted. More frequent surveys, involving at least two field-trips per week, were undertaken by 2–4 people (the authors and students) throughout the breeding season (February–August). Half-monthly counts (in eastern Numidia), monthly counts (in eastern Hauts Plateaux and the Sahara) and winter counts (in western Numidia and Jijel) were also carried out by co-workers for a number of years during the study period; these have been reported separately for some species (Boulkhsaïm *et al.* 2006; Samraoui & Samraoui 2007). Several of the sites were large salt lakes, at which it is difficult to obtain a complete count of the birds present from ground surveys, so only minimum numbers were recorded.

Sampling effort was not uniform across the study area. Indeed, more effort was devoted to wetlands in eastern Algeria, which is in part justified by the number and

diversity of habitats in that region. Some wetlands, mainly in the western part of Algeria, were visited only once. Chott Merouane and Oued Khrouf, although grouped as a single IBA site (Coulthard 2001) were judged sufficiently distinct to warrant treating them separately. Similarly, the Guerbes Senhadja wetland complex encompasses a variety of habitats (Samraoui & de Bélaïr 1997) that have been dealt with separately in the present assessment.

Sites were considered to be of IBA status if they met one of the following IBA criteria as described in Fishpool & Evans (2001), namely that the site regularly holds: (1) species of global conservation concern (A1 criterion), (2) a significant component of restricted range species (A2 criterion), (3) a significant component of a species whose distribution is largely confined to one biome (A3 criterion), or (4) significant numbers of a congregatory bird species (A4 criterion). Potential Ramsar sites were those that matched one of the numerical criteria of the Ramsar Convention, by supporting at least 20,000 waterbird species, or by regularly supporting at least 1% of the individuals in a biogeographic population of waterbird species. There is a great deal of similarity between IBA criteria (A1, A4i, A4ii, A4iii, A4iv, B1i, B1ii, and B1iii) and Ramsar criteria (2, 4, 5, and 6) and it is to be expected that most wetland IBAs would qualify as potential Ramsar sites. Global threat status and population thresholds follow BirdLife International (2001) and Wetlands International (2006). With regards to habitats, threats were classified as ‘High’ when current impact has considerably degraded the ecological integrity of the site,

as 'Medium' when anthropogenic impact has brought marked changes to ecological processes, and as 'Low' when only minor impacts have been detected. Although subjective, these categories aim to highlight threats to important wetlands and the urgency of their protection.

Results

A total of 100 wetlands were visited during the surveys, at which 99 species were recorded. Of these, 41 qualified as IBAs because they complied with at least one of the IBA criteria, including 19 already listed as IBAs (Table 1). Most of the sites qualifying as IBAs (78%) occurred within just four districts: the Eastern Hauts Plateaux (12 IBAs), Eastern Numidia (9 IBAs), the Oran complex (5 IBAs) and the Sahara (Oued Righ and El Goléa; 6 IBAs).

The sites qualifying as IBAs are aligned along three north–south transects (Fig. 2). The eastern flyway consists of sites in Numidia, the Eastern Hauts Plateaux and the Oued Righ valley. The central flyway encompasses the Lac of Réghaïa (a Ramsar site in the Algiers region), the Lac of Boughzoul in the Central High Plateaux, two other Ramsar sites (Zahrez Chergui et Zahrez Gharbi), Oguila Dar Chioukh and Lac of Goléa. Thirdly, the Oran complex, Dayet El Ferd, Chott Chergui, Sebkhia of Naama and Aïn Ben Khelil constitute a western flyway. The diversity and connectivity of these three flyways are crucial for desert migrants (herons, storks, ibises, waders, ducks and passerines) that cross the Algerian desert.

The most species-rich wetlands included

Salines (72 species; three of them breeding), Lac Fetzara (61 species), the Mekhada (49 species), Timerganine and Lac des Oiseaux (each with 48 species) and Lac Tonga (46 species) (Table 1). Currently Algeria has 42 Ramsar sites and of these 33 are or were of ornithological interest (Table 2) with 19 qualifying as IBAs. Because of insufficient sampling or prolonged drought, some species-rich sites did not meet IBA criteria in the present study (Table 3). Several sites, including the Lac Mellah IBA and Ramsar site, have become degraded with a concomitant decrease in bird diversity.

Similarly, of 99 species identified during the surveys (Fig. 3), 36 were seen breeding, including three species not known at the start of the study to breed in Algeria: Greater Flamingo *Phoenicopterus roseus*, Slender-billed Gull *Larus genei* and Avocet *Recurvirostra avosetta*. Other species that have not been or have rarely been recorded breeding since the 19th century were Common Shelduck *Tadorna tadorna*, Glossy Ibis *Plegadis falcinellus* and Red-knobbed Coot *Fulica cristata*. Waterbirds were seen breeding at 30 wetlands in northeast Algeria (*i.e.* not including terrestrial sites used by Cattle Egrets *Ardea ibis* and White Storks *Ciconia ciconia*), where the main breeding areas were Eastern Numidia (7 sites with at least 5 breeding species), Eastern Hauts Plateaux (4 sites) and Western Numidia (3) (Table 4). The most important breeding sites, in terms of species richness, were Lac Fetzara, Lake Tonga, the Mekhada marsh, Boussedra and Tinsilt (Table 4). While harbouring far fewer breeding species, Ezzemoul and Guelif can each support over 5,000 nests (Samraoui *et al.* 2006; B. Samraoui unpubl. data).

Table 1. Status of Algerian wetlands qualifying as Important Bird Areas (IBAs).^a Site codes for sites not listed as IBAs run on from the previous IBA site code.^b Site boundaries used here differ to those for the listed IBAs (e.g. the Chott Merouane and Oued Khrouf IBA is treated as two sites).

IBA site code ^a	Sites	Recorded species	Threats	Current status	Global IBA criteria
DZ001	Lac Oubeira (EN)	37	Medium	Ramsar, IBA	A1 (<i>O. leucocephala</i>), A4iii
DZ002	Lac Tonga (EN)	46	Medium	Ramsar, IBA	A1 (<i>A. nyroca</i> , <i>M. angustirostris</i> , <i>O. leucocephala</i>), A4i (<i>A. ralloides</i>), A4iii
DZ005	Lac des Oiseaux (EN)	48	Medium	Ramsar, IBA	A1 (<i>A. nyroca</i> , <i>O. leucocephala</i>)
DZ006	Mekhada (EN)	49	High	Ramsar, IBA	A1 (<i>A. nyroca</i> , <i>M. angustirostris</i>), A4i (<i>A. ralloides</i>), A4iii
DZ008	Fetzara (WN)	61	Medium	Ramsar, IBA	A1 (<i>A. nyroca</i> , <i>M. angustirostris</i> , <i>O. leucocephala</i>), A4i (<i>P. roseus</i> , <i>A. ralloides</i>), A4iii
DZ009 ^b	Hadj Tahar (WN)	34	Medium	Ramsar (<i>Gierbes</i>), IBA	A1 (<i>A. nyroca</i> , <i>O. leucocephala</i>)
DZ010	Bazer Sakra (EHP)	24	Low	Ramsar, IBA	A1 (<i>A. nyroca</i> , <i>M. angustirostris</i>)
DZ011	Chott Tinsilt (EHP)	32	Medium	Ramsar, IBA	A1 (<i>A. nyroca</i> , <i>M. angustirostris</i>)
DZ012	Ezzemoul (EHP)	15	High	IBA	A4i (<i>P. roseus</i>)
DZ013	Djendli (EHP)	13	Medium	IBA	A1 (<i>M. angustirostris</i>), A4i (<i>P. roseus</i> , <i>T. tadornia</i>)
DZ014	Garaet Tarf (EHP)	17	Medium	Ramsar, IBA	A4i (<i>P. roseus</i>)
DZ015	Boughzoul (CHP)	32	Medium	IBA	A1 (<i>T. ferruginea</i> , <i>M. angustirostris</i>)
DZ016	Dayet El Ferd (WHP)	29	Low	Ramsar, IBA	A4i (<i>T. ferruginea</i>)
DZ017	La Mactra (OC)	18	Medium	Ramsar, IBA	A1 (<i>L. andouinii</i>)
DZ018	Grande Sebkhia d'Oran (OC)	8	High	Ramsar, IBA	A4i (<i>P. roseus</i>)
DZ019 ^b	Oued Khrouf (S)	33	Low	Ramsar, IBA	A1 (<i>M. angustirostris</i>)
DZ019 ^b	Chott Merouane (S)	3	Low	Ramsar, IBA	A4iii

DZ030	Iles Habibas (OC)	6	High	IBA	A1 (<i>L. audouinii</i>), A3 (<i>F. eleonorae</i>)
DZ031	Ile Rachgoun (OC)	7	High	IBA	A3 (<i>F. eleonorae</i>)
DZ032	Salines (EN)	72	Medium	Not protected	A1 (<i>O. leucocephala</i>)
DZ033	Boussedra (EN)	35	High	Not protected	A1 (<i>A. nyroca</i> , <i>O. leucocephala</i>)
DZ034	Sidi Achour (EN)	18	High	Not protected	A1 (<i>A. nyroca</i>)
DZ035	Dakhla (EN)	13	High	Not protected	A4i (<i>A. ralloides</i>)
DZ036	Chatt (EN)	10	High	Not protected	A4i (<i>A. ralloides</i>)
DZ037	Ile Srighina (WN)	3	Medium	Not protected	A3 (<i>F. eleonorae</i>)
DZ038	Beni Belâïd (JC)	16	Low	Ramsar	A1 (<i>A. nyroca</i>)
DZ039	Dayet Morcelly (OC)	20	High	Not protected	A1 (<i>A. nyroca</i> , <i>M. angustirostris</i> , <i>O. leucocephala</i>)
DZ040	Timerganine (EHP)	48	Medium	Not protected	A1 (<i>A. nyroca</i> , <i>M. angustirostris</i> , <i>O. leucocephala</i>), A4i (<i>T. ferruginea</i>)
DZ041	Tazougart II (EHP)	32	Low	Not protected	A1 (<i>A. nyroca</i> , <i>M. angustirostris</i>)
DZ042	Chott Hodna (EHP)	24	High	Ramsar	A1 (<i>T. ferruginea</i> , <i>M. angustirostris</i>)
DZ043	Boulehilet (EHP)	23	High	Not protected	A1 (<i>M. angustirostris</i> , <i>O. leucocephala</i>)
DZ044	Guelif (EHP)	22	High	Ramsar	A4i (<i>T. tadorna</i> , <i>A. recurvirostra</i> , <i>H. bimantopus</i> , <i>L. genei</i> , <i>S. nilotica</i>)
DZ045	Tazougart I (EHP)	12	Low	Not protected	A1 (<i>O. leucocephala</i>)
DZ046	Ank Djmel (EHP)	5	Medium	Ramsar	A4i (<i>P. roseus</i>)
DZ047	Oguila Dar Chiroukh (CHP)	9	Unknown	Not protected	A4i (<i>T. ferruginea</i>)
DZ048	Boughrara's reservoir (WHP)	13	Medium	Not protected	A1 (<i>O. leucocephala</i>)
DZ049	Sebkha of Naama (WHP)	3	Medium	Ramsar	A4i (<i>T. ferruginea</i>)
DZ050	Merja Hamraïa I (S)	28	Medium	Not protected	A1 (<i>A. nyroca</i> , <i>M. angustirostris</i>)
DZ051	Sidi Amrane (S)	19	Medium	Not protected	A1 (<i>M. angustirostris</i>)
DZ052	Merja Hamraïa II (S)	15	Low	Not protected	A1 (<i>M. angustirostris</i>), A4i (<i>T. ferruginea</i>)
DZ053	Lac d'El Goléa (S)	12	Medium	Ramsar	A1 (<i>A. nyroca</i>), A4i (<i>T. ferruginea</i>)

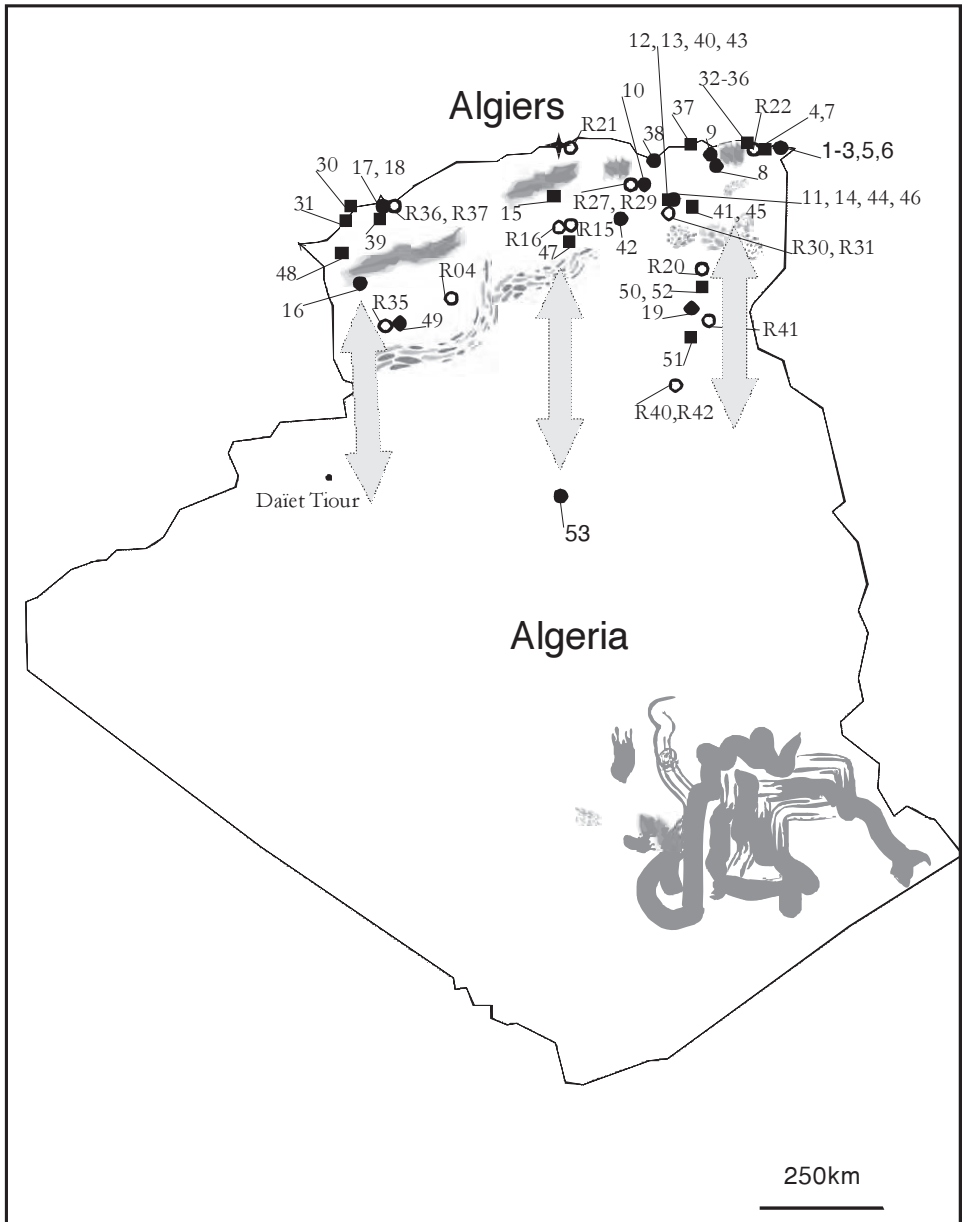


Figure 2. The location of sites in Algeria qualifying as Ramsars sites (empty circles), IBAs (filled squares) and sites fulfilling the criteria for both designations (filled circles). Site codes relate to the codes given in Table 1 and Table 2.

Table 2. Ramsar sites of ornithological importance in Algeria.

Ramsar site code	Site name	Year designated as a Ramsar site	IBA status, or reasons why the site not included as an IBA
R01	Lac Tonga (EN)	1982	IBA
R02	Lac Oubeïra (EN)	1982	IBA
R03	Lac des Oiseaux (EN)	1999	IBA
R04	Chott Chergui (WHP)	2001	Insufficient sampling
R05	Guerbes (WN)	2001	IBA (<i>Hadj Tabar</i>)
R06	Chott Hodna (EHP)	2001	Meets IBA criteria
R09	Chott Merouane et Oued Khrouf (S)	2001	Two IBAs
R10	Macta (OC)	2001	IBA
R12	Grande Sebkhia d'Oran (OC)	2001	IBA
R15	Zehrez Chergui (CHP)	2003	Drought
R16	Zehrez Gharbi (CHP)	2003	Insufficient sampling
R19	Mekhada (EN)	2003	IBA
R20	Chott Melghir (S)	2003	Drought
R21	Lac de Réghaïa (AR)	2003	Insufficient sampling
R22	Lac Noir (EN)	2003	Degraded (de Bélair & Samraoui, 1994)
R24	Lac de Béni Bélaïd (JC)	2003	Meets IBA criteria
R26	Fetzara (WN)	2003	IBA
R27	Sebkhet Hamiet (EHP)	2004	Insufficient sampling
R28	Bazer Sakra (EHP)	2004	IBA
R29	Beïda Bordj (EHP)	2004	Insufficient sampling
R30	Ank Djmel et Maghssel (EHP)	2004	Meets IBA criteria
R31	Guelif (EHP)	2004	Meets IBA criteria
R32	Chott Tinsilt (EHP)	2004	IBA
R33	Garaet Tarf (EHP)	2004	IBA
R34	Dayet El Ferd (WHP)	2004	IBA
R35	Aïn Ben Khelil (WHP)	2004	Drought
R36	Salines d'Arzew (OC)	2004	Insufficient sampling
R37	Lac de Telamine (OC)	2004	Insufficient sampling
R38	Lac Mellah (EN)	2004	Degraded due to hydrological changes
R39	Lac d'El Goléa (S)	2004	Meets IBA criteria
R40	Sidi Khouiled (Chott Oum Raneb) (S)	2004	Insufficient sampling
R41	Chott Sidi Slimane (S)	2004	Drought
R42	Chott Aïn El Beïda (S)	2004	Drought/degraded

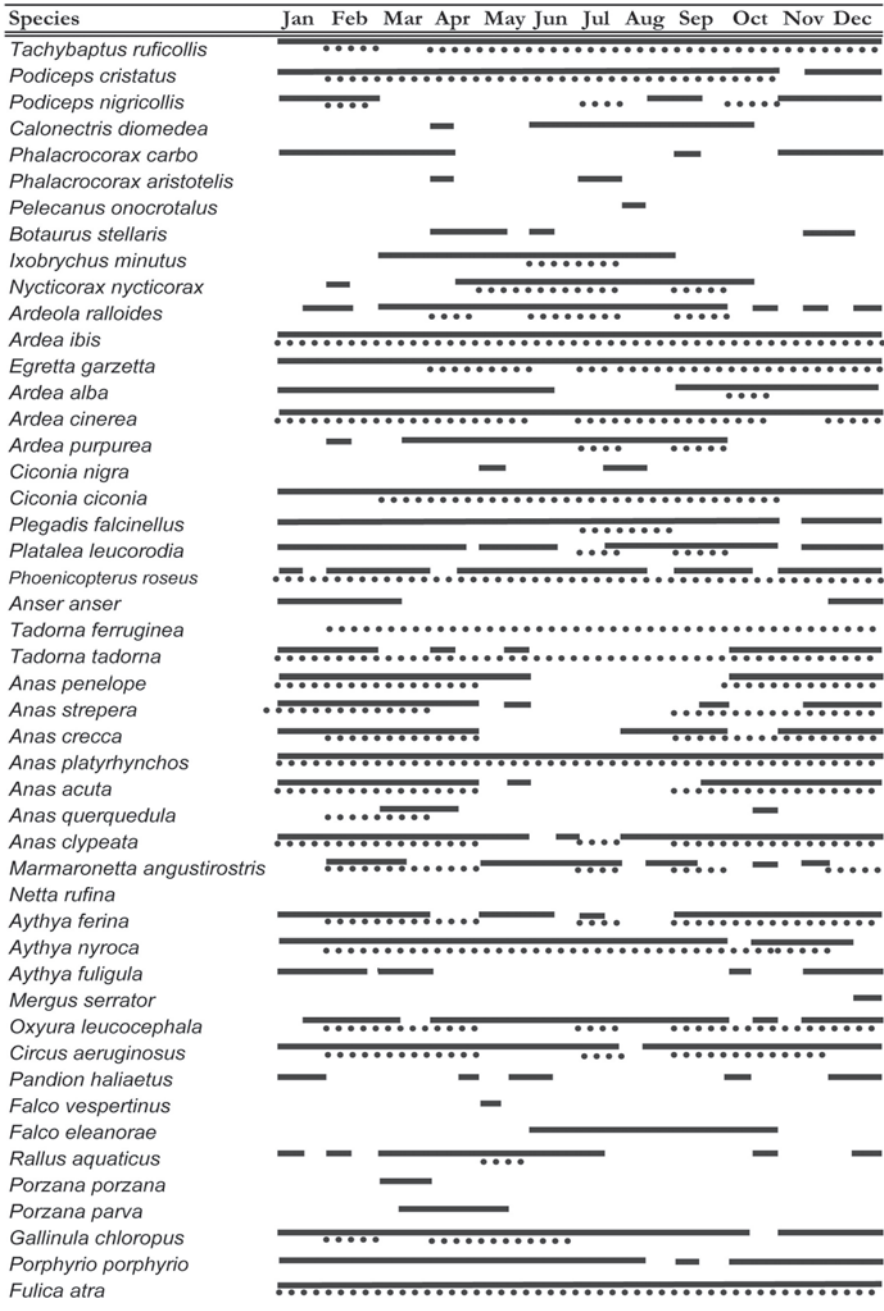


Figure 3. Species observed in the coastal region (continuous line) and the Hauts Plateaux (dotted line) during the surveys.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Fulica cristata</i>											
<i>Grus grus</i>
<i>Haematopus ostralegus</i>		—								—		
<i>Himantopus himantopus</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————
<i>Recurvirostra avosetta</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————
<i>Burhinus oediconemus</i>				———					
<i>Cursorius cursor</i>											
<i>Glareola pratincola</i>				—————			—			
<i>Charadrius morinellus</i>											
<i>Charadrius dubius</i>	—	—			—	—————	—————
<i>Charadrius hiaticula</i>					—			—		—		—
<i>Charadrius alexandrinus</i>	—————
<i>Pluvialis apricaria</i>	—————									———	———
<i>Pluvialis squatarola</i>	—————			—			———	———	
<i>Vanellus vanellus</i>								—————
<i>Calidris canutus</i>										—		
<i>Calidris alba</i>	—————	—————	—————	—————	—————					———	———
<i>Calidris minuta</i>	—————
<i>Calidris ferruginea</i>	—————		
<i>Calidris alpina</i>		—————					—————	—————
<i>Philomachus pugnax</i>				—					———		
<i>Lymnocyptes minimus</i>			—	—								—
<i>Gallinago gallinago</i>	—————							—————	—————	—————
<i>Limosa limosa</i>		—————		—				———		———
<i>Limosa lapponica</i>									—			
<i>Numenius phaeopus</i>									———		
<i>Numenius arquata</i>	———
<i>Tringa erythropus</i>		—	—————	—————	———				———	———
<i>Tringa totanus</i>	—————			———	———		———	———
<i>Tringa stagnatilis</i>				—	———				———		
<i>Tringa nebularia</i>	—————
<i>Tringa ochropus</i>		—————		———			———	———	———
<i>Tringa glareola</i>	—											
<i>Actitis hypoleucos</i>	—————	———		
<i>Arenaria interpres</i>										—		
<i>Larus melanocephalus</i>		———										———
<i>Larus minutus</i>		—————	———	———					———		———	———
<i>Larus ridibundus</i>	—————
<i>Larus genei</i>	—————
<i>Larus audouinii</i>	———						———			———		
<i>Larus fuscus</i>	—————	———	———	———	———	———	———	———	———	———	———	———
<i>Larus michahellis</i>	—————
<i>Sterna nilotica</i>			
<i>Sterna caspia</i>				———						———		
<i>Sterna bengalensis</i>	———					———			———			
<i>Sterna sandvicensis</i>	—————	———	———	———	———	———	———	———	———	———	———	———
<i>Sterna hirundo</i>										———		
<i>Sterna albifrons</i>					———	———	———	———	———			
<i>Chlidonias hybridus</i>	———	———	———	———	———	———	———	———	———	———	———
<i>Chlidonias leucopterus</i>					———							
<i>Chlidonias niger</i>					———	———	———	———		

Table 3. Species-rich sites which did not qualify as an IBA based on data recorded during the present survey.

Sites	Recorded species	Threats	Current status	Reasons not meeting Ramsar/IBA criteria
Boukhmira (EN)	38	Low	Not protected	Insufficient sampling
Garaet M'Hamed (WN)	26	Low	Ramsar (<i>Guerbes</i>), IBA	Aerial sampling needed
Oum El Ghelez (OC)	22	Medium	Not protected	Insufficient sampling
Lac Mellah (EN)	18	Medium	Ramsar, IBA	Degraded
Mafragh estuary (EN)	18	High	Not protected	Degraded
Lac de Reghaïa (AR)	16	Medium	Ramsar	Insufficient sampling
Jemott (EHP)	16	Low	Not protected	Insufficient sampling
Sidi Makhlouf (WN)	16	Medium	Ramsar (<i>Guerbes</i>), IBA	Insufficient sampling
Chichaya (WN)	15	Medium	Ramsar (<i>Guerbes</i>), IBA	Insufficient sampling
Guelb (WN)	15	Medium	Ramsar (<i>Guerbes</i>), IBA	Insufficient sampling
Sidi Chahmi (OC)	13	High	Not protected	Degraded
Sidi Salem beach (EN)	12	High	Not protected	Degraded
Chekaka (WN)	12	Unknown	Not protected	Insufficient sampling
Boucif (EHP)	12	Medium	Not protected	Drought
Tindla (S)	12	Low	Not protected	Insufficient sampling
Aïn Makhlouf reservoir (G)	11	Low	Not protected	Insufficient sampling
Bekouche Lakhdar (G)	11	Low	Not protected	Insufficient sampling
Mengoub (OC)	11	Unknown	Not protected	Insufficient sampling
Chott Chergui (WHP)	11	Unknown	Ramsar	Insufficient sampling
Oued Seybouse II (G)	10	Medium	Not protected	Insufficient sampling

The timing of the occurrence of each species in Algeria (with the exception of the Red-crested Pochard *Netta rufina*, noted only in the Sahara) is shown in Fig. 3. Over the last decade, individuals of a number of species (White Stork, Squacco Heron *Ardeola ralloides*, Black-crowned Night Heron *Nycticorax nycticorax* and Whiskered Tern *Chlidonias hybridus*) have been recorded overwintering in coastal wetlands. Small groups of other species (Great Egret *Ardea alba* and Eurasian Spoonbill *Platalea leucorodia*) have begun to spend the summer in the same coastal wetlands or in the Hauts Plateaux (Glossy Ibis and Black-headed Gull *Larus ridibundus*).

The species of greatest conservation concern found breeding in Algeria were Marbled Teal, White-headed Duck, Audouin's Gull, and Eleonora's Falcon (Table 5). All known breeding sites of Audouin's Gull (the offshore rocky islands of Ile Rachgoun, Iles Habibas and Kef Amor) have been degraded through pollution, human disturbance, and the presence of rats and other predators. In all of these islands, an increase in the commensal Yellow-legged Gull *Larus michahellis* has corresponded with a decline in Audouin's Gull numbers (Isenmann & Moali 2000). Both Little Crake *Porzana parva* and Eurasian Spoonbill bred over a century ago at Lake Fetzara but we were unable to confirm their breeding during the study period (Table 5). The Great Bittern *Botaurus stellaris* is thought to have bred at Mekhada marsh in 2005 and at Lake Fetzara in 2006, on the basis of a number of singing males. This bird is now thought to be a rare resident breeder in Tunisia (Isenmann *et al.*

2005), and possibly no longer breeds in Morocco (Thévenot *et al.* 2003).

Ducks were among the most dispersed of the wetland birds (Table 6). Lake Fetzara and numerous salt lakes across the Hauts Plateaux (Timerganine, Chott Tinsilt, Chott Hodna and Bazer Sakra) and the Sahara (Chott Merouane, Oued Khrouf and El Goléa) held large flocks of several thousand migrant ducks such as Northern Shoveler *Anas chrypeata*, Eurasian Wigeon *Anas penelope* and Northern Pintail *Anas acuta* (B. Samraoui unpubl. data). Although breeding was widely recorded for Ferruginous Duck (9/35 sites) and Black-winged Stilt *Himantopus himantopus* (9/47 sites) (Table 6), only a few sites (Tonga and Fetzara for the former, in favourable years; Guelif and Tazougart II for the latter) hold hundreds of nests. Partly due to persecution (both species being highly prized by hunters and poachers), Greylag Geese *Anser anser* and Common Crane *Grus grus* were found in large numbers (several thousand birds) at only a few sites in the coastal region (Mekhada and Lake Fetzara) and in the Hauts Plateaux (Marshel and Dayet El Ferd), respectively.

Discussion

The present study is the first to present comprehensive survey data on breeding and wintering habitats of Algerian wetland birds since the seminal work of Heim de Balsac & Mayaud (1962). It also supports and extends the previous work of Coulthard (2001), which provided the first assessment of Important Bird Areas (IBAs) of Algeria, and updates data provided by Coulthard (2001)

Table 4. Noteworthy breeding sites in northeast Algeria.

Sites	No. years visited during the surveys	No. of breeding species	Species recorded breeding (no. of years breeding)
Fetzara (WN)	3	23	<i>Podiceps nigricollis</i> (3), <i>P. cristatus</i> (3), <i>Ixobrychus minutus</i> (3), <i>Nycticorax nycticorax</i> (2), <i>Ardeola ralloides</i> (3), <i>Ardea ibis</i> (3), <i>Egretta garzetta</i> (3), <i>Ardea cinerea</i> (1), <i>Ardea purpurea</i> (3), <i>Ciconia ciconia</i> (3), <i>Plegadis falcinellus</i> (3), <i>Anas platyrhynchos</i> (3), <i>Marmaronetta angustirostris</i> (2), <i>Aythya nyroca</i> (3), <i>Oxyura leucocephala</i> (3), <i>Rallus aquaticus</i> (1), <i>Gallinula chloropus</i> (1), <i>Porphyrio porphyrio</i> (3), <i>Fulica atra</i> (3), <i>Clareola pratensis</i> (3), <i>Himantopus himantopus</i> (2), <i>Recurvirostra avosetta</i> (1), <i>Sterna nilotica</i> (2)
Lac Tonga (EN)	7	17	<i>Podiceps nigricollis</i> (7), <i>P. cristatus</i> (7), <i>Ixobrychus minutus</i> (7), <i>Nycticorax nycticorax</i> (7), <i>Ardeola ralloides</i> (7), <i>Ardea ibis</i> (7), <i>Egretta garzetta</i> (7), <i>Ardea purpurea</i> (7), <i>Plegadis falcinellus</i> (6), <i>Anas platyrhynchos</i> (7), <i>Aythya nyroca</i> (7), <i>Oxyura leucocephala</i> (7), <i>Circus aeruginosus</i> (1), <i>Gallinula chloropus</i> (7), <i>Porphyrio porphyrio</i> (7), <i>Fulica atra</i> (7), <i>Chlidonias hybridus</i> (7)
Mekhada (EN)	3	13	<i>Podiceps nigricollis</i> (3), <i>P. cristatus</i> (3), <i>Nycticorax nycticorax</i> (3), <i>Ardeola ralloides</i> (3), <i>Ardea ibis</i> (3), <i>Egretta garzetta</i> (3), <i>Ardea purpurea</i> (1), <i>Ciconia ciconia</i> (3), <i>Anas platyrhynchos</i> (1), <i>Aythya nyroca</i> (1), <i>Circus aeruginosus</i> (1), <i>Porphyrio porphyrio</i> (1), <i>Fulica atra</i> (3)
Boussedra (EN)	3	12	<i>Podiceps nigricollis</i> (3), <i>P. cristatus</i> (3), <i>Ixobrychus minutus</i> (3), <i>Ardeola ralloides</i> (1), <i>Ardea ibis</i> (1), <i>Anas platyrhynchos</i> (3), <i>Aythya nyroca</i> (2), <i>Oxyura leucocephala</i> (2), <i>Circus aeruginosus</i> (1), <i>Gallinula chloropus</i> (3), <i>Porphyrio porphyrio</i> (3), <i>Fulica atra</i> (3)
Tinsilt (EHP)	2	11	<i>Podiceps nigricollis</i> (1), <i>Tadorna ferruginea</i> (1), <i>T. tadorna</i> (2), <i>Anas platyrhynchos</i> (1), <i>Aythya nyroca</i> (1), <i>Fulica atra</i> (2), <i>Himantopus himantopus</i> (1), <i>Recurvirostra avosetta</i> (1), <i>Charadrius alexandrinus</i> (2), <i>Larus genei</i> (1), <i>Sterna nilotica</i> (1)

Lac des Oiseaux (EN)	2	9	<i>Podiceps nigricollis</i> (2), <i>P. cristatus</i> (2), <i>Ixobrychus minutus</i> (2), <i>Ardea purpurea</i> (2), <i>Ciconia ciconia</i> (2), <i>Aythya nyroca</i> (1), <i>Gallinula chloropus</i> (2), <i>Porphyrio porphyrio</i> (1), <i>Fulica atra</i> (2)
Dakhlia (EN)	3	9	<i>Nycticorax nycticorax</i> (2), <i>Ardeola ralloides</i> (2), <i>Ardea ibis</i> (2), <i>Egretta garzetta</i> (2), <i>Ardea cinerea</i> (2), <i>Ardea purpurea</i> (2), <i>Plegadis falcinellus</i> (1), <i>Circus aeruginosus</i> (2), <i>Porphyrio porphyrio</i> (1)
Chatt (EN)	3	7	<i>Ardeola ralloides</i> (3), <i>Ardea ibis</i> (3), <i>Egretta garzetta</i> (3), <i>Ardea purpurea</i> (3), <i>Ciconia ciconia</i> (3), <i>Plegadis falcinellus</i> (2), <i>Anas platyrhynchos</i> (1)
Ile Rachgoun (OC)	1	6	<i>Colonectris diomedea</i> (1), <i>Ardea ibis</i> (1), <i>Egretta garzetta</i> (1), <i>Pandion haliaetus</i> (1), <i>Falco eleonorae</i> (1), <i>Larus michahellis</i> (1)
Timeganine (EHP)	2	6	<i>Podiceps nigricollis</i> (2), <i>P. cristatus</i> (2), <i>Ixobrychus minutus</i> (1), <i>Ardeola ralloides</i> (1), <i>Anas platyrhynchos</i> (1), <i>Fulica atra</i> (2)
Sidi Achour (EN)	1	6	<i>Podiceps nigricollis</i> (1), <i>Ixobrychus minutus</i> (1), <i>Ardea ibis</i> (1), <i>Anas platyrhynchos</i> (1), <i>Porphyrio porphyrio</i> (1), <i>Fulica atra</i> (1)
Guelif (EHP)	2	6	<i>Tadorna tadorna</i> (2), <i>Himantopus himantopus</i> (2), <i>Recurvirostra avosetta</i> (2), <i>Charadrius alexandrinus</i> (2), <i>Larus genei</i> (2), <i>Sterna nilotica</i> (2)
Tazougart II (EHP)	1	6	<i>Tadorna tadorna</i> (1), <i>Himantopus himantopus</i> (1), <i>Recurvirostra avosetta</i> (1), <i>Charadrius alexandrinus</i> (1), <i>Anas platyrhynchos</i> (1), <i>Fulica atra</i> (1)
Iles Habibas (OC)	1	5	<i>Colonectris diomedea</i> (1), <i>Phalacrocorax aristotelis</i> (1), <i>Falco eleonorae</i> (1), <i>Larus audouinii</i> (1), <i>Larus michahellis</i> (1)
Hadj Tahar (WN)	2	5	<i>Podiceps nigricollis</i> (2), <i>Ixobrychus minutus</i> (1), <i>Ardea purpurea</i> (1), <i>Porphyrio porphyrio</i> (2), <i>Fulica atra</i> (2)
Sidi Makhlouf (WN)	2	5	<i>Podiceps nigricollis</i> (2), <i>Aythya nyroca</i> (1), <i>Gallinula chloropus</i> (2), <i>Porphyrio porphyrio</i> (2), <i>Fulica atra</i> (2)

Table 5. Status of breeding and migrant waterbirds using Algerian wetlands. Numbers in brackets represent recorded sites (for migrants) or breeding sites/total sites where the species was recorded (for breeding species). **EN**, **VU** and **NT** indicate species listed by the International Union for Conservation of Nature as endangered, vulnerable and near threatened, respectively.

Species recorded as rare migrants	Localised breeding species
Great White Pelican <i>Pelecanus onocrotalus</i> (1)	Little Crake <i>Porzana parva</i> (0/3)
Red-crested Pochard <i>Netta rufina</i> (1)	Great Bittern <i>Botaurus stellaris</i> (0/6)
Red-breasted Merganser <i>Mergus serrator</i> (1)	Eurasian Spoonbill <i>Platalea leucorodia</i> (0/13)
Spotted Crake <i>Porzana porzana</i> (1)	Common Tern <i>Sterna hirundo</i> (1/2)
Red Knot <i>Calidris canutus</i> (1)	Little Tern <i>Sterna albifrons</i> (1/3)
Wood Sandpiper <i>Tringa glareola</i> (1)	European Shag <i>Phalacrocorax aristotelis</i> (1/3)
Ruddy Turnstone <i>Arenaria interpres</i> (1)	Audouin's Gull <i>Larus audouinii</i> (1/4) NT
White-winged Tern <i>Chlidonias leucopterus</i> (1)	Water Rail <i>Rallus aquaticus</i> (1/9)
Red-footed Falcon <i>Falco vespertinus</i> (1)	Whiskered Tern <i>Chlidonias hybridus</i> (1/11)
Eurasian Dotterel <i>Charadrius morinellus</i> (1)	Black-necked Grebe <i>Podiceps nigricollis</i> (1/12)
Black Stork <i>Ciconia nigra</i> (2)	Marbled Duck <i>Marmaronetta angustirostris</i> (1/18) VU
European Golden Plover <i>Pluvialis apricaria</i> (2)	Greater Flamingo <i>Phoenicopterus roseus</i> (1/40)
Bar-tailed Godwit <i>Limosa lapponica</i> (2)	Red-knobbed Coot <i>Fulica cristata</i> (2/2)
Whimbrel <i>Numenius phaeopus</i> (2)	Osprey <i>Pandion haliaetus</i> (2/9)
Little Gull <i>Larus minutus</i> (2)	Ruddy Shelduck <i>Tadorna ferruginea</i> (2/15)
Caspian Tern <i>Sterna caspia</i> (2)	Grey Heron <i>Ardea cinerea</i> (2/45)
Eurasian Oystercatcher <i>Haematopus ostralegus</i> (3)	Eleonora's Falcon <i>Falco eleonorae</i> (3/4)
Grey Plover <i>Pluvialis squatarola</i> (3)	Collared Pratincole <i>Glareola pratincola</i> (3/6)
Jack Snipe <i>Lymnocyrtus minimus</i> (3)	Gull-billed Tern <i>Sterna nilotica</i> (3/13)
Mediterranean Gull <i>Larus melanocephalus</i> (3)	White-headed Duck <i>Oxyura leucocephala</i> (3/14) EN
Lesser-crested Tern <i>Sterna bengalensis</i> (3)	Slender-billed Gull <i>Larus genei</i> (3/15)
	Cory's Shearwater <i>Calonectris diomedea</i> (4/7)
	Glossy Ibis <i>Plegadis falcinellus</i> (4/15)
	Common Shelduck <i>Tadorna tadorna</i> (4/34)

Table 6. Highly dispersed wetland birds in Algeria. **NT** indicates species listed as near threatened by the International Union for Conservation of Nature.

Widespread breeding species in Algeria	Highly dispersed migrant species
Common Coot <i>Fulica atra</i> (19/53)	Northern Shoveler <i>Anas clypeata</i> (47)
Cattle Egret <i>Ardea ibis</i> (14/58)	Common Pochard <i>Aythya ferina</i> (33)
White Stork <i>Ciconia ciconia</i> (11/35)	Eurasian wigeon <i>Anas penelope</i> (31)
Mallard <i>Anas platyrhynchos</i> (10/53)	Common Teal <i>Anas crecca</i> (30)
Ferruginous Duck <i>Aythya nyroca</i> (9/34) NT	Common Sandpiper <i>Actitis hypoleucos</i> (30)
Black-winged Stilt <i>Himantopus himantopus</i> (9/46)	Northern Pintail <i>Anas acuta</i> (29)
Little Grebe <i>Tachybaptus ruficollis</i> (9/42)	Gadwall <i>Anas strepera</i> (27)
Purple Swampphen <i>Porphyrio porphyrio</i> (8/19)	Black-headed Gull <i>Larus ridibundus</i> (27)
Squacco Heron <i>Ardeola ralloides</i> (8/15)	Common Snipe <i>Gallinago gallinago</i> (25)
Purple Heron <i>Ardea purpurea</i> (7/13)	Northern Lapwing <i>Vanellus vanellus</i> (22)
Little Bittern <i>Ixobrychus minutus</i> (7/9)	Great Cormorant <i>Phalacrocorax carbo</i> (21)
Great-crested Grebe <i>Podiceps cristatus</i> (7/34)	Common Greenshank <i>Tringa nebularia</i> (20)
Little Egret <i>Egretta garzetta</i> (7/44)	Little Stint <i>Calidris minuta</i> (17)
Common Moorhen <i>Gallinula chloropus</i> (6/34)	Common Redshank <i>Tringa totanus</i> (14)
Black-crowned Night Heron <i>Nycticorax nycticorax</i> (6/11)	Great Egret <i>Ardea alba</i> (13)
Kentish Plover <i>Charadrius alexandrinus</i> (6/27)	Spotted Redshank <i>Tringa erythropus</i> (13)

on the status of sites degraded through anthropogenic pressure. Results confirmed the importance of Algerian wetlands for avian biodiversity in providing key wintering sites, staging areas and breeding habitats. With a few notable exceptions (for instance Ledant *et al.* 1981; Isenmann & Moali 2000), past surveys were sporadic and rarely covered the whole of Algeria. The data presented here indicate that a reassessment of the ornithological value of Algerian wetlands is overdue by demonstrating that some areas are 'hot-spots' for waterbird species.

Of 100 wetlands surveyed, 41 qualified as IBAs, and most of these were clumped into five major clusters: Numidia (including both eastern and western parts), the Eastern Hauts Plateaux (including the Oum El Bouaghi salt lakes complex and the El Eulma wetland complex), the Oran wetland complex (extending through the regions of Oran, Aïn Temouchent, Mostaganem and Tlemcen), the Western Hauts Plateaux and the Sahara (Oued Righ valley and El Goléa). Numidia offers a mosaic of habitats of various depth, vegetation cover and salinity,

providing valuable breeding or wintering sites for birds in the region. Species-rich wetlands included sites such as Salines, Lac Fetzara, Lac Tonga, and the Mekhada. The former is a discarded salina bordered by a wadi (Oued Boukhmira), close to the seashore. It harbours a dozen basins exhibiting different water depth, making them attractive to various species of gulls and waders. The latter three sites are, with the Macta, the largest freshwater marshes of Algeria. Worthy of special note are sites like Ile Rachgoun, Iles Habibas, Timerganine, G. Hadj Tahar and Bousseadra. The ornithological importance of these three latter sites and that of Salines has previously been overlooked.

Previous assessment of key ornithological sites, based on the African Waterbird Census and other data, identified a total of 31 Important Bird Areas (IBAs) within Algeria (Coulthard 2001). Over half of all the IBAs (22) were wetlands located mostly in the Tell region and the Hauts Plateaux. Coulthard (2001) also identified two major clusters of international importance to migratory and resident birds: the El Kala complex and the salt lake complex of Oum El Bouaghi. When both the present assessment and that of Coulthard's (2001) are taken into account, a total of 53 sites (44 wetlands) qualify as IBAs in Algeria. Cheffia Reservoir did not reach IBA criteria in our survey despite two visits to the site. It had been included as an IBA on the basis of a record number of Eurasian Wigeon (95,000 individuals in 1974; Smart 1974). Lac Mellah and Bou Redim also did not qualify for IBA status in our survey, both sites having

been considerably degraded following hydrological changes in recent years. Another IBA, the poorly known Garaet El Haaies, possibly a temporary *daya* (*i.e.* a small depression holding water) located in the Erg Occidental (Coulthard 2001), was not sampled in the present study.

Over the last 25 years, the Algerian government has introduced several pieces of legislation as part of its strategy for the conservation of natural resources. This has led to the creation of Natural Reserves, Marine Reserves, Ramsar sites, National Parks and Biosphere Reserves. Yet of the 41 wetlands that on the basis of data recorded in the surveys would qualify as IBAs, 16 are not protected by national and international legislation. Many of the sites that meet the IBA criteria, such as Bousseadra (noteworthy for breeding and/or wintering Little Bittern, Great Bittern, Ferruginous Duck and White-headed Duck) and Sidi Achour (which also has Ferruginous Duck in winter) are being lost due to land-filling. There were also high level threats to several species-rich sites which did not qualify for IBA status: Mafragh estuary, Sidi Chahmi, and Sidi Salem beach. Other wetlands included in the survey found to be of less importance for waterbirds, such as Lac Bleu or several of the seasonal ponds (mare Gauthier, mare Feid and Garaet Estah) could nevertheless qualify as Ramsar sites. They are the last sanctuaries for endemic fish such as *Pseudophoxinus callensis* or the amphibians *Pleurodeles poiretii* and *P. nebulosus* (Veith *et al.* 2004). They also house a rich macroinvertebrate fauna with several Afrotropical relicts including the dragonflies *Urothemis edwardsii*, *Acisoma panorpoides* and

Diplacodes lefebvrei (Samraoui *et al.* 1993), the Belostomid *Hydrocyrius columbiae* or the water beetles *Cybister senegalensis* and *C. bipunctatus*. More sampling effort is needed to evaluate other sites which have in the past proved most interesting; for instance, a total of 37 Slender-billed Curlews *Numenius tenuirostris* was recorded at Chott El Frain in the 1980s (Gretton 1991).

Of the breeding birds, the greatest threat is perhaps to the globally near-threatened Audouin's Gull and to other coastal species such as the Common Tern *Sterna hirundo* and Little Tern *Sterna albifrons*. Open-air refuse dumps appear to benefit Yellow-legged Gulls, and an increase in Yellow-legged Gull numbers has corresponded with a decline in the Audouin's Gull (Isenmann & Moali 2000). Over-fishing and proliferation of rats and other mammals is thought to have had a negative impact on other marine birds breeding in Algeria (Bayle & Fernandez 1992; Martin *et al.* 2000). The site of the only (outlier) colony of the Common Tern has recently been developed as a beach resort. Two known breeding sites for Little Tern in northeast Algeria (Salines and the Mafragh) have also undergone extensive development. The introduction of Common Carp *Cyprinus carpio* at Lac Oubeïra has had a major effect on the local fauna and vegetation (Samraoui 2002). Some piscivorous birds (Grey Heron *Ardea cinerea*, Purple Heron *Ardea purpurea* and Great White Egret *Egretta alba*) may, on the other hand, have benefited from the expansion of carp which have now invaded most waterbodies. Hunting pressure on waterbirds is largely not documented within

the country but is considered neither as extensive nor as important as in southern Europe. Although no species is restricted to a particular belt, some (Common Crane and Greater Flamingo) are most common in the Hauts Plateaux where they are clearly targeted whereas geese and ducks are the traditional quarry in the north. Pressure on breeding birds, especially colonial birds is particularly high with egg pilfering and disturbance putting traditional breeding sites at risk (Saheb *et al.* 2006).

The commonest species are those able to use freshwater as well as brackish and even saline habitats, and the widespread distribution of Northern Shoveler, Mallard, Black-winged Stilt and Greater Flamingo can be partly explained by the nature of the wetland habitats which predominate across the region. With the exception of Numidia in the extreme northeast of Algeria, which houses mostly freshwater habitats, the vast majority of Algerian wetlands are brackish or salty, and thus can only be exploited by salt-tolerant waterbirds. As salt lakes are the dominant wetland type outside the coastal region, salt-tolerant species may be favoured. This is most true for breeding species such as ibises where nestlings may be more sensitive to salt (Bildstein 1993). The Ferruginous Duck also appears to have a wide spectrum of breeding habitats and microhabitats (including alder carrs, Salt Cedar *Carex elata* trees, islets with willow *Salix* sp. and stands of Yellow Flag *Iris pseudoacorus*) and is thus relatively widespread.

The survey data indicated that waders are among the least widespread of the birds in Algeria. This may be partly due to their

long-distance migrations, with the birds making only brief halts at Algerian wetlands. Inadequate records may also be a factor, however, as large numbers of plovers and lapwings are regularly observed at Lac Fetzara and thousands of waders use the salt lakes across the Hauts Plateaux.

With the exception of resident birds, Algerian waterbirds follow one of three main dispersal patterns during the year. The first involves Palearctic birds (many species of ducks and waders) which breed in northern Europe and visit Algeria during migration or over winter. The second is undertaken by waterbirds such as Purple Heron, Squacco Heron, Black-crowned Night Heron and Little Bittern that winter in sub-Saharan regions but move to Algeria to breed. The third movement, the least marked, involves species such as Avocet and Marbled Teal that are displaced seasonally to the Sahara to winter and return to the Hauts Plateaux to breed.

The findings of the present study demonstrate that diverse regions such as the Hauts Plateaux and the Sahara provide key habitats which are significantly more important for the conservation of migratory birds than previously thought. A full survey is required for the western part of Algeria, which should be based on a complete analysis of the distribution of wetlands, patterns of habitat use, pending threats and human activities. Special attention should be paid to wetland connectivity in the light of pending global changes (Amat *et al.* 2005). Urgent measures are needed, however, to protect internationally important habitats from human pressure. This could be achieved by creating core areas within

connected Biosphere Reserves, centred on 'hot-spot' clusters of major wetlands. The situation at Lake Fetzara highlights this issue; the avifauna of this vast marsh has been known since the 19th century (Heim de Balsac & Mayaud 1962), and draining the site in the 20th century is thought to have reduced its ornithological value (Ledant *et al.* 1981). The survey found that Lake Fetzara is still one of the most important sites for migrant and breeding waterbirds within the West Mediterranean Basin, but it is threatened by land reclamation despite its status as Ramsar site. Daïet Tiour, which lies between Beni Abbes and Béchar, was a key site for migrants on their way to cross the Sahara, but the damming of Oued Guir subjected it to prolonged drought and land reclamation. The case of Garaet Boulehilet is similar to that of Daïet Tiour; the construction of a reservoir on its main tributary is thought to have had a negative effect on its ornithological potential, but the site still plays a major role for wintering waterbirds whenever it is refilled. Garaet Ezzemoul, one of the main breeding grounds for the Greater Flamingo in the West Mediterranean Basin (Samraoui *et al.* 2006) and the site where the Critically Endangered (CR) Slender-billed Curlew *Numenius tenuirostris* was last recorded in Algeria (Bellamy *et al.* 1990) is another example. Efforts are being made to provide legal protection to Garaet Ezzemoul and its neighbouring saline lakes and to prevent excessive hydrological changes. We hope that national and international legislation will be brought in swiftly for the effective protection of networks of key wetlands elsewhere in Algeria, including those identified in this study.

Acknowledgements

We thank Eileen Rees, Mark O'Connell and Mike Smart for many suggestions which greatly improved the manuscript. We are most grateful to members of the Laboratoire de Recherche des Zones Humides and in particular to R. Menai for the valuable help provided. We are indebted to directors and staff of National Parks, and Conservation des Forêts of many wilayas who facilitated this survey. We also thank the Algerian Ministère de l'Enseignement Supérieur et de la Recherche Scientifique, l'A.N.D.R.U., l'O.N.E.D.D. and we are grateful to Luc Hoffmann and the MAVA foundation for material support.

References

- Amat, J.A., Rendon, M.A., Rendon-Martos, M., Garrido, A. & Ramirez, J.M. 2005. Ranging behaviour of greater flamingos during the breeding and post-breeding periods: linking connectivity to biological processes. *Biological Conservation* 125: 183–192.
- Bayle, P. & Fernandez, O. 1992. Protection of Cory's shearwater *Calonectris diomedea* by limitation of a population of feral rabbit *Oryctolagus cuniculus* on Frioul archipelago (Marseille, France). *Avocetta* 16: 67–70.
- Bellamy, P., Elliot, G. & Trubridge, M. 1990. Slender-billed curlews in Algeria? An ornithological survey of the Chotts Constantinois, 16 January–6 February 1990. Unpublished report to the Royal Society for the Protection of Birds, RSPB, Sandy, UK.
- Bildstein, K. L. 1993. *White Ibis: Wetland Wanderer*. Smithsonian Institution Press, Washington, D.C., USA.
- BirdLife International 2001. *Important Bird Areas and potential Ramsar Sites in Europe*. BirdLife International, Wageningen, The Netherlands.
- Boulekhsaim, M., Houhamdi, M. & Samraoui, B. 2006. Population dynamics and diurnal behaviour of the Shelduck *Tadorna tadorna* in the Hauts Plateaux, northeast Algeria. *Waterfowl* 56: 65–78.
- Coulthard, N.D. 2001. Algeria. In L.D.C. Fishpool & M.I. Evans (eds.), *Important Bird areas in Africa and associated islands: priority sites for conservation*, pp. 51–70. BirdLife Conservation Series No. 11, Pisces Publications and BirdLife International, Newsbury and Cambridge, UK.
- Fishpool L.D.C. & Evans M.I. (eds.) 2001. *Important Bird Areas in Africa and associated islands: priority sites for conservation*. BirdLife Conservation Series No. 11, Pisces Publications and BirdLife International, Newsbury and Cambridge, UK.
- Gretton, A. 1991. *Conservation of the slender-billed curlew*. International Council for Bird Preservation Monograph No. 6, ICBP, Cambridge, UK.
- Heim de Balsac, H. & Mayaud, N. 1962. *Les oiseaux du Nord-Ouest de l'Afrique*. Paul Lechevalier, Paris, France.
- Isenmann, P. & Moali, A. 2000. *Birds of Algeria*. Société d'Etudes Ornithologiques de France. Paris, France.
- Isenmann, P., Gaultier, T., El Hili, A., Azafzaf, H., Dlensi, H. & Smart, M. 2005. *Oiseaux de Tunisie*. Centre National du Livre.
- Jacob, J.P. & Jacob, A. 1980. Nouvelles données sur l'avifaune du lac de Boughzoul (Algérie). *Alauda* 48: 209–220.
- Ledant, J.P., Jacobs, J.P., Jacobs, P., Malher, F., Ochando, B. & Roché, J. 1981. Mise à jour de l'avifaune algérienne. *Gerfaut* 71: 295–398.

- Martin, J.-L., Thibault, J.-C. & Bretagnolle, V. 2000. Black rats, island characteristics and colonial nesting birds in the Mediterranean: Current consequences of an ancient introduction. *Conservation Biology* 14: 1452–1466.
- Saheb, M., Boukhssaim, M., Ouldjaoui, A., Houhamdi, M. & Samraoui, B. 2006. Sur la nidification du Flamant rose *Phoenicopterus roseus* en 2003 et 2004 en Algérie. *Alanda* 74: 368–371.
- Samraoui, B. 2002. Branchiopoda (Ctenopoda and Anomopoda) and Copepoda from eastern Algeria. *Hydrobiologia* 470: 173–179.
- Samraoui, B. & de Béclair, G. 1997. The Guerbes-Senhadja wetlands. Part I: An overview. *Ecologie* 28: 233–250.
- Samraoui, B. & de Béclair, G. 1998. Les zones humides de la Numidie orientale. Bilan des connaissances et perspectives de gestion. *Synthèse* 4: 1–90.
- Samraoui, B. & Corbet, P.S. 2000. The Odonata of Numidia, northeast Algeria. Part I: status and distribution. *International Journal of Odonatology* 3: 11–25.
- Samraoui, B. & Menai, R. 1999. A contribution to the study of Algerian Odonata. *International Journal of Odonatology*. *International Journal of Odonatology* 2: 145–165.
- Samraoui, F. & Samraoui, B. 2007. The reproductive ecology of the Coot *Fulica atra* L. in the Hauts Plateaux, northeast Algeria. *Waterbirds* 30: 133–139.
- Samraoui, B., Benyacoub, S., Mecibah, S. & Dumont, H.J. 1993. Afrotropical libellulids (Insecta: Odonata) in the lake district of el Kala, north-east Algeria, with a rediscovery of *Urothemis e. edwardsi* (Selys) and *Acisoma panorpoides ascalaphoides* (Rambur). *Odonatologica* 22: 365–372.
- Samraoui, B., Ouldjaoui, A., Boukhssaim, M., Houhamdi M., Saheb, M. & Béchet, A. 2006. The first recorded reproduction of the Greater Flamingo *Phoenicopterus roseus* in Algeria: behavioural and ecological aspects. *Ostrich* 77: 153–159.
- Smart, M. 1974. Midwinter count in Algeria, February 1974. *Bull. International Waterfowl Research Bureau* 37: 86–87.
- Spaans, B., van Dijk, G., van Der Kamp, J. & Treep, F. 1976. Les oiseaux nidificateurs des zones humides de l'est de l'Algérie, printemps 1976. Wageningen, polycopié.
- Stevenson, A.C., Skinner, J., Hollis, G.E. & Smart, M. 1988. The El Kala National Park and environs, Algeria: an ecological evaluation. *Environmental Conservation* 15: 335–348.
- Thévenot, M., Vernon, R. & Bergier, P. 2003. *The birds of Morocco*. British Ornithologists' Union, Peterborough, UK.
- Veith, M., Mayer, C., Samraoui, B., Donaire Barroso, D. & Bogaerts, B. 2004. From Europe to Africa and vice versa: evidence for multiple intercontinental dispersal in ribbed salamanders (Genus *Pleurodeles*). *Journal of Biogeography* 31: 159–171.
- Wetlands International. 2006. *Waterbird Population Estimates – Fourth Edition*. Wetlands International, Wageningen, The Netherlands.

Appendix 1. Wetland sites visited during the study. Numbers relate to the location of each site in Fig. 2.

I. Eastern Numidia (EN), which includes the El Kala-Annaba wetlands (Samraoui & Bélair 1998):

1. Boussedra (36°51.26'N, 07°43.82'E): a temporary pond close to El Bouni, covered with *Scirpus maritimus*, *Typha angustifolia*, *Scirpus lacustris* and *Tamarix gallica*. The site is being land-filled and, over the last two years, has lost >25% of its surface area.
2. Sidi Achour (36°52.79'N, 07°43.54'E): a temporary marsh at the southern fringe of Annaba. The vegetation includes *Tamarix gallica*, *Typha angustifolia*, *Juncus acutus*. The site is in the process of being land-filled (Samraoui *et al.* 2007).
3. Salines (36°50.34' N, 07°47.46'E): abandoned salt pans almost devoid of aquatic vegetation dominated by *Salicornia europea*. The site was subjected to major hydrological changes in mid-2003.
4. Lac Bleu (36°54.70' N, 08°20'E): a permanent dune slack covered with *Nymphaea alba*, *Phragmites australis*, *Ceratophyllum demersum*, *Iris pseudoacorus*. Human encroachment seriously threatens this unique relict wetland (Samraoui *et al.* 1993).
5. Lac Tonga (36°52'N, 08°31'E): a shallow lake covered with *Nymphaea alba*, *Phragmites australis*, *Iris pseudoacorus*, *Typha angustifolia*, *Scirpus lacustris*, *Salix* sp. Fish farming and exotic fish are pending threats which may undermine the ecological integrity of Lac Tonga.
6. Lac Oubeira (36°50'N, 08°23'E): a shallow lake covered with *Trapa natans*, *Myriophyllum spicatum*, *Ceratophyllum demersum*, *Phragmites australis*, *Typha angustifolia* and *Scirpus lacustris*. Introduced carp have altered the trophic web of this Ramsar site (Samraoui 2002).
7. Mekhada (36°48'N, 08°00'E): an extensive marsh of 16,000 ha covered with *Scirpus maritimus*, *Scirpus lacustris*, *Scirpus triqueter*, *Typha angustifolia* and *Phragmites australis*. The building of the Mexenna dam and a new road which crosses the marsh will increase the anthropogenic pressure on this Ramsar site.
8. Lac Mellah (36°54'N, 08°19'E): a lagoon of 800 ha.
9. G. Estah (36°50.56'N, 07°58.94'E): a dune slack covered with *Nymphaea alba*, *Phragmites australis*, *Scirpus lacustris* and *Iris pseudoacorus*. Water extraction is a recurrent problem for this site.
10. G. Dakhla (36°50.67'N, 07°59.08'E): a dune slack covered with *Nymphaea alba*, *Salix cinerea*, *Typha angustifolia*, *Phragmites australis*, *Scirpus lacustris*, *Iris pseudoacorus*. The surrounding vegetation is rapidly being stripped down and the site is subjected to periodic fires.
11. Lac Okréa (36°50.83'N, 08°10.79'E): a dune slack covered with *Paspalidium obtusifolium*, *Typha angustifolia*.
12. Oued Seybouse I (Annaba): the second major wadi of Algeria. It was sampled at two stations: Annaba and Guelma.
13. Sidi Kaci: a marsh just north of the village of Sidi Kaci.
14. Chatt (36°49.81'N, 07°54.68'E): a marsh of less than 2 ha dominated by *Typha angustifolia* and *Iris pseudoacorus*.
15. Sebaa (36°49.73'N, 08°00.67'E): an alder carr north of the Mekhada marsh and sandwiched between the inundated plain and the coastal dunes.

16. Lac des Oiseaux (36°47'N, 08°07'E): a freshwater pond of 70 ha covered with *Scirpus lacustris* and *Typha angustifolia*.

17. Bou Redim (36°47'N, 08°13'E): a freshwater marsh covered with *Scirpus lacustris*, *Carex elata* and *Alnus glutinosa*.

18. Oued Boukhmira: The estuary of a wadi, north of Salines, with dense stands of *Phragmites australis*.

19. Khoud El Barouk: a dunary slack north of Dakhla covered with *Carex elata* and *Scirpus lacustris*. The site has since been claimed for agriculture.

20. Mafragh: an estuary of two major wadi, Oued El Kebir and Oued Bounamoussa, north of the Mekhada marsh.

21. Cap de Garde: cliffs overhanging offshore rocks near Cape de Garde, north of the town of Annaba.

22. Cap Sigleb: Offshore rock outcrop close to Cape Sigleb, near the Tunisian border.

In addition to the main wetlands of Eastern Numidia, a number of temporary ponds (26) were visited monthly over a period of 5 years.

II. Western Numidia (WN), including Lac Fetzara and the Guerbes-Senhadja wetlands (Samraoui & Bélair 1997):

23. Lac Fetzara (36°48'N, 7°30'E): an extensive marsh criss-crossed with drainage canals. The vegetation is mainly composed of *Scirpus maritimus*, *Typha angustifolia*, *Phragmites australis* and *Tamarix gallica*. There have been several attempts to drain this important site.

24. G. Hadj Tahar (36°51.77'N, 07°15.96'E): a pond covered with *Nymphaea alba*, *Scirpus lacustris* and *Phragmites australis*. Water extraction is the major threat.

25. G. Mhamed (36°57' N, 07°16.02' E): a brackish marsh, extensively covered by *Salicornia europaea*.

26. G. Loughat (36°50'N, 07°17'E): a seasonal marsh.

27. G. Bouina (36°53.49'N, 07°17.57'E): a dunary slack.

28. G. Chichaya (36°53.79'N, 07°18.23'E): a seasonal marsh.

29. G. Messaoussa: a seasonal marsh.

30. G. Chekaka: a seasonal pond.

31. Sidi Lakhdar (36°54.80'N, 07°12.09'E): a seasonal pond.

32. G. Guelb (36°53.17'N, 07°18.46'E): a seasonal marsh.

33. G. Khedidja (36°52.08'N, 07°20.94'E): a dune slack.

34. Islet of Srigina, Skikda (36°56'15.88"N, 06°53'09.60"E): a rocky islet off Skikda's Stora harbour. Disturbance by tourists may increase in the future.

35. Ouajaa (36°53.290'N, 07°18.960'E): a marsh covered with *Scirpus lacustris*, *Typha angustifolia* and a row of *Salix cinerea*.

36. Kef Amor (37°05.064'N, 07°19.894'E): formerly known as Ile de St. Piastre, a rocky islet off Chetaibi's harbour.

III. Guelma wetlands (G):

37. Oued Seybouse II (Guelma): Oued Seybouse close to the town of Guelma with stands of *Typha angustifolia* and *Tamarix gallica* bordering its banks.

38. Hammam Debagh reservoir (36°28.07'N, 07°31.55'E): a dam on Oued Hammam Debagh almost devoid of vegetation along its shore.

39. Bekhouche Lakhdar' reservoir (36°38.07'N, 07°17.00'E): a dam.

40. Majen Belhariti (36°26.19'N, 07°5.24'E): a freshwater pond covered with submerged vegetation.

41. Beljoudi dam (36°13.54'N, 70°12.48'E, 956 m a.s.l.): a small reservoir near Beljoudi.

42. Aïn Makhoulouf Reservoir (36°13.41'N, 07°17.78'E, 816 m a.s.l.).

IV. Jijel complex (JC) (Bélaïr & Samraoui 2000):

43. Lac de Beni Belaïd (36°52'32.55"N, 06°06'07.69"E): a shallow lake.

44. G. Kennar (36°49'N, 05°56'E): a marshy area subjected to heavy water extraction.

V. Algier region (AR):

45. Lac de Réghaïa (36°45.77'N, 03°20.42'E): a shallow lake threatened by industrial pollution.

VI. Oran complex (OC):

46. Sidi Chahmi (35°40.20'N, 00°31.78'W).

47. Oum El Ghelez (Lac des Gharabas) (35°36.238'N, 0°24.791'W).

48. Salines of Arzew (35°41.880'N, 00°17.082'W): a salt pan.

49. La Macta (35°42.550'N, 00°10.944'W): an extensive marsh.

50. Mengoub (35°43.828'N, 00°00.489'W).

51. Lac de Telamine (35°43.924'N, 00°22.972'W).

52. Dayet El Bagrat (35°32.862'N, 00°33.670'W).

53. Grande Sebkhia of Oran (35°N, 00°W): a salt lake.

54. Dayet Morcelly (Petit Lac d'Oran, 35°40.182'N, 00°36.794'W): a heavily polluted lake with an adjacent marsh.

55. Iles Habibas (35°43.405'N, 01°7.845'W): Two rocky islets (Gharbia and Chargaïa) 20 km off the coast of Oran.

56. Ile de Rachgoun (35°19.445'N, 01°28.764'W): A rocky islet off the Tafna's estuary and two satellite islets (Siga and Pain de Sucre).

57. Ouled El Kihel reservoir (35°21.151'N, 01°13.611'W).

58. Mkhaisia reservoir (35°18.081'N, 01°15.912'W).

59. Water treatment plant of Sidi Safi (35°17.158'N, 01°19.502'W).

60. Boughrara reservoir (34°53.482'N, 01°39.886'W).

61. Beni Bahdal reservoir (34°42.426'N, 01°30.203'W).

VII. Eastern High Plateaux (EHP), which includes mainly the Hauts Plateaux, southwest of Constantine:

62. G. Tarf (35°42'N, 07°08'E): an extensive salt lake of 25,000 ha mainly fed by Oued Boulefreiss. The building of dams and reservoirs constitutes the major and recurrent problem for most Algerian salt lakes.

63. G. Guelif (35°47.200'N, 07°00.00'E): a salt lake of 5,525 ha.

64. G. Ank El Djmel (35°46.298'N, 06°52.00'E): a salt lake of 8,550 ha.

65. Chott Tinsilt (35°53.619'N, 06°30.000'E): a salt lake of 3,600 ha.

66. G. Ezzemoul (35°53.137'N, 06°30.200'E): a salt lake of 6,000 ha.

67. G. Boucif (35°47.211'N, 07°04.991'E): a brackish lake.

68. Fom El Gueïss: a shallow reservoir.

69. Chott Djendli (Boumia) (35°42.000'N, 06°31.554'E): a salt lake.

70. Tazouguert I (35°21.04'N, 07°16.042'E): a salt lake.

71. Tazouguert II (35°23.777'N, 07°19.920'E): a salt lake.

72. Timerganine (35°34.655'N, 06°58.275'E): an oligohaline pond with *Phragmites australis*, *Scirpus maritimus*, *S. triquetus*.

73. Jemott (35°38.708'N, 07°00.825'E): a brackish wetland.

74. G. Marshel (35°48.528 N, 06°44 437'E): a salt lake.

75. G. Boulehilet (35°44.699'N, 06°47.431'E): a freshwater pond.

76. Zaher (Chott Melah) (35°36'43.18"N, 07°02'26.06"E): a complex of satellite salt lakes south-west of Garaet Tarf.

77. Sebkhha Bazer Sakra (36°04.385'N, 05°39.216'E): a salt lake.

78. Beïda Bordj (35°56.046'N, 05°44.362'E): salt lake.

79. El Fraïn (35°55.292'N, 05°36.714'E): a salt lake.

80. Sebkhhat El Hamiett (Aïn El Hadjar) (35°55.444'N, 05°31.927'E): a salt lake.

VIII. Central High Plateaux (CHP)

81. Chott El Hodna (35°21.076' N, 04°32.513'E): a salt lake.

82. Oguila Dar Chioukh (34°52.413'N, 03°27.124'E): a salt pan.

83. Zahrez Gharbi (34°57.382'N, 02°48.838'E): a salt lake.

84. Sebkhha of Boughzoul (35°41.384'N, 02°50.264'E): a salt pan.

85. Boughzoul's reservoir (35°44.910'N, 02°46.622'E): subjected to major and rapid

hydrological change; this impedes its ecological function and value.

IX. Western High Plateaux (WPC)

86. Chott Chergui (34°03.376'N, 00°05.164'W): a vast salt lake.

87. Sebkhha of Naama (33°17.953'N, 00°13.722'W): a salt lake.

88. Dayet El Ferd (34°30.416'N, 01°13.959'W): a brackish lake.

X. Sahara (S):

89. Outaya reservoir (35°07.700'N, 05°36.323'E): a reservoir on the northern fringe of the Sahara.

90. Merja Hamraïa I (34°06.223'N, 06°14.784'E): a brackish wetland covered with *Phragmites australis*.

91. Merja Hamraïa II (34°05.588'N, 06°20.667'E): a salt lake.

92. Chott Melghir (34°10.631'N, 06°17.322'E): a salt lake.

93. Chott Merouane (34°02.433'N, 05°58.748'E): a salt lake.

94. Oued Khrouf (33°53.451'N, 06°01.921'E): a marshy area.

95. Tindla (33°39.781'N, 06°02.815'E): a salt pan.

96. Sidi Amrane (33°29.87'N, 05°59.38'E): a salt lake.

97. Merjaja (33°03.43'N, 06°03.97'E): a depression bordered with *Phragmites australis*.

98. Temacine (33°01.04'N, 06°01.44'E): A brackish pond.

99. Sidi Khouiled (32°02.91'N, 05°22.14'E): a salt lake heavily polluted by sewage from the town of Ouargla.

100. Ed Goléa (30°31.778'N, 02°56.302'E): a salt lake.