ISSN 2336-3193
DOI: 10.2478/cszma-2022-0006

Acta Mus. Siles. Sci. Natur., 71: 105-113, 2022
Published: online 30th May 2022, print May 2022

The influence of environmental factors on the abundance and composition of water bird's in Tiffech lake (Northeastern Algaria)

Moundji Touarfia, Noureddine Bouali, Sameh Djebablia,
Meriem Rebbah & Nadhra Boukrouma

The influence of environmental factors on the abundance and composition of water bird's in Tiffech lake (Northeastern Algaria). – Acta Mus. Siles. Sci. Natur., 71: 105-113, 2022.

Abstract: The effects of environmental factors (water conditions) on water bird's distribution and abundance was determined using distance sampling point count method, direct visual observation and principal component analysis (PCA) at Tiffech lake Wetland, North East of Algeria. A total of 26 bird species were recorded in the present study; of these, 12 were passage visitor, 7 winter visitors, 5 winter migrant and 2 species are resident breeder. The R i386 (version 4.0.3) software were used for data analyzing. Principal component analysis indicated strong correlation ship between water bird abundance and environmental factors (water conditions) (86.35%) in Tiffech lake wetland. The most important environmental factors associated with abundance of water bird's species composition in Tiffech lake communities were water pH, dissolved oxygen, nitrates, nitrites and chloride. While among the environmental factors water Temperature and phosphore showed a negative correlation. This study gives important insights on ecological relationships between water bird's biodiversity and environmental factors in a primary wetland ecosystem in North East of Algeria.

Keywords: Water bird; Tiffech Lake; bird species; environmental factors; wetland ecosystem.

Introduction

Algeria is rich in aquatic resources such as lakes, wetlands, mangroves, estuaries, lagoons, and the sea. These aquatic resources provide diverse habitats for wildlife species particularly water birds. Water birds depend on wetlands for a variety of activities such as foraging, nesting, loafing, and moulting (Rajpar & Zakaria 2009). They are bioindicators of wetland ecosystems, because they quickly respond to any changes in water fluctuation as compared to other animals (Siriwardena *et al*. 1999; Krebs *et al*. 1999).

Water condition (physical and chemical characteristics) among wetlands always fluctuates from time to time depending upon precipitation, and incoming water resources.

It has been reported that fluctuation in water condition influenced the distribution of water birds such as from total drought (Bhat *et al*. 2009) to major flooding.

Determining the fluctuation of water birds in wetlands is very important to understand the water bird community structures and population status of existing species in the dwelling areas (Kaminski *et al*. 2006). For this reason, the distance sampling point count method and principal component analysis (PCA) are the most common quantitative survey techniques that have been widely used in order to monitor the correlation ship between water bird's species and water condition (Codesido & Bilenca 2000). Very little information is available on the effects of water condition (physical and chemical characteristics) fluctuation on water bird abundance and distribution in Algeria (Loucif *et al*. 2020; Boukrouma *et al*. 2020; Bara *et al*. 2000). The main objective of this study was to determine and understand the effects of water condition fluctuations on water birds in Tiffech lake, Northeastern Algeria.

sciendo

Materials and methods

Study area

The study was conducted in Tiffech lake wetland (36°08. 513 N, 07°45. 417 E, alt. 868 m a. s. l., area: 110 ha), located in souk Ahras province, North-east of Algeria (Fig. 1). The region belongs to a sub humid climate, with an average annual temperature of 14.1°C and annual precipitation of 1,300 mm. There is a clear separation between the rainy and dry seasons.

The rainy season is from November to the following March, when the water level reaches 24.6 m. The dry season usually lasts from April to July in the following year, with the water level fluctuating between 6 and 14 m (Boukrouma *et al*. 2018).

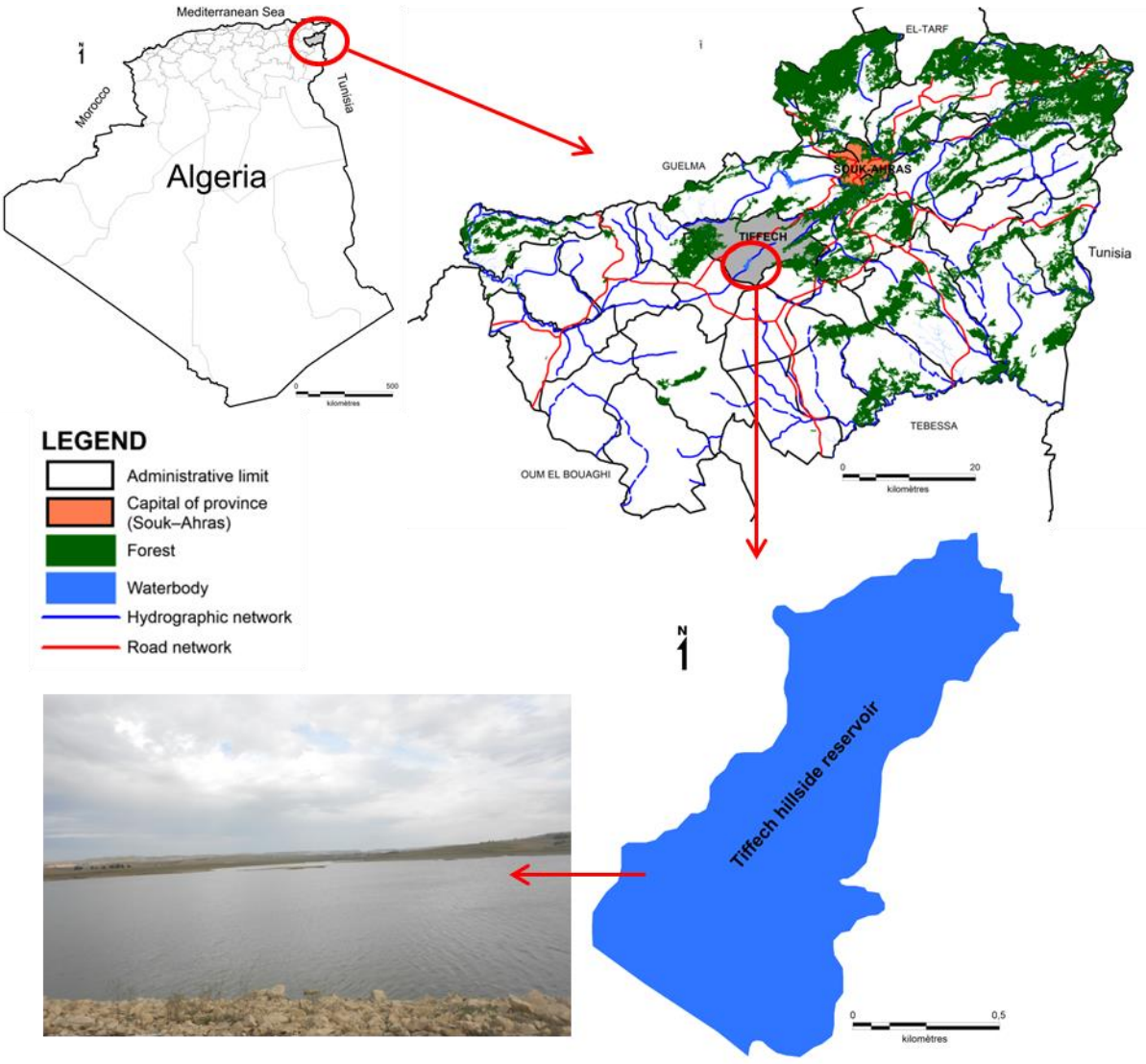


Fig 1: Geographical location of the study area (Touarfia 2022)

Water analyses

The water condition (water pH, water Temperature, water dissolved oxygen (mg/l), nitrate (mg /1), nitrites (mg/l), phosphorus (mg/l) and chlorides (mg/l)) was obtained from Department of Irrigation, Province of Souk Ahras, Algeria , from November, 2018 to January, 2020 in order to determine and understand the fluctuation of water conditions and its effects on the water bird distribution and abundance at Tiffech lake wetland.

Bird surveys

Bird surveys was done fourteen times at monthly interval in order to obtain reliable results and avoid bias. The repetition increased the precision and provided accurate estimates. The survey was carried out early in the morning, that is, 08 30–12 00 hrs. The detections of birds within each point count station were done for 15 minutes.

During each survey, all water bird species and individuals seen or heard were recorded. The methodology was followed as described by Smith *et al*. (1993), Petit *et al*. (1995) and Nadeau *et al*. (2008). A pair of binoculars with magnification 7× 50 was used in identification of birds visually alongside a field guide (Guide Ornitho) and the checklist was prepared using standardized common and scientific names of the birds following Bird Life Checklist Version 7, (2014). Residential status of different species like passage visitors, migratory and breeder migrant have assigned strictly with reference to the study area on the basis of sightings during study period.

Analysis of bird community

For each count session, the species richness, relative abundance and local occurrence status (frequency of occurrence) was calculated. We have determined the relative abundance (%) of bird species using the expression: n/N* 100 (where n is the number of the recorded bird species and N the total number of observations recorded) (Zakaria *et al*. 2009). To describe the frequency of occurrence (*fi*) according to Dajoz (2006) the number of surveys during which the species was recorded was divided by the total number of conducted surveys.

For the analysis of bird community, Shannon – Weiner diversity index (Shannon & Wiener 1949), Evenness index (Pielou 1966) and Relative abundance (Rajpar & Zakaria 2010) were employed in the present investigation.

Statistical analysis

The R 4.0.3 software was used for data analysis to calculate arithmetic average, standard and deviation value for each of the studied features, for each species, and environmental factors.

To investigate the relationship between the water bird's species and environmental factors PCA methods was used. The analyses were performed in the "Facto Miner" package for a program R 4.0.3 (R core Team 2016). PCA is ordination technique that constructs the theoretical variable that minimizes the total residual sum of squares after fitting straight lines to species data. Also, species with high variance, often the abundant ones, therefore dominate the PCA method, whereas species with low variance, often the rare ones, have only minor influence on the method. These may be reasons to apply standardized PCA, in which all species receive equal weight. Before analysis, the scaling was focused on inter-species correlations, samples were cantered and standardized, but the data were not transformed. The selection of environmental variables was automatic.

Results and discussion

Diversity indices

26 species were recorded from Tiffech lake during 2018-2021 survey using distance sampling point count method (Tab. 1). Our results reflecting a poorly diversified and unbalanced population, since some species in terms of abundance largely dominate population during this period, such as *Fulica atra* (43.39%)*, Anas platyrhynchos* (39.43%) *and Aythya ferina* (27.15) (Tab. 2). In general terms, on the 26 species of water birds recorded in Tiffech lake, Passage visitors dominate with twelve species; seven are winter visitor; five are winter migrant and two species are resident breeder (Tab. 2). Based on the frequency of sightings, 11 species were considered to be Mondatory Common, 9 species to be Omni present and 6 to be Uncommon species (Tab. 2). In accordance with the Bird Life Checklist Version_7 (2014), all species were assigned the status of 'Least Concern' (Tab. 1).

Table 1: Univariate metrics of water birds at Tiffech lake during 2018-2021

Diversity indices	Values
-Species richness (S)	26
-Shannon wiever diversity index (H2)	3.17
-Pielon's evenness index (e)	0.65

Table 2: Ecological status and relative abundance of water birds occurring at Tiffech lake

Scientific name (abbreviation)	Phenological status [a]	Conservation status [b]	Local status [c]	Annual relative Abundance %
Anas platyrhynchos (ANPL)	RB	LC	O	39.43
Mareca strepera (MAST)	WV	LC	MC	1.23
Spatula clypeata (SPCL)	WV	LC	MC	4.83
Mareca penelope (MAPE)	WV	LC	MC	4.63
Anas crecca (ANCR)	WV	LC	MC	4.59
Oxyura leucocephala (OXLE)	WV	LC	UC	8.25
Aythya ferina (AYFE)	WM	LC	O	27.15
Aythya nyroca (AYNY)	WM	LC	MC	3.89
Tadorna tadorna (TATA)	VP	LC	UC	0.15
Tringa erythropus (TRER)	VP	LC	UC	0.12
Gallinago gallinago (GAGA)	VP	LC	O	1.88
Tringa nebularia (TRNE)	WV	LC	MC	2.37
Phalacrocorax carbo (PHCA)	VP	LC	UC	0.41
Tachybaptus ruficollis (TARU)	WM	LC	O	11.39
Podiceps cristatus (POCR)	WM	LC	O	14.52
Ardea cinerea (ARCI)	VP	LC	O	1.45
Bubulcus ibis (BUIB)	WM	LC	O	15.31
Ardea alba (ARAL)	VP	LC	MC	0.49
Egretta garzetta (EGGA)	VP	LC	MC	0.45
Phoenicopterus roseus (PHRO)	WV	LC	MC	26.64
Ciconia ciconia (CICI)	VP	LC	UC	0.16
Fulica atra (FUAT)	RB	LC	O	43.39
Gallinula chloropus(GACH)	VP	LC	UC	0.25
Vanellus vanellus(VAVA)	VP	LC	MC	1.98
Circus aeruginosus(CIAE)	VP	LC	MC	0.44
Larus michahellis(LAMI)	VP	LC	O	1.14

Note: WV[a]: Winter visitor, **VP[a]:** Passage visitor**, WM[a]:** Winter migrant, **RB[a]:** Resident breeder
[b]Bird life checklist version7 (2014): LC: least concern. [c]Species Omnipresent (O) (fi=100%); Mondatory Common (MC) (50%<fi<75%), Uncommon (UC) (25%<fi<50%), Rare (R) (5%<fi<25%).

Water quality analysis

To determine most effective variables on the separation of water birds, PCA was performed on 7 factors in the study area (Fig. 2). The first ordination axis (PC1, 74.44%) showed a positive correlation with water pH, dissolved oxygen, nitrates, nitrites and chloride (Tab. 4) and negatively correlated with Temperature. Defined by the appearance of species: *Anas platyrhynchos, Spatula clypeata, Mareca penelope, Anas crecca, Tadorna tadorna, Aythya ferina, Aythya nyroca, Mareca strepera, fulica atra, Gallinula chloropus, Ardea cinerea, Bubulcus ibis, Egretta garzetta, Ardea alba, Tringa erythropus*, *Gallinago gallinago, Phoenicopterus roseus*. PC2 accounted for 11.91 % of the original variance and represents an axis of decreasing trophic status, as it was negatively correlated with phosphore favoring the appearance of species: *Larus michahellis*, *Vanellus vanellus*, *Ciconia Ciconia* and *Tachybaptus ruficollis* (Fig. 2).

Table 3: Mean and standard error (±SE) values of the water conditions in Tiffech lake wetland, Souk Ahras, Northeast Algeria

Variable	Mean ± S. D
pH	7. 18 ±0.02
Temperature (C°)	18±1.2
Disolved oxygen (mg/l)	6.5±1.3
Nitrites (mg/l)	1.4±0.01
Nitrates (mg/l)	15.5±0.2
Phosphate (mg/l)	0.03±0.01
Chlorides (mg/l)	581±2.1

Table 4: PCA applied to the correlation matrix of the environment factors in Tiffech lake

Species	PC1	PC2
Fulica atra	.784	-.156
Anas platyrhynchos	.970	.160
Spatula clypeata	.985	.065
Anas crecca	.978	.130
Mareca penelope	.886	.353
Tadorna tadorna	.968	.237
Aythya ferina	.970	.093
Podiceps cristatus	-.786	.042
Tachybaptus ruficollis	-.643	.608
Ardea cinerea	.974	.162
Bubulcus ibis	.913	-.122
Egretta garzetta	.997	-.002
Ardea alba	.987	.021
Tringa erythropus	.997	-.002
Vanellus vanellus	-.752	.610
Larus michahellis	.260	.817
Phalacrocorax carbo	-.989	.126
Ciconia ciconia	-.545	.569
Circus melanoleucos	-.441	.172
Phoenicopterus roseus	.922	-.338
Mareca strepera	.989	-.126
Oxyura leucocephala	-.504	-.359
Aythya nyroca	.975	.130
Gallinago gallinago	.989	-.126
Tringa erythropus	.989	-.126
Gallinula chloropus	.572	.795
PH	.990	.018
Temperature	-.834	.352
Disolved oxygene	.992	.096
Chloride	.977	.006
Nitrates	.992	-.043
Nitrites	.876	.418
Phosphore	-.040	-.886

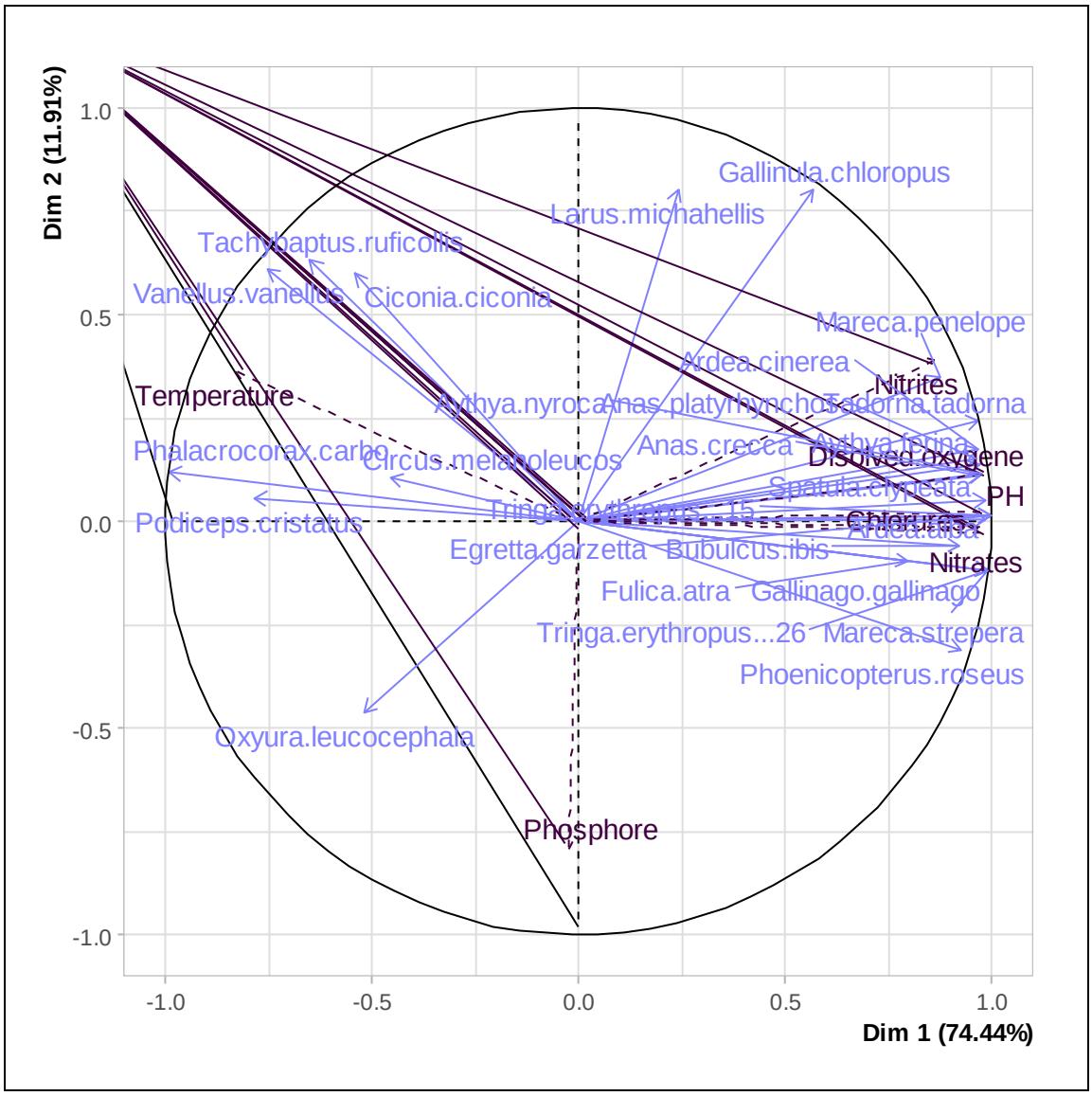


Fig 2: PCA plot of water factors and water bird's species against their values for axes 1 and 2 in Tiffech lake, Souk Ahras, Northeast Algeria.

Discussion

The attraction of water birds in relation to water conditions is conspicuous and reflects the status of wetlands at a given time of a particular area.

The number of bird species reported in this study (26 species) seems higher as compared to 15 species reported in Oued Charef dam, North-eastern Algeria (Boukrouma *et al*. 2020) and Madjen Djedj Marsh, North-eastern Algeria (15 species) (Boukrouma *et al*. 2018), but less than that reported in Tonga lake, North-eastern Algeria (35 species) (Loucif *et al* . 2020). The range of species richness are closely linked to physical and biological attributes of the wetland. Any variation in any of these wetland features affects the richness of birds (Muralikrishnan *et al*. 2017). Murphy *et al*. (1984) and Brown & Dinsmore (1986) have reported that selection of wetland by avifauna appears to be influenced by the trophic status of the wetlands. When a wetland is productive there is probably enough food for the avifauna. Hoyer & Canfield (1994) observed that sewage habitats as well as productive ecosystem are able to support a greater number of birds.

It has been reported that the higher water bird abundance is related to availability of diverse foraging sites, which might vary from exposed mud to deeper water with submerged aquatic plants (Safran *et al*. 1997; Isola *et al*. 2000) and correlates to hydrological variation (Bolduc & Afton 2004; Robertson & Massenbauer 2005). Murphy *et al*. (1984) stated that physico-chemical characteristics of water bodies regulate the abundance of water bird's. Additionally, Desgranges *et al*. (2006) examined the wetland birds' response to water conditions fluctuation and revealed that wetland bird species were significantly associated with hydrological context.

Low values of Shannon and evenness indices were due to the high abundance of *Fulica atra* and *Anas platyrhynchos* a resident breeder species in Tiffech lake wetland. The diversity indices obtained in the present study were lower than those reported in Garaet Hadj-Tahar, North-eastern Algeria (H' = 3.5 and E = 0.7) (Metallaoui & Houhamdi 2010) and Lake Tonga, North-eastern Algeria (H' = 3.58 and E = 0.38) (Locif *et al*. 2020). The structural patterns indicate that the wetland has suffered an anthropogenic or natural stress. (Battisti *et al*. 2006).

The results of PCA indicated a significant effect of hydro chemical parameters on water bird abundance. The present study demonstrate that abundance of water bird's species increases with increase in water pH, dissolved oxygen, nitrates, nitrites and chloride. This finding is in agreement with those of many previous studies on water birds in other geographic areas (Paracuellos 2006; Guadagnin *et al*. 2009, Sebastián-González & Green 2014).

Wetzel (1975) pointed out that total nitrates and nitrites reflect the pond productivity. According to Savard *et al*. (1994) total dissolved nitrates and nitrites levels were usually associated positively with density of most bird species. Brandolin & Blendinger (2015) have reported that, combination of nitrates and nitrite and allow structuring of vegetation growth which determining waterbirds composition (mainly coots and ducks).

Dissolved oxygen and chloride are also reported to be the determining factors, which may be conducive for native and migratory birds for feeding and breeding. (Muralikrishnan *et al*. 2017).

Haines (1982) noted that distribution of water brid's in areas sensitive to pH variation, and alluded to an impoverished food supply. Nyholm & Myhrberg (1977) and Nyholm (1981) described shell-thinning and a reduction in breeding success in passerines feeding on insects emerging from moderately of pH lakes.

This investigation demonstrated that Temperature and Phosphore does not play an important role in the structure of water bird's in the study area. These results disagree with those reported in Florida lakes (Hoyer & Canfield 1994) and in southwestern Manitoba and southeastern Saskatchewan (Epners *et al*. 2010). A possible reason can lie in the fact that water features appear to have different effects on the ecosystem structure and diversity of water bird's species.

Overall, our results confirm the importance of Tiffech lake wetland as a wintering area for Palearctic water-birds, especially Passage visitor's birds, winter visitor, winter migrant and resident breeder. They also show that among the investigated ecological parameters, wetland area was the major factor affecting wetland use by water birds.

Conclusion

We explored the diversity of the bird community structure and its correlation with key environmental factors (water conditions) in Tiffech lake wetland. The results of this study indicate that water conditions influenced the relative abundance and distribution of water bird's species directly and indirectly. Finally, we believe that a multi-year monitoring work of water birds in a larger sample of the wetland would be needed to better identify the ecological factors and processes that affect the diversity of water birds occupied Tiffech lake.

References

Bara Y., Bara M., Bensouilah M., Saheb M., Atoussi S. & Houhamdi M. (2020) : Assessments of physico-chemical parameters of Garaet Hadj Tahar wetland and their effect on waterbirds settlement. – Ukrainian Journal of Ecology 10(2): 33-39.

Battisti C., Aglitti C., Sorace A. & Trotta M. (2006): Water level and its effect on the breeding bird community in a remnant wet-land in Central Italy. – Ekològia 25: 252-263.

Bhat P.I., Cristopher S.S. & Hosetti B.B. (2009): Avifaunal diversity of Anekere wetland, Karkala, Udupi district, Karnataka, India. – Journal of Environmental Biology 30(6): 1059-1062.

Bird Life International (2014): The Bird Life Checklist of Birds of the World, with Conservation Status and Taxonomic Sources. Version 7. http: //www. birdlife. org/datazone/species/ taxonomy. html.

Bolduc F. & Afton A.D. (2004): Relationships between wintering water birds and invertebrates, sediments and hydrology of coastal marsh ponds. – Waterbirds 27(3): 333-341.

Boukrouma N., Lalaibia L. & Djelloul F. (2018): Diversity and seasonal variation of water Birds in Tiffech lake (Souk Ahras, Northeastern Algeria). – International journal of ecology & development 33(4): 104-111.

Boukrouma N., Daoudi R & Hefaidia A. (2020): Water quality parameters and bird diversity in Oued Charef dam, (souk Ahras, Northeastern Algeria). – Journal of Applied Biological Sciences 14(1): 53-61.

Brandolin P.G. & Blendinger P.G. (2015): Effect of habitat and landscape structure on waterbird abundance in wetlands of central Argentina. – Wetlands Ecology and Management 24(1): 93-105.

Brown M. & Dinsmore J.J. (1986): Implications of marsh size and isolation for marsh bird management. – Journal of Wildlife Management 50: 392-397.

Codesido M. & Bilenca D.N. (2000): Comparación de los métodos de transecta de fajay de conteo de puntos de radio fijo en una comunidad de aves del bosque semiárido santiagueno. – El Hornero 15 : 85-91.

Dajoz R. (2006): Précis d'ecologie. 8yh edn. Number 4152. Dunod, Paris: Fundamental and applied ecology. Gauthier-Villars.

Desgranges J.L., Ingram J., Drolet B., Morin J., Savage C. & Borcard D. (2006): Modelling wetland bird response to water level changes in the Lake Ontario-St. Lawrence River hydrosystem. – Environmental Monitoring and Assessment 113(1-3): 329-365.

Epners C.A., Bayley S.E., Thompson J.E. & Tonn W.M. (2010): Influence of fish assemblage and shallow lake productivity on waterfowl communities in the boreal transition zone of western Canada. – Fresh water Biology 55: 2265-2280.

Guadagnin D.L., Maltchik L. & Fonseca C.R. (2009): Species–area relationship of Neotropical water bird assemblages in remnant wetlands, looking at the mechanisms. – Diversity and distributions 15: 319-327.

Haines T.A. (1981): Acidic precipitation and its consequences for aquatic ecosystems: a review. – Transactions of the American Fisheries Society 110: Issue 6.

Hoyer M.V. & Canfield D.F. (1994): Bird abundance and species richness on Florida lakes: Influence of trophic status, lake morphology and aquatic macrophytes. – Hydrobiologia 297/280: 107-119.

Isola C.R., Colwell M.A., Taft O.W., Safran R.J. (2000): Interspecific differences in habitat use of shorebirds and waterfowl foraging in managed wetlands of California's San Joaquin Valley. – Waterbirds 23(2):196-203.

Kaminski M.R., Baldassarre G.A. & Pearse A.T. (2006): Water bird responses to hydrological management of wetlands reserve program habitats in New York. – Wildlife Society Bulletin 34(4): 921-926.

Krebs J.R., Wilson J.D., Bradbury R.B. & Siriwardena G.M. 1999. The second silent spring? – Nature 400(6745): 611-612.

Loucif K., Bara M., Grira A., Maazi M.C., Hamli A. & Houhamdi M. (2020): Ecology of avian settlements in lake Tonga (Northeast Algeria). – Zoodiversity 54(4) : 275-284.

Metallaoui S. & Houhamdi M. (2010) : Biodiversité et écologie de l'avifaune aquatique hivernante dans Garaet Hadj-Tahar (Skikda, Nord-Est de l'Algérie). – Hydroécologie Appliquée 17 :1-16.

Murphy S.M., Kessel B. & Vining L.J. (1984) : Waterfowl populations and limnological characteristics of taiga ponds. – Journal of Wildlife Management 48: 1156-1163.

Nabahungu N. L. & Visser S.M. (2011) : Contribution of wetland agriculture to farmers' livelihood in Rwanda. – Ecological Economics 71: 4-12.

Nadeau C.P., Conway C.J., Smith B.S. & Lewis T.E. (2008): Maximizing detection probability of wetland-dependent birds during point-count surveys in Northwestern Florida. – Wilson Journal of Ornithology 120(3): 513-518.

Nyholm N.E.I. (1981): Evidence of involvement of aluminium in causation of defective formation of eggshells and of impaired breeding in wild passerine birds. – Environmental Research 26: 363-371.

Nyholm N.E.I. & Myhrberg H.E. (1977): Severe eggshell defects and impaired reproductive capacity in Small Passerines in Swedish Lapland. – Oikos 29: 336-341.

Paracuellos M. (2006): How can habitat selection affect the use of a wetland complex by water birds. – Biodiversity Conservation 15: 4569-4582

Petit D.R., Petit L.J., Saab V.A. & Martin T.E. (1995) : Fixed radius point counts in forests: factors influencing effectiveness and efficiency, in Monitoring Bird Populations by Point Counts, Diane Publishing Co., New Orleans, La, USA, USDA, Forest Service, Research Paper SO-274, Southern Forest Experiment Station.
Pielou E.C. (1966): The measurement of diversity on different types of biological collections. – Journal of Theoretical Biology 13: 131-144.
R Development Core Team (2016): R. A language and environment for statistical computing R Foundation for Statistical Computing. Vienna, Austria.
Rajpar M.N. & Zakaria M. (2009) : Assessment of water birds at Paya Indah Wetland Reserve, Peninsular Malaysia, in Proceedings of the UTM 8th Annual Symposium on Sustainability Science and Management, Kuala Terengganu, Peninsular Malaysia, Malaysia, pp. 606-612.
Rajpar M.N. & Zakaria M. (2010) : Density and diversity of water birds and terrestrial birds at Paya Indah Wetland Reserve, Selangor Peninsular Malaysia. – Journal of Biological Sciences 10 (7): 658-666.
Robertson D. & Massenbauer T. (2005): Applying hydrological thresholds to wetland management for water birds using bathymetric surveys and GIS in MODSIM International Congress on Modelling and Simulation. In: Zerger A. & Argent R.M (Eds). Modelling and Simulation Society of Australia and New Zealand, Australia, pp. 2407-2413.
Safran R.J., Isola C.R., Colwell M.A., Williams O.E. (1997): Benthic invertebrates at foraging locations of nine water bird species in managed wetlands of the Northern San Joaquin Valley, California. – Wetlands 17(3): 407-415.
Savard J.L., Seanboyd W. & Johnsmith G.E. (1994): Waterfowl-wetland relationships in the Aspen Parkland of British Columbia: Comparison of analytical methods. – Hydrobiologia 279/280: 309-325.
Sebastián-González E.C. & Green A.J. (2014): Habitat use by water birds in relation to pond size: water depth and isolation: lessons from a restoration in Southern Spain. – Restoration Ecology 22: 311-318
Shannon C.E. & Wiener W. (1949): The mathematical theory of communication. University of Illinois Press, Urbana, No. 117.
Siriwardena G.M., Baillie S.R., Buckland S.T., Fewster R.M., Marchant J.H. & Wilson J.D. (1999): Trends in the abundance of farmland birds: a quantitative comparison of smoothed common birds census indices. – Journal of Applied Ecology 35(1): 24-43.
Smith W.P., Twedt D.J., Wiedenfeld D.A., Hamel P.B., Ford R.P. & Cooper R.J. (1993): Point counts of birds in Bottomland Hardwood Forests of the Mississippi Alluvial Valley: duration, minimum sample size, and points versus visits, Research Paper SO-274, USDA, Forest Service, Southern Forest Experiment Station, Diane Publishing Co, New Orleans, La, USA. – Trans. American Fisheries Society 110: 669-707.
Trivedi R.K. & Goel P.K. (1984): Chemical and biological methods for water pollution studies, Ist ed., Environmental Publications. Karad, India, 251 pp.
Wetzel R.G. (1975): Limnology. W. B. Saunders Company, Philadelphia, London and Toronto. W. B. Saunders Company, 743 pp.
Zakaria M., Rajpar M.N. & Sajap S.A. (2009) : Species diversity and feeding guilds of birds in Paya Indah Wetland Reserve, Peninsular Malaysia. – International Journal of Zoological Research 5(3): 86-100.

Authors' addresses: Moundji Touarfia, Department of Biology, Faculty of Sciences, University Mohamed Cherif Messaadia, 41000 Souk-Ahras, Algeria
Laboratory: Terrestrial and Aquatic Ecosystem, Faculty of Sciences and Nature, University Mohamed Cherif Messaadia Souk-Ahras, 41000, Algeria.

Noureddine Bouali, Department of Biology, Faculty of Sciences and Nature, University Echahid Hamma Lakhdar Oued-Souf, 39000, Algeria.

Sameh Djebablia, Meriem Rebbah, Nadhra Boukrouma, Department of Biology, Faculty of Sciences, University Mohamed Cherif Messaadia, 41000 Souk-Ahras, Algeria.

*Correspondence author: nboukrouma@yahoo.fr