

Diurnal behaviour of Ferruginous Duck *Aythya nyroca* wintering at the El-Kala wetlands (Northeast Algeria)

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Abstract. The wetlands of Northeast Algeria host a wintering population of the Ferruginous Duck *Aythya nyroca* whose winter number fluctuates between 1,500 and 3,500 individuals, with a maximum of 3,642 birds recorded during January 2008. The spatial-temporal distribution study revealed that the Mekhada Marsh and Lac Tonga remain the preferential sites for this species. Results of the study of the diurnal time budget achieved in the four main wetlands (Mekhada Marsh, Lac des Oiseaux, Lac Oubeïra and Lac Tonga), indicate that sleeping was the main activity (41.94% of time spent), followed by feeding (30.79%), whereas swimming, preening and flying were less frequent and occupy a secondary position. In addition, monitoring of the daily activities at Lac Tonga showed that feeding was always important at the beginning of the day rather than the end of the afternoon (50 % in the morning vs. 30 % in the afternoon). In the mid-day, time allocated to sleeping becomes frequently apparent for the majority of individuals. This result confirms the role of the lake as a feeding area and a roost.

Key words: Algeria, Mediterranean wetlands, El Kala, Ferruginous Duck *Aythya nyroca*, wintering, time budget.

Comportement diurne du Fuligule nyroca *Aythya nyroca* hivernant dans les zones humides de l'éco-complexe d'El-Kala (Nord-Est de l'Algérie).

Résumé. Les zones humides du Nord-Est de l'Algérie hébergent une population du Fuligule Nyroca *Aythya nyroca* dont l'effectif moyen hivernal fluctue entre 1500 et 3500 individus, avec un maximum de 3642 d'oiseaux enregistré durant le mois de janvier 2008. Du point de vue occupation-spatio temporelle, le marais de la Mekhada et le Lac Tonga restent les sites préférentiels de cette espèce. Les résultats du bilan total du rythme d'activité diurne réalisés dans les quatre principales zones humides (le marais de la Mekhada, le Lac des oiseaux, le Lac Oubeïra et le Lac Tonga), révèlent que le sommeil est l'activité prédominante (41,94 %) suivi par l'alimentation (30,79 %). Les autres activités de confort occupent un rang secondaire. Au Lac Tonga, les activités d'alimentation sont plus intenses le matin qu'en fin d'après-midi (50 % le matin contre 30 %). En milieu de la journée, le sommeil est la principale activité chez la majorité des individus observés. Ce résultat confirme le rôle de remise et de gagnage joué par ce lac.

Mots clés : Algérie, Zones humides méditerranéennes, El Kala, Fuligule Nyroca *Aythya nyroca*, hivernage, budget temps.

INTRODUCTION

The Ferruginous Duck *Aythya nyroca* is a key species of the coastal wetlands of Algeria, constituting with the White-headed Duck *Oxyura leucocephala* and the Mallard *Anas platyrhynchos*, the only breeding Anatidae (Ledant *et al.* 1981, Isenmann & Mouali 2000). However, there is no real information on the global number frequenting these hydrosystems during the wintering season or on the number of breeding pairs, although it has clearly been reported by several ornithologists that there is a significant population using the complex of the wetlands of the Northeast Algeria (Boumezbeur 1993, Houhamdi & Samraoui 2008, Metallaoui & Houhamdi 2008).

In this paper we expose a global review on the number of Ferruginous Ducks wintering in the complex of the wetlands of the extreme Northeast Algeria (phenology, structure and spatio-temporal distribution) as well as the results of the monitoring carried out during all the wintering period, of the diurnal behaviour in order to determine on the one hand the role played by these hydrosystems for this

species, and on the other hand to contribute to the knowledge of its wintering strategy.

STUDY SITES

The Algerian coastal region includes large wetlands of variable size. In addition to the well-known Lac Fetzara, those known under the appellation of 'the Great complex of the wetlands of Northeast Algeria', situated in the region of El Kala (Fig. 1), are the most diversified. The majority of them have received at least an international classification, belonging to the National Park of El Kala (P.N.E.K) covering a total surface of 76,438 ha.

With a total surface of 2,500 ha (Belhadj *et al.* 2007), Lac Tonga (36°53'N; 8°31'E) represents one of the most important Ramsar sites of Algeria as well as of North Africa (Boumezbeur 1993, Samraoui & De Belair 1998). The abundant aquatic vegetation of this lake plays a major role in the distribution of waterfowl species by offering both shelter and feeding area at the same time. It is mainly composed of floating islets of *Typha angustifolia*, *Iris*

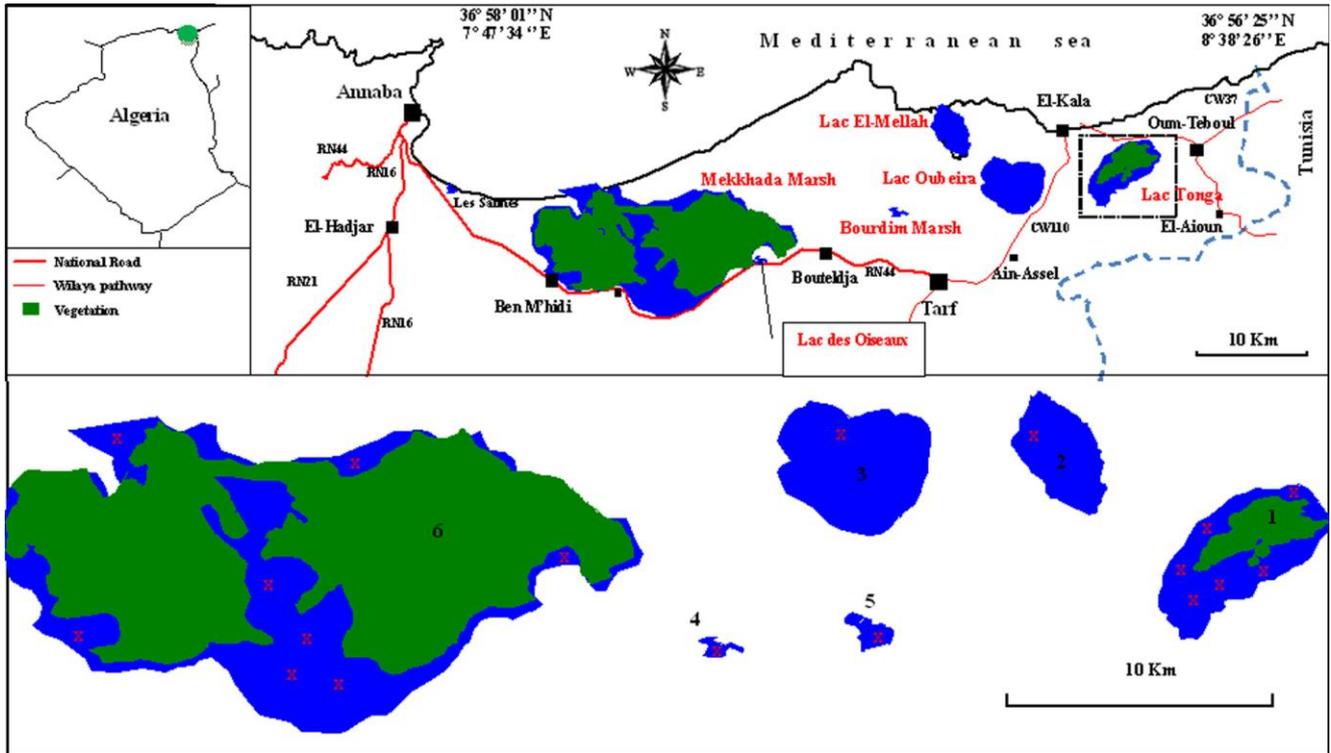


Figure 1. Geographic setting of the Northeast wetlands (Algeria) showing the location (x) of wintering Ferruginous Duck *Aythya nyroca*. (1: Lac Tonga, 2: Lac Oubeira, 3: Lac El Mellah, 4: Lac Des Oiseaux, 5: Bourdim Marsh, 6: Mekkada Marsh)

pseudoacorus, *Scirpus lacustris*, *S. maritimus*, *Phragmites australis*, *Salix pedicellata*, *Sparganium erectum* and *Nymphaea alba* (Abbaci 1999). This floristic richness sustains the reception and the frequentation of a significant population of water birds.

The Lac Oubeira (36°50'N; 08°23'E) with a surface of 2,600 ha and a depth of about 2 m (Morgan 1982) has become very poor in aquatic vegetation since the introduction of fish species that has strongly modified the composition of this lake. It is famous for the water sweet chestnut *Trapa natans* (Miri 1996, Samar 1999). Forty-three species of water birds have been recorded (Anatidae, Ardeidae, Rallidae, Charadriidae and Sternidae).

The Lac El Mellah (36°53'N; 8°19.29'E), covering a surface of 879 ha (Skinner & Smart 1984), is at present a lagoon supplied with sea water which increases its salinity up to 8.5 g/l in summer (Morgan 1982). These extreme halophilous conditions lead to the proliferation of a poorly diversified vegetation limited to the presence of *Juncus maritimus*, *Tamarix gallica*, *Anthemis maritima*, *Salicornia europea*, *S. arabica*, *Atriplex portulacoides*, *Limonium densiflorum*, *Juncus acutus*, *Ranunculus baudotii*, *Bellis repens*, *B. annua* and *Centaureum maritimum* (Morgan 1982).

The Lac des Oiseaux (36°47'N; 8°7'E) is an endoreic lake which extends up to 70 ha in winter, but its surface reduces to 40 ha (Samraoui *et al.* 1992) in summer. Its salinity is similar to that of the Lake Oubeira (Morgan 1982). The water vegetation is essentially represented by *Typha angustifolia*, *Scirpus lacustris*, *Ranunculus baudotii*

and *Nymphaea alba* (Houhamdi & Samraoui 2002). This wetland is especially known as a regular wintering site for the Common Coot and Anatidae as it represents an excellent site for both roost and feeding ground. In summer, this shallow pond is known to receive an important population mainly composed of Ardeidae, Charadriidae and Laridae (Houhamdi 2002).

The Lac Bleu (36°54'N; 8°20'E) is one of the smallest wetlands of the park, with a surface of only 2 ha, entirely surrounded by human dwellings which cause considerable disturbances, intensive pumping of water and discharges of detergents.

The Mekhada marsh (36°47'16.26''N; 8°00'33.40''E), with a total surface of 16,000 ha (De Bélair & Bencheikh Le Hocine 1987) is mainly fed by three oueds (wadis) which completely dry during the summer (Morgan 1982, Smart & Skinner 1984), and is open to the sea through the channel of Mafragh. The water vegetation covers more than 90 % of the water surface and is essentially composed by *Scirpus lacustris*, *S. maritimus*, *Phragmites australis*, *Typha angustifolia*, *Myriophyllum spicatum*, *Myriophyllum spicatum*, *Nitella* sp., *Alisma plantago-aquatica*, *Zanichellia* sp., *Lemna minor* and *Ranunculus baudotii* (De Bélair & Bencheikh Le Hocine 1987). This marsh is frequented in all its sectors by a very significant number of water birds, probably exceeding 50,000 individuals during the winter season.

The Bourdim marsh is a shallow, fresh water pond of 25 ha, with a proliferation of the white Water lilies *Nymphaea alba* and *Ranunculus baudotii* in spring. It is

surrounded by a forest composed of ashes, alders and willows. It is fed by Oued Bourdim and Oued Kebir, and was famous in the past by a colony of Cattle Egret *Bubulcus ibis* (Darmellah 1989).

MATERIAL AND METHODS

Weekly counts of Ferruginous ducks *Aythya nyroca* in North-east Algeria wetlands were carried out during a winter cycle from September 2002 to March 2009 using an ornithological telescope SOLIGOR (25×60) and a pair of binoculars KONUSPOT (10×50). Individual ducks were counted when the number was small. When the number of individuals exceeded 200, a visual estimate of the population size was achieved by dividing the flock into small virtual equal bands and counting the total number of total bands which reflect the total numbers estimated in each site (Bourliere & Lamotte 1969, Blondel 1975, Bibby *et al.* 1998). The data were collected from several observation points, chosen so as to cover the maximum circumference of the wetlands.

Time-activity budgets were quantified weekly using a scan sample approach (Altman 1974, Baldassare *et al.* 1988, Losito *et al.* 1989, Tamisier & Dehorter 1999) over winter cycles, starting from September 2004 to March 2009 in the most important sites, namely Mekhada marsh, Lac des Oiseaux, Lac Oubeira and Lac Tonga. The instantaneous behaviour was recorded with an interval of half an hour between 7:00 AM and 5:30 PM. Lac Tonga was selected for the detailed daily time budgets because it is easily accessible and a significant number of Ferruginous ducks could be easily monitored.

Behaviour was classified into five categories: (1) resting (inactive with eyes open, or sleeping), (2) feeding (including dabbling, up-ending and diving), (3) preening (including scratching and splash-bathing), (4) swimming, and (5) flying.

RESULTS AND DISCUSSION

The Ferruginous Duck is sedentary in North Africa (Isenmann & Moali 2000, Isenmann *et al.* 2005, Boumezbeur *et al.* 2005, Petkov *et al.* 2003, Azefzaf 2003, Houhamdi & Samraoui 2008) and is granted a particular status by the International Union for the Conservation of Nature (IUCN) and BirdLife International. The species is significantly represented in the majority of the main wetlands of Northeast Algeria.

The Ferruginous Duck winters in the majority of wetlands of Northeast Algeria where it exploits open water area cleared from any aquatic vegetation. This wintering duck was seen forming several homogeneous or mixed groups with other species (Fig. 1) mainly the Common Pochard *Aythya ferina* observed at Lac Tonga.

However, in the Mekhada marsh remains a significant number dispersed on different sides of the marsh,

neighbouring the Tufted Duck *Aythya fuligula*, the Common Pochard *Aythya ferina* and the White-headed Duck *Oxyura leucocephala*.

At Lac Oubeira, most individuals distinguish themselves from the other water birds, forming only one compact group located at the North part and in the center of the lake.

The spatial distribution of this diving duck at Lac El Mellah is remarkably concentrated at the northwestern part, which offers favourable conditions such as a simultaneous low depth and richness of trophic resources. In this lake, the Ferruginous ducks were observed near the Eurasian Wigeon *Anas penelope*. At Lac des Oiseaux, they share the open water with the Common Pochard *Aythya ferina*, and exploit the Northwest Bulrush *Scirpus lacustris* that offers an excellent refuge from human disturbance. At Bourdim marsh, they concentrate in the southern sector. Finally, a very small population of Ferruginous Duck was found at Lac Bleu, because of its small surface and its great depth

Evolution of the number of birds

The evolution of the total number displays a bell shape, dividing the wintering season into three periods (Fig. 2, a). The number of birds was initially characterized by 1,500 individuals; then, the population size increased steadily and remained fairly stable for several weeks at 3,000-3,500 (second period) whose peak was reached during January (3,642 birds). A progressive decline followed at the end of the wintering season and their number stabilized at the initial value. The drop observed between late March and early April can be explained by the departure and the migration of the majority of individuals from their wintering sites to their breeding areas.

The graph of the population variation in the Mekhada marsh exhibits the same shape. This marsh attracted a maximum of 1,520 individuals in January and a minimum at the end of April (Fig. 2, b).

Ferruginous ducks start to frequent Lac Tonga in early September with an initial number of 670 birds, followed by a progressive increase to reach, at the end of the study period, a total of 1,036 ducks (Fig. 2, c); they spend most of the day in open water, neighbouring the Northern Shoveler *Anas clypeata* and the Common Pochard *Aythya ferina*. The Lac Tonga represents both a regular winter site and an excellent breeding area for this species and for several other water birds, including the White-headed Duck, the Common Coot, the Purple Swamphen, the Great Crested Grebe and the Little Grebe.

Counts carried out in Lac Oubeira showed a maximum of 600 ducks (Fig. 2, d). A small population of 100 birds has been recorded at the beginning and at the end of the wintering season. In the past, it was the most privileged breeding habitat of the Ferruginous Duck and the White-headed Duck *Oxyura leucocephala*, but since the introduction of the Common Carp *Cyprinus carpio*, which has largely invaded all water bodies and destroyed the vegetation

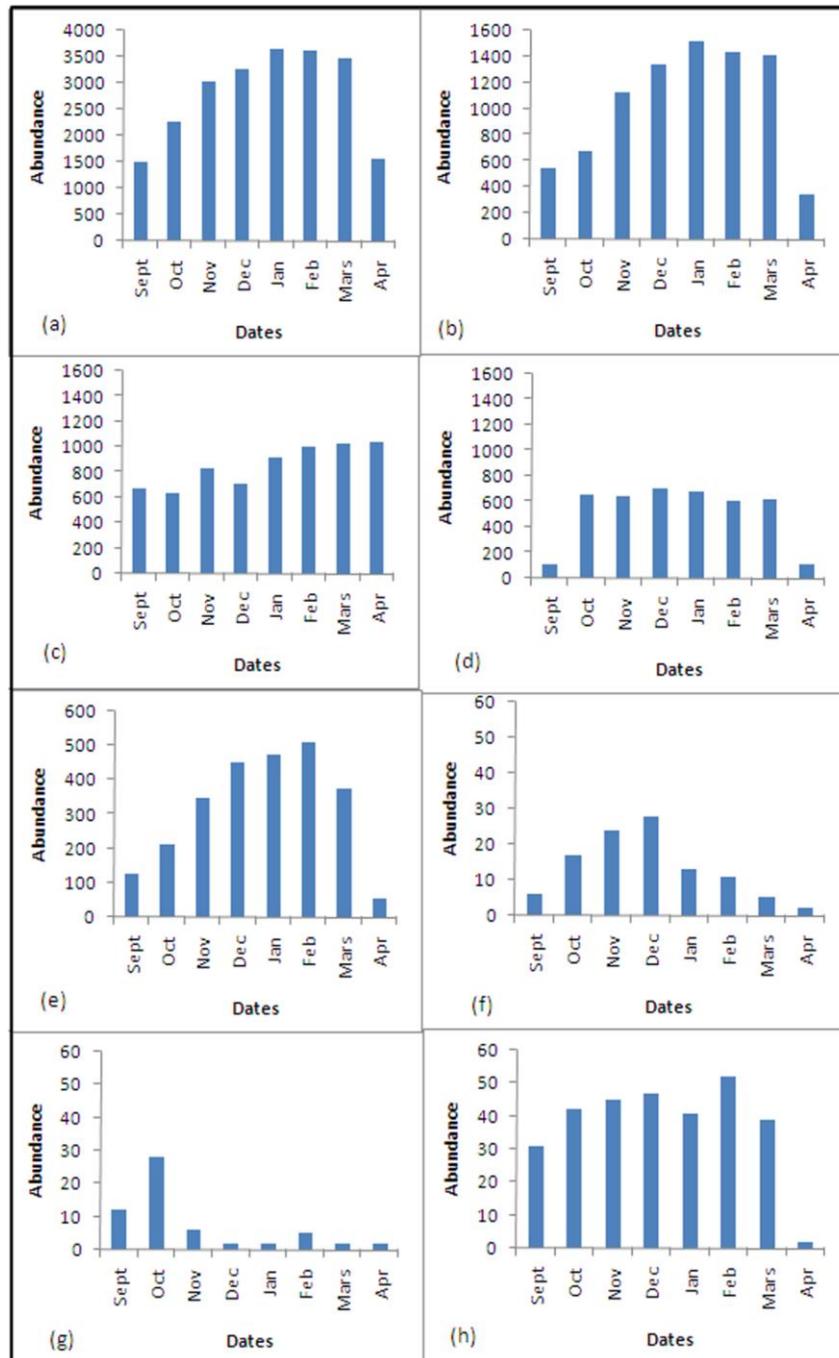


Figure 2. Weekly counts of Ferruginous duck populations across the Northeast wetlands during wintering season from 2002 to 2009. (a) total number, (b) Mekhada marsh, (c) Lac Tonga, (d) Lac Oubeira, (e) Lac des oiseaux, (f) Lac Bleu, (g) Lac El Mellah, (h) Bourdim marsh.

support necessary for building the nests, the lake has lost one of its more significant ecological features (Ledant *et al.* 1981, Samraoui & Samraoui 2008).

The first Ferruginous ducks at Lac des Oiseaux arrive with the first September rains. They are regularly seen with the Common Pochard during the wintering season, occupying the central and northwestern parts of the lake (Bulrush *Scirpus lacustris*) far from human disturbance. The population size (100 birds recorded in September)

starts to increase, and the peak is reached during February with 500 individuals (Fig. 2, e). Thereafter, the number decreases at the end of the wintering season.

The Lac Bleu is considered as a wintering site for a small population of Ferruginous ducks and Common Pochard. Their number hardly exceeds 30 individuals (Fig. 2, f). They are observed generally in open water and show a diurnal behaviour largely dominated by flying, because of continuous human disturbances.

However, only 2 to 5 individuals occupied Lac El Mellah (Fig. 2, g) because of its high salinity and significant depth. The large number noted at the beginning of the season corresponds to the transient populations.

The Bourdim marsh houses a small population which never exceeds 50 individuals which are present throughout the wintering season (Fig. 2, h). The anthropogenic pressure increases considerably at the end of April with the intensification of the agricultural activities such as pumping large quantities of water, forcing the ducks to leave the marsh.

Time budget

Analysis of the time budget recorded within the four main sites of the wetlands complex of the North-East Algeria, shows that the birds devoted most of the day to sleep (42 % of time spent) and feed (Fig. 3, a). This activity was mainly accomplished at night and has been recorded in most Anatidae (Tamisier & Dehorter 1999, Houhamdi & Samraoui 2008), often during the pre-migratory fattening period (Paulus 1988, Tamisier & Dehorter 1999).

Swimming is a major activity of most diving ducks. It has occupied the third position with 15 % as an average (Fig. 3, a; 14 % to 17 % depending on the sites) and is generally associated to feeding (Tamisier & Dehorter 1999).

Preening and flying were secondary activities (8 % and 5 % respectively). Preening was observed on the individuals at the extremity of the group; Flying, mainly caused by disturbance, also allowed the rearrangement of the group.

Monitoring of the diurnal activities was well established at Lac Tonga because of the presence of a representative population of Ferruginous ducks. Sleeping proved to be the main diurnal activity, with more than one third of the time budget. It generally varied between 30 % and 40 % during the study period (Fig. 4, a). The highest value, largely exceeding 40 %, was recorded during November, coinciding with the passage of post-nuptial populations (Fig. 2). Thus, for this transient period, Ferruginous ducks having nested outside this wetland exhibited a long diurnal rest exceeding 60 %, enabling them to use their energy at its minimum level (Green 1998, Costa & Bondi 2002, Tucakov 2005). The diurnal rest represents, on the one hand, the best way to restore management and valorization of the essential energy reserves during the migratory flights (Rave & Baldassare 1989, Tamisier & Dehorter 1999) and, on the other hand, to insure a successful breeding in the same wintering quarter for the sedentaries, or in the breeding area for the wintering population (Hill & Ellis 1984, Hohman & Rave 1990, Green *et al.* 1999).

Feeding, a main activity accomplished during the night by the majority of Anatidae (Tamisier 1972a,b, 1974, 1978,

Houhamdi 2002, Houhamdi & Samraoui 2001-2003, Mayache *et al.* 2008), shows several fluctuations (Fig. 4, a). The highest values (46 %) were recorded during the mid-season of wintering, around December. The lowest values are however observed during November, a period largely dominated by diurnal rest. The variable diurnal fattening can be explained by insufficient feeding and eventual possible threats exerted on the water birds during the night.

Swimming, as it is the case for all Anatidae, is a main activity closely associated to feeding due to the fact that the individuals often feed while moving (Houhamdi & Samraoui 2008). This activity is observed especially at the onset and at the end of the wintering season. The first period (onset of wintering) represents an effective and rapid means to recover and restore the energy used during the migratory flights. By the end of April, the wintering populations can be clearly distinguished from the resident breeding populations by their spatial distribution. The first ones are gregarious, preparing a pre-marital migration, expressed by displacements and high agitation, whereas the second ones isolate themselves in order to form the first breeding couples of the breeding season. In the mid-season, this activity oscillates between 7,50 % and 17 %. The Ferruginous Duck devote a little time to preening which is intense at the beginning of day. The peak of this comfort activity is reached at the beginning and at the end of the wintering season. Ducks need replacing and rearranging the damaged feathers after a long costly itinerary. Flight represents a minor part of the time budget, and displays a remarkable variation. Nevertheless, at the beginning of the winter period, we recorded a slight rise in this activity due to the disturbances caused by the arrival of the first wintering birds. Generally, flight occurs and appears due to many factors of disturbance, such as poaching, overflights of the marauding Marsh Harrier *Circus aeruginosus*, and with an antagonistic behaviour among the various individuals (intra-specific antagonism, or inter-specific antagonism with Common Pochard *Aythya ferina*).

Hourly time budget monitoring from 7:00 AM to 5:30 PM at Lac Tonga revealed that sleeping is observed mainly at the start and at the end of the day with a very low percentage (Fig. 4, b). Maximum increases in values of mean time percentage allocated to sleeping were recorded in mid-day, with a more or less stable percentage which lasted from 10:30 AM to 4:00 PM (5:30 hours; 57.21 % at 10:30 AM and 71.34% at 3:00 PM, representing the two thirds of the total time budget). This activity was observed on the individuals, either gregarious or grouped with other duck populations, accomplishing the same activity taking place mainly in the spots cleared from vegetation, and far from disturbances. Moreover, the time allocated to feeding by Ferruginous ducks displayed an inverse relationship to sleeping; the highest values were especially recorded early in the morning (~60%) and at the end of the day. The lowest values lasted for many hours, between 10:30 AM and 03:30 PM and marked a considerable fluctuation between 6% and 16% (Fig. 4, b). Our results clearly indicate that Ferruginous ducks wintering in the north-eastern coastal wetlands carry on feeding diurnally and thus we consider that the beginning and the end of the day are

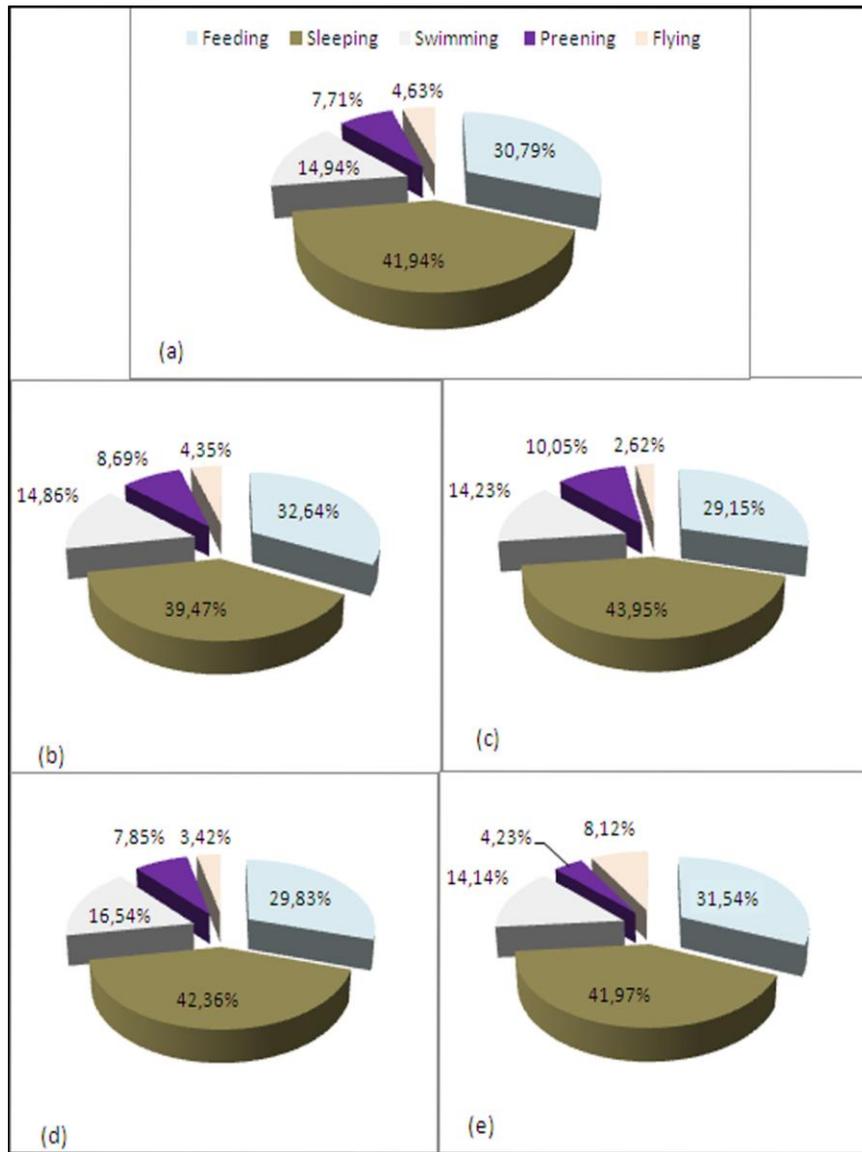


Figure 3. Time budget of wintering Ferruginous Duck in the most important Northeast wetlands of Algeria. (a) Total, (b) Tonga, (c) Oubeira, (d) Mekhada marsh and (e) Lac des oiseaux.

the continuity of the night feeding activity that compensates an increased thermoregulatory energy requirement, due to food availability and quality. Previous studies of time budgets of wintering waterfowl (Jeske & Percival 1995, Houhamdi & Samraoui 2003) have revealed a similar pattern of feeding, dedicating a sizeable part of daytime to this activity.

Swimming, frequently associated to the food search activity, occupied the third position and exhibited a similar graphical shape to that of feeding, but with lowest values. Maximum increase of mean time percentage allocated to this activity was recorded at 9:00 AM (21 %) and in late afternoon (18,35 % at 5:30 PM), whereas the mid-day was characterised by a decrease of the number of ducks (~10 %), devoted to swimming. Indeed, it represents a secondary means of removal of ducks on the wetland, in quest of both food and to avoid the drift of waves and

winds (Tamisier & Dehorter 1999). The preening activity was recorded with a mean percentage of spent time less than 12 %. The highest values (12.09 % and 11.99 %) were recorded during late afternoon (5:30 PM) and earlier in the morning (8:30 AM), whereas the lowest values were recorded (less than 7 %) in mid-day (Fig. 4, b). Flying was rarely observed during the wintering period with values fluctuating between 4 % and 5 %. It occurred following many disturbances mainly caused by marauding Marsh Harrier *Circus aeruginosus*, the small boats of poachers and hunters, and finally by the fishermen of the electric Eel *Anguilla anguilla*. In this protected area, the natural disturbance is not the most important factor compared to the increase of human activities by using motorised boats for fishing of Eel during the winter season. The Ferruginous ducks and other waterfowl were forced to disperse and to fly away when the boats approached closer than 30 m to the large flocks.

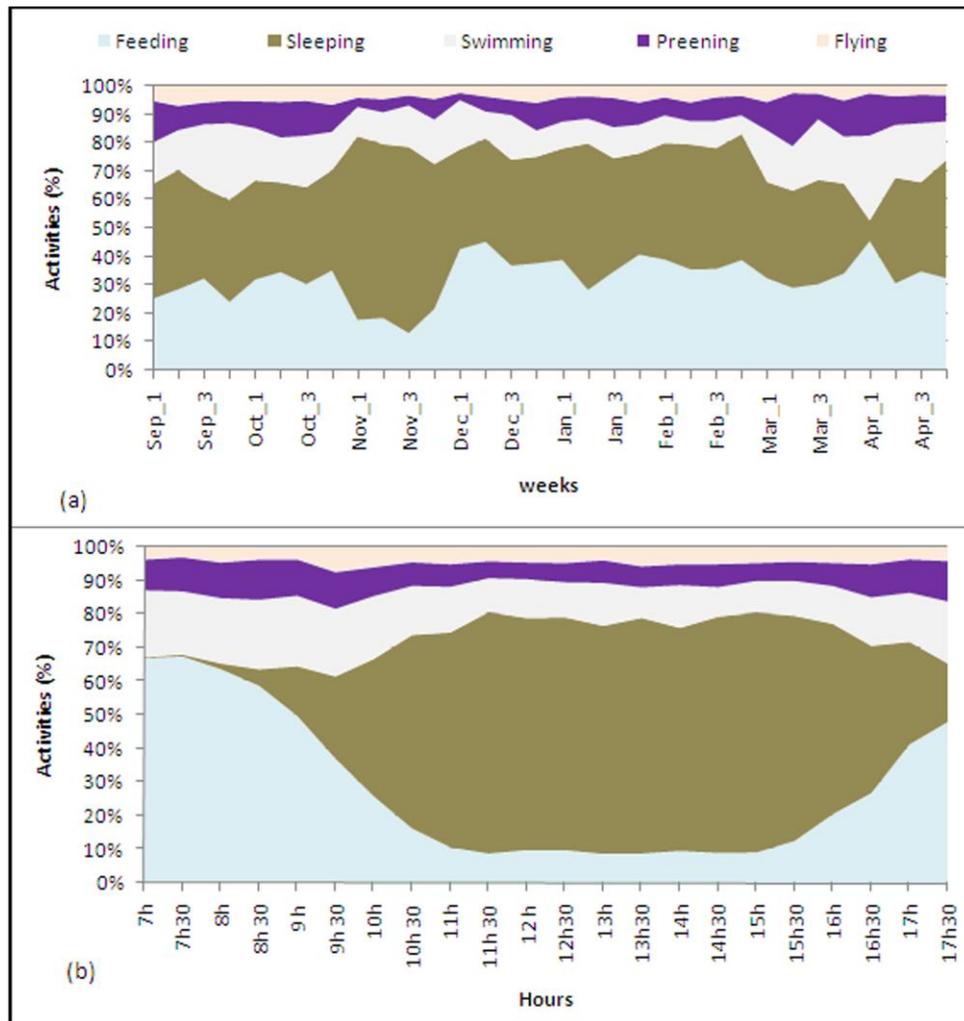


Figure 4. (a) Percentage of time allocated by wintering Ferruginous Duck at Lac Tonga, Northeast Algeria, to diurnal activities. (b) Percentage of daily activities spent by Ferruginous Duck in winter at Lac Tonga.

CONCLUSION

The Northeastern wetland complex of Algeria represents an excellent habitat for wintering, migratory and partly sedentary breeding Ferruginous ducks *Aythya nyroca*. Recent counts have confirmed the presence of a sizeable proportion largely exceeding the international 1 % threshold. The majority of the wetlands are under local protection and listed as Ramsar sites. In addition, it is vital to establish a national or a single action plan as recommended by AEWA to create conservation measures (Robinson & Hughes 2005) for this near-threatened species. This plan will implement the coordinated measures that prevent the loss and degradation of habitats, in order to insure and improve a successful breeding for a breeding population, reduce the intensive pressure of poaching and hunting and raise public awareness and knowledge of the preservation requirements of the Ferruginous Duck and its natural habitats.

Ferruginous duck number was characterised by a significant fluctuation from one site to another. The most attractive sites were the Mekhada Marsh and Lac Tonga

which were selected habitats within the complex for a sizeable population during wintering seasons. In fact, it was noticed that these two sites, with their capacity of reception, enabled the wintering of a very important population of water birds while offering them the essential conditions (quietness and less disturbance) for the wintering. Ferruginous Duck flock in gregarious groups regularly mixed with other species such as the Common Pochard *Aythya ferina*, the Tufted Duck *Aythya fuligula*, the Northern Shoveler *Anas clypeata* and the Eurasian Wigeon *Anas penelope*.

Monitoring of the diurnal time budget was much easier to realise at Lac Tonga than at Mekhada Marsh due to its easy access and its large population. Nevertheless, the results of diurnal activities obtained at Lake Tonga show a considerable fluctuation owing to, in our opinion, the mixture of two distinct populations, allochthonous (migratory) and autochthonous (local nesting). Time budgets were characterised by an increase of time spent feeding by accumulation of energetic reserves that are necessary over the wintering period (return flyway) or for breeding season needs. Further surveys are needed

In order to assess the availability of trophic resources and their direct relationship and influence on the feeding strategies in order to define the carrying capacities of the coastal wetlands of the North-east Algeria.

Acknowledgements

The authors are most grateful to Mrs BERGIER P. and OUCIF S. on their helpful comments on earlier drafts of this manuscript. We would like to thank also the staff of National Park of El Kala and Skander for assistance in data collection and field work.

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*Manuscript received 15 February 2011
Revised version accepted 1st November 2011*