

## Breeding and survival factors of the White-headed Duck *Oxyura leucocephala* in a small reservoir (Saïss Plain, Morocco)

### *Facteurs de reproduction et de survie de l'Érismature à tête blanche Oxyura leucocephala dans un petit réservoir (plaine de Saïss, Maroc)*

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**Abstract.** The presence of the White-headed Duck *Oxyura leucocephala* in the small artificial reservoir of El Mehraz, located on the Southern border of Fez city (Saïss plain, Morocco), was monitored in five nesting seasons (2014, 2015, 2016, 2018 and 2019). As a result, when the species fled the area in 2016 and 2017, the wetland dried up and made it impossible to discover any brood. With variable breeding numbers (2 to 11 females per season), this species had developed a few broods when the reservoir hydrology permitted it: nine in 2014, two in 2015 and five in 2019.

This small population enjoys the abundance of emergent vegetation in the shallow reservoir, but its survival chance depends on different factors: disturbance by visitors, predation by stray dogs, vandalism and, more especially, the drying up of the wetland for 1-2 successive years. This population is also threatened by hybridization with the Ruddy Duck since two adults and a hybrid individual were identified in the site. Nevertheless, this new breeding wetland provides hope of increasing the Moroccan population, that's why we recommended some management actions against these threats for ensuring to the White-headed duck a favorable hydrology and less disturbance and predation.

**Keywords:** *Oxyura leucocephala*, Breeding, reservoir, population, Maroc.

**Résumé.** La présence de l'Érismature à tête blanche *Oxyura leucocephala* dans le petit réservoir artificiel d'El Mehraz, situé à la frontière sud de la ville de Fès (plaine du Saïss, Maroc), a été suivie au cours de cinq saisons de nidification (2014, 2015, 2016, 2018 et 2019). L'assèchement de la zone humide au cours des années 2016 et 2017, par conséquent, n'a pas permis de trouver des couvées lorsque l'espèce a quitté la zone. Avec des effectifs reproducteurs variables (2 à 11 femelles par saison), cette espèce avait développé, lorsque l'hydrologie du réservoir le permettait, peu de couvées : neuf en 2014, deux en 2015 et cinq en 2019.

Cette petite population bénéficie de l'abondance de végétation émergente dans le réservoir peu profond, mais ses chances de survie dépendent de différents facteurs : dérangement par les visiteurs, prédation par les chiens errants, vandalisme et surtout assèchement du milieu humide pendant 1 à 2 années successives. Cette population est également menacée par l'hybridation avec l'Érismature rousse, puisque deux adultes et un individu hybride ont été identifiés sur le site. Néanmoins, cette nouvelle zone humide de reproduction laisse espérer une augmentation de la population marocaine, c'est pourquoi nous avons recommandé certaines actions de gestion de ces menaces afin d'assurer à l'Érismature à tête blanche une hydrologie favorable et moins de perturbations et de prédation.

**Mots clés :** *Oxyura leucocephala*, Reproduction, réservoir, population, Morocco.

## INTRODUCTION

The White-headed Duck *Oxyura leucocephala* (WHD) is a diving Anatidae belonging to the group of Oxyurini (Hughes *et al.* 2006), native to the Palearctic and classified as "Endangered" on the IUCN red list (IUCN 2017). This species is a winter visitor and breeder in Morocco, where it was first observed until the seventies of the 20th century, mainly in the northwest of the country, before it disappears due its habitats' loss (Thévenot *et al.* 2003). It reappeared in early 2000, in the Saïss plain at 'Lake of Dwiya (Bergier *et al.* 2003) and in two coastal wetlands, Sidi Boughaba and Fouwarate marshlands (Lahrouz *et al.* 2012, Cherkaoui *et al.* 2013). Since then, the conservation status of the WHD is gradually improving (El Hamoumi *et al.* 2017, Lahrouz *et al.* 2018) in Morocco, and corroborates with the slightly positive

evolution of the Hispano-Moroccan population (Wetlands International 2018).

El Mehraz dam, created in 1993 in the Saïss plain, in order to protect some districts of Fez city against floods, is a small shallow reservoir, invaded by hydrophytes (Squalli *et al.* 2022). Quickly after, it developed a diverse avifauna consisting of both visiting and nesting birds, which we observed from 2014 to 2019, mostly in the breeding season. Among the nesting species, we discovered some rare/threatened species, such as the Coot *Fulica cristata*, Common pochard *Aythya ferina*, Ferruginous duck *Aythya nyroca* and the White-headed duck *Oxyura leucocephala* (WHD).

Before finding this location, the semi-artificial lake of Dwiya was the sole wetland in the Saïss Plain recognized as the WHD breeding site. This private lake is practically inaccessible, situated 15 km northwest of El Mehraz reservoir.

Consequently, the monitoring of the aforementioned reservoir provided a chance to learn about the variables contributing to the development of the Saïss population of the species..

In addition, chicks of this species were seen in a stream (Fez Wadi) on the Western border of the city of Fez, due to the mobility restrictions during the Covid 19 pandemic, we were unable to monitor them, but more recent visits to this site do not reveal any more reproduction.

This study aims to investigate the breeding of the white-headed duck in the small reservoir of El Mehraz reservoir. This ecosystem is located in the vicinity of Fez City and hosts an important community of avian birds counting breeding, staging, and migratory species (Squalli *et al.* 2022). On the other hand, the El Mehraz reservoir is threatened by rough climatic conditions, including aridity, low precipitations, and hot temperatures, as well as anthropogenic activities, such as pastoralism and farmlands that pump huge quantities of water.

## MATERIAL AND METHODS

### Study site

El Mehraz wetland (4.971008°W, 33.967503°N) is a small artificial reservoir with a capacity of 620,000 m<sup>3</sup>, created in 1993 on the irregular stream of El Mehraz, one of the five tributaries of Fez wadi. This stream drains a relatively ramified

watershed (52.40 km<sup>2</sup>), overlapping the northern margin of the Middle Atlas Mountain and the Saïss plain south to Fez city (Figure 1).

This reservoir, also called Moulay Arafa and Oulad Bouabid, is located at about 500 m of altitude, on the southern border of Fez city, it is intermittently fed by El Mehraz stream and can dry up for several months, while it can receive violent floods (Reynard *et al.* 2011), which damaged some southern districts of Fez city before 1993. Thus, the reservoir undergoes large seasonal variations of its submersion level (Fig. 1), but remains generally shallow, due to the little slope of the local topography and the great width of its dike (500 m).

The water surface is usually 10 hectares, but it can exceed 16 hectares during rainy years, without ever reaching the 48 hectares supposed to be floodable by extreme floods. The submersion level gradually decreases during the dry season, reaching 3-4 ha, but the lake can dry up for a long time (i.e. from autumn 2016 to winter 2018).

The reservoir undergoes an active siltation that allows maintaining a luxurious vegetation on its banks, composed of hydrophytes (especially *Typha*) and *Tamarix*, which provide favorable habitats to waterbirds, more especially for the breeding species. The abundance of algae testifies the high productivity of the waters, which favors the presence of planktivorous birds.

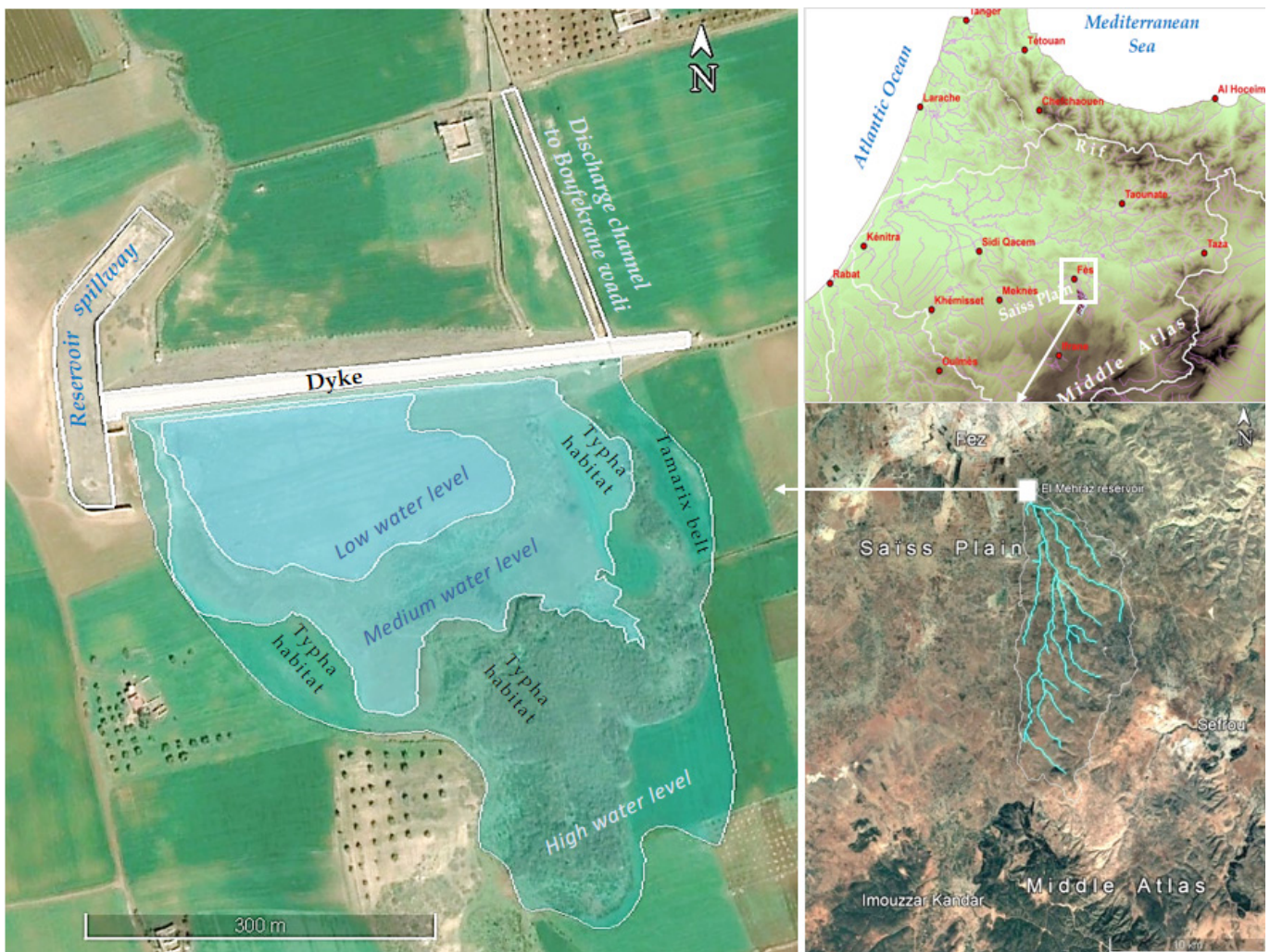


Figure 1. El Mehraz reservoir: location and main hydrological features.

## Methods

To accomplish this study, we carried out forty field visits during five breeding seasons (2014-2016 and 2018-2019) in El Mehraz dam. This monitoring was interrupted in autumn 2016, after the reservoir dried up until the winter 2018. These visits start in March or in April and end late August or early September, however, we adjusted these dates to the water conditions in the reservoir, as we were regularly in contact with a local farmer who informed us on the water level. At each visit, we spent the four early hours (after sunshine) in observing and counting birds by direct observations using binoculars and telescopes and covering the entire reservoir. This duration is sufficient to observe all active birds. We carried out the counts from the dike and the western bank of the lake. The monitoring provides both total counts, covering adults and large chicks, in order to provide an idea of the breeding chronology and success. As we cannot determine the exact age of the chicks, we used their approximate size, which is subdivided to three classes: small (newly hatching, identifiable by their typical downy plumage), medium (between 1/4 and 1/3 of the female size) and large (between 2/3 and 3/4 of the female size).

The annual number of broods generated corresponds to the number of freshly hatched chicks; the difference between this number and the total number of large size chicks provides insight into the success of reproduction.

## RESULTS

We organized forty visits to the site, but the WHD was present only in eight of them (Table 1). In addition to the periods where the reservoir is dried (as communicated by a local farmer), the 32 unfruitful visits (no WHD observed) are also indicated in this table.

When the reservoir was originally visited in March 2014, four males and one female were found there; the female later vanished, and three more males showed up on May 21. Ten males fled the site before July 26th, but four females showed up over the next two weeks and stayed until mid-August.

In June 1<sup>st</sup>, each of the four females had 3 to 9 chicks, aging one-week maximum, 17 days later (June 18<sup>th</sup>), three females have again newly hatching chicks (respectively 1, 2 and 4 chicks), while two others have respectively 6 and 7 medium-size chicks. Two final broods (respectively of 2 and 14 newborn chicks) appeared on June 22<sup>th</sup>.

Most of these broods have very small sizes and reflect a high loss rate of eggs in the nests and some females proceed then to a second laying.

These results mean that the laying activity has lasted about one month, from May 24 to June 22. The medium-sized chicks were not seen until the third week of June, they were in two groups of 7 and 8 chicks (Tab. 1), very probably related to two females. As five females nested in the site, we should assume that at least two of them lost their first broods.

Concerning elder chicks (slightly smaller than the female), their total number was 14 on July 26<sup>th</sup> and increased afterwards to 27 on August 15<sup>th</sup>. Assuming that no hatching occurred in July in the study site, we conclude that about 13 sub-adults came from other wetlands. This hypothesis means that among the 47 chicks born in the El Mehraz reservoir, only 14 were able to reach the fledging age. The breeding success rate of the species in the site was estimated in 2014 at 29.8% (14 out of 47 chicks), with an average of 2.8 chicks per female.

In 2015, nine females and one single male were recorded in March. The number of males increased to four before April 12<sup>th</sup>, and to 14 to 18 individuals between early May and mid-July, while we counted up to 11 females. Although this cohort is larger than the 2014's cohort is, only two broods have taken place (4 and 5 small chicks), not until July 4<sup>th</sup>. Since the species left the area by July 23<sup>rd</sup> and it didn't dry out until the end of the next winter, these would have been lost.

In 2016, seven visits were organized to the site, they revealed 5 males and 3 females in April 24<sup>th</sup>, which were joined by 4 other females between June 18<sup>th</sup> and July 9<sup>th</sup>. However, no broods were recorded and on July 16<sup>th</sup>, the species had already left the site, as the water level was very low. The reservoir did not take long to dry up, before getting back in water in March 2018, due to intense rains.

In 2018, we recorded two males in the site on April 22<sup>th</sup>, and two females joined them three weeks later, all individuals left the reservoir in June, without producing any broods.

In 2019, four males and two females were recorded on March 10<sup>th</sup>, and one more female joined them on March 22<sup>nd</sup>. By April 8<sup>th</sup>, four males and four females were on the site until June 23<sup>rd</sup>, where 20 chicks of medium size, divided into three broods, have been seen. On July 24<sup>th</sup>, 33 chicks were observed, 13 of them being of medium size but curiously without any female. We suppose that some of the large chicks came from other nesting sites (i.e. Fez Wadi or Dwiya lake). On August 1<sup>st</sup>, we did not find these chicks. Since this date, ten more visits did not reveal any WHD individual in the reservoir, which was quite dry.

In terms of density, we estimate the total productivity of the population in the reservoir to 2.8 individuals per hectare.

Table 1. Breeding of WHD in El Mehraz reservoir in 2014-2019: broods observed.

Years	2014					2015	2019		
Dates	June 1 <sup>st</sup>	June 18 <sup>th</sup>	June 22 <sup>nd</sup>	July 26 <sup>th</sup>	August 15 <sup>th</sup>	July 4 <sup>th</sup>	June 23 <sup>rd</sup>	July 9 <sup>th</sup>	July 24 <sup>th</sup>
Males	7	7	7	0	0	14	4	2	2
Females	4	5	4	5	5	11	1	2	0
Brood	SC	9.7.5.3	4.2.1	2.14		5.4			
	MC	6.7		7.8				10.4.6	4.9
Sizes	LC	14			27		10.10		

Chick size classes: SC: small chicks, MC: medium-size chicks, LC: large chicks

Brood sizes: ex. 9.7.5.3 means: 4 separate groups of respectively 9, 7, 5 and 3 chicks.

Visits with no broods: **2014** (March 16<sup>th</sup>, April 6<sup>th</sup> and 27<sup>th</sup>, May 07<sup>th</sup> and 21<sup>th</sup>, July 26<sup>th</sup>, August 15<sup>th</sup>), **2015** (March 15<sup>th</sup> and 29<sup>th</sup>, April 12<sup>th</sup>, May 2<sup>th</sup> and 23<sup>th</sup>, June 13<sup>th</sup>, July 23<sup>th</sup> and Sept. 6<sup>th</sup>), **2016** (April 24<sup>th</sup>, June 18<sup>th</sup> and 27<sup>th</sup>, July 9<sup>th</sup> and 16<sup>th</sup> and July 23<sup>th</sup>, Sept. 4<sup>th</sup>), **2018** (April 22<sup>th</sup>, May 10<sup>th</sup> and 25<sup>th</sup>), **2019** (March 10<sup>th</sup>, March 22<sup>th</sup>, April 08<sup>th</sup>, April 22<sup>th</sup>, May 11<sup>th</sup>, May 22<sup>th</sup>, June 10<sup>th</sup>, July 09<sup>th</sup>, August 1<sup>st</sup>).

## DISCUSSION

### Breeding potentialities of the WHD in the El Mehraz reservoir

This study presents new data on the importance of the El Mehraz reservoir for avian species in Central Morocco, particularly the globally threatened white-headed duck *Oxyura leucocephala*.

The objective of this investigation was to study the breeding bioecology of the white-headed duck in the small reservoir of El Mehraz reservoir. Obtained results revealed important breeding populations from 2014 to 2019. These data clarify the importance of the small reservoir for the breeding activity of *Oxyura leucocephala*. Similar results were recorded in many Moroccan and Mediterranean wetlands. For example, 30% of *Oxyura leucocephala* populations, including breeding pairs were recorded in wetlands and reservoirs of the Iberian Peninsula in Southwest Europe (Green & Hughes 1996, Arroyo & Esquivias 2000, Almaraz & Amat 2004). In another study, Gürsoy-Ergen (2019) reviewed the populations of *Oxyura leucocephala* in 41 wetlands in Turkey. The results confirmed the breeding populations in 17 sites from 1966 to 2000, and after this period the annual breeding populations were estimated at only 80–125 pairs. In Morocco, the globally threatened white-headed duck *Oxyura leucocephala* is a resident breeder and wintering species (Ouassou *et al.* 2021), they investigated the distribution of three Globally Threatened Waterbird Species, including the White-Headed Duck in the entire Morocco from 1983 to 2019. The obtained results confirmed important wintering populations of the species in the Middle Atlas wetlands, which are only 45 km from the El Mehraz Reservoir. Generally, central areas of Morocco are known for a wide diversity of wetlands counting dams, Lakes, and humane-made reservoirs that offer breeding and foraging resources for waterbirds (Green *et al.* 2002, Cherkaoui *et al.* 2014, Es Salai *et al.* 2021). In our case, the El Mehraz reservoir is rich in plants that could serve as nesting materials, water that could host higher diversity of phyto, and zooplankton considered forage for many aquatic birds (Urfi 2017).

Our expectation that this reservoir will serve as a preferred breeding location for the WHD, which is presently seeing a population increase in Morocco (Ouassou *et al.* 2021), justifies the current study. This hope grows with the species breeding success recorded in the site during 2014 and 2019, moreover, the arrivals of adults and sub-adults to this reservoir from other breeding sites, most probably from the Saïss plain and/or the Middle Atlas lakes (mainly Dayet Ifrah), would give to this site additional importance as a summer refuge for the species. Nevertheless, the recurrent breeding failure that happened during 2015 and 2016 and the high rate of loss in eggs and newborn chicks in 2014 justify the need to intervene for ensuring this population survival. To make possible this intervention, we provide hereafter the necessary information, as additional elements to the national action plan for the species (El Hamoumi *et al.* 2017).

### Major obstacles to the breeding success

The interannual variations in the success of reproduction attempts attest that the species' survival in the site faces several obstacles, which are presented hereafter.

Hydrological instability is certainly the main negative factor playing against this success. Indeed, the water level in the reservoir is highly variable, with long periods of drying up (i.e. from autumn 2016 to winter 2018), outside the rainy period, El Mehraz stream has a low and occasional flow,

whereas the reservoir loses its water by flowing through an opening in the lower part of the dam. In addition, withdrawals by the local population amplify this water loss, especially since the high siltation rate of the reservoir reduces the water volume and depth in the reservoir (Squalli *et al.* 2020, 2022). These factors lead to an early drying of the reservoir and to the failure of the breeding attempts. Similar results were recorded by Squalli *et al.* (2022) (Squalli *et al.* 2022) who recorded the drying up of the El Mehraz between 2017 and 2018 due to low precipitations and water pumping for agricultural purposes, which is in agreement with our results.

Another major barrier to successful reproduction is stray dogs, who are typically grouped in bands, preying on eggs and chicks (Chokri *et al.* 2023). In our case, dogs were frequently seen in and near reedbeds actively searching for nests. The predation of eggs by dogs was confirmed in other wetlands (Rihane & El Hamoumi 2016, Hilmi *et al.* 2020), and is probably the main reason for the small size of most broods of the WHD, as demonstrated by the rapid decrease of the small chick numbers. We suspect also, but without any proof, predation by the Marsh Harrier *Circus aeruginosus* because a couple is frequently flying over the site and Squalli *et al.* (2022) (Squalli *et al.* 2022) recorded its breeding in the same site.

The picnics are a significant source of disturbances for nesting birds, as picnickers regularly move on the dike and the western banks of the reservoir (Squalli *et al.* 2022). In our case, many local and international visitors were observed inside and in the vicinity of the reservoir during spring and summer. They were also frequently swimming in the middle of the lake and this noisy activity, practiced also by local children, imposes to the birds to gather for several hours on the vegetated eastern banks of the reservoir. Similar results were mentioned in other Mediterranean wetlands such as the case of Sardinian wetlands (Italy) (Ferrarini *et al.* 2023), coastal wetlands of Costa Brava (Spain) (Pueyo-Ros *et al.* 2018), and Turkish wetlands, East of the Mediterranean basin (Temple *et al.* 1999).

Sheep and cattle are frequently watered along the lakeshore, which might disrupt the nesting birds, particularly in the event that the water level drops and the cattle are able to approach the area in search of fresh herbs. Even cattle do not seem scary for breeding birds, they are presumed to destroy bird nests and eggs. Similar results were mentioned in other Mediterranean wetlands (Temple *et al.* 1999, Faria *et al.* 2016).

Local residents use engine pumps to fill their truck tanks with water from the lake, this frequent activity keeps birds away from the vegetated banks, which constitute their nesting habitat.

A contamination risk of the lake waters could be due to the intensive use of pesticides and artificial fertilizers in agriculture. However, another possible cause of habitat deterioration is solid garbage (paper, plastic bottles and bags, etc.), which is frequently observed on the banks and even in the water. It is uncertain how this may affect nesting birds.

The possible hybridization of the studied species with the Ruddy duck *Oxyura jamaicensis* another serious risk to the survival of the WHD (Perennou *et al.* 1997, Robertson *et al.* 2015). During our monitoring in El Mehraz reservoir, the Ruddy duck was seen in 2015 (one hybrid individual) and in 2016 (at least two females). Nevertheless, despite being in the middle of the reservoir and swimming with other ducks,

primarily ferruginous ducks, the observed individuals were isolated in that they never came near the WHD troops.

#### Towards a bird conservation action plan in the reservoir

The prior action needed concerns the site hydrology, which requires hydraulic management that could guarantee a permanent submersion of the habitats in the reservoir. This management, relying to the Sebou Hydraulic Basin Agency, as manager of this dam, remains feasible, as it does not affect the objective of floods control, assigned to this dam. On another hand, a high quantity of the reservoir water flows through a dam opening and is channeled to the Boufekrane stream, probably without any use objective. It is also hoped that the expected water supply from the El Himmer stream to El Mehraz reservoir, via an artificial channel (Reynard *et al.* 2011), will compensate for the summer level drop in the El Mehraz stream.

The other negative factors (disturbance, destruction of nests and removal of eggs, predation by dogs, etc.) are far from being negligible, especially during the breeding season, and deserve special attention. Their management is the responsibility of the Regional Water and Forests Directorate of Fez, the body in charge of protecting wildlife. This administration is officially responsible for fighting against the hybridization risk between WHD and the Ruddy duck, this fight should be considered in the national context (Dakki *et al.* 2015, El Hamoumi *et al.* 2017), as well as in the international one (Robertson *et al.* 2015, Hall 2016). These recommended the systematic eradication of this alien species and the resulting hybrids, whatever their origin.

Finally, an awareness campaign should accompany these actions, it mainly concerns the local residents, the visitors, and the water users. The majority of the local population, who we have informed about the value of the lake's avifauna, have responded positively, which suggests that educational efforts should complement other initiatives like fencing the lake's east bank.

#### CONCLUSION AND PERSPECTIVES

The present note has explicitly shown the potential role that El Mehraz small reservoir can play in the development of the Moroccan WHD population, particularly in the wetland complex of 'Saïss-Middle Atlas', which seems becoming a second Moroccan region that contributes to species sustainability.

This potential role justifies the priority we gave to this reservoir in the national avifauna monitoring. Furthermore, the WHD, as a globally threatened species, developed in this reservoir an appreciable breeding population (with more than 1% of the regional population) that allows its registration as a Wetland of International Importance (Ramsar Site). In this context, we should remember that, due to their waterbirds, several dams in Morocco are Ramsar Sites and/or included in the Protected Areas Master Plan in Morocco.

However, the artificiality and the heavy disturbances on the hydrology of this wetland, mainly on the breeding activity of the species, could give rise to some doubt about the future of this WHD population. That's why we proposed some feasible actions that could guarantee the conservation and development of this population (and of other rare species) in the 'Sais-Middle Atlas' region. We expect also that the ongoing bird monitoring in both wintering and breeding periods will better explain the mechanisms adopted by this species to maintain its presence in this region.

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