

DISCOVERING THE SECRET LIVES OF WHITE-HEADED DUCKS: UNVEILING POPULATION TRENDS AND PHENOLOGY AT MOROCCO'S TWO BEST WINTERING AND NESTING SITES, MERJA FOUWARATE AND LAKE SIDI BOUGHABA

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Abstract. Due to its ongoing decline, the White-headed Duck (*Oxyura leucocephala*) is considered "endangered" and is, therefore, included in the IUCN Red List. It has been estimated that the species declined from 100,000 individuals in the early 20th century to only 8,000–13,000 individuals in the early 2000s. In order to investigate the trends and phenology of this species, we conducted fieldwork during the breeding and wintering seasons from 2011 to 2022 in Merja Fouwarate and at Lake Sidi Boughaba in Northwest Morocco. Our data show that the lowest numbers of individuals were observed in September, followed by a gradual increase throughout the autumn, reaching peak levels in the winter months between December and February. These peaks were observed in January at both locations in Merja Fouwarate, with 280 and 314 individuals recorded in 2021 and in 2022, respectively. At lake Sidi Boughaba, the peaks were lower, with 176 individuals recorded in 2021 and 120 individuals in 2022. In contrast, duck numbers declined throughout the spring, reaching their lowest point between March and May. In the course of the eleven-year observation period, the population of the species clearly increased. The population of Merja Fouwarate increased by 14.5 and 3.67 individuals on average each year, while that of Lake Sidi Boughaba increased gradually from 2011 to 2018 before declining in the years that followed.

INTRODUCTION

The White-headed Duck (*Oxyura leucocephala*) is a diving anatid whose global population is believed to be in constant decline (Wetlands International. 2012), which has led to it being classified as 'endangered' on the IUCN Red List (Birdlife 2017). Its numbers are thought to have fallen from 100,000 individuals in the early 20th century (Green and Hughes 1996) to around 8,000–13,000 in the early 2000s (Wetlands International. 2012). The global population of the species is divided into three subpopulations: (1) Iberian Peninsula–Morocco (2,500 individuals), (2) Algeria–Tunisia (400–500 individuals), and Eastern Europe–Asia (5,000–10,000 individuals) (Wetlands International 2018). The reported winter numbers worldwide are very variable and can exceed 20,000 individuals.

In Morocco, the first observations of the species date back to the beginning of the 20th century and indicate that it is nesting in the northwest of the country. How-

ever, it was no longer observed there until the 1990s, when it was seen again in a wetland in the Saïss region (Bergier et al. 2003), and then in the two wetlands of the Gharb region, the objects of the present study (Cherkaoui 2003; Maire et al. 2013). A significant increase in numbers of this bird in Morocco, with a dispersion outside its traditional sites, prompted us to carry out a quasi-monthly monitoring of its numbers and reproduction during the last decade. In this paper, we use some of the results of this species monitoring in its preferred wintering and nesting areas in Morocco: Merja Fouwarate and Lake Sidi Boughaba.

MATERIALS AND METHODS

Study sites

The study sites correspond to two Atlantic coastal swamps, located near the mouth of the Sebou River, on

either side of the city of Kenitra. They are relatively wide and shallow, with a submersion rate that varies greatly with the seasons. Their high primary productivity attracts large concentrations of wintering waterbirds and several breeding species, including the White-headed Duck.

Merja Fouwarate (34.242494°N, 6.548408°W) is a large freshwater marsh of 620 ha, located in the extreme northeast of the city of Kenitra, on the left bank of the terminal course of the Sebou River (Figure 1), 3–6 m above sea level (Lahrouz et al. 2011). Its water supply is provided by the Ma'mora water table, the hydrographic network of the Fouwarate River, rainfall, and some urban wastewater effluents. The excess water of this swamp is discharged into the Sebou River, through a natural spillway, which has been developed into a canal over several decades. A large part of this marsh is occupied by hydrophytes (*Typha angustifolia*, *Bolboschoenus maritimus*, *Juncus acutus*, *Phragmites australis*, *Nerium oleander*). On its western bank, the marsh is bordered by the built-up area of the city of Kenitra, and on its eastern and northern banks, by small patches of eucalyptus, pine and tamarix. During low-water periods, the edges of the site are flooded, showing a wide mudflat where the plant cover is often grazed by cattle (Lahrouz et al. 2013). These habitats provide favourable conditions for approximately 60 species

of waterbirds, which can exceed 20,000 individuals during wintering and passage periods (Lahrouz 2015). Several rare/threatened species exist at this site and give it a high heritage value (Lahrouz et al. 2011, 2012; Maire et al. 2013): three anatids (*Oxyura leucocephala*, *Marmaronetta angustirostris*, and *Aythya nyroca*), two rails (*Fulica cristata* and *Porphyrio porphyrio*), and two waders (*Limosa limosa* and *Numenius arquata*). These ecological assets, among others, were behind the classification of this swamp as a Site of Biological and Ecological Interest (AEFCS 1996), then as a Ramsar Site (FDR 2018).

The **Sidi Boughaba lake** (34.239101°N, 6.674941°W), with a submerged area varying between 150 and 200 hectares, is located in a long interdune depression oriented parallel to the Atlantic coast. The hydrology of this lake is controlled by the fresh water table of the Ma'mora and by precipitation, which explains the strong variations in its submergence level, with regular elongation of its banks during the dry periods. It is rich in hydrophytes (*Typha angustifolia*, *Bolboschoenus maritimus*, *Juncus acutus*, *Phragmites australis*, *Nerium oleander*, etc.), which are growing in peripheral strips, but also in continuous and dense mass in the center of the site. Its immediate slopes are covered by a very dense thicket of *Juniperus phoenicea*, mixed with *Olea*



Figure 1. Location of the study sites (1: The Sidi Boughaba lake and 2: Merja Fouwarate) in relation to Kenitra city and the mouth of the Sebou River.

europaea, *Retama monosperma* and *Pistacia lentiscus*; a forest of eucalyptus occupies the Eastern shore of the lake (Atbib 1979, 1983). Unlike the Merja Fouwarate, whose ornithological history dates from the last two decades, the bird community of Sidi Boughaba has been the subject of numerous publications (Frété 1959, 1970; Thévenot 1976; Rguibi Idrissi et al. 2002; Harchrass et al. 2010; Cherkaoui et al. 2013). The above-mentioned references testify to its importance as both a wintering and breeding site for many waterbirds. This has led to several conservation classifications: permanent hunting reserve in 1951, biological reserve in 1974 (Morgan 1982; Hughes 1992), priority 1 site of biological and ecological interest in 1996 (AEFCS 1996), then Ramsar site in 1980 (Dakki et al. 2005).

This paper is based on the results of the species monitoring at the two above-mentioned sites from 2011 to 2022, with an interruption in 2020, due to the containment measures imposed by the Covid 19 epidemic. This monitoring consists of monthly counts using a pair of binoculars and a telescope; it is limited to the breeding season of the White-headed Duck at the two sites (Lahrouz et al. 2012; Cherkaoui et al. 2013), which extends over seven months (January to July). During the last two years (September 2021 to December 2022), counts were extended to all months of the year, in order to determine the phenological cycle of the species.

In order to carry out an exhaustive census, the two wetlands were divided into observation sectors (13 for the Merja Fouwarate and 11 for the Sidi Boughaba lake), defined for each wetland according to the availability of observation points allowing it to be circled while avoiding double counting. The counts were determined by two factors: the total number of individuals that were present and the total number of broods produced in a given year, (which refers to the number of female ducks accompanied by their offspring). The duration of the surveys was sufficiently extended to maximize the chances for observing the breeding females, which are often hidden in tall vegetation.

To identify any trends in numbers, data were compiled for each site to assign a single value to each year,

which was the inter-annual average of all the numbers counted during that year (seven months). The eleven values obtained were then used as dependent variables to identify the species trend at each site; for this purpose, we applied the classic linear regression model, with the adjustment of functions. After several different model fits, we chose the one that provided the best significance to the data ($p < 0.05$ and maximum value of the coefficient of determination R^2). When P and R^2 show the same values for two or three models, the use of residuals (low values) allows determining the best model. Means are presented with their standard error (mean ± 1 SE), using SPSS software. Values of $p < 0.05$ were considered significant. The phenological cycle of this species at the two sites is determined through the evolution of the numbers according to the census dates. The reproductive success is estimated at each site by the maximum number of females observed with ducklings per year. These values, as for the numbers, are then considered as dependent variables.

RESULTS

Phenology of the species

In Morocco, the White-headed Duck is considered as a resident breeder and winter visitor; the monitoring carried out between September 2021 and December 2022 showed a regular presence of the species at the two sites (Figure 2).

The lowest numbers are recorded in September; they gradually increase during the autumn, to reach their maximums in winter (December–February); in the Merja Fouwarate, these maximums were recorded in January (280 and 314 individuals respectively in 2021 and 2022); in Sidi Boughaba, these peaks were lower (176 in 2021 and 120 in 2022). Numbers then decrease during the spring, reaching their minimum in March–May. A rapid increase in numbers is noted in June, with the appearance of the young, but this is followed by a gradual decline from July onwards, ending in September. The decline in numbers during the spring can be

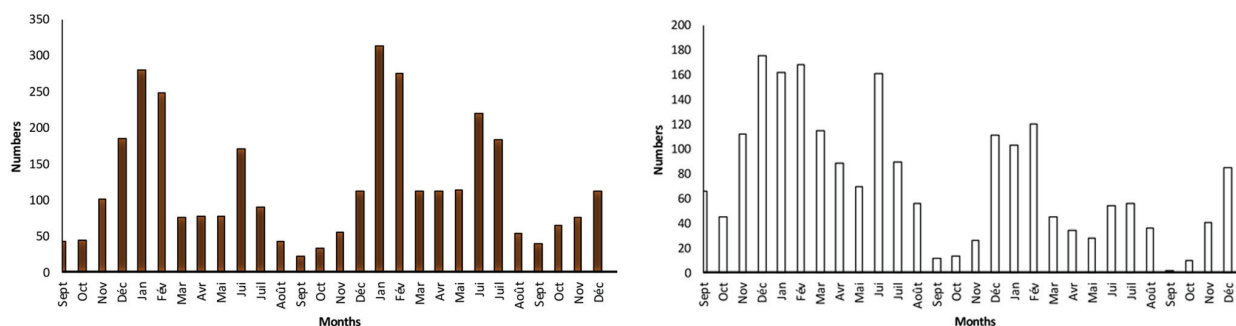


Figure 2. Monthly variations in numbers of the White-headed Duck in Merja Fouwarate (Left) and the Sidi Boughaba lake (Right) between September 2021 and December 2022.

attributed to two factors: the departure of overwintering individuals, on the one hand, and the challenge of detecting brooding females amidst the emerging vegetation, on the other. The rapid decrease in numbers between June and August is probably due to predation of the young, especially by stray dogs, which are found in large packs at both sites, but a dispersal of the species to other sites is not excluded.

Population trend

This trend is determined using two parameters: the average annual population size and the maximum annual number of females with ducklings.

Population of the Merja Fouwarate. During the eleven years of monitoring, the evolution of the species' numbers in this marsh shows a clear growth (Figure 3), following a linear model:

$y = 15.909 \times x - 31995$, $R^2 = 0.9601$, $p < 0.001$. According to this formula, the population of the species increased on average by 15 individuals per year (14.5 ± 3.67) with a clear increase between 2019 and 2022. In parallel, the number of broods shows a growth that fits well to a quadratic type curve: $y = 0.2391 \times x^2 - 1445.2 \times x + 3E + 06 \times 2E + 09$, $R^2 = 0.9996$, $p = 0.001$. This model (Figure 4) indicates the average annual growth estimated according to a geometric progression of 1.69 individuals (1.69 ± 0.06).

Population of the Sidi Boughaba lake. Over the whole period of the study, the numbers of the individuals evolved according to a quadratic type of growth model: $y = -0.8025 \times x^2 + 4850.7 \times x - 1E + 07 \times 7E + 09$, $R^2 = 0.9434$, $p = 0.0048$. Numbers increased steadily between 2011 and 2018, before beginning to decline in subsequent years (Figure 3). The number of females observed with ducklings also increased according to the same type of model: $y = 0.0118 \times x^2 - 71.546 \times x + 145117 \times -1E + 08$, $R^2 = 0.971$, $p = 0.27$. Here we can discern three phases of population size change: a rapid increase between 2011 and 2015, then a slowdown in 2018, before a rapid decline in 2019–2022 (Figure 4).

DISCUSSION

Since its reappearance in Morocco in the 1990s, the White-headed Duck has been exhibiting a progressive expansion of its population in this country, both numerically and geographically (El Hamoumi et al. 2017; Ouassou et al. 2021). In this context, the species has been observed on the Sidi Boughaba Lake only since 2007 (Cherkaoui et al. 2013), while in Merja Fouwarate it appeared only in 2012 (Maire et al. 2013). Although at present the species is observed in seven northern wetlands of Morocco (El Hamoumi et al. 2017), 73% of its numbers (winter or breeding) are recorded at the two Ramsar sites, which are

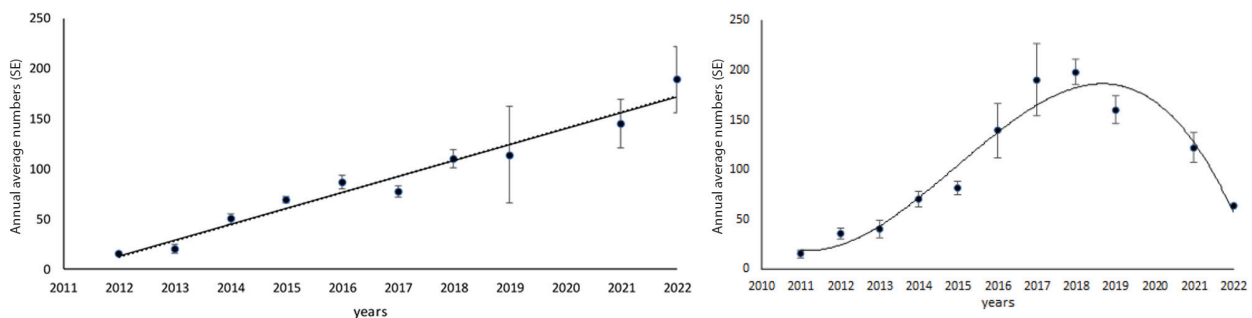


Figure 3. Evolution of the annual average numbers of the White-headed Duck in Merja Fouwarate (Left) and the Sidi Boughaba lake (Right) between 2011 and 2022.

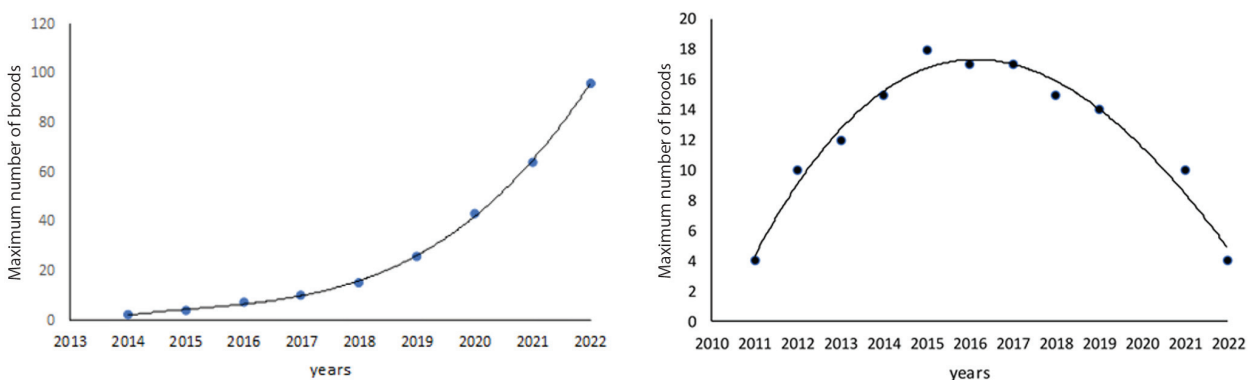


Figure 4. Evolution of the number of White-headed Duck broods in Merja Fouwarate (Left) and the Sidi Boughaba lake (Right) between 2011 and 2022.

the subject of this study (Ouassou et al. 2021). This means that the results of our monitoring can be considered as representative of the Moroccan population of this species and can be used as a basis for explaining its dynamics in the country, its phenological status and recent trends (during the years 2011 to 2022).

The monthly variations in numbers indicate a phenology marked by two peaks of abundance, which are intervened by two periods of low numbers. The winter peak is linked to the gradual arrival of adult visitors, mostly Iberian migrants (Lahrouz et al. 2018), who leave the site after a 2–3-month stay. In Fouwarate, this peak is earlier than in Sidi Boughaba, where the numbers remain high. The second peak is recorded at the beginning of summer at both sites, due to the indigenous contribution of the young, but it is short-lived as the numbers fall in July (sometimes August in Sidi Boughaba). This fall in numbers can be explained based on two hypotheses: the abandonment of the sites by part of the population due to the depth decrease and the resurfacing of large marginal areas, and predation pressure from stray dogs. Trends of duck populations in the two wetlands differ. In Fouwarate, the population increase follows a linear pattern with a regular annual contribution of 15 individuals on average, and the number of broods increases quadratically without downturns. The nesting habitats in this wetland can still receive new nesters. In Sidi Boughaba, the population size follows a quadratic pattern, with an exponential growth period between 2011 and 2018 and a decline in numbers from 2018 to 2022. This trend is explained by the evolution of the annual brood production, which peaked in 2015 with 16–18 broods before starting to steadily decline from 2018. The recent negative trend in this population can be explained by the reproduction failure due to the dramatic shrinkage of habitats induced by the increasing drying of most of the wetland, including the area that is fenced for providing the quietude necessary for the nesting avifauna. Indeed, the water table, which contributes to the prolongation of the post-winter watering of this wetland, has been negatively affected by the increased water pumping for agricultural and domestic purposes that was made possible by the installation of a water pump at the southern edge of the site. Now the species is present only in the permanent north-eastern part of the site, which in turn is highly exposed to disturbance caused by visitors and their vehicles. However, we cannot avoid mentioning the inhibiting effect of stray dogs, whose presence at the site is almost permanent, and which constitutes a real threat to the nesting of waterbirds (El Hamoumi et al. 2017).

We assume that during the last years, the breeders leave lake Sidi Boughaba for Merja Fouwarate, given that the two sites are only 12 km apart. Indeed, after the installation of a six-meter- high dam, which was intended to

protect human dwellings adjacent to the wetland from its flooding, this swamp has enjoyed a certain quietude for four years. Even though this peri-urban Ramsar site has not benefited from any field protection actions, the breeding habitats of this duck are subject to both over-grazing and repeated mowing of hydrophytes. However, these activities do not seem to severely hamper the nesting of the species, which finds a good alternative to the Sidi Boughaba swamp.

At both sites, the possibility of this species hybridization with the Ruddy Duck remains conceivable since the latter has been observed on several occasions, but this threat is negligible compared with the threat posed by stray dogs, which feed on chicks and eggs and have become, due to their abundance, a real obstacle to the reproduction of several bird species, including the threatened ones.

CONCLUSIONS

The present study has elucidated the phenology of the White-headed Duck in Morocco (resident population, plus wintering visitors). Moreover, since its relocation to the two study sites, this species has experienced a gradual increase in numbers. But since 2018, at Sidi Boughaba lake, where the reproduction of this duck is experiencing recurrent failures, this trend has reversed, although this site enjoys several protection statutes. The increasing gradual drying of nesting habitats is among the most decisive factors at play accounting for these failures; this problem is also partly linked to the decrease in rainfall, but water deficiencies in this lake during the spring and summer are mainly due to the increased pumping of the water table. We intend to continue our scientific monitoring to further support our hypotheses and conclusions on the spatio-temporal dynamics of this species and the factors that affect it. Additionally, we recommend that this monitoring be extended to all Moroccan wetlands, as per the Action Plan established in 2018 for this species.

CONFLICT OF INTERESTS

The authors declare they have no competing interests.

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Data Availability

The data used to support the findings of this study are included in the article.

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