

# Distribution and demographic trend of Algerian Nuthatch (*Sitta ledanti*) population of Mount Babor forest in Babor-Tababort National Park

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**Summary** The Algerian Nuthatch (*Sitta ledanti*) is the only bird species endemic to Algeria and it's a protected species by the Algerian law since 1983. So far, we have no precise information on recent changes in population density as well as the demographic trends of this endangered species in its entire range in the Kabylia of Babors. The population of the species in the Babor-Tababort National Park remains the most abundant, with 275 individuals recorded in 2020. Thirty-eight years after the 1982 census, it multiplied with an annual multiplication rate of ( $\lambda$ ) = 1.01 and grew with an annual growth rate of  $r = 1.36\%$ . The Algerian Nuthatch has been present throughout the Mount Babor forest from 1,300 m altitude to the summit at 2,004 m altitude. The Algerian Nuthatch, in 2020, was more abundant in the mixed cedar forest because this type of forest covers the largest area in Mount Babor. The population of the species in the Mount Babor forest remains isolated that, however, could be connected to the population in the Tababort forest through the setting of an ecological corridor.

**Keywords:** Algerian Nuthatch, Babor-Tababort National Park, distribution, growth, habitat

**Összefoglalás** Az Atlasz csuszka (*Sitta ledanti*) Algériában 1983 óta védett, egyetlen endemikus madárfaj. Az Kizárólag a Badors Kabylia régióban fordul elő, de nincsenek pontos információk a populációk nagyságáról és az egyedszámok változásáról. A Babor-Tababort Nemzeti Parkban 2020-ban végzett felmérés szerint az ott élő populációt kb. 275 egyed alkotja. Az 1982-ben (Ledant 1985) végzett felméréshez képest a populáció növekedett, éves átlagos növekedési rátája 1,36% volt. A Babor-hegy erdei élőhelyein az 1300 m tengerszint feletti magasságtól a 2004 m-es csúcsig mindenhol előfordul. A 2020-as felméréskor a legnagyobb számban a legnagyobb kiterjedésű, kevert cédrus erdőkben fordult elő. A Babor-hegyi populáció elszigetelt a többi költőpopulációtól. Fennmaradását segítené, ha ökológiai folyosókkal kapcsolódhatna a Tabort erdőség nagyobb populációihoz.

**Kulcsszavak:** Atlas csuszka, Babor-Tababort Nemzeti Park, elterjedés, denzitás, populációdinamika, élőhely

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## Introduction

Population dynamics is a discipline that has as interest the description and understanding the fluctuations in number of individuals in a given population over space and time. Thus fluctuations result in growth, decline or stability (Besnard & Salles 2000, Kricsfalusy 2012). The population growth potential of vertebrates allows the creation of population reserves, which can only exist with the availability of heterogeneous and favorable habitats (Blondel 2000) that provide refuges in case of rare climatic events such as prolonged drought or extreme cold (Wiens 1977). Demographic analyses of long-term monitoring data allow exploration of a variety of ecological and evolutionary questions, ranging from social behavior (Boulinier *et al.* 1996) to adaptation to spatio-temporal habitat heterogeneity (Blondel 2007). This kind of analysis is also applicable to investigate the impact of global changes and human activities on bird populations (Lebreton 2019) through the management of exploited populations and conservation (Weimerskirch *et al.* 1997, Nichols & Williams 2006). Thus, studies of population dynamics are used in population viability analysis and threat assessment criteria (IUCN 2012). They are also involved in assessing the status of endemic and threatened species (Schemske *et al.* 1994).

The Algerian Nuthatch *Sitta ledanti* is the only endemic bird for Algeria (Isenmann & Moali 2000) and a protected species by the Algerian law since 1983 (J.O.R.A. 1983). Since its discovery in 1975 in the Mount Babor forest situated in the Babor-Tababort National Park (Ledant 1977, Ledant & Jacobs 1977), its numbers continue to increase thanks to new discoveries in new habitats. The Algerian Nuthatch is distributed over twelve different habitats, which are all within the biogeographic area of Kabylia of Babors (Petite Kabylie) in northeastern Algeria (Chalabi 1989, Bellatrèche & Chalabi 1990, Moulai & Mayache 2018, Haddad & Afoutni 2019, Bougaham *et al.* 2020, Mayache & Moulai 2021, Bougaham *et al.* 2021). Despite the increase of its numbers, the Algerian Nuthatch still remains on the IUCN Redlist with numbers below 1000 individuals (IUCN 2012, Hamitouche & Bougaham 2021). The Algerian Nuthatch population estimations were carried out via censuses in many of its habitats, namely Guerrouch, Babor, Djimla, Tamentout, Larbaâ, El-Djarda, Sendouh, Tloundène, Tazegzeout, Coudia and Tababort (Hamitouche & Bougaham 2021). However, studies on the aspect of the population dynamics of the bird remain anecdotal and less precise. The only work was done in the Mount Babor forest and there is variation in the number of individuals from year to year (Vielliard 1978). Fluctuations in the number of individuals (between 12–70 pairs) from year to year may be related to field sampling effort (Vielliard 1976a, Ledant 1977, Ledant & Jacob 1977, Gatter & Mattes 1979). Apart from the variable sampling efforts, the availability of coniferseeds of the Atlas cedar *Cedrus atlantica* and the Numidian fir *Abies numidica* may also cause differences in nuthatch density.

The exhaustive and general census that took place on the whole Mount Babor forest (Ledant 1985) in 1982 is the reference work for our present study. The demographic changes of this endemic bird must be followed very closely (Vielliard 1978) because of its reduced numbers (Ledant 1977).

In this paper, our main objective is to describe the population dynamics of Algerian Nuthatch in the Mount Babor forest on the basis of: 1) the increased population density after

38 years; 2) the rate of multiplication and 3) the annual growth rate. Finally, the distribution of the species in the Babor forest is defined according to habitat types and altitudinal gradients.

## Material and Methods

### Study area

The Babor-Tababort National Park is part of the territory of Kabylia of Babors. It spreads over three Wilayas (Districts), namely Bejaia, Jijel and Sétif. It covers an area of 23,656 hectares. It is delimited by the following geographical coordinates: (36.600948°; 36.463018°) \* N (5.327397°; 5.583446°) E (J.O.R.A. 2019) (Figure 1). The Mount Babor forest is defined as a core area of the Babor-Tababort National Park (J.O.R.A. 2019). It is located at 45 km east of Bejaia and forms the highest point of Petite Kabylie (2,004 m). The extent of the forest is 1,268 hectares (Ledant 1985). Mount Babor is a 7 km long and 4 km wide extrusion (Duplan 1952). It has got more than 500 plant taxa; including 45 tree species and 24 endemic species, as well as 22 species have a protected status by the Algerian law (J.O.R.A. 2012). Recently, two new orchid species have been reported including *Epipactis microphylla* (Bougaham & Rebbas 2020), as a new orchid for the Algeria flora and *Cephalanthera rubra* (Bougaham *et al.* 2020) as a new site for the species in the Mount Babor forest. The average annual precipitation ranges from 512 mm (1,000 m altitude) to 920 mm (2,004 m altitude) on the

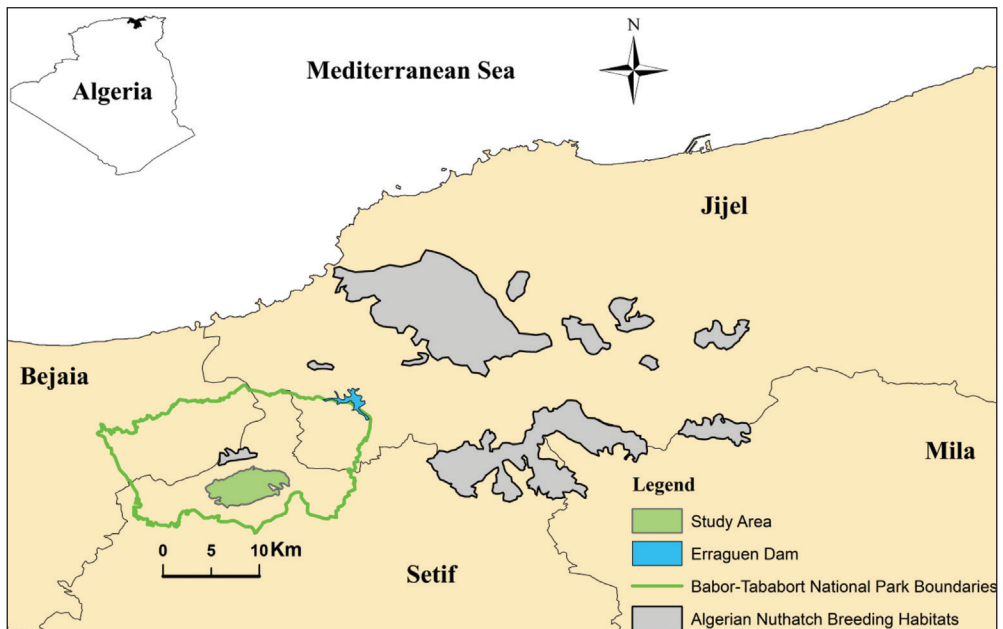


Figure 1. The study area in the Babor-Tababort National Park

1. ábra A vizsgálati terület földrajzi elhelyezkedése a Babor-Tababort Nemzeti Parkban

northern slopes and from 980 mm (1,000 m altitude) to 1,397 mm (2,004 m altitude) on the southern slopes. The average annual temperatures of the coldest month are between 0.0 °C (1000 m altitude) and -5.4 °C (2,004 m altitude) on the north slope and between 3.8 °C (1,000 m altitude) and -3.2 °C (2,004 m altitude) on the south slope (Gharzouli 2007).

### **The census**

To estimate the size of the Algerian Nuthatch population, we used a point count census method suggested by Frochot (2010). The census in the Mount Babor forest was carried out from the beginning of June (04/06/2020) until the beginning of July (11/07/2020). We took the liberty of spreading out our census over time because of the late breeding period of the Algerian Nuthatch in this forest and especially in high altitudes (Vielliard 1976b, Vielliard 1978). The census was carried out during the breeding season, during the mornings (bird activity is intense) and during favorable weather conditions (absence of rain, fog and wind). The census was conducted on the basis of point counts (Blondel 1975, Ledant *et al.* 1985, Bougaham *et al.* 2018, Hamitouche *et al.* 2020). The point counts were practiced along a line transect in aim to cover the entire forest. At each point count, the song of the species is played via a tape recorder in order to stimulate and observe the species. The point counts on the line transects are spaced about 200 to 300 meters apart, except in the case of crossing the ridge line or the no possibility of access. This distance between two point counts was in order to avoid counting the same individual twice, while limiting the risk of not detecting some individuals. At each point count, after the species' song has been played, a 20 minutes period was observed on site. During the 20 minutes, the presence or absence of the species is first noted by auditory and/or visual identification. In case of presence, we noted if it was a pair or a solitary bird. Finally, in each point count, we noted the GPS coordinates, the altitude and the type of dominant forest stand on a radius of 30m.

### **Mapping and statistics**

We used Esri 2014, ArcGis (spatial analysis software) with the ArcMap application v10.2.2 for processing geographic information. The spatial geo-referencing data (GPS coordinates of presence/absence points and altitude) were taken in the field with a GPS Carmin map 76 CSx' model. The distribution map (presence and absence) of the species in the Mount Babor forest was made on the basis of Arcmapv10.2.2 and the spatial geo-referencing data taken in the field. The chi-squared statistical test was carried out under the software R. This test was performed in aim to show relationship of the Algerian Nuthatch numbers in each habitat type, between the two census periods (1982 and 2020).

### **Distribution according habitat type**

The dominant trees were noted in a radius of 30 meters around of each point count in aim to identify the habitat type.

### Distribution according to altitudinal classes

Altitudinal classes were calculated via Yule's rule: the number of classes =  $2.5\sqrt[4]{n}$ , where  $n$  corresponds to the total number of point counts performed ( $n = 240$ ), and the class interval is calculated by the ratio of the difference between the highest and lowest altitude divided over the already calculated classes number (Highest altitude – Lowest altitude/number of classes).

### Population dynamics of the Algerian Nuthatch

The numbers obtained after our count of the Algerian Nuthatch in the Mount Babor forest during the breeding season of the year 2020 were compared to those of Ledant (1985) carried out in the same forest during the breeding season of the year 1982. A comparison of numbers according to the habitat type was also made. The typology of our habitats was respected, as far as possible, with respect to the one defined by Ledant (1985). The population dynamics of the species was checked, after a 38-year period, via densities, annual multiplication rate and annual growth rate.

### The density and the individuals mean number

The density is the total number of pairs counted divided by the forest total area surface, multiplied by 10 (Hamitouche *et al.* 2020). The individuals mean number per point count is the ratio between the number of individuals counted in each habitat and the number of point counts performed.

### Average annual multiplication rate ( $\lambda$ )

The population numbers variation, in a considered time lapse, is given according to the formula of Migot and Linard (1984):

$$\lambda = \sqrt[n]{E_f/E_i}$$

$n$  = number of years between two censuses;  $E_f$  = final number;  $E_i$  = initial number;

$\lambda = 1$ : Population size is stable;

$\lambda > 1$ : Population size is increasing;

$\lambda < 1$ : Population size is declining.

### Annual growth rate ( $r$ )

According to Gibbs (2006), the annual growth rate (%) is calculated according to the following function:

$$r = \frac{\ln(Nt) - \ln(N0)}{t}$$

$t$  = number of years between two censuses;  $Nt$  = final number;  $N0$  = initial number;  $\ln$  = natural logarithm;

$r \simeq 0$ : Population size is stable;  
 $r > 0$ : Size of the population is increasing;  
 $r < 0$ : Population size is declining.

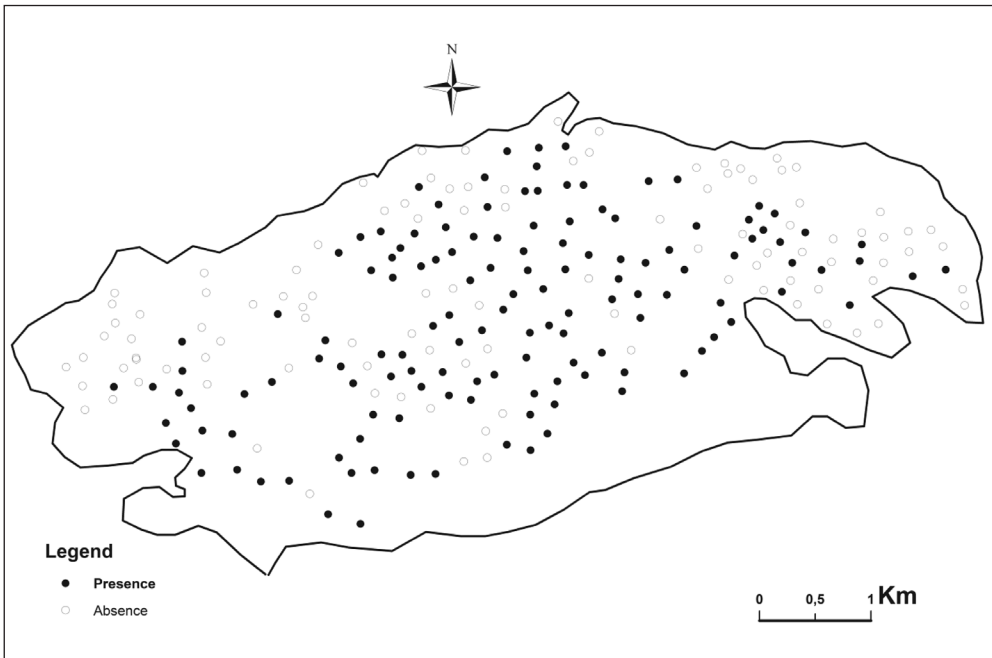
## Results

### Number of pairs and individuals counted

Out of 240 point counts carried out on the whole Mount Babor forest, we counted 133 pairs, nine solitaires and 105 absences. A total of 275 individuals were counted. The number of this population in the Mount Babor forest is the highest compared to that counted in other known forests.

### Distribution of the Algerian Nuthatch

The species distribution within the forest follows the same pattern of distribution as that of the different habitat types distinguished. The species distribution map in the Mount Babor forest (*Figure 2*) shows the concentration of numbers was in the forest central parts which are the least degraded. The very degraded and open patches (clearings and edges) were totally avoided by Algerian Nuthatches.



*Figure 2.* The Algerian Nuthatch distribution map (presence and absence) in the Mount Babor forest  
 2. ábra Az Atlasz csuszka elterjedési térképe (jelenlét és hiány) a Babor-hegyi erdőben

Table 1. Distribution of the Algerian Nuthatch by habitat type. N: number of point counts  
1. táblázat A csuszák számának megoszlása élőhelytípusok szerint. N: felvételezési pontok száma

Habitat	N	Pairs	Solitaries	Absences	Total individuals number	Mean individuals number
Mixed cedar forest	119	85	4	27	174	1.46
Cedar forest	70	30	5	35	65	0.93
Deciduous oak forest	29	10	0	19	20	0.69
Fir-Deciduous oak forest	10	6	0	4	12	1.20
Summit forest	2	2	0	0	4	2.00
Evergreen oak forest	10	0	0	10	0	0.00
Totals	240	133	9	92	275	1.15

### Distribution according to habitat type

The total point counts number was lower than the sum of the points with pairs, solitaires (unpaired birds) and without birds in the mixed Cedar forest, because there were point counts where more than two birds were recorded (Table 1), especially in the mixed cedar forest.

The most preferred habitat by the Algerian Nuthatch for reproduction is the mixed cedar forest (85 pairs and four solitaires), followed by the pure cedar forest (30 pairs and five solitaires), the deciduous oak forest with 10 pairs, followed by the fir oak forest with 6 pairs. The summit forest recorded only 2 pairs based on two counts only. In terms of mean individual number, the summit forest is apparently the most abundant (although the number of points is not significant), followed by the mixed cedar and fir-oak forest (Table 1). Finally, on the northern slope (Ubac), the evergreen oak *Quercus ilex* forest, located at an altitude below 1,200 m, was infiltrated in 2020 by some young individuals of zeen oak *Quercus canariensis*, and we even recorded at this altitude small bunches of young and pure zeen oak forest. The Algerian Nuthatch was still absent in this habitat and at this altitude.

### Distribution according to altitudinal classes

The number of altitudinal classes was 10, with a class interval of 92.4 m (Figure 3). The first two altitude classes included between 1,079–1,263.8 m were empty of any Algerian Nuthatch presence. The first Algerian Nuthatch pair was noted at 1,326 m altitude, and the first solitary male was noted at 1,357 m altitude. The two altitude classes ([1,818.2–1,910.6] and [1,541–1,633.4]) recorded more occurrences with 52 and 54 individuals, respectively. The other altitudinal classes had relatively high abundances ranging from 12 to 43 individuals. The Algerian Nuthatch has been present throughout the Mount Babor forest from 1,300 m altitude to the summit at 2,004 meters altitude. It should be noted that our census stopped at 1,700 m altitude on the southern slope because of habitat degradation on this exposure below that altitude.

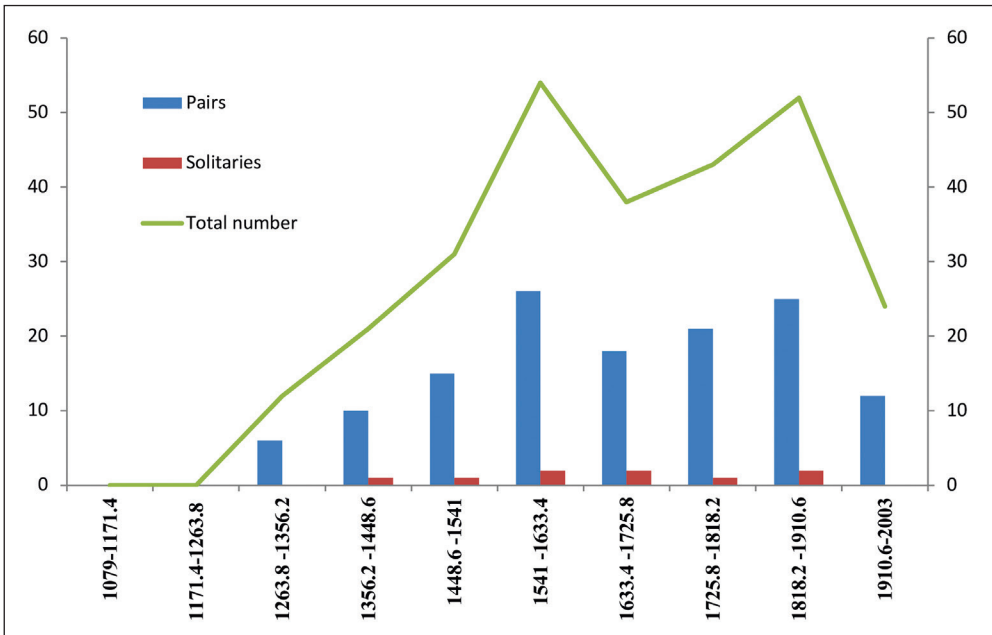


Figure 3. The Algerian Nuthatch distribution according to altitudinal classes in the Mount Babor forest  
3. ábra Az Atlasz csuszka eloszlása a Babor-hegyi erdőben a magassági osztályok szerint

### Numbers and population growth of the Algerian Nuthatch

The Algerian Nuthatch population total density within this habitat for the year 2020 was estimated to be 1.05 pairs/10 ha and 2.17 individuals/10 ha. The individuals mean number varies according to the type of habitat, with the highest one recorded in the summit forest (2 individuals/point count) and no nuthatches were observed in the evergreen oak forest. The mixed cedar forest and the fir oak forest also contained many individuals, while the Cedar forest and the deciduous oak forest recorded less than one individual per point count (Table 1).

The Algerian Nuthatch numbers in the Mount Babor forest increased from 164 individuals in 1982 to 275 individuals in 2020. The annual growth rate and the average multiplication rate calculated gave positive values and greater than 1, which are in the order of 1.36% and 1.01, respectively.

### Discussion

The species flourishing in the Mount Babor forest may be due to the absence of species-specific predators of adults (Vielliard 1976b, Bougaham *et al.* 2017). The population size of the Algerian Nuthatch in this area has almost doubled in a 38 year period (from 164 individuals in 1982 to 275 individuals in 2020). In the Guerrouch forest, 91 individuals were counted by Bellatrèche and Chalabi (1990), 60 individuals were counted in the Djimla



forest by Bougaham *et al.* (2018), and 187 individuals were estimated in the Tamentout forest by Hamitouche *et al.* (2020). In the other habitats recently discovered, the population size was low (Hamitouche & Bougaham 2021). The Algerian Nuthatch distribution in Mount Babor forest started from 1326 m altitude up to 2004m. In the lower altitudes, the Algerian Nuthatch is still absent below 1200 m (Ledant *et al.* 1985), despite at this altitude the existing evergreen oak forest is dotted with zeen oak forest. This absence may be due to its preference for forests with older trees (Brichetti & Di Capi 1987). The same is true for the Corsican Nuthatch (Tibault *et al.* 2006), which chooses trees with diameters greater than 80 cm due to the greater availability of pine seeds from older trees (Villard *et al.* 2014). In the higher altitudes, we encountered many overlapping nesting territories (the distance between nests was less than 100 m). This observation was made in the mixed cedar forest on the northern slope between the altitudes of 1800 m and 1900 m. This may be due to the abundant food availability offered by a diverse habitat with several plant species (Bougaham *et al.* 2018, Hamitouche *et al.* 2020) and a sedentary lifestyle more marked in the Algerian Nuthatch (Bellatrèche 1994). We used the same habitat typology defined by Ledant (1985) in order to have a more realistic comparison between the population sizes from the two censuses carried out in 1982 and in 2020. The habitat types distinguished by Ledant (1985) are those illustrated in the text and not those in the tables. In the Mount Babor forest, the Algerian Nuthatch has been absent in the evergreen oak forest since 1982. The absence of the species in the Evergreen oak stand in 1982 and 2020 may be due to the fact that this type of stand is the result of regeneration after fires (Ledant 1985). These degraded types of habitat are avoided by the Algerian Nuthatch (Bougaham *et al.* 2018, Hamirouche *et al.* 2020). A Chi-squared test was used to check the density differences between habitat types. Number of nuthatch individuals significantly differed between habitats (Chi-squared test = 251.23, df = 4,  $P < 2.2e-16$ ). The most frequented habitat in 1982 was the deciduous oak forest, whereas in 2020 it was the mixed cedar forest. The 2020 census showed a higher number than in 1982. Indeed, the annual population growth of the species is 1.36% with a multiplication rate of 1.01. The calculated growth indices indicate a low population demography of the species, as already predicted by Ledant and Jacobs (1977). In addition to nestling predation (Vielliard 1976b, Bougaham *et al.* 2017), the low demography could be due to the low fecundity of the Algerian Nuthatch (Ledant & Jacobs 1977). The number of fledged nestlings is lower than the number of eggs laid per nest (Bougaham *et al.* 2017). The mortality rate is high for this species during the winters because of a single and fluctuating food resource (Vielliard 1978). Its diet consists of coniferous seeds (Vielliard 1978) and the acorns of deciduous trees (Ledant & Jacobs 1977). In the Stenbrohult Forest in southern Sweden, the mortality rate of adult Nuthatches was studied by Nilsson (1982) between 1974 and 1978 via monitoring of adults (at least one-year-old). The study showed that only 47% of ringed adults survived to the next nesting period, when the maximum mortality rate was recorded during winter. For our study area, the average temperature of the three winter months (December, January, February) recorded from 1946 to 2019 is around 10.09 °C (Harris *et al.* 2020). However, the same temperature 37 years before the 1982 census (1946–1982) is 10.01 °C and 37 years after the 1982 census (1983–2019) is around 10.18 °C. This increase in temperature

leads to mild winters which, according to Nilsson (1987), will lead to a high survival rate probably due to lower thermoregulation costs and an increase in food availability. The birds' total density calculated in 2020 was 2.17 individuals (10 ha) and 1.05 pairs (10 ha). These figures indicate a slight increase compared to the density found by Ledant *et al.* (1985), which was in the order of 0.65 pairs (10 ha) and 1.29 individuals (10 ha) in 1982. It seems that the densities obtained varied more in direct proportion to the population size of the species than to the change in the area of the Mount Babor forest. On the other hand, the Tamentout forest hosts the Algerian Nuthatch with a density of 0.19 individuals/10 ha (Hamitouche *et al.* 2020), and in the Djimla forest the species is distributed with a density of 0.6 individuals/10 ha (Bougaham *et al.* 2018). The low densities in these habitats may be due to the non-wooded (degraded) habitats in these forests, which the Algerian Nuthatch does not use as breeding sites (Bellatrèche & Chalabi 1990, Bougaham *et al.* 2018).

### **Threats and conservation**

The Mount Babor forest is still among the more preserved forests in Algeria (Ledant 1985). The insecurity that Algeria had observed since the 90s until the end of the 2010s has reduced and limited all anthropogenic origin nuisances (wood cutting, overgrazing, fires and clearing). The non-adventurousness of humans in the Mount Babor forest has contributed to forest safeguarding (living trees) and especially to the standing dead wood safeguarding used by the Algerian Nuthatch as nesting and foraging sites (Bougaham *et al.* 2017, Bougaham *et al.* 2018, Hamitouche *et al.* 2020, Zemouri *et al.* 2021). In spite of the Mount Babor forest having a protected status in an official way, after the foundation of the National Park Babor-Tababort (J.O.R.A. 2019) until now, there is no visible physical and administrative progression on the field. Uncontrolled grazing still remains a threat to the Mount Babor forest, especially after the return of quietness. We have noticed a high number in cattle individuals, which graze the young trees and prevent the regeneration of this forest. The Algerian Nuthatch population in the Mount Babor forest is considered an isolated population (no exchange of individuals with other nearby populations). Due to its isolated location, it can neither receive other individuals from other nearby populations (immigrants) nor allow its individuals to nest elsewhere (migrants) because of the absence of an ecological corridor. It would be interesting to create an ecological passage (corridor) between this forest and the nearest forest of Tababort over a distance of 4 km, to allow the species' individuals to fly between these isolated habitat patches (Bougaham *et al.* 2021).

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