

Distribution and population size of the Corsican Nuthatch *Sitta whiteheadi*

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Summary

Endemic to the island of Corsica in the western Mediterranean, the Corsican Nuthatch *Sitta whiteheadi* only occupies mature stands of Corsican Pine *Pinus nigra laricio* which cover a very small area. We present estimates of the distribution and population size of the Corsican Nuthatch, based on both field investigation and analysis of vegetation maps for the 103 county and municipality forests identified. Between spring 1997 and summer 2008, 48 forests were systematically investigated to map nuthatch territories, requiring 20 months of fieldwork. In the 55 forests not explored, we estimated the number of territories from analysis of digital maps with a calculated mean density from six spot-mapping censuses previously made in mature forests. The total estimated number was estimated to be 1,557–2,201 territories, distributed across 45 forest fragments (= group of connected stands) totalling 185 km². At distances varying from 250 m to 16 km from each other, fragments were separated by unfavourable vegetation (shrubs, trees other than pines) or rocky outcrops. The area of these fragments varied from seven to 3,159 ha. Of the 45 fragments, 19 held fewer than 10 nuthatch pairs, 20 had 10–99 territories, and only six had more than 100 territories. We suggest that nuthatch numbers have declined by 10% in the past 10 years because of a reduction in suitable habitat due to fires and logging. The Corsican Nuthatch currently fulfils the criteria established by IUCN to qualify as “Vulnerable”.

Introduction

Although fewer than 20% of birds are island species, over 90% of recorded bird extinctions have occurred on islands (Johnson and Stattersfield 1990). Insular vertebrates are more likely to be threatened than mainland species because their population sizes are necessarily limited and therefore habitat loss and fragmentation constitute a major cause of extinction (Simberloff 1995). For forest-dwelling resident species, both low population size and fragmentation increase the risk of decline (Lampila *et al* 2005). This is the case of the Corsican Nuthatch *Sitta whiteheadi*, endemic to Corsica (42°N, 9°S; area: 8,722 km²). This nuthatch is one of the few landbirds endemic to the Western Palearctic (Harrison 1982) and is genetically closely related to other small nuthatches living in North America, North Africa, and Eurasia, especially to the Chinese Nuthatch *S. villosa* (Pasquet 1998). The first research on the ecology of the Corsican Nuthatch took place in the 1950s (Löhr 1960) and the first mapping of the range was completed in the 1970s (Yeatman 1976) and 1980s (Bricchetti and Di Capi 1985, 1987). All these studies emphasised its dependence on the Corsican Pine *Pinus nigra laricio*, whose seeds constitute its main food resource (Thibault *et al*. 2002), especially in winter (Thibault *et al*. 2006). Thus, the sedentary Corsican Nuthatch is completely dependent on Corsican Pine habitat for food and breeding. A map of Corsican Pine distribution (Anon. 1988) shows it is fragmented, with a range restricted to less than 2.5% of the area of Corsica. This situation, mainly due to fires and to

a lesser extent to logging, began a long time ago (Carcaillet *et al.* 1997), but the trend has been accentuated recently (Thibault *et al.* 2004). A comprehensive map of the breeding range of this species and a reliable estimate of its population size are still lacking. This paper presents a new estimate of population size based on field studies and an analysis of vegetation maps.

Methods

Estimation of the area of habitat

The Corsican Nuthatch is almost exclusively confined to the range of Corsican Pine (c.100 county and municipality forests; Anon. 1993). It tolerates the presence of deciduous trees (Beech *Fagus sylvatica*, Silver Birch *Betula pendula*) provided that their relative cover remains below 50% (Villard *et al.* in prep.). It lives in various mixed stands (Corsican Pine/Maritime Pine *Pinus pinaster*), but its presence in pure Maritime Pine stands is restricted to a few patches with old trees where it occurs at a low density (P. Villard unpubl. data). The nuthatch is rare in European Silver Fir *Abies alba* and absent in mixed Beech–Silver Fir forests (Thibault *et al.* 2002). Because Corsican Pine stands are generally monospecific, we considered that habitat heterogeneity had no influence on the estimate of Corsican Nuthatch range. The range of Corsican Pine, in pure or mixed stands, is estimated at 213 km² by the Institut Forestier National (Anon. 1988). Our study area was confined to this range, but with the addition of areas with mature stands of Maritime Pine and Silver Fir, where Corsican Pine is rare. The Corsican Nuthatch only occupies mature pine stands where trees are at least 50 cm in diameter (Thibault *et al.* 2006), the habitat becoming clearly more favourable when some of the trees have a diameter > 80 cm (Villard *et al.* in prep.). These forest stands, the most productive in cones, correspond to the categories “forest” (40–60 cm diameter and 90–150 years old estimated) and “old forest” (60–70 cm diameter and 120–180 years old estimated) used by foresters to describe pine stands in their management plans and on vegetation maps. To estimate the area of forest suitable for the Corsican Nuthatch and its quality for the bird, we used the two following sources of data: forest management plans and vegetation maps.

Forest management plans

These plans, available for most of the forests managed by the administration, are prepared by the Office National des Forêts. They provide the range and describe the forest stands in each parcel (seedlings - young pines; young forest; forest; old forest). However, the interpretation of these categories has varied. To overcome this, we merged the categories “forest” and “old forest” into one, that we termed “mature forest”. Most management plans we used covered the period 1995–2005.

Vegetation maps

Vegetation maps on GIS (digital data of SODETEG [Anon. 1978–81] and Institut Forestier National [Anon. 1988] with MapInfo Professional version 7.5 software) were used for the unmanaged stands. Forested areas are represented by patches which indicate surface area, main tree species, quality of the stand (density, young or mature), and owner (private, city, or Corsican region).

Definition of forest fragments

Nuthatch population estimates were obtained from forests identified by their administrative limits, from both digital maps and field mapping censuses (see below). However, certain Corsican Pine stands can overlap several forests that are administratively distinct; conversely, one administrative forest can be made up of several isolated Corsican Pine stands. In the first case,

we merged the stands into one fragment; in the second, we split the stand into distinct fragments. Certain fragments can be made up of several stands linked by a wooded corridor. We arbitrarily decided that a distance > 250 m without Corsican Pines defined two fragments as distinct. In the Dutch lowlands, van Langevelde (2000) retained a distance of 200 m to separate forest fragments occupied by the European Nuthatch *S. europaea*. Nuthatches are reluctant to cross gaps, probably because of increased predation risk (Rodríguez *et al.* 2001).

Estimating nuthatch numbers

We used the word “territory” rather than “pair”. A territory includes a nest-site (a hole excavated in a snag) and a feeding area, defended year round by a pair of nuthatches (Thibault and Villard 2005). Non-territorial birds, if any, are therefore not included in our estimates.

Field mapping censuses

Between spring 1997 and summer 2008, 48 forests were systematically investigated to map nuthatch territories, in the known range of both Corsican Pine and Silver Fir (as defined by Anon. 1988), but also in old stands of Maritime Pine. Overall, this mapping required nearly 20 months of fieldwork by eight different observers who were familiar with the breeding biology and vocalisation of the species. Corsican Nuthatches are conspicuous and vocally active all day. During the breeding season (March–June) occupied nests were searched for by inspecting snags. Territorial birds were located mainly by their vocalisations (songs and male-female contact calls). Locations of both were recorded with a GPS (Garmin Summit®). Surveys were made once in each forest at the rate of 10–15 ha per day. Long-term field studies conducted for several years in Ascu forest showed that the same territories, often the same nest-sites, were reoccupied with almost no inter-annual fluctuation in numbers (Thibault and Villard 2005); thus, the fact that the census work was spread over several years is unlikely to constitute a bias for the population estimates.

Estimates from digital maps

In the 55 forests not surveyed, we calculated a mean density from six spot-mapping censuses previously made in forest stands belonging to the categories “forest” and “old forest” of local foresters (1.00 ± 0.26 territories 10 ha^{-1} with 95% confidence limits) (Thibault *et al.* 2002, unpubl. data). We estimated the number of territories in a forest stand considered as favourable by multiplying this mean density by its area. In the burnt and logged forests we corrected the number when the areas affected were known (for the burned areas, see Thibault *et al.* 2004, Moneglia *et al.* 2009; for logged areas, data were provided by foresters and their management plans). A digital map of the public forests was provided by the ONF services (Corte unit). It was completed by us for the private forests. Means are reported ± 1 SD.

Results

Distribution

The largest stands of Corsican Pine were all occupied by the Corsican Nuthatch. Moreover, we did not find any mature stands with an area ≥ 5 ha where the nuthatch was absent and the species was present even in isolated stands which are more numerous in the north than in the south of the island. Certain stands with *a priori* suitable habitat, but whose surface area was too small owing to past fires, may have been occupied formerly. Investigations in other species of conifers confirmed the presence of some nuthatches in a small number of Maritime Pine and Silver Fir patches; the corresponding territories have been included in the overall population estimate.

Estimated population size

Data on forest area and nuthatch numbers obtained using the two methods of estimation are indicated in Table 1. The margin of uncertainty is obviously larger for populations estimated using GIS, because the mean density used for the estimate is conservative. There is also a margin of uncertainty with fieldwork when observers failed to find nests of several males singing at a short distance. Overall, we estimated the size of the Corsican Nuthatch population to be 1,557–2,201 territories.

Nuthatch numbers in forest fragments

We identified 45 forest fragments separated by distances varying from 250 m to 16 km (mean: 2.67 km \pm 2.93, median: 2 km). The barriers isolating the fragments corresponded to unfavourable vegetation in 34 cases (shrubs or trees other than pines, i.e. beech or oaks), and to rocky outcrops in 11 cases. Fragment area varied from seven to 3,159 ha (mean = 418 ha). We counted 19 fragments with fewer than 10 territories, 20 with 10–99 territories, and only six with 100 or more. The latter held 60% of the total population. Whatever the method is used, the correlation between area of stand and mean number of nuthatches is highly significant ($P < 0.001$): individual fragments ($r = 0.93$, $n = 45$), forest fieldwork ($r = 0.95$, $n = 48$), mapping ($r = 0.92$, $n = 55$). Data on forest fragments are indicated in Appendix S1 in the online Supplementary Materials. The distribution and size of the main populations in different fragments are shown in Figure 1.

Discussion

Population size of the Corsican Nuthatch

We estimated the population size of the Corsican Nuthatch to be 1,879 (1,557–2,201) territories occupying c.185 km² of pine stands (i.e. 87% of the overall range of the Corsican Pine). The first population estimate was made by Löhrl (1960) who estimated 3,000 pairs; this estimate was based on the following parameters: (i) forest distributed over 20% of the island (= 1,750 km²), of which 25% consists of Corsican Pine (= 437.50 km²), (ii) a range of nuthatch territory estimated at 10–15 ha. Later, Brichetti and Di Capi (1985) estimated the population at c.2,000 pairs, using the following parameters: (i) the range of Corsican Pine estimated at 240 km², (ii) mean nuthatch density estimated at 0.85 pairs 10 ha⁻¹. No trend in population size can be inferred from the difference between these estimates and ours because the methods used are too dissimilar. The area of Corsican Pine used by Löhrl seems an overestimate. The distribution of Corsican Pine is concentrated in the centre of the island and corresponds to the largest forests stands (Figure 1; fragments no. 1, 3, 18, 22, 28 and 30 of class 3, see Appendix S1 in online Supplementary Materials). In the north, the numerous small fragments (classes 1 and 2) correspond to remnants of larger forests destroyed by fire during the preceding centuries.

Table 1. Number of territories and range of the Corsican Nuthatch in the 103 forests investigated.

Method of estimate	Number of territories	Range (ha)	Number of forests
Fieldwork	872–1,005	8,943 (including 473 of Silver Fir or Maritime Pine)	48
Mapping on GIS	685–1,196	9,577 (including 26 of Maritime Pine)	55 for which 18 have been partially visited
Total	1,557–2,201	18,520	103

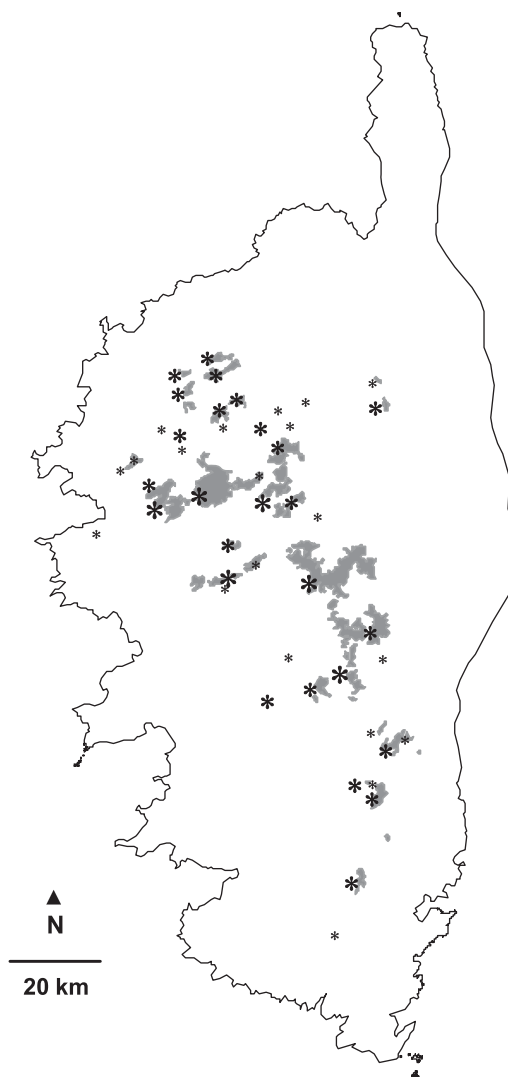


Figure 1. Range of the Corsican Pine (from Anon. 1988) represented in grey; and range of the Corsican Nuthatch, shown by stars; the size of the star indicates the population size in each fragment according to the mean number of territories [three classes: 1 (1–9 territories) = small star, 2 (10–99) = medium star, 3 (≥ 100) = large star; see Appendix S1. Each star is situated in the centre of the fragment as shown by the GIS. We used a digital map of common property forests (GIS, ONF-Corte), completed by us for private forests.

Threats to the habitat

One can hypothesise that forests never disappeared from Corsica during the cold periods of the Pleistocene (Prodon *et al.* 2002), but that they have probably always been more or less fragmented. Over the past centuries, this fragmentation has increased because of human activity (Carcaillet *et al.* 1997, Carcaillet and Vanni re 2005) through the development of agriculture, grazing and logging. Pollen deposits (Reille 1977), fossil charcoal (Thinon 1998, 2003), and old

manuscripts from the Genovese period (15th–17th centuries; Rota, 1991) suggest that the area of the Corsican forest has considerably decreased, probably resulting in a decline of the Corsican Nuthatch. Today its habitat, the mature Corsican Pine forest, represents only 2.1% of the area of the island. During the last century, the habitat favourable to the Corsican Nuthatch has been reduced by fires (especially in mature stands on steep slopes) and by logging. Since the 1970s, local foresters have tended to rejuvenate the pine forest by shortening the logging rotation (Bourcet 1996, Anon. 2006). Logging affects mainly trees whose diameter is larger than about 40–50 cm, which is precisely the minimum threshold selected by nuthatches (Villard *et al.* in prep.). Every time an area larger than 2 ha is logged in a forest stand suitable for the bird, a potential territory is likely to disappear for more than a century due to the slow growth of Corsican Pine. After the large 2000 and 2003 forest fires, we estimated that 50–63 territories had vanished, and 47–80 other territories were severely affected (Thibault *et al.* 2004; Moneglia *et al.* 2009). In total, we estimate that 78–122 territories have been destroyed by logging since 1998. Thus, taking into account territories destroyed by both fire and logging, we think that about 10% of nuthatch territories have been lost over the past decade. Conversely, large areas currently abandoned by farmers and shepherds, especially summer pastures in hilly areas, are being progressively colonised by young Corsican Pines (Gamisans 1999, Saïd and Gégout 2000). Provided that it is not burnt before reaching maturity, it will not be used by Corsican Nuthatches for a century or more. The slow expansion of the forest in certain sectors does not currently compensate for the loss of mature stands.

Conservation status of the Corsican Nuthatch

Corsican Pine is considered as a “priority habitat” by Directive 92/43/EEC (on the Conservation of Natural Habitats and of Wild Fauna and Flora) adopted by the European Union in 1992. The Corsican Nuthatch is classified in Annex 1 of the Council Directive 79/409/EEC on the Conservation of Wild Birds, adopted by the European Union in 1979, implying the creation of protected or managed areas, such as the Natura 2000 network. Corsican sites listed in the Natura 2000 network include a significant part of the Corsican Nuthatch population (c.30%) and should be managed according to the habitat requirements of the bird through appropriate forest management plans. However, there was until now little pressure on the French and Corsican local authorities to define and respect contractual policies, so the efficiency of the European directives remains unclear.

Presently, the Corsican Nuthatch is classified as “Least Concern” (IUCN 2009), based on data indicating its population size is stable (Tucker and Heath 1994). We present arguments that this is no longer the case today. Moreover, preliminary phylogeographic analyses show the existence of genetically structured nuthatch populations occupying distinct forest areas. If confirmed by further investigation, these data might suggest limited capacity for dispersion, and consequently a likely difficulty in reaching and (re)colonising the most isolated fragments (Cibois *et al.* unpubl. data). With fewer than 10,000 adults and a population decline of near 10% during the last decade, the Corsican Nuthatch should be classified as “Vulnerable” according to IUCN criterion C1 (IUCN 2001).

Supplementary Material

The supplementary materials for this article can be found online at journals.cambridge.org/bci

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References

- Anon. (1978–81) *Eléments pour un zonage agro-sylvo-pastoral de la Corse*. Paris: SODETEG. (Maps digitised by «Directions départementales de l'agriculture et de la forêt», Ajaccio and Bastia).
- Anon. (1988) *Inventaire forestier national. Département de Haute-Corse et de Corse du Sud*. Paris: Ministère de l'Agriculture et Développement Rural, Direction de l'Espace Rural et Forestier. (Maps digitised by Directions départementales de l'agriculture et de la forêt», Ajaccio and Bastia).
- Anon. (1993) *ORLAM – Région Corse. Annexe 6.1- Localisation des forêts domaniales et communales soumisees*. Ajaccio: Office National des Forêts.
- Anon. (2006) *Contribution à la conduite des peuplements de pin laricio et habitats associés*. Pierron-Sarreguemine: Office National des Forêts.
- Bourcet, J. (1996) Aperçu sur deux siècles d'histoire forestière en Corse. *Rev. Forestière Française* 48: 563–580.
- Brichetti, P. and Di Capi, C. (1985) Distribution, population and breeding ecology of the Corsican nuthatch, *Sitta whiteheadi* Sharpe. *Riv. Ital. Ornitol.* 55: 3–26.
- Brichetti, P. and Di Capi, C. (1987) Conservation of the Corsican Nuthatch *Sitta whiteheadi* Sharpe, and proposals for habitat management. *Biol. Conserv.* 39: 13–21.
- Carcaillet, C. and Vannière, B. (2005) *Les incendies de végétation: une très vieille histoire naturelle et humaine*. Prades-Lez, France: Ed. Les écologistes de l'Euzière.
- Carcaillet, C., Barakat, H. N., Panaïotis, C. and Loisel, R. (1997) Fire and late-Holocene expansion of *Quercus ilex* and *Pinus pinaster* on Corsica. *J. Veg. Sci.* 8: 85–94.
- Gamisans, J. (1999) *La végétation de la Corse*. Aix-en-Provence: Edisud.
- Harrison, C. (1982) *An atlas of the birds of the western Palaearctic*. London: Collins.
- IUCN (2001) *Red List categories and criteria. Version 3.1*. IUCN, Gland, Switzerland and Cambridge, UK: IUCN Species Survival Commission.
- IUCN (2009) *IUCN Red List of threatened species. Version 2009.2*. www.iucnredlist.org.
- Johnson, T. H. and Stattersfield, A. J. (1990) A global review of island endemic birds. *Ibis* 132: 167–180.
- Lampila, P., Mönkkönen, M. and Desrochers, A. (2005) Demographic responses by birds to forest fragmentation. *Conserv. Biol.* 19: 1537–1546.
- van Langevelde, F. (2000) Scale of habitat connectivity and colonization in fragmented nuthatch populations. *Ecography* 23: 614–622.
- Löhr, H. (1960) Vergleichende Studien über Brutbiologie und Verhalten der Kleiber *Sitta whiteheadi* Sharpe und *Sitta canadensis* L. *J. Ornithol.* 101: 245–264.
- Moneglia, P., Besnard, A., Thibault, J.-C. and Prodon, R. (2009) Habitat selection of the Corsican nuthatch (*Sitta whiteheadi*) after a fire. *J. Ornithol.* 150: 577–583.
- Pasquet, E. (1998) Phylogeny of the nuthatches of the *Sitta canadensis* group and its evolutionary and biogeographic implications. *Ibis* 140: 150–156.
- Prodon, R., Thibault, J.-C. and Dejaifve, P.-A. (2002) Expansion vs. compression of bird altitudinal ranges on a Mediterranean island. *Ecology* 83: 1294–1306.
- Reille, M. (1977) Quelques aspects de l'activité humaine en Corse durant le subatlantique et ses conséquences sur la végétation. «Approche écologique de l'homme fossile». *Supplément Bulletin AFEQ* 47: 329–342.
- Rodriguez, A., Andrén, H. and Jansson, G. (2001) Habitat-mediated predation risk and decision making of small birds at forest edges. *Oikos* 95: 383–396.
- Rota, M. P. (1991) Les forêts de la Corse et la politique internationale de la République

- de Gênes aux XVIe et XVIIe siècles: un problème de géographie historique. *Cahier Corsica (Bastia)* 144: 1–13.
- Saïd, S. and Gégout, J.-C. (2000) Using the age of the oldest woody specimen for studying post-pasture successions in Corsica (Mediterranean island). *Acta Oecol.* 21: 193–201.
- Simberloff, D. (1995). Habitat fragmentation and population extinction of birds. *Ibis* 137: S105–S111
- Thibault, J.-C. and Villard, P. (2005) Reproductive ecology of the Corsican Nuthatch. *Bird Study* 52: 282–288.
- Thibault, J.-C., Seguin, J.-F., Villard, P. and Prodon, R. (2002) Le Pin laricio (*Pinus nigra laricio*) est-il une espèce clé pour la sittelle corse (*Sitta whiteheadi*)? *Rev. Ecol. (Terre et Vie)* 57: 329–341.
- Thibault, J.-C., Prodon, R. and Moneglia, P. (2004) Impact des incendies de l'été 2000 sur l'effectif d'une espèce endémique menacée: la Sittelle corse (*Sitta whiteheadi*). *Ecologia Mediterranea* 30: 63–71.
- Thibault, J.-C., Prodon, R., Villard, P. and Seguin, J.-F. (2006) Habitat requirements and foraging behaviour of the Corsican nuthatch (*Sitta whiteheadi*). *J. Avian Biol.* 37: 477–486.
- Thinon, M. (1998) *Etude de l'aire potentielle du pin laricio en Corse. Approche pédo-anthracologique*. Aix-Marseille: Université d'Aix-Marseille.
- Thinon, M. (2003) *Première approche pédo-anthracologique de l'histoire de la végétation de la réserve naturelle de Scandola*. Aix-Marseille: Université d'Aix-Marseille.
- Tucker, G. M. & Heath, M. F. (1994) *Birds in Europe: their conservation status*. Cambridge, UK: BirdLife International (BirdLife Conservation Series No. 3).
- Yeatman, L. (1976). *Atlas des oiseaux nicheurs de France*. Mayenne: Société Ornithologique de France.

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