A GIS-based approach to assess the population size of Krüper's Nuthatch, *Sitta krueperi* at a newly found breeding area in Inner Anatolia

(Aves: Passeriformes)

Tamer Albayrak, Ali Erdoğan

Abstract. A new breeding area for Krüper's Nuthatch (*Sitta krueperi* Pelzeln, 1863) was discovered in the Ak Mountains of Yozgat province of Inner Anatolia in pure Scots Pine (*Pinus silvestris*) woodland. The average bird density was 1.23±0.85 individuals/km². The Habitat Suitability Index (HSI) was applied for altitude and habitat characteristics of Scots Pine within a raster of 500 x 500 m, and, based on this, a model distribution map was prepared using a Geographic Information System (GIS). Using a HIS-based threshold of more than 0.7 and the area of habitat, we calculated the population size of Krüper's Nuthatch in the Ak Mountains region as 558 individuals.

Key words. Turkey, GIS, habitat modelling, distribution modelling, Habitat Suitablity Index.

Introduction

Krüper's Nuthatch, *Sitta krueperi* Pelzeln, 1863, is a 'Near Threatened' species (IUCN 2006). Its distribution is confined to the coastal periphery of the Anatolian peninsula; limited numbers are also found on the adjacent Greek island of Lesbos and in the Caucasus region (HARRAP & QUINN 1996, HAGEMEIJER & BLAIR 1997, ALBAYRAK & ERDOĞAN 2005a, HOYO et al. 2008). Krüper's Nuthatch occurs only in conifereous forests, from sea level to the tree line (ALBAYRAK 2007). It is mostly sedentary with some post-breeding dispersal and seasonal altitudinal movements (HOYO et al. 2008).

Mapping the distribution of species is a key issue in ecology and conservation because hypotheses often rely on an accurate knowledge of where a species occurs (BROTONS et al. 2004b). Geographic information systems (GIS) are a useful software for predictive habitat distribution models, which are again very helpful in wildlife management (BROTONS et al. 2004a, MEGGS et al. 2004) and for estimating population size (GOTTSCHALK et al. 2007).

In this paper we estimate the distribution and density of Krüper's Nuthatch in a pure Scots Pine (*Pinus silvestris* L.) forest at a recently discovered breeding area, the Ak Mountains (Yozgat, Inner Anatolia). We specifically focus on the association between the birds and altitude, habitat structural variations, ages and density of the Scots Pine. Our study provides a base for determining the potential distribution of Krüper's Nuthatch in the Ak Mountains and other areas. Our aims are to illustrate and to discuss the new distribution area and also to predict the habitat distribution and calculate the total population size of Krüper's Nuthatch in the Ak Mountains.

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Table 1. The suitability of different altitudes and vegetation types for Krüper's Nuthatch according to ALBAYRAK (unpubl.), ALBAYRAK (2007) and ALBAYRAK et al. (2006). HSI = Habitat Suitability Index.

Parameter	Subparameter	HSI*
Altitude (m)	800–1000	0.4
	1001–1250	0.5
	1251–1500	0.7
	1501–1750	0.75
	1751–2000	0.8
	2001–2250	0.7
River		0
Scots Pine Forest: Age level (diameter at breast height)	08.0–19.9 cm	0.75
	20.0–35.9 cm	0.85
	36.0–51.9 cm	1.00
Scots Pine Forest: Coverage (percentage)	0–10	0
	11–40	0.25
	41–70	0.50
	71–100	0.75
Maquis		0
Open areas		0

Material and methods

Study site and density. The study area is located in the Ak Mountains of Yozgat province, Inner Anatolia Region of Turkey, and consists of pure Scots Pine woodland (Fig. 1). An inventory of Krüper's Nuthatch was conducted within a radius of 150 m at 23 point counts during the breeding season in late May 2006. A modified strip point transect (BIBBY et al. 1992, 1998) was used to estimate the density and frequency of occurrence of Krüper's Nuthatch. Additionally, we used a three-minute playback on each point. Males, also occasionally females and young birds, show territorial behaviour (ALBAYRAK & ERDOĞAN 2005b) and respond to playback. A minimum of 300 m was kept between points. The density of Krüper's Nuthatch was calculated using the following equation: $D = n / p\pi r^2$ = individuals/km^2, where D = density (number of individuals per km^2), n = total number of the individuals detected along the points, p = total number of point counts, r = fixed radius (0.15 km).

GIS analysis. Base maps of the distribution of woodlands were taken from the Ministry of Environment and Forestry (ORBIS 2009). From these maps, information such as vegetation types, age structure of Scots Pine, and relative forest cover was extracted. Digitised maps were edited to four coverage layers in a GIS software, Geomedia Professional 6,0. The vegetation layer contained two different vegetation types, forest and non-forest. The Scots Pine layer included the age level (alSP) b (8.0-19.9 cm diameter at breast height), c (20.0-35.9 cm diameter at breast height) and d (36.0-51.9 cm diameter at breast height) and four different cover percentages of forest in the area (dSP: 0 = <10 %, 1 = 11-40%, 2 = 40-70%, 3 = 70-100% of the area forested) (ORBIS 2009). The altitude layer included elevation levels of 250 m intervals ranging from 750 m to 2250 m. All layers were transformed to raster layers (cell size: 500 m x 500 m) using a GIS software module, Geomedia Grid 6.0. Each raster layer contains 28,640 cells (total 7,160 km^2). A Digital Elevation Model (DEM) was built using contours of altitude. Each raster layer cell which had its own characteristic information such as vegetation types, age level of Scots Pine, proportion of forest cover and altitude was transformed to a Habitat Suitability Index value (Table 1). Habitat

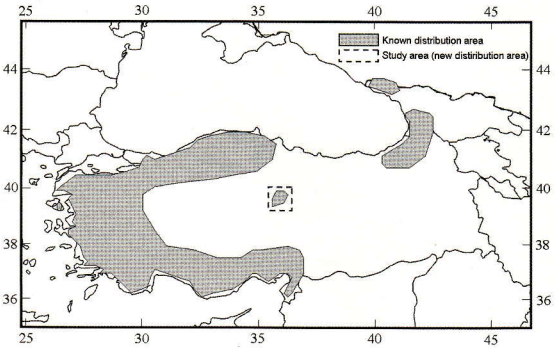


Fig. 1. Study area, known distribution area after HOYO et al. (2008), and the newly found distribution range of Krüper's Nuthatch in the Ak Mountains, Turkey.

Table 2. Habitat Suitability Index (HSI) values and proportion of the study area, classified as of high, moderate, and low suitability for Krüper's Nuthatch (given as % of total study area). DEM = Digital elevation model, dSP = density of trees in the area, alSP = age level of Scots Pine.

		DEM	dSP	alSP	dSP + alSP	dSP + DEM	alSP + DEM	DSP+alSP+ DEM (km^2)
0.91–1.0	High			0.1				
0.81–0.9	High						0.1	
0.71–0.8	High	40.2	6.6	10.8	6.3	6.6	10.8	6.3 (453.5)
	Subtotal	**40.2**	**6.6**	**10.9**	**6.3**	**6.6**	**10.9**	**6.3 (453.5)**
0.61–0.7	Moderate	40.8			3.4	2.8		3.4 (239.8)
0.41–0.6	Moderate	18	3.8		1.2	2.3		1.9 (132.8)
	Subtotal	**58.8**	**3.8**		**4.6**	**5.1**		**5.3 (372.6)**
0.21–0.4	Low	1.0	1.3		0.7	3.2	4.0	3.3 (238)
0.01–0.2	Low				0.1			0.02 (1.3)
0.0	Low		88.3	89.1	88.3	85.1	85.1	85.1 (6094,6)
	Subtotal	**1**	**89.6**	**89.1**	**89.1**	**88.3**	**89.1**	**88.4 (6333.9)**
TOTAL		100	100	100	100	100	100	**100 (7160.0)**

Suitability Index (HSI) models characterise landscapes with index values (usually ranging from 0 to 1) that indicate habitat suitability based on measured features (LAUVER & BUSBY 2002, LI et al. 2008).

The HSI values were estimated on the basis of our long-term experience from 1999 to the present. Every individual cell was assigned a HSI value according to Table 1 (ALBAYRAK, unpubl. data). Krüper's Nuthatch only occurred in coniferous forest, so the HSI of non-forest areas, maquis and river were set at 0. Though its density was positively correlated with altitude (ALBAYRAK et al. 2006, ALBAYRAK 2007), the vegetation type in some areas higher than 2000 m made these areas unsuitable. Krüper's Nuthatch prefers old and natural forest (ALBAYRAK 2007), as the most important variable of the birds' habitat suitability is the number of trees offering potential nesting sites (LAUVER & BUSBY 2002). Using this information, we gave a higher suitability value for thicker Scots Pine stands and more dense forest in the area. After overlaying the four layers with different weights, we obtained the average value of Suitability Index for each layer, which is the integrated suitability of the landscape for Krüper's Nuthatch. HSI values can range from 0

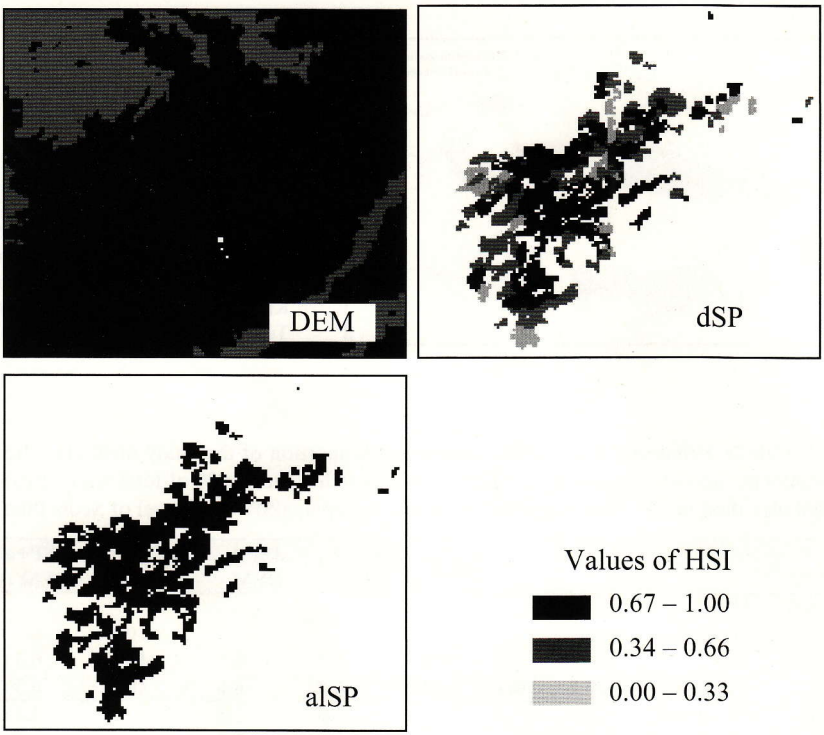


Fig. 2. HSI maps of Krüper's Nuthatch based on the Digital Elevation Model (DEM), density of Scots Pine (dSP), and age level (alSP) of Scots Pine in the Ak Mountains.

(unsuitable) to 1.0 (optimal habitat). This range was divided into evenly spaced tree classes (0-0.33, 0.34-0.66, 0.67-1.0) to indicate low, moderate, and high quality habitat for Krüper's Nuthatch, respectively.

Results and discussion

Published distribution maps of Krüper's Nuthatch include only the coastal region of Anatolia (Fig. 1, HOYO et al. 2008), but we found Krüper's Nuthatch in a new area, the Ak Mountains, Inner Anatolia Region, in late May 2006, apparently discrete from the previously documented range (HARRAP & QUINN 1996, HAGEMEIJER & BLAIR 1997, HOYO et al. 2008, KIRWAN et al. 2008). The new localities are composed of pure forest of Scots Pine. The mean density of Krüper's Nuthatch was 1.23±0.85 ind./km^2.

The HSI model that has been generated scores across the range of 0 to 1 (Table 1-2). The model predicted that high quality Krüper's Nuthatch habitats are found at certain sites throughout the study area. The maps of HSI of DEM, dSP, and alSP are given in Fig. 2 and the calculated HSI values as well as their proportion of the study area are given in Table 2.

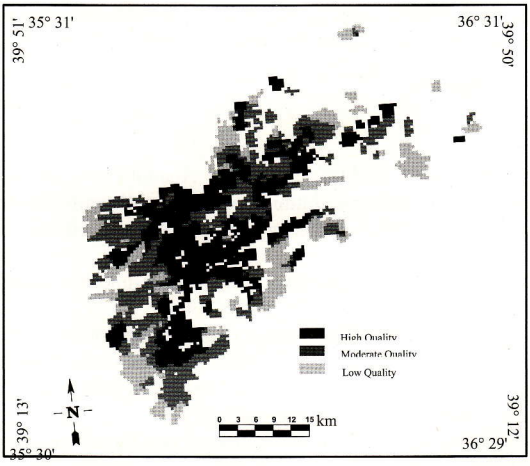


Fig. 3. Potential distribution of Krüper's Nuthatch in the Ak Mountains, Turkey, based on the Habitat Suitability Model.

Over 85% (6094.8 km²) of the study area was classified as open and maquis area. Only less than 15% of the study area consists of Scots Pine forest. Our results show that out of a total of 1065 km² Scots Pine woodland, 453.5 km² (42.6%) consists of high quality habitats for Krüper's Nuthatch (HSI>0.67) (Table 2, Fig. 3). The distribution model of the occurrence of Krüper's Nuthatch in the Ak Mountains region using HSI is given in Fig. 3. Krüper's Nuthatches were observed only in high quality habitats (HSI>0.67). Based on the surface size of the high quality habitats (453.5 km², HSI>0.67, Fig. 3) and calculating the density of the species (1.23±0.85 ind./km²), we calculated the population size of Krüper's Nuthatch as 558 individuals. This population size is given as the possible total number of individuals on account of the response of males, and occasionally of females and young birds of Krüper's Nuthatch, to playback in the area.

Assigned HSI was used to evaluate the habitat quality for Krüper's Nuthatch. This is a fast and convenient method for estimating habitat availability with spatial explicitness in a heterogeneous landscape (Li et al. 2002). The species uses nest cavities excavated by woodpeckers, or makes its own entrance holes in slightly decayed, old tree trunks (Albayrak & Erdoğan 2005a). It prefers semi-natural old forests and its density was positively correlated with altitude (Albayrak et al. 2006). Our experience on Krüper's Nuthatch and the HSI model are recommended for the rapid integration of key habitat features at various scales. In conclusion, the calculated distribution model of the occurrence of Krüper's Nuthatch using HSI provides an important base for determining its potential habitat in the area. This case study demonstrates a fast and useful method suitable for assessing the potential habitat of Krüper's Nuthatch across the whole of Turkey to support conservation measures and wildlife management.

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References

ALBAYRAK, T. (2007): Türkiye ve Midilli Adası'ndaki Anadolu sıvacısı (*Sitta krueperi*) populasyonunun çeşitliliği, yayılışı ve habitat seçiminin belirlenmesi [Population density, distribution and habitat selection of Krüper's Nuthatch in Turkey and on Lesbos]. – Biyoloji 164 (Akdeniz Üniversitesi, Antalya).

ALBAYRAK, T. & A. ERDOĞAN (2005a): Breeding ecology of Krüper's nuthatch (*Sitta krueperi*) near Antalya, Turkey. – Israel Journal of Zoology 51: 309-314.

ALBAYRAK, T. & A. ERDOĞAN (2005b): Observation on some behaviours of Krüper's Nuthatch (*Sitta krueperi*), a little-known West Palearctic bird. – Turkish Journal of Zoology 29: 177-181.

ALBAYRAK, T. & A. ERDOĞAN & F. BAIRLEIN (2006): The density and habitat of Krüper's Nuthatch in Mediterranean Turkey. – Journal of Ornithology 147: 125.

BIBBY, J. C., N. D. GESS & D. A. HILL (1992): Bird Census Techniques. – London.

BIBBY, C., M. JONES & S. MARSDEN (1998): Expedition field techniques bird surveys. – London (Expedition Advisory Centre).

BROTONS, L., S. MANOSA & J. ESTRADA (2004a): Modelling the effects of irrigation schemes on the distribution of steppe birds in Mediterranean farmland. – Biodiversity and Conservation 13: 1039-1058.

BROTONS, L., W. THUILLER, M. B. ARAUJO & A. H. HIRZEL (2004b): Presence-absence versus presence-only modelling methods for predicting bird habitat suitability. – Ecography 27: 437-448.

GOTTSCHALK, T. K., K. EKSCHMITT, S. ISFENDIYAROĞLU, E. GEM, & V. WOLTERS (2007): Assessing the potential distribution of the Caucasian Black Grouse *Tetrao mlokosiewiczi* in Turkey through spatial modelling. – Journal of Ornithology 148: 427-434.

HAGEMEIJER, W. J. M. & M. J. BLAIR (1997): The EBCC Atlas of European breeding birds: their distribution and abundance. – London.

HARRAP, S. & D. QUINN (1996): Tits, Nuthatches and Treecreepers. – London.

HOYO, J. D., A. ELLIOTT & D. CHRISTIE (2008): Handbook of the birds of the world. Vol. 13. Penduline-tits to Shrikes. – Barcelona.

IUCN (2006): IUCN Red list of threatened species. – www.iucnredlist.org [Downloaded on 26.vi.2007].

KIRWAN, G. M., K. A. BOYLA, P. CASTELL, B. DEMIRCI, M. ÖZEN H. WELCH & T. MARLOW (2008): The Birds of Turkey. – London.

LAUVER, C. L. & W. H. BUSBY (2002): Testing a GIS model of habitat suitability for a declining grassland bird. – Environmental Management 30: 88-97.

LI, D., S. GAO, Y. WU, L. SUN, S. GUO & J. LI (2008): Model to assess the habitat suitability for endangered bird species: Brown Eared-Pheasant *Crossoptilon mantchuricum* (Swinhoe) in Xiaowutaishan Reserve, China. – Polish Journal of Ecology 56: 723-729.

LI, X. H., D. M. LI, Y. M. LI, Z. J. MA & T. Q. ZHAI (2002): Habitat evaluation for crested ibis: A GIS-based approach. – Ecological Research 17: 565-573.

MEGGS, J. M., S. A. MUNKS, R. CORKREY & K. RICHARDS (2004): Development and evaluation of predictive habitat models to assist the conservation planning of a threatened lucanid beetle, *Hoplogonus simsoni*, in north-east Tasmania. – Biological Conservation 118: 501-511.

ORBIS (2009): Orman Bilgi Sistemi [Forest Information System]. – Republic of Turkey, Ministry of Environment and Forestry. http://orbisgenel.ogm.gov.tr/genelorbis.

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