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Population of Tengmalm's Owl *Aegolius funereus* in Kopaonik National Park (central Serbia)

Populacija koconogega čuka *Aegolius funereus* v Narodnem parku Kopaonik (srednja Srbija)

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The altitudinal distribution, breeding density and population size of Tengmalm's Owl *Aegolius funereus* was studied in Kopaonik National Park (central Serbia) during the 2011 and 2012 breeding seasons. The size of the study area was 24 km². The **s**urvey method applied was a line transect in combination with stop points and playback of territorial male call. During the two-year research project, 37 territories were located. In Kopaonik National Park, Tengmalm's Owl males inhabit Norway Spruce *Picea abies,* mixed Norway Spruce-Silver Fir *Abies alba* and Norway Spruce-European Beech *Fagus sylvatica* forests in the altitudinal belt stretching between 1,367 and 1,689 m a.s.l. The breeding density in the studied area was 8.3 territories/10 km² in 2011 and 7.1 territories/10 km² in 2012. Total population estimate of Tengmalm's Owl in Kopaonik National Park is substantially higher than previously assumed, its 42–49 breeding territories making it currently the most important breeding site in Serbia.

Key words: Tengmalm's Owl, *Aegolius funereus*, population size, breeding density, altitudinal distribution, Kopaonik, Serbia
Ključne besede: koconogi čuk, *Aegolius funereus*, velikost populacije, gnezditvena gostota, višinska razširjenost, Kopaonik, Srbija

1. Introduction

The Tengmalm's Owl *Aegolius funereus* is a small tree hole nesting species with main distribution range confined to the boreal forests zone of Eurasia and North America (Mikkola 1983, König *et al.* 1999). In northern Europe, Tengmalm's Owl is distributed in continuous range, but towards the south its distribution is fragmented to patchy and isolated populations, e.g. mountains of the Balkan Peninsula (Korpimäki 1997, König *et al.* 1999). The Balkan population is regarded as post-glacial relict (Mikkola 1983, Simeonov *et al.* 1990). European breeding population of Tengmalm's Owl is large and stable with more than 110,000 pairs and this species evaluated as Secure in Europe (BirdLife International 2004).

Knowledge of the numbers and distribution pattern of the species in Serbia is poorly known, without any specific study conducted to date. Until recently, the Tengmalm's Owl was supposed to be rare in Serbia, inhabiting high-mountain mixed and coniferous forests at an altitude between 1,200 and 1,800 m a.s.l. in the south and SW parts of the country (Matvejev & Aleksandrov 2002, Puzović *et al.* 2003). Nevertheless, a few recent findings at altitudes of 790–1,100 m a.s.l. indicated a broader distribution and probably larger population (Rajković *et al.* 2010). However, according to Puzović *et al.* (2003) estimations, this owl species has a relatively small population of 65–115 pairs in Serbia. The accurate data on distribution and population size of Tengmalm's Owl on Mt Kopaonik are unclear, with only 17 confirmed records for the period 1938–2010 (Rajković *et al.* 2010). On the other hand, Mt Kopaonik was the only confirmed breeding site in Serbia with two clutches found in nest

boxes (Rajković *et al.* 2010). The latest population size estimate is between 15 and 30 breeding pairs in IBA "Kopaonik" (Puzović *et al.* 2009).

This article gives details on the first systematic survey of Tengmalm's Owl population anywhere in Serbia. We present recent results of the research carried out in two breeding seasons in the northern part of Mt Kopaonik (within the National Park borders). The three main aims of our study were to establish the species' (1) altitudinal distribution, (2) breeding density and (3) population size on Mt Kopaonik. These analyses are useful for understanding the number and distribution of this species in similar habitats in Serbia and proposing measures for future conservation along the southern limits of its European distribution range.

2. Study area

Mt. Kopaonik (43°17'6"N, 20°48'19"E) is the largest mountain in central Serbia spreading its wide ridge 83 km in NW–SE direction. It is situated at the border of two significant Balkan provinces, the more humid Illyrian-western and drier Moesian-eastern provinces. Mt Kopaonik as morphological and geological massif borders on the Jošanička and Koznička Rivers in the north, the Ibar River in the west, the valleys of Rasina and Toplica Rivers in the east and Lab River in the south (Vasović 1988). Our investigated area included part of Kopaonik National Park (hereinafter referred to as "NP Kopaonik"), which covers the area of 11,809 ha (Figure 1). Altitudes vary between 640 and 2,017 m a.s.l. (average ca. 1,700 m a.s.l.). Approximately 75% of the study area consists of forests, 22% of open grassland-rocky terrain, and 3% of built-up areas.

Vegetation types in NP Kopaonik are variable and depend on the elevation and other geographical-climatic characteristics. The most widespread tree species are the European Beech *Fagus sylvatica*, Silver Fir *Abies alba* and Norway Spruce *Picea abies*. Basically, these tree species with several herbaceous plants form five most abundant forest associations in NP Kopaonik: *Fagetum montanum, Fagetum subalpinum, Abieti-Fagetum moesiacum, Piceetum excelsae montanum* and *Vaccinio-Junipero-Piceetum subalpinum* (Lakušić & Elleboode 2011). The most distinct characteristics of the high part of Kopaonik are its many small and three large peat bogs. NP Kopaonik has sub-alpine climate. Average annual air temperature is 2.7 °C and precipitations are higher than 1,000 mm per year (Public enterprise NP Kopaonik *unpubl.*). In the southern and highest parts of NP Kopaonik, large ski-resorts exist, with 25 lifts and 67 km of ski slopes.

Our investigated area covers 24 km² at altitudes between 1,100 and 1,900 m a.s.l. We decided to carry out a research at these higher elevations due to the lack of suitable habitat (mixed and coniferous forests) on lower elevations, based on published data from Serbia (Rajković *et al.* 2010) and Bulgaria (e.g. Nankinov 2002, Shurulinkov *et al.* 2003) and from personal experience of the authors.

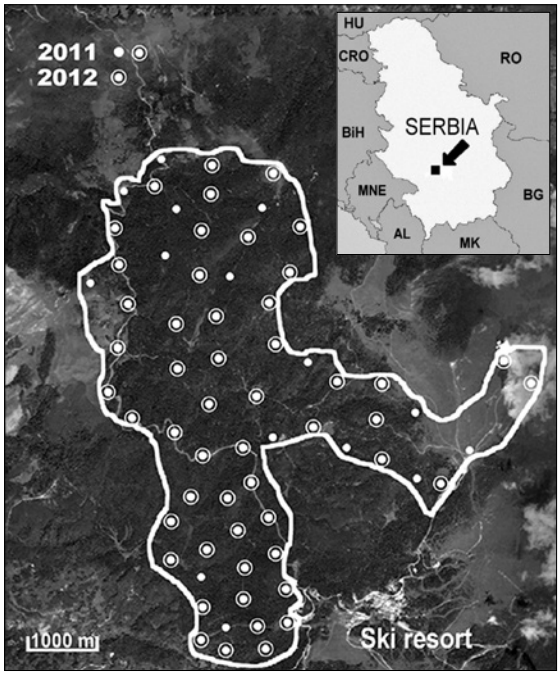

Figure 1: Study area in Kopaonik National Park with stop points depicted

Slika 1: Raziskovano območje v Narodnem parku Kopaonik z označenimi popisnimi točkami

3. Methods

During March, April and May 2011 and 2012 (16 survey nights), we searched systematically for territorial Tengmalm's Owls. We used survey method according to Takats *et al.* (2001): a line walking transect in representative habitat in combination with pre-defined stop points. Basically, it meant that we did not note Tengmalm's Owls males just at stop points, but also during the walking process (in this case birds were recorded only if we were 100% sure that they were not the already recorded individuals). If necessary (if we did not hear a spontaneous advertising call) we used playback of tape-recorded male territorial call at stop points (Hayward *et al.* 1993, Takats *et al.* 2001, Shurulinkov *et al.* 2003).

Surveys started in the evening when darkness permitted to view the first stars (Hayward *et al.* 1993) and ended ca. 60–90 min after midnight. We travelled along forest roads or, rarely, ridge lines and stopped at count points every 600–1,050 m, which depended on terrain configuration and forest canopy. At each stop without any spontaneous calling we initially played the tape for 1 min and then listened for 1 min. After repeating this procedure a few times, we played the tape for 2 mins and then listened for 4 mins. Each stop point was visited usually twice in each research year. In addition, we often stopped outside the count points (during transect) in order to locate singing owls (Takats *et al.* 2001). We conducted the surveys only in suitable weather conditions – calm night without rain, heavy snowfall or strong wind. After listening to territorial (advertising) call, we usually walked, if possible, towards the singing male in attempt to locate its position.

We were navigated with a GPS device (points later stored in Google Earth) and, in addition, used topographical maps. Only a singing male was interpreted as a territory of a potential breeding pair (Pačenovský & Shurulinkov 2008). Also, presence of two or more calling males per one stop point or during transect was considered only if males were detected at the same time (Vrezec 2003), or if vocal variation between males was very specific and easily distinguishable (König *et al.* 1999). The presence of calling males within the range of more than 500 m from stop point was excluded from breeding density calculation due to possible double detection (Vrezec 2003).

Statistical significance between occupied and unoccupied stop points was calculated with the Mann-Whitney *U*-test. Crude breeding density per 10 km² was calculated with a simple formula: number of territories / surface of investigated area × 10.

4. Results

In total, we conducted 120 point counts (68 in 2011 and 52 in 2012) and 112.5 km of transects (61 km in 2011 and 51.5 km in 2012). The distance between neighbouring Tengmalm's Owl singing males varied from 279 to 2,731 m. In both years together, we found 37 territories: 20 in 2011 and 17 in 2012. According to these data and study area surface, the calculated population density was 8.3 territories/10 km² in 2011 and 7.1 territories/10 km² in 2012.

71% of all territories were positioned mostly on the northern, NW and western slope exposures. Only the altitude belt between 1,350 and 1,750 m was occupied by Tengmalm's Owl singing males (Figure 2). The lowest record of calling male was at 1,367 m, the highest at 1,689 m, with a mean of 1,511 m a.s.l. Difference in the mean altitude between the occupied and unoccupied stop points was not statistically significant (Mann-Whitney *U*-test, $Z = 0.507$, $P = 0.256$).

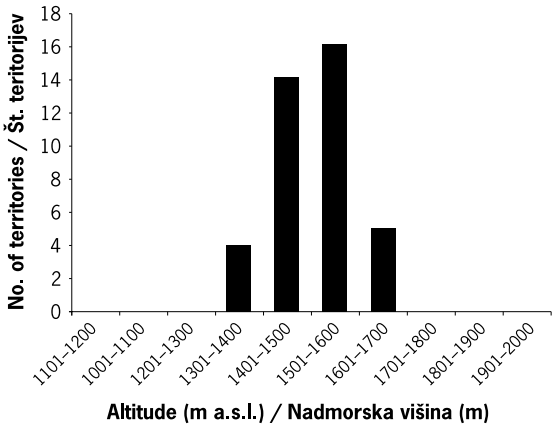

Figure 2: Altitudinal distribution of territorial Tengmalm's Owl *Aegolius funereus* males in Kopaonik National Park (n = 37)

Slika 2: Višinska razširjenost teritorialnih samcev koconogega čuka *Aegolius funereus* v Narodnem parku Kopaonik (n = 37)

We investigated ca. 45% of the mixed and coniferous forest (apparently suitable habitat) in NP Kopaonik. In the light of this study (breeding density data) and according to the available suitable habitat (ca. 5,900 ha), we estimate the total population of Tengmalm's Owl in NP Kopaonik at 42–49 nesting pairs.

5. Discussion

With the exception of several cases (mixed deciduous-coniferous forests), the Tengmalm's Owl territories in NP Kopaonik overlap with distribution of pure coniferous (Norway Spruce) forests within the altitude range of around 400 m. According to the previous literature data, the Tengmalm's Owl breeding distribution in Serbia lies between 1,100 m and the tree-line at 1,800 m a.s.l. (Rajković *et al.* 2010). Our work in NP Kopaonik gave quite similar distribution of this species. In the neighbouring countries, Shurulinkov *et al.* (2003), Shurulinkov & Stoyanov (2006), Shurulinkov *et al.* (2012) for Bulgaria and Božič & Vrezec (2000) for parts of Slovenia also suggested comparatively same or similar data for altitudinal distribution. On the other hand, in

Table 1: Breeding densities of Tengmalm's owl *Aegolius funereus* in different study areas across Europe

Tabela 1: Gnezditvena gostota koconogega čuka *Aegolius funereus* v različnih preučevanih območjih po Evropi

Region, country/ Regija, država	Study area/ Območje raziskave (km^2)	Breeding density/ Gnezditvena gostota (pairs/10 km^2)	Sources/ Viri
Kopaonik National Park, Serbia	24	7.7	This study / ta raziskava
Bialowieza, Poland	620	4.5	Domaszewicz (1993)
Germany (few different regions)	-	0.3 (0.01–2.4)	Mammen & Stubbe (2005)
Gorodok, Vitebsk region, N Belarus	400	1.5 (0.5–2.5)	Shamovich & Shamovich (2005)
Kivach Nature Reserve, Karelia, Russia	103	2.0	Khokhlova *et al.* (2005)
Mt Krim - North Dinaric Alps, C Slovenia	32.2	2.8	Vrezec (2003)
Mt Pirin, SW Bulgaria	275	6.9	Shurulinkov *et al.* (2003)
Pieniny National Park, S Poland	23.25	1.3 (0.9–1.7)	Ciach (2005)
Pinega, Arkhangelsk region, Russia*	827	0.8 (0.16–2.17)	Rykova *et al.* (2005)
Polotsk, Vitebsk region, N Belarus	300	2.2	Shamovich & Shamovich (2005)
Teici Nature Reserve, Latvia	160	0.7	Bergmanis (1997)

* Only data for the European part of Russian Federation are given / Predstavljeni so samo podatki za evropski del Rusije

many areas of central and northern Europe, altitudinal distribution does not play such an important role. For example, in parts of the Czech Republic (Kloubec 2003, Vacík 1991a) and northern Germany (König *et al.* 1999), this species inhabits different types of forests (also broad-leaved) and its occurrence is not limited by the altitude. We did not investigate reasons for that, but we can assume that climatic factors play an important role in the distribution of this boreal owl species in Serbia.

Findings of Tengmalm's Owl territories mostly on the northern and NW slopes of the massif are expected for isolated and patchy high mountain population as in Kopaonik (Dejaifve *et al.* 1990). According to Hayward *et al.* (1993), northern and western slopes provide, usually together with smaller tree density and often humid floor covered with mosses, cool native boreal climatic conditions and help to avoid symptoms of summer heat stress. In addition, larger forest-dwelling owls such as Tawny *Strix aluco* and Ural Owl *S. uralensis*, which can determine distribution of smaller forest owls through predation (Hakkarainen & Körpimaki 1996, Vrezec & Tome 2004), are very rare in investigated area and usually inhabit lower elevations and warm sun facing slopes (D. Rajković *unpubl.*).

Breeding densities vary considerably across Tengmalm's Owl distribution range and depend upon many various factors such as habitat quality, abundance of nesting cavities, food supply or climate conditions (Mikkola 1983, Hayward *et al.* 1993, König *et al.* 1999). According to our results, the Tengmalm's Owl breeding density in NP Kopaonik is one of the highest known from literature in Europe (Table 1). However, this conclusion should be taken and interpreted with caution, as density estimates depend on the area over which populations are censused and higher densities tend to be recorded over smaller areas (Gaston *et al.* 1999). Locker & Flügge (1998) suggested three important limiting factors for Tengmalm's Owl breeding density: (1) presence of nest holes and cavities made by Black Woodpecker *Dryocopus martius*, (2) optimal forest areas with some clearings, and (3) absence of the Tawny Owl as avian predator. In addition, Hayward *et al.* (1993) in the Rocky Mts and Hakkarainen *et al.* (2002) in Finland show that the number and density of small mammal community, especially voles like potential prey, play an important role in survival rate and density of Tengmalm's Owl males. Nevertheless, our preliminary data collected during surveys suggest that some of the above-mentioned factors are probably not optimal for Tengmalm's Owl in NP Kopaonik (e.g. declining numbers of Black Woodpecker), while others certainly are (e.g. absence of large nocturnal predators, like Ural Owl and Eagle Owl *Bubo bubo*). However, for complete understanding, we will need to focus our attention on detailed studies of these topics in order to make final conclusions.

Our survey study shows that the Tengmalm's Owl is fairly common in high-mountain forest habitat in NP Kopaonik. Our systematic research supports the

hypothesis by Rajković *et al.* (2010), who believe that the breeding population in Kopaonik and entire Serbia is higher than previously suspected (Puzović *et al.* 2003 & 2009). However, this does not mean that population of this vulnerable species has increased. The reasons for a larger new estimate are lack of species-specific research in the past and use of specific survey methodology at the present time. Similar situation has been recorded in Bulgaria. Only two localities in Mt Rila had been documented until 1980. After that period with increasing number of special surveys in high mountain regions, knowledge about Tengmalm's Owl distribution pattern rapidly increased (Nankinov 2002).

As the abundance of Tengmalm's Owl has been underestimated in NP Kopaonik prior to our study, we recommend an update of population estimate for NP and IBA Kopaonik to 42–49 breeding pairs. Furthermore, we can conclude that NP Kopaonik is, at least to our current knowledge, the most important breeding site for Tengmalm's Owl in Serbia. Therefore, we urge for continuation of monitoring and further research, together with implementation of conservation measures for the species in the future.

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6. Povzetek

Avtorji članka so v gnezditvenih sezonah 2011 in 2012 preučevali višinsko razširjenost, gnezditveno gostoto in velikost populacije koconogega čuka *Aegolius funereus* v Narodnem parku Kopaonik v srednji Srbiji. Preučevano območje je pokrivalo 24 km². Raziskovali so z metodo linijskega transekta v kombinaciji s popisnimi točkami in predvajanjem oglašanja teritorialnega samca. Med dvoletnim raziskovanjem je bilo ugotovljenih 37 teritorijev koconogega čuka. V Narodnem parku Kopaonik samci te vrste naseljujejo gozdove navadne smreke *Picea abies,* mešane gozdove navadne smreke in bele jelke *Abies alba* in navadne smreke in bukve *Fagus sylvatica* v višinskem pasu med 1367 in 1689 m n.v. Gnezditvena gostota v preučevanem območju je dosegla 8,3 teritorija/10 km² v letu 2011 in 7,1 teritorija/10 km² v letu 2012. Ocenjena celotna populacija koconogega čuka v Narodnem parku Kopaonik je neprimerno večja v primerjavi s prejšnjo oceno, tako da je z zdaj ugotovljenimi 42–49 gnezditvenimi teritoriji trenutno najpomembnejše gnezditveno območje koconogega čuka v Srbiji.

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