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OWLS OF THE NATURE PARK ŽUMBERAK – SAMOBORSKO GORJE, NW CROATIA

Sove Parka prirode Žumberak – Samoborsko gorje

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ABSTRACT

This paper presents the results of owl surveys conducted in the Žumberak – Samoborsko gorje Nature Park (340 km²), NW Croatia, between 2002 and 2005. Five owl species were recorded, with the Tawny Owl *Strix aluco* being the most common. A total of 108 Tawny Owl territories, 22 Ural Owl *Strix uralensis* territories, 8 Northern Long-eared Owl *Asio otus* territories, 3 Little Owl *Athene noctua* territories, and 2 Common Barn Owl *Tyto alba* territories were identified. The primary conservation challenge is the ongoing succession of open habitats to forests, driven by significant depopulation and the decline in traditional agriculture. This poses a major threat to species associated with open habitats, such as the Barn Owl and the Little Owl. To maintain owl diversity, it is vital to support extensive agricultural practices within the Nature Park's boundaries, preserving and, where possible, restoring grasslands and traditional orchards.

Keywords: owls, distribution, call-playback, Nature Park, **Žumberak** Mountain

INTRODUCTION

Ten species of owls breed in Croatia; nine regularly and one occasionally (Tutiš *et al*. 2013). Despite Croatia's relatively rich owl fauna, research on these species significantly lags behind that of many other European countries. There is a notable lack of detailed information on the distribution, habitat preferences, and population densities of most owl species in Croatia. To date, only a few stud-

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ies have specifically addressed some of these aspects, namely for the Ural Owl *Strix uralensis* (Tutiš *et al*. 2009), the Eagle Owl *Bubo bubo* (Bordjan 2002, Barišić *et al*. 2016, Ječmenica *et al*. 2022), and the Eurasian Scops Owl *Otus scops* (Vrezec 2001, Zagoršek & Vrezec 2021).

The owl fauna of specific areas, including most protected ones, remains poorly known. Data on owls are largely anecdotal, gathered primarily through general avifaunal studies. These studies, especially historical ones, were often conducted in the morning when most owls are inactive and relatively silent. Consequently, data on owls collected through such research are inadequate. Specific techniques and additional effort are needed to obtain sound ecological information on owl species in a given area (Zuberogoitia & Campos 1998).

This also applies to the Nature Park Žumberak – Samoborsko Gorje, where only limited historical data on owls are available. The only information comes from Renata Rucner (Rucner 1975), who listed the Tawny Owl *Strix aluco* as a breeding species in Samoborsko Gorje, and Dragutin Rucner (Rucner 1994, 1997), who identified the Little Owl *Athene noctua* as a regular but rare breeding species in settlements, and the Tawny Owl as a common breeding species in the beech forests of Žumberak.

This paper reports the results of the first systematic survey of owls in the Žumberak – Samoborsko Gorje Nature Park, conducted from 2002 to 2005. The aim of the study was to assess the diversity, distribution and habitat associations of owl species within the area.

METHODS

Study Area

The research was conducted in the Žumberak – Samoborsko Gorje Nature Park, located in northwest Croatia (45°43'N 15°15'E – 45°47'N 15°41'E, Fig. 1), designated as a protected area since 1999. Covering 342 km², the Park encompasses the Croatian side of Žumberak Mountain (known as "Žumberačka Gora" in Croatian and "Gorjanci" in Slovenian). Stretching 45-50 km in length and 18-22 km in width, the mountain lies between the expansive plains of the Krka River in Slovenia and the Kupa River in Croatia, aligned along a northeast-southwest axis (Crkvenčić 1974). Žumberak Mountain features a diverse and complex relief and geological structure (Bognar 1980, Buzjak 2011). The Croatian side is characterized by spacious, gentle slopes, contrasting with the narrower, steeper slopes of the Slovenian side. The Croatian portion of Žumberak Mountain is traditionally divided into Žumberak and Samoborsko Gorje (Crkvenčić 1974). Elevation within the Park ranges from 180 m to the highest peak of Žumberak Mountain, Sveta Gera (also known as Trdina Peak in Slovenian), at 1,178 m above sea level, situated on the Croatian-Slovenian border.

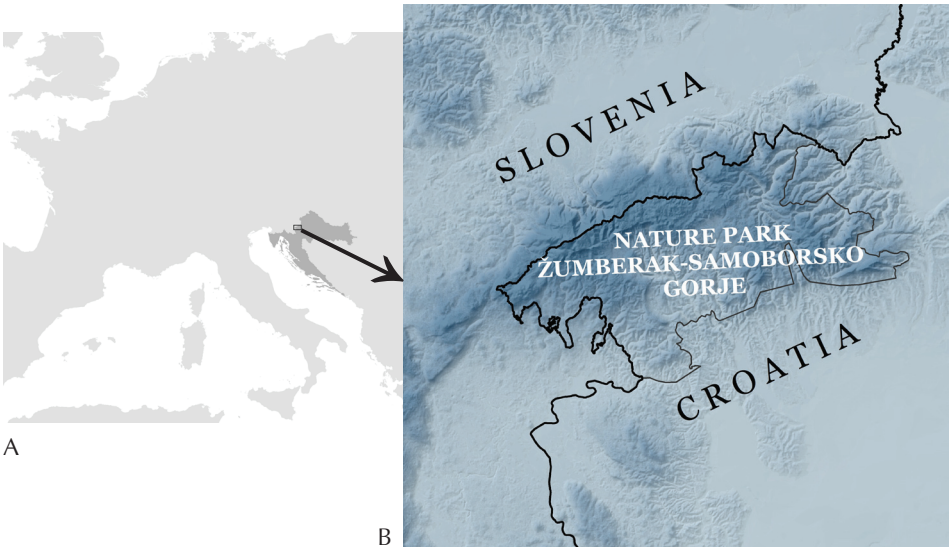

Figure 1. Geographical position of the study area (A). The Žumberak – Samoborsko gorje Nature Park and its wider area (B).

Slika 1. *Geografski položaj istraživanog područja (A). Park prirode Žumberak – Samoborsko gorje i njegovo šire područje (B).*

According to the Köppen climate classification, the climate in the Žumberak – Samoborsko gorje Nature Park is categorised as Cfb, temperate humid with warm summers (Šegota & Filipčić 2003). The mean annual temperatures in the Park vary with altitude, ranging from 6°C in the highest mountain regions to 11°C in the lower areas. January temperatures average between –1°C and –2°C, while July temperatures average between 18°C to 20°C. The mean total annual precipitation ranges from 1,000 mm to 1,500 mm (Zaninović *et al*. 2008).

Forests cover the largest part of the Nature Park, with sessile oak *Quercus petraea* dominating the lower elevations and beech *Fagus sylvatica* prevailing at higher elevations (Horvat 1962, Šugar 1972). The forests are most compact in the highest zones of the mountain, where extensive beech stands are prevalent. The most dominant forest type is the Illyrian beech forest, *Lamio orvalae-Fagetum sylvaticae* (Horvat 1938, Borhidi 1963), covering approximately 38% of the Park's area. In the lower hilly regions, greater human impact has resulted in more fragmented forests. Here, a mix of sessile oak and common hornbeam (*Epimedio-Carpinetum betuli,* Horvat 1938, Borhidi 1963) is the dominant forest type, accounting for about 16% of the Park's area.

Up to 800 metres, the forest landscape is interspersed with traditional villages and hamlets, closely integrated with small patches of extensively managed ploughlands, grasslands, orchards, and vineyards. Žumberak Mountain stands out in inland continental Croatia as the highest mountain area where the population predominantly resides above 400 meters, setting it apart from other inland highlands where settlements rarely exceed this elevation (Crkvenčić 2002). Nevertheless, strong depopulation has resulted in only a small number of inhabitants still residing in the higher parts of the mountain today (Crkvenčić 2002). According to Jelaska *et al*. (2005), by 2003, the forest coverage in the Nature Park had notably increased to 77% from 61% fifty years prior, attributed to depopulation and the abandonment of traditional land use.

Owl survey

The research was designed using published (Giester 1995, Kralj 1997, Rössler 1902, Rucner 1975, 1994, 1997, Sušić *et al*. 1988) and unpublished sources (data collected for the Breeding bird atlas of Croatia 1985-1987, Institute of Ornithology archive, Zagreb), focusing on the distribution and records of owls within the Nature Park and in its wider area (Fig. 1). The data suggested that the Žumberak – Samoborsko Gorje Nature Park could potentially host seven owl species: Common Barn-owl *Tyto alba* (hereafter Barn Owl), Little Owl, Eurasian Scops-owl (hereafter Scops Owl), Northern Long-eared Owl *Asio otus* (hereafter Long-eared Owl), Tawny Owl, Ural Owl and Eurasian Eagle-owl (hereafter Eagle Owl). All of these, apart from the Eagle Owl, have been noted as recent breeders in the referenced sources.

The call-playback method (Fuller & Mosher 1987, Smith 1987) was utilised to ascertain the presence and distribution of all expected species apart from the Barn Owl. This method capitalizes on the fact that broadcasting recordings of owl vocalisations, typically species-specific territorial calls, can stimulate territorial behaviour in owls and provoke vocal responses. This enables researchers to identify the locations of their territories (Fuller & Mosher 1981, Johnson *et al*. 1981, Smith 1987, Fuller & Mosher 1987, Clark 1989, Vrezec & Bertoncelj 2018, Zuberogoitia *et al*. 2020). The call-playback method is a widely used and efficient approach in the study of distribution, abundance, and habitat associations of many owl species (Zuberogoitia & Campos 1998, Vrezec & Tome 2004, Johnson *et al*. 2009, Tutiš *et al*. 2009, Barišić *et al*. 2016, Zagoršek & Vrezec 2021).

To determine the presence of the Barn Owl, we opted not to use the call-playback method. Although this method can be employed to ascertain the presence of the Barn Owl (Zuberogoitia & Campos 1998, Wingert & Benson 2018), it is considered largely ineffective for surveying this species by some authors (e.g. Shawyer 1994). Barn Owls do not defend a clearly defined territory and vocalise mainly in the vicinity of their breeding sites. Since Barn Owls often nest or roost

in the attics of old houses, churches, and barns, the survey concentrated on detecting characteristic field signs left by roosting or nesting birds, such as pellets, moulted feathers, droppings and other remains. Barn Owl pellets are distinctive and differ from those of the Little Owl or Tawny Owl, which can also be found in such places. Evidence of occupancy by the Barn Owl and other owl species were sought in the attics and bell towers of churches in Žumberačko Mrzlo polje, Grabno, Stojdraga, Kalje, Sošice (Greek Catholic and Roman Catholic churches), Kašt, Radatovići, Dragoševci, Liješće, Šiljki, Mrki, Bodovinci, Dančulovići, and Tupčina, as well as in the attics of schools in Kašt and Radatovići, and Čotrović's mansion.

The call-playback method

The call-playback method is most effective during periods of increased vocal activity in species, typically aligning with the breeding season (Johnson *et al*. 2009, Zuberogoitia *et al*. 2019). Since the onset of the breeding season differs among owl species in a given area, the optimal timing for conducting call-playback surveys also varies among species.

Call-playback surveys were conducted at a total of 176 stations distributed throughout the Nature Park, aimed at investigating potentially suitable habitats for each species. Approximately one-third of the stations were positioned in more open habitats, while the remaining two-thirds were situated in forested areas.

Call-playback surveys for each species were conducted during their specific peak vocalization periods. Surveys for the Long-eared Owl were conducted in March (Tome 1997), for the Little Owl from March to mid-April (Johnson *et al*. 2009), for the Scops Owl from late April-May (Mori *et al*. 2014), and for the Eagle Owl from February to mid-March (Penteriani 2002, Harms 2020). Each species was surveyed separately using the same protocol, but with species-specific vocalizations. The total duration of the call-playback protocol was seven minutes, beginning with a one-minute silent listening period, followed by three distinct calling bouts of male territorial calls, each lasting approximately 40 seconds, alternated with one-minute silent periods, and concluding with a two-minute silent period. Little and Scops Owls were surveyed from the same stations, with a total of 48 stations arranged in four routes of ten stations each along roads, and eight stations clustered in small groups. An additional small cluster of four stations was surveyed specifically for the Scops Owl. Stations were set about 1 km apart, measured as areal distance. The Long-eared Owls were surveyed from 15 stations, spaced apart at 1 km along a single route. The Eagle Owl was surveyed from 25 stations grouped in clusters and dispersed throughout the Nature Park. Given that Eagle Owl calls can be heard from up to 1.5 km away, and exceptionally up to 4 km (Glutz von Blotzheim & Bauer 1980), the survey stations were spaced at least 3 km apart to minimize the chances of detecting the same owl at

neighbouring stations. Surveys for the Long-eared Owl took place in 2003, while those for the Eagle, Little, and Scops Owls were conducted in both 2003 and 2005. The stations for the Little, Long-eared and Eagle Owls were surveyed once, while about two-thirds of the stations for the Scops Owl were surveyed twice.

Surveys for Tawny and Ural Owls were conducted in 2002, from mid-February to March during the breeding season, and from September to mid-October, a time when birds reaffirm their territories and exhibit heightened vocal activity (Lundberg 1980, Zuberogoitia *et al*. 2019). Both species were surveyed simultaneously at the same stations using a 12-minute call-playback protocol. At each station, calls from the Tawny Owl were broadcast first. The protocol began with a one-minute silent listening period, followed by three 40-second bouts of Tawny Owl male territorial calls, each separated by one-minute silent intervals. After the final Tawny Owl call, there was a 1.5-minute silent period before broadcasting three 40-second calling bouts of Ural Owl male territorial calls, also interspersed with one-minute silent periods, concluding with another 1.5-minute silent period. In total, 84 survey stations were established, either arranged in routes or dispersed in clusters throughout the Nature Park, with each station spaced at least 1 km apart. The Tawny and Ural Owls were surveyed at 46 stations twice during the breeding period and at 38 stations once during the autumn.

The call-playback was transmitted using a car radio CD player connected to high-quality 40 W loudspeakers, set at a volume audible to humans from roughly 1 km away for Tawny, Ural, Long-eared and Eagle Owl surveys, and approximately 500 m for Little and Scops Owl surveys. The loudspeakers, positioned on the car's roof about 2 metres above the ground, were directed to project sound in opposite directions. The recordings of calls used to elicit responses from owls in our protocols were sourced from Roché (1990).

Surveys were conducted under favourable conditions: wind speeds of less than 20 km per hour (Beaufort 3 or lower), no precipitation, and temperatures within the seasonal norm. Surveys generally took place from half an hour after sunset until half an hour before sunrise. Specifically, surveys for Tawny and Ural Owls in the spring of 2002 were conducted from half an hour after sunset until midnight.

RESULTS AND DISCUSSION

This study has confirmed the presence of five owl species in the Žumberak – Samoborsko gorje Nature Park: Barn Owl, Tawny Owl, Ural Owl, Long-eared Owl, and Little Owl.

The Tawny Owl was identified as the most numerous owl species, with a total of 108 territories found (Fig. 2). Within the Nature Park, the Tawny Owl is ubiquitous, indicating that the entire area is suitable for this species. Primarily residing in forests and along forest edges, the Tawny Owl can also adapt to more open

habitats, provided there are scattered trees to perch and hunt from (Cramp 1985). The non-forested habitats in the Park, occupying slightly less than a quarter of the total area, consist of small-sized patches of traditionally managed agricultural mosaics that are suitable for the Tawny Owl.

The presence of the Ural Owl seems to be the only obstacle to the Tawny Owl's distribution in the Nature Park. Both species utilise similar hunting techniques and have comparable habitat requirements. Thus, in areas where they coexist, they compete for resources and since the Ural Owl is significantly larger, this competition typically disadvantages the Tawny Owl, leading to its displacement from otherwise suitable areas occupied by the Ural Owl (Vrezec & Tome 2004, Kajtoch *et al*. 2015). During the study, 22 territories of the Ural Owl were identified in various parts of the Nature Park (Fig. 2), with a slightly higher concentration in its northwestern section. Ural Owls were found at elevations ranging from 290 to 930 m, with over 70% of territories recorded at elevations above 600 m.

Figure 2. Distribution of Tawny Owl (black circles) and the Ural Owl (white circles) territories found in the Nature Park Žumberak – Samoborsko gorje during the study.

Slika 2. *Rasprostranjenost teritorija šumske sove (crni krugovi) i jastrebače (bijeli krugovi) u Parku prirode Žumberak – Samoborsko gorje tijekom istraživanja.*

Call-playback surveys for the Long-eared Owl were conducted in the eastern part of the Nature Park, across an elevation range of 400 to 750 metres, with 15 stations in total. Three of these stations were positioned in forests near settlements, while 12 were situated in traditionally managed agricultural mosaics. A total of eight owl territories were identified (Fig. 3): seven within the agricultural mosaic and only one in a forested area. Although Long-eared Owls inhabit for-

ests, woodlands, and various types of scrub, they are found only on the very edges of larger woods and forests; most breed in small woodland patches surrounded by open meadows and fields (Mikkola 1983). They typically hunt in a slow, steady, searching flight over open ground (Cramp 1985). The detection of Long-eared Owls at seven out of twelve survey stations suggests that the proportion of open habitats within larger patches of traditionally managed agricultural mosaics in the Park, despite being partly in a state of succession, was still sufficient for the Long-eared Owl.

Figure 3. Distribution of Barn Owl (white triangles), Little Owl (black circles), Long-eared Owl (black triangles) and Scops Owls (white rectangles) territories found in the Nature Park Žumberak – Samoborsko gorje during the study.

Slika 3. *Rasprostranjenost teritorija kukuvije (bijeli trokuti), sivog ćuka (crni krugovi), male ušare (crni trokuti) i ćuka (bijeli kvadrati) u Parku prirode Žumberak – Samoborsko gorje tijekom istraživanja.*

The Little Owl and the Barn Owl were found to be rare in the Nature Park. Call-playback surveys of the Little Owl were conducted at 48 stations located in traditionally managed agricultural mosaics, yet only two Little Owl territories were identified: one in Slani dol (450 m a.s.l.) and another in Vivodina (350 m a.s.l.). Additionally, remains of a Little Owl (flight feathers and skull) were discovered in the attic of an abandoned building in Kašt (423 m a.s.l.) (Fig. 3). Evidence of the Barn Owl occupancy was found at only two locations: the bell tower of the Roman Catholic church in Sošice (560 m a.s.l.) and the attic of the church in Radatovići (574 m a.s.l.) (Fig. 3). At both sites, only a few old pellets and feathers were discovered, suggesting that these locations were not used regularly.

Both the Little Owl and the Barn Owl are primarily lowland species. In Central Europe, the Little Owl is seldom found at elevations above 600 meters (Glutz von Blotzheim & Bauer 1980, Cramp 1985, Juillard 1985). In neighbouring Slovenia, it predominantly occupies areas below 400 meters (Tome 1996). Similarly, the Barn Owl rarely ascends above 600 meters in continental climate zones, due to climate limitations, especially harsh winters, preferring breeding areas where snow cover typically lasts fewer than 40 days and is less than 7 cm deep (Glutz von Blotzheim & Bauer 1980). Given that over 70% of the Nature Park's area lies above 400 meters, a significant portion of the Park is only marginally suitable for these two species.

Both species avoid forested areas. The Barn Owl occupies a wide range of primarily open habitats, such as grasslands, deserts, marshes, and agricultural fields, preferring rough-grassland farmland with hedges, ditches, ponds and banks that provide prey-rich foraging grounds (Cramp 1985). The Little Owl occupies semi-open to mosaic rural landscapes, from steppes and stony semi-deserts to farmlands, open woodlands, villages, and urban areas, especially favouring areas rich in grasslands, traditional orchards, and vineyards (Cramp 1985, Juillard 1985, Van Nieuwenhuyse *et al*. 2001). Non-forested habitats, mainly in the form of traditionally managed agricultural mosaics comprising rural settlements with adjacent small-sized grassland parcels, cultivated fields, old orchards, vineyards, hedges, and tree lines, occupy about 23% of the Nature Park's area (Jelaska *et al*. 2005). Although these habitats cover a considerable area (about 79 km^2in total), they are fragmented across 138 settlements, forming habitat "islets"- small, isolated patches averaging 2.5 km^2, scattered amidst expansive forested areas. Due to their small size, most of these patches of traditionally managed agricultural mosaics are too small to support a pair of Barn Owls. For example, in a typical farmland landscape in Western Switzerland, the average home range for a breeding male Barn Owl is 6 km^2 (Séchaud *et al*. 2022), while in the farmland landscape of Scotland's Lowlands, it is 3.2 km^2 (Taylor 1994).

In this context, the Little Owl may be in a more favourable position than the Barn Owl, as it is a significantly smaller bird with typically much smaller home ranges. For example, the average home range of the Little Owl is about 0.2 km^2 in eastern Poland (Grzywaczewski 2009), 0.31 km^2 in northeastern France (Génot & Wilhelm 1993), and 0.15 km^2 in Germany (Exo 1992). However, the Little Owl faces potentially significant predation pressure from the Tawny Owl (Mikkola 1983, Juillard 1985). Small patches of agricultural mosaics, when enclosed by forests, rapidly become overgrown when abandoned. This overgrowth not only leads to habitat loss for both the Little Owl and the Barn Owl but also favours the Tawny Owl. Additionally, the Tawny Owl is known to prey on the Little Owl (Mikkola 1983) and thus can significantly impact the Little Owl's abundance and distribution in an area (Juillard 1985, Schönn 1986). Avoidance of forests and forest edges

is a well-documented response of the Little Owl to the presence of the Tawny Owl (Zabala *et al*. 2006, Michel *et al*. 2016). Little Owl site occupancy decreases markedly within 150 m of forests where Tawny Owls are present (Michel *et al*. 2016). Considering the small size and "island" arrangement of the mosaic habitats, the Tawny Owl is likely having a significant negative impact on the Little Owl population in the Žumberak – Samoborsko gorje Nature Park. At many survey stations where attempts to lure the Little Owl were unsuccessful, the Tawny Owl readily responded to the broadcast of the Little Owl's territorial calls.

During the call-playback surveys for the Scops Owl conducted at 36 stations in 2003, no Scops Owls were detected. Nevertheless, four spontaneously singing males were documented during a Corncrake *Crex crex* surveys carried out in the last decade of May that same year (Vlatka Dumbović, pers. comm.). The birds were found in Sošice (560 m a.s.l.), Sopotske planine (860 m a.s.l.), Javor (560 m a.s.l.) and Noršić selo (640 m a.s.l.) (Fig. 3). In 2005, call-playback surveys were conducted at 52 stations, including all locations where Scops Owls had been previously detected two years earlier; however, no Scops Owls were found again. It remains uncertain whether the Scops Owl is a regularly occurring species in the Nature Park, but it is certainly rare.

The Eagle Owl was not recorded during this research. However, its presence was confirmed more than a decade later at the border of the Nature Park and in its immediate vicinity (Ječmenica *et al*. 2022). Between 2018 and 2022, four Eagle Owl territories were identified: two along the southeastern border of the Park, and two located 2 and 3 km beyond its northeastern border (Biljana Ječmenica, pers. comm).

This study provided a first insight into the owl fauna of the Žumberak – Samoborsko gorje Nature Park. Given the Park's extensive area, more intensive research is necessary to accurately determine the distribution, abundance, and population sizes of the recorded owl species. Further research is needed to confirm whether the Scops Owl is a regularly occurring species and whether the Eagle Owl breeds within the Park boundaries. Notably, breeding of the Boreal Owl *Aegolius funereus* was recently recorded on the Slovenian side near the peak zone of Žumberak Mountain (Vrezec 2019). The Boreal Owl was not a target of this study, so further research is needed to verify if it also breeds on the Croatian side. The study identified 22 Ural Owl territories in the Nature Park, representing over 3% of the total Ural Owl population in Croatia. This underscores the national importance of this population and highlights the need for long-term monitoring of the Ural Owl population within the Park. Importantly, since not all areas of the Park were covered by the survey, the recorded number is not definitive. Therefore, the actual population of the Ural Owl is likely to be higher than this figure.

This work is based on research conducted from 2002 to 2005. Since then, the number of inhabitants has declined by 38% between the 2001 and 2021 popula-

tion censuses. This decline has inevitably led to the further abandonment of traditional agricultural production and the loss of open habitats due to succession, negatively impacting species that rely on open and semi-open habitats. Notably, five out of the seven species of owls found in the Žumberak – Samoborsko gorje Nature Park are associated with open or semi-open habitats and their existence in the Park depends on the preservation and restoration of these habitats. To maintain the diversity of owls, as well as the overall bird fauna in the Nature Park, it is essential to design and implement programmes that strongly encourage extensive agricultural production within the Park boundaries. Preserving existing grasslands and traditional orchards, and restoring them wherever feasible, is imperative.

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SAŽETAK

U radu su prikazani rezultati istraživanja sova provedenih između 2002. i 2005. godine u Parku prirode Žumberak – Samoborsko gorje, koji se prostire na 340 km². Tijekom ovih istraživanja zabilježeno je pet vrsta sova, pri čemu je šumska sova *Strix aluco* bila najbrojnija s ukupno 108 teritorija. Također su zabilježena 22 teritorija jastrebače *Strix uralensis*, 8 teritorija male ušare *Asio otus*, 3 teritorija sivog ćuka *Athene noctua* i 2 teritorija kukuvije *Tyto alba*. Populacija jastrebače čini više od 3% ukupne populacije u Hrvatskoj, što ukazuje na njezin nacionalni značaj. Stoga je važno pokrenuti program dugoročnog praćenja populacije ove vrste unutar Parka. Istraživanjima drugih autora u Parku su zabilježene još dvije vrste: ušara *Bubo bubo* i ćuk *Otus scops*, čime ukupan broj vrsta sova u Parku doseže sedam. Glavni izazov za očuvanje raznolikosti faune sova u Parku je sukcesija otvorenih staništa u šume, uzrokovana depopulacijom i nestankom tradicionalne poljoprivrede. Ovo predstavlja veliku prijetnju za vrste ovisne o otvorenim staništima, kao što su kukuvija i sivi ćuk. Za očuvanje raznolikosti sova u n Parku ključno je provoditi programe za poticanje tradicionalne poljoprivrede te očuvati i, gdje je to moguće, obnoviti travnjake i tradicionalne voćnjake.