# The Population Density of the Eurasian Scops-owl (*Otus scops*) Along the Eastern Adriatic Coast

## Densidade populacional do mocho-d'orelhas (*Otus scops*) ao longo da costa leste do Adriático

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## ABSTRACT

The Eurasian Scops-owl (*Otus scops*) is one of least studied owl species in Europe. From the area of eastern Adriatic coast (western Balkan Peninsula) there have been few studies on the species from Croatia and Slovenia. We aimed to determine the population density of the species along the eastern Adriatic coast by field surveys and literature review. We surveyed calling male owls at seven study sites distributed along the coast from Slovenia, Croatia to Montenegro in the breeding seasons of 2012 through 2017. We combined field survey results and literature data on published densities from the regions. A significant decrease in the density of calling males was found along a 250 km gradient from the sea coast inland to continental Slovenia (density range: 0.05 – 1.0 males/km$^2$), but not along a 600 km long north-south region of the eastern Adriatic coast (density range: 0.06 – 2.0 males/km$^2$). The eastern Adriatic coast is probably one of the most important breeding sites of the Eurasian Scops-owl in Europe.

**Keywords:** Mediterranian region, *Otus scops*, playback method, singing males, survey

## RESUMO

The Eurasian Scops-owl (*Otus scops*) is one of least studied owl species in Europe. From the area of eastern Adriatic coast (western Balkan Peninsula) there have been few studies on the species from Croatia and Slovenia. We aimed to determine the population density of the species along the eastern Adriatic coast by field surveys and literature review. We surveyed calling male owls at seven study sites distributed along the coast from Slovenia, Croatia to Montenegro in the breeding seasons of 2012 through 2017. We combined field survey results and literature data on published densities from the regions. A significant decrease in the density of calling males was found along a 250 km gradient from the sea coast inland to continental Slovenia (density range: 0.05 – 1.0 males/km$^2$), but not along a 600 km long north-south region of the eastern Adriatic coast (density range: 0.06 – 2.0 males/km$^2$). The eastern Adriatic coast is probably one of the most important breeding sites of the Eurasian Scops-owl in Europe.


**Palavras-chave:** emissão de vocalizações conspecíficas, machos a vocalizar, monitorização, *Otus scops*, região Mediterrânica

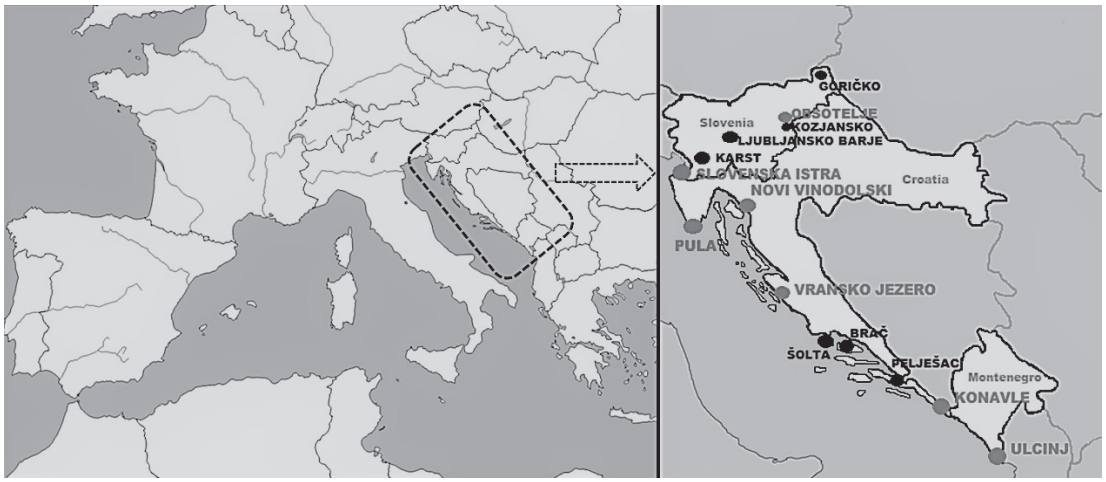
## Introduction

The Eurasian Scops-owl (*Otus scops*) is a small insectivorous owl, using open and semi-open grassland habitats rich in large insects (Marchesi & Sergio 2005, Šušmelj 2011). It is a widespread summer breeder across much of southern and eastern Europe (Bavoux et al.1997). The species is a long-distance migrant and spends the winter in sub-Saharan Africa. Resident populations are known from Cyprus, Mallorca and Crete (Mikkola 1983). In Europe it is one of the least studied and monitored owl species (Vrezec et al. 2012), and its abundance in many European countries is declining (Sergio et al. 2009; BirdLife International 2017). One of the species population strongholds in Europe is situated along the eastern Adriatic coast (west Balkan Peninsula) including countries of Slovenia, Croatia, Bosnia and Herzegovina and Montenegro, which holds 10-13% of the total European population (BirdLife International 2017). The most recent population estimate in Slovenia is 600 – 1000 pairs (Denac et al. 2011), which is based on many systematic surveys across the country (Štumberger 2000, Jančar & Trebušak 2000, Denac 2003, Denac 2009, Kmecl et al. 2010, Šušmelj 2011). In Slovenia the species meets its northern breeding range limit with only a few pairs breeding further north in Austria (Malle & Probst 2015). To the south in Croatia, the Eurasian Scops-owl is much more abundant with a population estimate of 20.000–25.000 breeding pairs (BirdLife International 2017), which is the second largest in Europe (Bavoux et al. 1997, BirdLife International 2017), if excluding Russia and Turkey. However, the accuracy of this estimate is low due to the lack of systematic surveys, although locally the species was found in high densities (Vrezec 2001). Further south, along the Adriatic coast in Montenegro, the population was recently estimated at 2.000–3.000 breeding pairs (BirdLife International 2017), but the reliability of this estimate is low as there are no published surveys of the species.

The aim of this study is to give a first overview of the population density of Eurasian Scops-owl along the eastern Adriatic coast in Slovenia, Croatia and Montenegro combin-

Figure 1 - Study areas distributed along the Adriatic coast from Slovenia to Montenegro where Eurasian Scops-owls (*Otus scops*) were surveyed.

Figura 1 - Áreas de estudo distribuídas ao longo da costa do Adriático, da Eslovénia a Montenegro, onde decorreu a monitorização de mocho-d'orelhas (*Otus scops*).




ing field survey and literature data on published densities from the region (Denac 2000, Jančar & Trebušak 2000, Štumberger 2000, Vrezec 2001, Mužinić & Purger 2008, Bordjan & Rozoničnik 2010, Kmecl et al. 2010, Denac et al. 2011, Šušmelj 2011, Denac et al. 2015).

# Methods

## Study Area

We conducted field surveys at seven study sites and collected survey data from the literature from an additional seven areas distributed along the Adriatic coast in Slovenia, Croatia, and Montenegro (Table 1, Fig. 1).

Slovenia is situated in central Europe, at the confluence of four distinct regions – the Alps, the Dinaric Alps, and the Pannonian and Mediterranean basins. The climate ranges from alpine through temperate continental to mediterranean (Orožen Adamič 2004). We conducted surveys in the Slovenian Istria and Obsotelje, and reviewed data from the Karst, Ljubljansko, Kozjansko and Goričko areas (Table 1).

Croatia is a geographically very diverse country: flat agricultural plains in the NE (lowland Pannonia), mountainous Dinaric lying NW-SE, with the highest mountains along the edges and the coastal Adriatic with islands. Along the 6278 km coast, there are 1,246 islands (Kos et al. 2002). The climate varies from Mediterranean along the Adriatic coast, with hot, dry summers and mild, rainy winters, to continental inland, with cold winters and warm summers (Kos et al. 2002). We conducted our surveys in four areas: Pula, Novi Vinodolski, Vransko jezero and Konavle, and reviewed data from the Pelješac peninsula and the islands of Šolta and Brač (Table 1).

Montenegro is a country located in the west-central Balkans at the southern end of the Dinaric Alps (Allcock et al. 2018). The country is geographically divided into three regions: northern high mountains, central part is a segment of the Karst region of the western Balkan Peninsula and a narrow (2-6

**Table 1** - Descriptions of study areas surveyed within this and other studies. Description data are from Perko et al. (1999), Njavro (2000), Kos et al. (2002), Perko (2004), Clancy (2007), and ARSO (2018).

Tabela 1 - Descrições das áreas de estudo monitorizadas neste e noutros estudos. A descrição foi adaptada de Perko et al. (1999), Njavro (2000), Kos et al. (2002), Perko (2004), Clancy (2007) e ARSO (2018).

| COUNTRY | STUDY AREA | GEOGRAPHICAL COORDINATES | MEAN ELEVATION [M, A.S.L.] | MEAN JULY TEMP | PREVAILING HABITAT TYPE | SCOPS OWL DATA SOURCE |
|---|---|---|---|---|---|---|
| Slovenia | Slovenian Istria | 45°31'- 45°31' N 13°54' - 13°38'E | 180 | 22°C | flysch low hills with vineyards and orchards | this study |
| Slovenia | Karst | 45°50' - 45°36' N 13°47' - 14°06' E | 330 | 20.8°C | flat to hilly, predominantly limestone area | Šušmelj (2011) |
| Slovenia | Ljubljansko barje | 45°59' - 45°57' N 14°20' - 14°33' E | 297 | 19°C | isolated hills within a surrounding plain | Denac (2000) |
| Slovenia | Kozjansko | 46°07' - 45°59' N 15°33' - 15°38' E | 306 | 19°C | hilly and mostly forested area, which gradually flatten out onto a plain by the River Sotla | Kmecl et al. (2010), Denac et al. (2011) |
| Slovenia | Obsotelje | 46°13' - 46°16' N 15°26' - 15°49' E | 307 | 18.6°C | hilly and mostly forested area | this study |
| Slovenia | Goričko | 46°49' - 46°43' N 16°01' - 16°20'E | 275 | 19.1°C | hillocky landscape overgrown by trees, many marshes and wet meadows | Štumberger (2000), Denac et al. (2015) |
| Croatia | Pula | 44°50'- 44°48' N 13°52'- 13°54' E | 30 | 23.7°C | densely populated city and lies on and beneath seven hills on the inner part of a wide gulf | this study |
| Croatia | Novi Vinodolski | 45°15' - 45°07' N 14°36' - 14°47' E | 140 | 23°C | divided into three areas: coastal area, flysch valleys and steep high hills of Gorski kotar | this study |
| Croatia | Vransko jezero | 43°57' - 43°49' N 15°33' - 15°40' E | 44 | 24.1°C | the area with the largest natural lake, rare natural habitats, freshwater springs and rich biodiversity | this study |
| Croatia | Šolta | 43°24' - 43°20' N 16°12' - 16°23' E | 102 | 23°C | | Mužinić & Purger (2008) |
| Croatia | Brač | 43°20' - 43°17' N 16°26' - 16°52' E | 440 | 24.5°C | third largest island in Croatia, region with thermophilous evergeen forests and Mediterranean scrub | Bordjan & Rozonićnik (2010) |
| Croatia | Pelješac | 43°01' - 43°56' N 17°10' - 17°29' E | 470 | 23.5°C | region with thermophilous evergeen forests and important cultural plants olive tree and vine | Vrezec (2001) |
| Croatia | Konavle | 42°36' - 42°25' N 18°17' - 18°29' E | 575 | 25.1°C | karstic valley between mountain Sniježnica and the Adriatic sea | this study |
| Montenegro | Ulcinj | 42°01' - 41°51' N 19°09' -19°21' E | 85 | 25.2°C | its southern part borders the river Bojana, in its central part is Lake Shas, and in the hinterland is the mountain massif of Rumia | this study |

km wide) coastal plain (Allcock et al. 2018). Although the major part of Montenegro is mountainous, it has two climate regions that create two distinct landscapes. The southern and central regions belong to the Adriatic Sea basin with a Mediterranean climate, with dry summers and mild, rainy winters, and the northern regions north of the capital Podgorica belong to the Black Sea basin and have a Continental Alpine climate zone with hot, humid summers and cold winters with heavy snowfall (Allcock et al. 2018, Clancy 2007). In Montenegro, we conducted our study in the southern-most Montenegrin area of Ulcinj (Table 1).

## Field Surveys

Breeding-season field surveys were conducted from 2012 through 2017. We used the playback method as suggested by Samwald & Samwald (1992). At each survey point we first listened for spontaneously calling males for one minute, then broadcast playback of a male call for one minute, and then waited three minutes more for responses (Samwald & Samwald 1992, Denac 2009). In all study areas the survey was conducted only once. Points in each study area were spaced 500 to 1500 m apart, depending on the openness and forest cover of the terrain (Samwald & Samwald 1992, Denac 2009). All survey points were selected in a way that allowed us to cover almost the entire surface of the selected area. We conducted each survey after sunset and finished it one hour before sunrise. Survey nights were dry with little or no wind. We had two survey areas in Slovenia: in the Slovenian Istra we surveyed an area of 338 km$^2$ from 308 points, and in Obsotelje we surveyed an area of 242 km$^2$ from 231 points. In Croatia we conducted surveys at four survey areas: in Pula we surveyed an area of 42 km$^2$ from 44 points; in Novi Vinodolski an area of 37 km$^2$, from 30 points; by Vransko jezero an area of 42 km$^2$ from 38 points; and in Konavle an area of 211 km$^2$ from 88 points. In Montenegro we conducted a survey in Ulcinj where we 52 km$^2$ from 38 points.

## Data Analysis

Crude density of Eurasian Scops-owl males was estimated by dividing the total number of singing males obtained from a single survey area by the total size of that study area (km$^2$). We explored the data for any changes in the population densities along the eastern Adriatic coast (north to south) and with the distance from the sea (west to east). Statistical analysis was conducted with the program PAST, version 3.16 (Hammer et al. 2001).

# Results

Overall, a total of 498 singing Eurasian Scops-owl males were detected at 272 of the 777 (35%) survey points. A total of 964 km$^2$ was surveyed. Population densities in our field surveys ranged from 0.09–1.6 males/km$^2$, and were from 0.06 – 1.0 males/km$^2$ in the published literature (Table 2).

In Slovenia, the population density of Eurasian Scops-owls was highest in the Slovenian Istria (0.7 males/km$^2$) (Fig. 2). From the sea coast to 250 km inland, densities gradually decreased ($r_S$ = -0.84, p <0.05). In the area of Karst (0.3 males/km$^2$; Šušmelj 2011) population density was very similar to that of Goričko (0.2–0.5 males/km$^2$; Štumberger 2000, Denac et al. 2015) and Ljubljansko barje (0.2–0.4 males/km$^2$; Denac 2000). Very low densities were recorded in the areas of Kozjansko (0.05–0.3 males/km$^2$; Jančar & Trebušak 2000, Kmecl et al. 2010, Denac et al. 2011) and Obsotelje (0.09–0.12 males/km$^2$), probably because both areas are very densely forested and there is very little suitable habitat for the species.

**Table 2** - Distribution and population density of the Eurasian Scops-owl (*Otus scops*) in Slovenia, Croatia and Montenegro (this study and published literature). The size of dots represent the calling density of males/km2.

Tabela 2 - Distribuição e densidade populacional do mocho-d'orelhas (*Otus scops*) na Eslovénia, Croácia e Montenegro (neste estudo e na literatura), O tamanho dos pontos representa a densidade de machos detetados a vocalizar por km2.

| SURVEY AREA | SURVEY YEAR | BREEDING DENSITY (males/km$^2$) | SURVEY AREA (KM$^2$) | NUMBER OF CALLING MALES | NUMBER OF SURVEY POINTS | NUMBER OF CALLING MALES PER SURVEY POINT (males/survey point) | SOURCE |
|---|---|---|---|---|---|---|---|
| Goričko (SI) | 1997 | 0.5 | 442 | 210 | 247 | 0.9 | Štumberger (2000) |
| Goričko (SI) | 2015 | 0.2 | 408 | 77 | 418 | 0.2 | Denac *et al.* (2015) |
| Obsotelje (SI) | 2015 | 0.09–0.12 | 242 | 21 | 231 | 0.09 | this study |
| Kozjansko (SI) | 2010 | 0.07 | 206 | 15 | - | - | Kmecl *et al.* (2010) |
| Kozjansko (SI) | 2001–2010 | 0.3 | 206 | 60-70 | - | - | Denac *et al.* (2011) |
| Kozjansko (SI) | 1999 | 0.05-0.1 | 198 | 10-20 | - | - | Jančar & Trebušak (2000) |
| Ljubljansko barje (SI) | 1998 | 0.4 | 163 | 64 | - | - | Denac (2000) |
| Ljubljansko barje (SI) | 1999 | 0.2 | 163 | 40 | - | - | Denac (2000) |
| Karst (SI) | 2006, 2008 | 0.3 | 665 | 347 | 406 | 0.9 | Šušmelj (2011) |
| Slovenian Istra (SI) | 2013 | 0.7-1.0 | 338 | 239 | 308 | 0.8 | this study |
| Pula (HR) | 2012 | 1.6-2.0 | 42 | 69 | 44 | 1.6 | this study |
| Novi Vinodolski (HR) | 2016 | 0.9-1.4 | 37 | 34 | 30 | 1.1 | this study |
| Vransko jezero (HR) | 2016 | 0.2-0.3 | 42 | 8 | 38 | 0.2 | this study |
| Šolta (HR) | 2008 | 0.25 | 52 | 13 | - | - | Mužinić & Purger (2008) |
| Brač (HR) | 2003 | 0.06 | 395 | 24 | - | - | Bordjan & Rozoničnik (2010) |
| Pelješac (HR) | 1998 | 1.0–1.5 | 93 | 90 | - | - | Vrezec (2001) |
| Konavle (HR) | 2012 | 0.5–1.5 | 211 | 103 | 88 | 1.2 | this study |
| Ulcinj (ME) | 2017 | 0.4–0.8 | 52 | 24 | 38 | 0.6 | this study |

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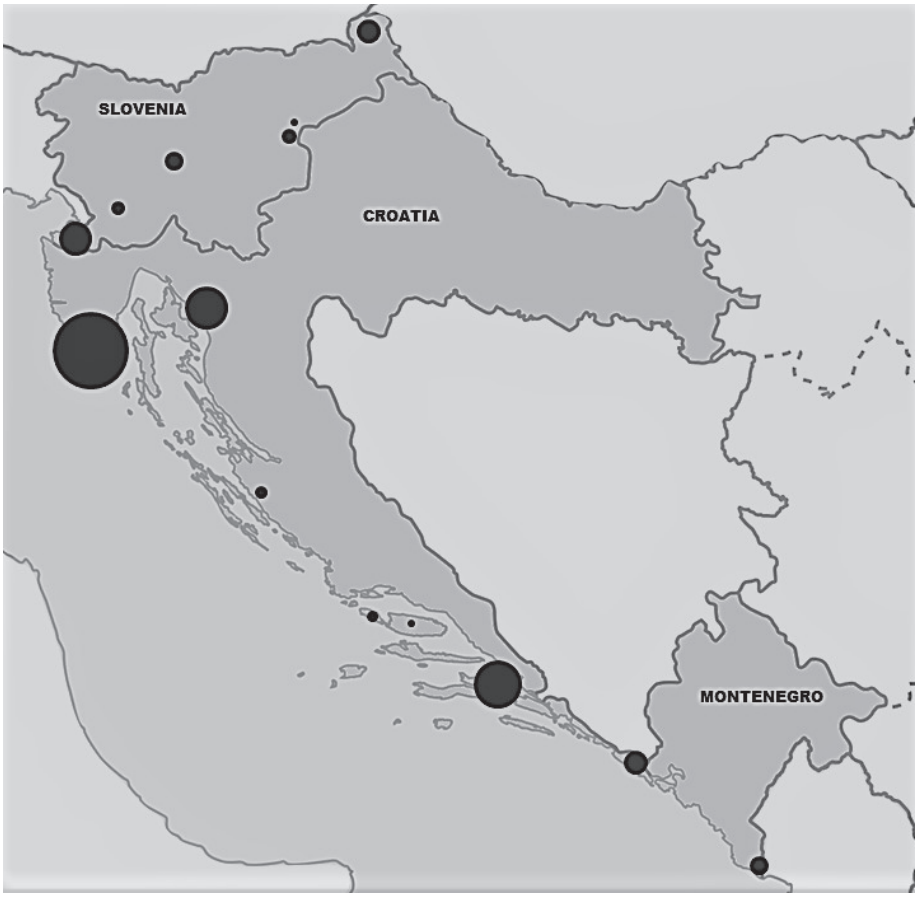


Along the eastern Adriatic coast from Slovenia to Montenegro densities of Eurasian Scops-owls did not show any trends, even at the 600 km distance ($r_S$ = -0.37, p = 0.33) (Fig. 2). The highest densities were found in Pula (1.6–2.0 males/km$^2$) and the Pelješac peninsula (1.0–1.5 males/km$^2$; Vrezec 2001). Also high was the density in Novi Vinodolski (0.9–1.4 males/km$^2$). In the most southern area of Ulcinj (0.4–0.8 males/km$^2$) and in Konavle (0.5–1.5 males/km$^2$) densities were also high and similar. Densities in the central part of Dalmatia were very low: in Vransko jezero (0.2–0.3 males/km$^2$) and in islands of Šolta (0.25 males/km$^2$; Mužinić & Purger 2008) and Brač (0.06 males/km$^2$; Bordjan & Rozoničnik 2010).

## Discussion

The present study is an overview of the population density of Eurasian Scops-owls along the eastern Adriatic coast in Slovenia, Croatia, and Montenegro, which showed a significant decrease of density in a gradient from the sea coast inland, but not north-south along the sea coast. The Eurasian Scops-owl more or less uniformly populated areas with a Mediterranean climate, but there is a great switch toward a more continental climate a few hundred km to the north. For example, in Slovenia the highest abundance was found in the Slovenian Istria, which is probably the largest population in Slovenia,

but the density was almost half in Goričko, 250 km to the north. Several climate-driven factors contribute to changes in the vegetation structure, which is mainly forest (Perko et al. 1999), altering the overall species assemblages, especially within the owl guild, with larger intraguild predatory owls, such as the Tawny Owl *(Strix aluco)* (Galeotti & Gariboldi 1994, Sergio et al. 2009), which is rarer in the Mediterranean region, but more common in continental areas (Sovinc 1994, Geister 1995).

In three areas of Croatia, population densities were much higher compared to other study sites. One of the characteristics of the species is that it can be locally very concentrated (Vrezec 2001) or it can form calling groups (Štumberger 2000). This agrees with the statement from Glutz von Blotzheim & Bauer (1980) that Eurasian Scops-owls can form colonies where conditions are favourable. Comparing the number of calling males per survey point in our study areas, we can see that in some study sites like in Pula (1.6 males/survey point), in Novi Vinodolski (1.1 males/survey point) and in Konavle (1.2 males/survey point) calling males were distributed evenly along the study area, while in other study sites calling males were very dispersed. In two study sites in Obsotelje (0.09 males/survey point) and in Goričko (0.2 males/survey point) calling males were very rare. This may be because of the unfavourable habitat conditions for this species (dense forest and open panoramas with fields) and that Eurasian Scops-owl is uncommon summer visitor in the continental regions (Mikkola 1983) meanwhile, along the eastern Adriatic coast it is a very common but locally distributed.

Population density (measured as calling males per km$^2$) is an important metric for assessing population status. We suggest that one of the owls' population strongholds in Europe is situated along the eastern Adriatic coast including the countries of Slovenia, Croatia, and Montenegro. The eastern Adriatic coast appears to be a very important breeding area for this species in comparison with continental regions, where the species is also decreasing as shown by the data from Goričko in the NW part of Slovenia (Denac et al. 2015). Data suggest that the owl is well distributed in the coastal areas of Slovenia in Slovenian Istria, and also in Croatia, in Pula, Novi Vinodolski, Peninsula Pelješac and in Konavle. We urge future studies in Montenegro, to assess the distribution, density and population size of Eurasian Scops-owls in that country.

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