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Distribution, density and habitat relationships of the Ural Owl *Strix uralensis macroura* in Croatia

Vesna Tutiš[1,*], Dragan Radović[1], Davor Ćiković[1], Sanja Barišić[1] & Jelena Kralj[1]



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We surveyed the Ural Owl *Strix uralensis macroura* from 1993 to 2007 to determine the geographic range of the species in Croatia and to provide information on its density and habitat preferences. We conducted playback surveys at 365 survey points within 19 plots (total survey area 1070 km^2) systematically covering all of the major forest types in Croatia. Surveys were also carried out at 144 calling stations arranged in transects and at 133 stations scattered over larger areas. Playback surveys were conducted twice at stations in plots and along transects, and once at scattered stations. A total of 234 Ural Owl territories were located. We estimate the total population of the Ural Owl in Croatia to be 700–1000 pairs, and include an updated map of its distribution. The owls occurred in Dinaric fir–beech forests, montane beech, Sessile Oak *Quercus petraea* and Common Oak *Quercus robur* forests. The majority of the population, around 80%, was located in Mountain Croatia, where mixed Dinaric fir–beech forests predominated, at densities ranging from 1.1 to 5.4 pairs/10 km^2 (average 2.3 pairs/10 km^2). The highest density was found in the Plitvice Lakes National Park, in forests that have not been commercially logged for more than 50 years. Approximately 20% of the total population was found in the western part of Lowland Croatia, in the zone of beech and Sessile Oak–hornbeam forests, with average density of 0.9 pairs/ km^2, as well as in Common Oak forests, with density of 0.7 pairs/10 km^2. In Mediterranean Croatia the Ural Owl was found only in the mountainous zone of thermophile beech forests. There we recorded a density of 0.3 pairs/km^2 and estimate the population at 15–25 breeding pairs constituting approximately 2% of total population in Croatia.

Key words: Ural Owl, *Strix uralensis macroura*, Croatia, distribution, population size, density, habitat

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INTRODUCTION

The Ural Owl *Strix uralensis* occurs throughout the Palaearctic region in boreal climatic zones. Disjunct populations occur in mountains south of the broad transcontinental boreal forest, extending from Scandinavia eastward across Asia to Japan. Nine to eleven subspecies are recognized, of which three can be found in Europe. The subspecies *S. uralenis macroura* occurs in central and southern Europe, with rather isolated populations inhabiting areas of the Dinaric Alps, Carphathian and Rodopi Mountains (Cramp 1977, Mikkola 1983). The population size, abundance and range of the Dinaric Alps population is poorly known. Mihelič *et al.* (2000) summarised the results of comprehensive research carried out in Slovenia, but similar results have not been published for the rest of the known species' range in the Dinaric Alps. Knowledge of the status of the species in Croatia has been rather poor, based on incidental observations and on birds collected and archived in museum collections (Rössler 1902, 1909, Sušić & Radović 1988, Piasevoli & Pallaoro 1991, Kralj & Tutiš 1996, Kralj 1997). The first attempted summary of overall distribution in Croatia was

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based on data collected in 50 × 50 UTM squares during the Breeding Bird Atlas inventory, carried out in 1985–88 (Tutiš *et al.* 1991). This confirmed the presence of Ural Owls only in a few squares, giving a population estimate of 100–200 pairs.

This paper presents results of research undertaken on Ural owls in Croatia, carried out from 1993 to 2007. The study was designed to determine the current geographic range of the species, to provide data on its habitat preferences, and to estimate the total numbers of pairs currently within the country.

METHODS

Study area

In order to obtain the most complete picture on the Ural Owl distribution in Croatia we surveyed extensive areas of different forest habitats throughout the country. Forests cover approximately 21 000 km^2 or 37% of the Croatian land area. The geographic position of the country on the borders between continental and Mediterranean climatic zones and the complex topography results in a diverse mosaic of vegetation types, with more than 60 forest associations and sub-associations recognised (Rauš *et al.* 1992). Forests of four types, as defined in Tucker & Evans (1997) occur in Croatia: lowland temperate, montane, riverine and Mediterranean forests.

Three major natural and geographic regions exist in Croatia (Lowland, Mountain and Mediterranean; Fig. 1), and were used to frame our survey approach. The Lowland region comprises the lowland and hilly parts of eastern and north-western Croatia (Pannonian and Peri-Pannonian areas) where mountains higher than 500 m are rare and of an insular character. Elevations range up to 1180 m a.s.l. but approximately 80% of the area is below 200 m a.s.l. The Mountain region is the area of the north-western Dinaric Alps. Elevations range up to 1831 m a.s.l. with approximately 70% of the area between 500–1000 m a.s.l. The Mediterranean region encompasses the narrow coastal belt with islands separated from the hinterland by high mountains.

Temperate oak *Quercus* forests cover extensive areas of the Lowland region. According to the Habitat Map of Croatia (Oikon Ltd. for MEPPP 2004) Sessile Oak *Quercus petraea* forests, mainly developed as mixed Sessile Oak–hornbeam forests, cover around 5800 km^2. They are widespread but very fragmented, well preserved only as the lowest, rather narrow, forest belt on hills and mountains. Common Oak *Quercus robur* forests, covering around 2000 km^2, are developed in

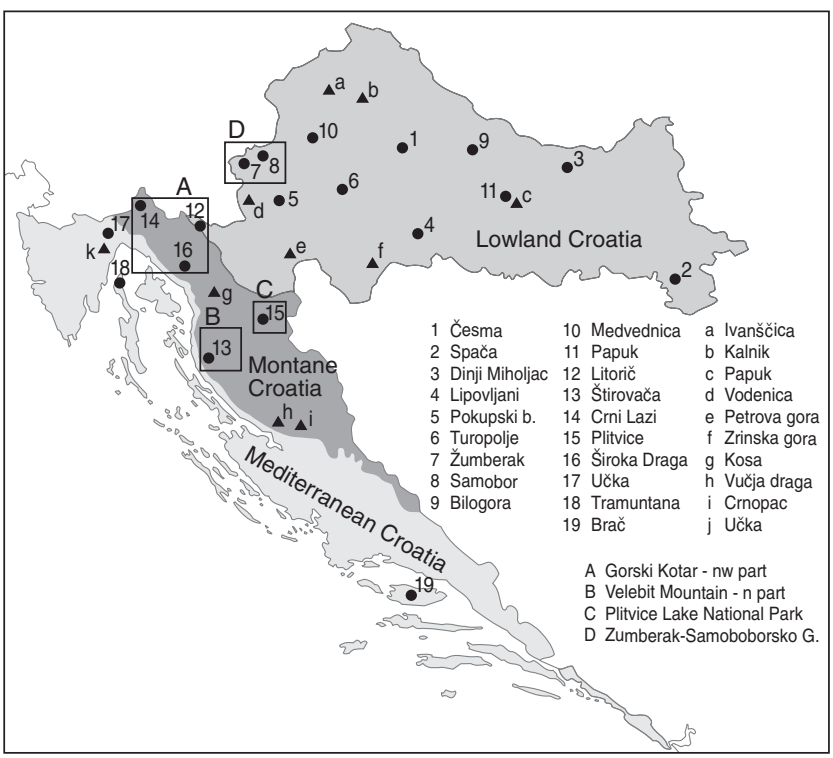


Figure 1. Map of Croatia showing the position of study plots (solid circles, 1–19), less intensively surveyed areas (solid triangles, a-k) and intensively surveyed areas (rectangles A-D).

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flood-plain areas within the Sava and Drava river basins, where large complexes of well-preserved Common Oak forests still persist.

Beech *Fagus* forest, which covers around 6500 km^2, is the most widespread forest type in Croatia. The forests are mainly at 400–800 m a.s.l. In the Lowland region montane beech forests cover upper parts of hills and mountains, while in the Dinaric Alps they occur on lower mountain slopes. Thermophile montane beech forests cover only around 590 km^2, mainly in northern part of the Mediterranean region. Sub-montane beech forests, developed on elevations above 1100 m a.s.l, cover the highest zone of the Dinaric Alps. Mixed forests of European Silver Fir *Abies alba* and beech occur mainly on elevations of 800–1200 m a.s.l., as an almost continuous forest belt of 3000 km^2 on the Dinaric Alps. They are also found on the peaks of mountains in the Lowland region. In the Mediterranean region forests are highly fragmented and degraded. In Istria, on north-Adriatic islands and along the coast, the remains of Downy Oak *Quercus pubescens* forests predominate. On the mid- and south- Adriatic islands and the most southern part of Croatian coast, Holm Oak *Quercus ilex* forests prevail.

Survey strategy. Nineteen plots were selected to study the distribution and abundance of the Ural Owl in Croatia: 11 in the Lowland region, five in the Mountain region and three in the Mediterranean region (Fig. 1). Size, elevation range and mean elevation of each plot are given in Table 1. The proportions of different habitat types within each study plot, derived from the Habitat Map of Croatia (Oikon Ltd. for MEPPP 2004), are presented in Fig. 2. Forests on all surveyed plots are commercially managed by the Croatian Forestry Service. The Plitvice Lake National Park, where the forest has not been commercially logged for more than fifty years was an exception.

Survey plots were used to study abundance of the species. In order to minimize the edge effect, as well as to obtain more accurate density estimates, we tried to establish large (>30 km^2) survey plots, and whenever possible, rather circular plots of continuous forest cover. Survey plots varied in size from 33 to 72 km^2 (average 56 km^2). The majority of our survey plots were parts of larger forest complexes, except for two survey plots in Mediterranean Croatia and one plot in the riverine oak forest zone, where it was impossible to find larger areas of continuous forests. Calling stations

Table 1. Number of territories and densities of Ural Owl on the study plots in Croatia. Area and elevation of the surveyed plots are given. See Fig. 1 for plot locations.

	Plots	Area (km^2)	Elevation (m a.s.l.)		Number of territories	Density pairs/10 km^2
			Range	Mean		
1	Česma	33.3	104–116	107	-	-
2	Spačva	67.0	79–82	80	-	-
3	Donji Miholjac	54.7	94–100	96	-	-
4	Lipovljani	63.0	93–103	95	4	0.6
5	Pokupski bazen	57.2	108–115	110	4	0.7
6	Turopoljski lug	34.0	96–104	99	3	0.9
7	Žumberak	58.0	290–1170	880	7	1.2
8	Samobor	57.3	270–855	570	4	0.7
9	Bilogora	72.6	139–180	180	10	1.4
10	Medvednica	66.7	240–1030	580	2	0.3
11	Papuk	57.0	320–800	570	-	-
12	Litorić	55.7	180–900	590	6	1.1
13	Štirovača	51.8	780–1570	1204	7	1.4
14	Crni Lazi	56.0	740–1350	1040	10	1.8
15	Plitvice	67.2	540–1250	880	36	5.4
16	Široka Draga	63.4	702–1340	1070	12	1.9
17	Ćićarija	58.0	370–1235	816	2	0.3
18	Tramuntana	48.2	30–645	305	-	-
19	Brač	47.0	248–780	496	-	-
	Total	**1067.0**			**107**	

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within sample plots were spaced 1000–2500 m apart (depending on the topography) and distributed in a way that provided complete coverage of study plots. As Lundberg (1980) reported that Ural Owl calls are audible up to 2 km, we presumed that calling points may be spaced as far as 2–2.5 km apart to attain systematic area coverage.

In the *Lowland region* six study plots were established within the zone of Common Oak forests (Fig. 1, plots 1–6). These varied from 33–67 km^2 in size, each having more than 80% forest cover. Five plots ranging from 55–72 km^2 in extent were established in the central parts of five mountains (Žumberak, Samoborska gora, Medvednica, Bilogora and Papuk) (Fig. 1, plots 7–11). All had more than 90% forest cover. Two plots were covered predominantly by beech forests, one plot had an almost equal share of beech and Sessile Oak forests, and two plots were covered by beech, fir–beech and, to a lesser extent, Sessile Oak forest (Fig. 2). Surveys in the mountains of Žumberak and Samoborsko gorje were the most comprehensive. On Medvednica and Papuk Mountains surveys were also carried at a number of points outside the plots. Additionally, less extensive surveys were made in forest areas of the mountains Kalnik, Zrinska and Petrova gora (Fig. 1) to determine owl presence there.

In the *Mountain region*, we conducted playback surveys within plots, along transects, and from individual points. The most intensively investigated areas were the northern-western part of Gorski Kotar, the northern part of Velebit Mountain and the Plitvice Lakes National Park (Fig. 1). We established five study plots within this region (Fig. 1, plots 12–16). Forests, predominately mixed fir–beech, covered more than 90% of each plot (Fig. 2). Transects consisted of 12 points (altogether 144 survey points in 12 transects). Transects were arranged along forest roads, with calling stations 1 km apart (straight-line distance). Playback surveys were also conducted at 133 survey points separate from the plots and transects.

In the *Mediterranean region*, we focused our efforts on the Ćićarija Mountain, the island of Cres in the northern part of the Adriatic and the island of Brać in the central Adriatic (Fig. 1, plots 17–19). On the island of Cres we surveyed the plot Tramuntana which was covered mainly with Downy Oak forests, while on the island of Brać a part of the plot was covered with pine forest and part with Holm Oak forest. On both plots forest cover was less than 70% of the total plot area. On the mountain of Ćićarija the investigations were carried out on the plot covered predominantly by thermophile beech forests (Fig. 2).

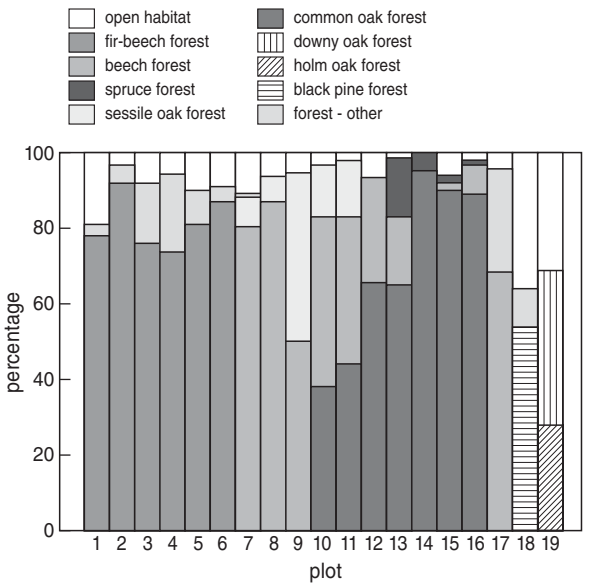


Figure 2. Proportion of different habitat types within the study plots. Proportions were derived from the Habitat Map of Croatia (Oikon Ltd. for MEPPP 2004).

Locating owls with call–playback

We used the call–playback method (Johnson *et al.* 1981, Fuller & Mosher 1987) to elicit responses from Ural Owls and to determine the location of their territories. Playback surveys were carried out at a total of 642 survey stations (calling points). Survey stations were distributed in a way to ensure good coverage of the forest types. Survey stations were arranged in the 19 survey plots (365 stations), 12 transects (144 stations) or scattered over wider areas (133 stations). Survey stations in plots and along transects were visited twice, while scattered stations were visited only one time during survey efforts.

Call–playback protocol used at all stations consisted of recordings of the territorial vocalization and silent listening periods. At each station we broadcast the series of Tawny and Ural Owl calls. The playback protocol for each species included 60 s of silent listening period at the beginning and 90 s of listening period at the end. The calls were broadcast in three distinct bouts (each lasting approximately 40 s), alternated with a 60 s listening period. The Tawny Owl calls were broadcast first. A car radio tape/CD player with 40 W loudspeakers was used and played on the level that was audible to human ear at distance of approximately 1 km. The call–playback surveys began approximately 0.5 hr after sunset. The surveys were done only during nights with calm weather without precipitation.

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The owls were identified primarily by vocalizations, although visual detections were also recorded. At each instance of vocalization the directional azimuth was recorded and the distance to owl was estimated. All locations of owls were plotted on 1: 25 000 maps. We assumed that each owl response indicated a separate territory (= pair). Ural Owls located less than 2 km apart were assumed to represent the same pair unless we were able to verify them as separate pairs/individuals by simultaneous or near simultaneous vocalizations; or unless the separate pair may be concluded upon the topography of the terrain. The majority of playback surveys were carried out during the breeding season. However, Ural Owls have also been found to respond well to playback from September to mid-October (e.g. Lundberg 1980; pers. obs.). Therefore, some surveys were also carried out in that period. In the final analysis of the distribution of the Ural Owl in Croatia, we used all the survey data as well as incidental observations of owls collected from 1993–2007.

RESULTS

A total of 234 Ural Owl territories were identified during the study. A total of 222 Ural Owl territories were identified using the playback method, with 107 of them in the study plots (Table 1). Incidental observations of Ural Owls in areas not covered by playback efforts revealed 12 additional territories. The Ural Owl was found in all three regions of Croatia covered by our investigations. With owl observations and forest habitat maps, we developed an updated map of the Ural Owl distribution in Croatia (Fig. 4).

Lowland region. In Lowland Croatia the Ural Owl was found only in the western part (west of 17°17' E), both on hills and mountains, as well as in flood-plain areas. Altogether 55 territories were found in this area, of which 14 were in flood-plain forests. In the zone of Common Oak forests surveys were carried out on six plots but Ural Owls were found only on three (Pokupski bazen, Turopolje and Lipovljani). On all three plots similar values of the density of Ural Owl was found, ranging from 0.6 to 0.9 pairs/10 km^2 (Fig. 3).

Eight mountains in Lowland Croatia were covered by our investigations. Forty one Ural Owl territories were found there. The Ural Owl was found in all areas surveyed except on Papuk Mountain, the most eastern of the mountains included in the survey. The species' abundance was studied on four plots (255 km^2 in total, average mean elevations of the plots being 550 m) where 22 territories were identified. The density ranged from 0.3 to 1.4 pairs/10 km^2 (average 0.9 pairs/10 km^2) (Fig. 3). The highest density was recorded on the Bilogora plot, the one almost equally covered by beech and Sessile Oak forests. The lowest density was found on Medvednica Mountain, on the plot where beech and fir–beech forests predominate.

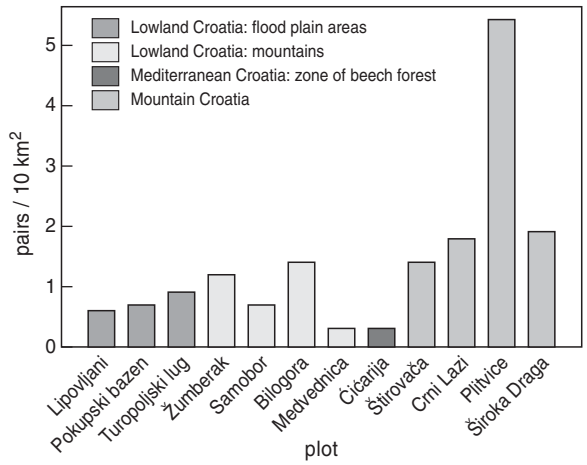


Figure 3. Density of Ural Owls recorded within the study plots.

Mountain region. In Mountain Croatia 172 Ural Owl territories were found during the study. The most intensive investigations were carried out in the Plitvice Lakes National Park, northern part of Velebit Mountain and in NW part of Gorski Kotar (Fig. 1). Abundance was



Figure 4. Distribution of the Ural Owl in Croatia as obtained from this investigation.

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studied on five plots (294 km^2 in total, average mean elevations of the plots being 950 m), where 71 Ural Owl territories were found. The densities ranged from 1.1 to 5.4 pairs/10 km^2 (average 2.3 pairs/10 km^2) (Fig. 3). The highest density was found on the plot in the Plitvice Lakes National Park, almost three times higher than the density on other plots with similar vegetation (Široka Draga and Crni Lazi). The lowest density was found on the Litorić plot, the one with the highest proportion of beech forest. Density was also low in Štirovača, the plot where sub-montane beech and spruce forests occurred.

Mediterranean region. In Mediterranean Croatia the Ural Owl was found only in the northern part, in the mountainous zone of thermophile beech forests of Učka and Cićarija Mountains. Seven territories were recorded, with two of them on the survey plots. The abundance of Ural Owl was studied on one plot where the densities of 0.3 pairs/10 km^2 were recorded. However, only about two thirds of the plot was covered by beech forest, while the rest of the plot was covered by hop–hornbeam forest. Both territories were found in western part of the plot, where beech forest predominated.

Population estimates. Collectively, we estimate the total population of the Ural Owl in Croatia to be 700 to 1000 pairs. Our investigations were relatively intensive in the Mountain region, and included the optimal habitats for this species. Extrapolating from the densities obtained in the study we estimate a population of approximately 550 to 750 pairs in Mountain Croatia. In Lowland Croatia, our research covered large sections of the best preserved and most intact Common Oak forests. We estimate that the 14 pairs recorded constituted about half of the pairs in this type of forest in Croatia. In the forests that covered the hills and mountains of Lowland Croatia we found 41 Ural Owl territories. Since our investigations covered a rather small part of these forests, we estimate that our findings reflect approximately one quarter of the population of the Ural Owl inhabiting these forests. The population of the Ural Owl in Lowland Croatia is thus estimated at 150–220 pairs. We found seven owl territories in the thermophile beech forests of the Mediterranean region; we estimate the total population in this forest type, that is, the population in Mediterranean Croatia, at 15–25 pairs.

DISCUSSION

Our investigations show that the Ural Owl is widespread in Croatia. It inhabits forests over most of continental Croatia with the exception the most eastern sector (Fig. 4). The structure of forests in this part of the country, as well as the manner of commercial logging of the forests do not differ significantly from those in the western parts of Croatia. A possible explanation for the apparent absence of the species in this region is that the most distant from the Dinaric Alps, the core area of the Ural Owl population. The eastern areas are also climatically somewhat different form the western part of Croatia, in that winters are colder, summers warmer and the mean annual precipitation is lower, which might negatively affect prey abundance. There is however, a possibility that Ural Owls may inhabit Papuk and surrounding mountains, since these forests are almost connected to those of Bilogora Mountain, where Ural Owls were recorded. If so, the density of Ural Owls at Papuk Mountain would have to be very low, as we recorded no owls from a survey plot and many scattered calling stations.

The Ural Owl in Croatia inhabits a variety of forest habitats, from Common Oak, Sessile Oak and montane beech forests to Dinaric mixed fir–beech forest. Dinaric fir–beech forest is obviously the optimal habitat, since the average density of the Ural Owl in that type of forest was three times higher than in other types of forests. Similar forest types occur in Slovenia and Dinaric beech–fir forest was also identified as optimal habitat there (Mihelič *et al.* 2000). The average densities recorded in our investigations ranged between 0.8 pairs/10 km^2 in the lowland forests to 2.3 pairs/10 km^2 in Dinaric Croatia. These densities are somewhat lower in comparison to those found in Slovenia (Benussi & Geneero 1995, Mihelič *et al.* 2000, Vrezec 2003) but comparable (Lundberg 1981, Mikkola 1983, Czuchnowski 1997) or higher (Pietiäinen & Saurola 1997, Tishechkin & Ivanovsky 2000) to those recorded in some other parts of Europe.

The maximum density recorded at a single study site was 5.4 pairs/10 km^2, in fir–beech forests of the Plitvice Lakes National Park. This density is almost three times higher than densities on other plots covered by fir–beech forests. Since the forests in the Plitvice Lakes National Park have not been commercially logged for more than fifty years, this suggests that logging may have a strong influence on the densities of Ural Owls. Our other studies showed that the whole bird community of fir–beech forest in the National Park was richer than bird communities of neighbouring fir–beech forests that are commercially logged. A lower intensity of illegal hunting in the National Park in comparison with other unprotected areas may also have positive effect on the population.

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In Lowland Croatia the highest density was recorded on Bilogora Mountain. The probable reason for this is that the plot studied there was almost equally covered by the forests of beech and Sessile Oak. The diversity of habitat likely reflects in the diversity and quantity of prey. The lowest density was recorded on Medvednica Mountain. It is unlikely this can be explained only by the type of forest on the mountain. Although the "Panonian fir–beech forest" (Rauš *et al.* 1999) on Medvednica differs somewhat in floristic composition and structure from Dinaric fir–beech forests, these differences are rather small. Rather, the reason may be the proximity of Medvednica Mountain to the town of Zagreb, and the disturbance caused by the large number of visitors and hikers to the mountain.

In conclusion, our investigations show that the population and range of the Ural Owl in Croatia is much bigger than previously thought. This is especially true regarding the presence of the Ural Owl in the Lowland Croatia. It may be questioned whether this is the consequence of a recent range extension in the species. In our opinion this is not the case: the forest area and structure in Croatia have not changed significantly in the last fifty years. While the introduction of legal protection for the species tends to reduce pressure from hunters, illegal hunting remains high and a spread in population from this protection seems unlikely. It seems most probable that previously the species was simply under-recorded and that our more exhaustive survey has given a more representative picture of the species' range.

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SAMENVATTING

In de jaren 1993–2007 is de verspreiding en dichtheid van de Oeraluil *Strix uralensis macroura* in Kroatië onderzocht. Dit gebeurde in 19 onderzoeksgebieden (met een totale oppervlakte van 1070 km^2), die over alle belangrijke bostypes waren

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verspreid. Om de aanwezigheid van de Oeraluil vast te stellen werd op 365 plekken binnen de onderzoeksgebieden de roep van de soort afgespeeld. Daarnaast werd het geluid ook afgespeeld op 144 plekken in alternatieve transecten en op 133 plekken die verspreid lagen over uitgestrekte en voor uilen aantrekkelijke gebieden. De inventarisaties vonden in de onderzoeksgebieden en langs de transecten tweemaal plaats, elders eenmaal. In totaal werden 234 territoria van de Oeraluil vastgesteld. De auteurs schatten de totale populatie van de Oeraluil in Kroatië op 700–1000 paar. De uilen kwamen voor in bossen met sparren en beuken, in beukenbossen op grote hoogte en in bossen met Wintereik *Quercus petraea* en Zomereik *Q. robur*. Ongeveer 80% van de populatie kwam voor in bergstreken waar sparren–beukenbossen het landschap bepaalden. De dichtheid varieerde van 1,1 tot 5,4 paar/10 km^2, met een gemiddelde van 2,3 paar/10 km^2. De hoogste dichtheid werd aangetroffen in het Nationaal Park Plitvice, in bossen die meer dan 50 jaren niet meer waren gekapt. Ongeveer 20% van de uilen kwam voor in het westelijke deel van het laagland, in een streek met beukenbossen en gemengde bossen met Wintereik en Haagbeuk, met een gemiddelde dichtheid van 0,9 paar/10 km^2. In bossen met Zomereik bedroeg de gemiddelde dichtheid 0,7 paar/10 km^2. In het Mediterrane deel van het land werd de Oeraluil alleen in de hoger gelegen delen van droge beukenbossen gevonden. Het ging daar om 15–25 broedparen (2% van de Kroatische populatie), met een dichtheid van 0,3 paar/10 km^2.

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