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BREEDING OF ROOK *Corvus frugilegus* IN OSIJEK AND VUKA DURING 2014 AND 2015 AND ITS LONG-TERM POPULATION TREND

Gniježđenje gačca Corvus frugilegus u Osijeku i Vuki tijekom 2014. i 2015. godine i njegov dugoročni trend populacije

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ABSTRACT

The breeding population of Rook was studied during 2014-2015 in the city of Osijek and the Vuka village. In total, 902 breeding pairs were counted in 14 colonies in 2014, while 928 pairs were counted in 13 colonies in 2015. Over one half of the colonies (ten colonies in 2014 and six colonies in 2015) were classified as small (below 50 pairs), with an average of 24.5 and 19.1 nesting pairs respectively. The number of medium-sized colonies (50-100 pairs) varied between one in 2014 and four in 2015, while two big colonies (over 100 pairs) were present in both years. During the past 23 years, the breeding population trend showed a moderate decline ($p < 0.01$, $y = -0.0186$, $SD = 0.0060$), mainly due to the harassment of the colonies, the destruction of nesting sites, and disturbance during breeding.

INTRODUCTION

Rook *Corvus frugilegus* is a regular and resident breeding bird in Croatia (Kralj & Barišić 2013, Lukač 2007), with estimated breeding population ranging

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between 5,000-10,000 nesting pairs (Birdlife International 2015, Lukač 2007). The colonisation and start of the breeding in Croatia are relatively well documented in the ornithological literature. Breeding was mentioned in the late 19th century around the Varaždin town, northwest Croatia by Jurinac (Kralj 1997); during the beginning of the 20th century, it was however not confirmed (Hirtz in Kralj 1997). Rare breeding was also recorded in 1915 near the Vukovar town, Lipovača, eastern Slavonia (Geyr von Schweppenburg 1915 in Kralj 1997). In northwest Croatia, the Koprivnica town, Podravina, Rook was known as wintering guest until 1927, when first breeding was confirmed (Ivković 1948). During the first half of the 20th century, the Rook breeding population increased and expanded. By the 1940s, they were nesting along the Drava River, northern Croatia, from Virovitica to Valpovo, and were numerous near Vukovar (Ivković 1948, 1950, Car 1957). The first nesting in Zagreb was recorded during 1959 (Rucner 1962). By the end of the 20th century, the Rook population was regularly nesting in the whole continental lowland Croatia (Eršek at al. 1993, 1994, 1995, Lukač 2007). In the Mediterranean region, they were considered migratory and wintering birds until mid-1950s, when they became increasingly rare (Kralj 1997, Rucner 1998, Kralj 2013), while in the mountainous parts they were largely absent (Kralj 1997). Birds from eastern populations, as far as Russia and Ukraine, are regularly over-wintering in northern Croatia (Kralj 2013).

Systematic surveys of breeding colonies were conducted in the period 1993–1995, covering large towns and their surroundings (Eršek *et al*. 1993, 1994, 1995). The only area where we have a long-term dataset about the nesting of Rook is eastern Slavonia around the city of Osijek, where an increase in the Rook breeding population has been observed (Jurčević 2002).

The aim of this study was to determine the number of breeding pairs and distribution of Rook colonies in the city of Osijek and the Vuka village, and to calculate the breeding population trend by compiling all previously known data from the period 1993–2013.

STUDY AREA AND METHODS

The city of Osijek is situated in the northeast part of Croatia, on the right bank of the river Drava, 12-22 kilometres upstream from the Drava–Danube confluence. The total area of Osijek covers 16,974 hectares. Out of that, 17 parks cover over 39 ha in addition to 10 greens covering 4 ha. More than 80 km of wooded alleys with over 8,000 trees make Osijek a city with the highest proportion of green areas in relation to its size in Croatia.

The Vuka village is situated 20 km southwest from Osijek, along the small stream Vuka. In the northern part of the village, a large woodland narrow-leafed ash *Fraxinus angustifolia* covering 1.2 ha hosts the Rook colony. This village was

included in this study since there are a well-documented evidence of how Rook changed locations of their colonies from Osijek towards Vuka due to harassment and disturbance.

The spring of 2014 was characterised as very warm and very wet, with air temperatures and precipitation higher than the average. The deviation from average spring air temperature was 1.6^0C, and from spring average precipitation 178% (CMHS 2015). The spring of 2015 was warmer than the average (the deviation from average spring air temperature was 1.2^0C), while the precipitation was close to the average (the deviation from spring average precipitation was 113%) (CMHS 2015).

Rook in northern Croatia would start with breeding during March, thus the counting of nesting pairs was conducted during late March/early April, before the complete foliation of trees, whose leaves would affect the visibility of nests (Mikuska *et al*. 2007). Only apparently occupied nests were counted, as suggested by Bibby *et al.* (1992), using binoculars and telescopes, and each colony was counted only once. Based on the number of pairs, we have classified colonies as small (1-50 pairs), medium (51-100 pairs) and large (101+ pairs).

For the long-term trend calculation, we have combined the data from the published counts (Eršek *et al.* 1993, 1994, 1995, Jurčević 2002) with our sporadic and unpublished (2002–2013), as well as recent counts (2014–2015). During the period 1993–2001, with 1998 as the only exception, most of the colonies were regularly and systematically counted. Counts were sporadically performed during the period 2002–2012, with frequently missing data in counts. In order to overcome the problem of the missing data TRIM (Trends and Indices for Monitoring Data, Version 3.54), a software package was used (Pannekoek & Van Strien 2001). TRIM is a program developed for analysing data collected via monitoring populations of wild animals (Pannekoek & Van Strien 2001). In practice, data for single years and locations are quite often missing, thus affecting the usability of indices (indices calculated using incomplete data reflect changes through the years, as well as changes in the missing samples). TRIM analyses annual data by series, using Poisson regression to estimate the missing data, as well as calculate annual indices and population trends.

RESULTS

In total, 902 breeding pairs were counted in 14 colonies in 2014 (Table 1). The largest colony (342 pairs) was built in the Vuka village, while the smallest ones (with only 8 pairs) were in Osijek – on Trg Lava Mirskog and at the crossroad of Vukovarska and Klajnova streets. Most of the colonies (ten) were small (bellow 50 pairs), with 24.5 nesting pairs in average (range 8 – 47 pairs), and supporting less than 28% of the total breeding population. These colonies were built within

the city of Osijek. Only one colony in Osijek (at Židovsko groblje cemetery) was classified as medium large and contained 75 pairs. Two large colonies (>100 pairs, range) were situated on southern (Mačkamama) or eastern edges (Autoslavonija, MIO Standard) of Osijek. With exception of the Vuka colony, all medium and large colonies were built on tree lines made of plane trees *Platanus acerifolia* along major avenues leading towards the town. Large colonies were supporting 64.5% of total breeding population.

In total, 928 breeding pairs were counted in 13 colonies during 2015 (Table 1). The largest colony (322 pairs) was built in the Vuka village again, while the smallest one (with only 7 pairs) was repeatedly situated on Trg Lava Mirskog in the centre of Osijek. Small colony at L. B. Mandića church has disappeared. Only six small colonies with 19.2 pairs in average (range 7 – 42 pairs) and supporting 12.4% of the total breeding population were present during 2015. On the other hand, the number of medium-size colonies has increased to four, supporting 28.7% of the total breeding population. Three large colonies were supporting 58.8% of the total breeding population.

Table 1. Colonies and breeding pairs of the Rook in Osijek and Vuka during 2014 and 2015.
Tablica 1. *Kolonije i broj gnijezdećih parova gačca u Osijeku i Vuki tijekom 2014. i 2015. godine.*

	Colony / Kolonija	2014	2015
1	Livana - L. B. Mandića church	9	0
2	Livana - L. B. Mandića street	41	29
3	Osijek - Autoslavonija	102	109
4	Osijek - Čepinska street	32	61
5	Osijek - L.B.Mandića/Sv. Ane streets	43	61
6	Osijek - Mačkamama	138	94
7	Osijek - MIO Standard	47	42
8	Osijek - OLT and University campus	11	9
9	Osijek - Sjenjak	33	51
10	Osijek - Trg L. Mirskog	8	7
11	Osijek - Ulica kneza Trpimira/Ulica cara Hadrijana	13	14
12	Osijek - Vukovarska/Klajnova streets	8	14
13	Osijek - Židovsko groblje cemetery	75	115
14	Vuka	342	322
	TOTAL / Ukupno	902	928

The size of the breeding Rook population during the period 1993–2015 is shown in Figure 1. During the period 1993–1997, the total Rook breeding popula-

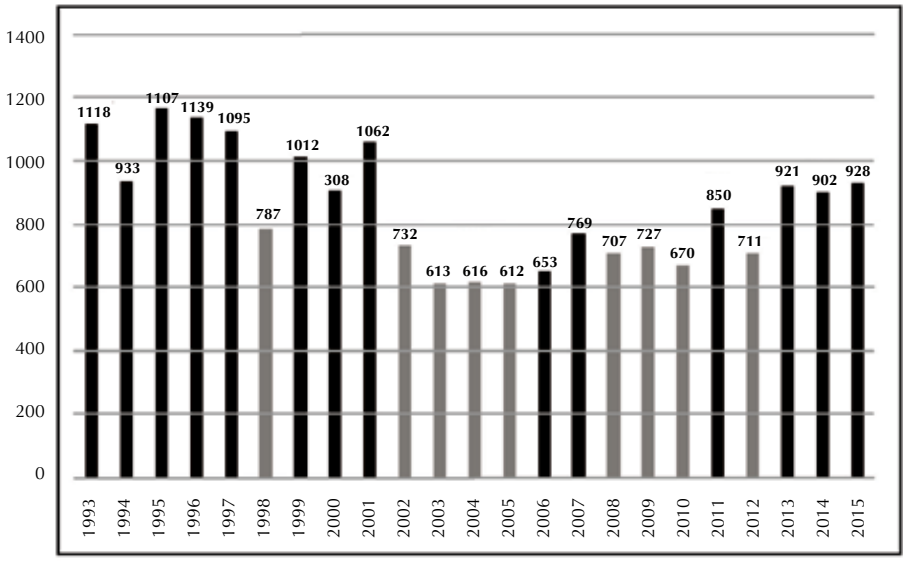

Figure 1. Breeding population size of the Rook in Osijek and Vuka during 1993-2015. Light grey columns indicate years without or partial counts, where missing data were generated by TRIM software.

Slika 1. *Veličina gnijezdeće populacije gačca u Osijeku i Vuki u periodu 1993-2015. Sivi stupci označavaju godine u kojima kolonije nisu opće ili su djelomično brojane, te su vrijednosti ukupne veličine gnijezdeće populacije dobivene pomoću TRIM programa.*

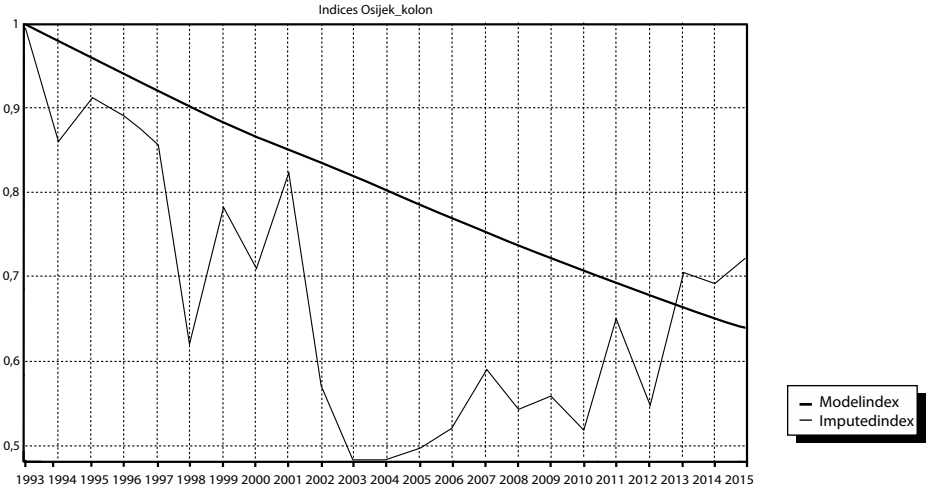

Figure 2. Long-term trend of the Rook breeding population in Osijek and Vuka during 1993-2015 period. The upper line (Modelindex) marks the population trend, while the lower line (Imputedindex) shows changes of annual indices for total breeding population.

Slika 2. *Dugoročni trend gnijezdeće populacije gačca u Osijeku i Vuki u period 1993-2015. Gornja linija (Modelindex) označava trend populacije, donja linija (Imputedindex) označava godišnje promjene indeksa ukupne gnijezdeće populacije.*

tion numbered between 933 and 1,167 pairs (1,090 pairs/year in average), while in the recent period 2014–2015, only 915 pairs/year in average were counted.

The long-term linear trend, using log-linear Poisson regression calculated by TRIM, shows moderate decline ($p < 0.01$; $\chi^2 = 29416.38$, df = 818) with negative slope (y = –0.0186, SD = 0.0060) (Figure 2).

DISCUSSION

During the period 2014–2015, the breeding Rook population in Osijek and Vuka was stable and within natural fluctuation levels. However, each colony showed its own dynamic – half of the existing colonies experienced an increase in the number of breeding pairs, while the other half decreased in size. The highest decrease (loss of 44 pairs) was observed in the Mačkamama colony, where a part of the colony was cut down during the breeding season 2014, when incubation and chick rearing period were already taking place. Contrary to that, the largest increase (40 breeding pairs) was observed in the colony Židovsko groblje cemetery. Observed increases in the number of breeding pairs might be attributed to fluctuations of the number of birds that would join the colony (Richardson *et al*. 1979). On the other hand, direct human disturbance and harassment during the breeding season are a significant source of decrease in the number of breeding birds in the colonies, and their subsequent abandonment. There is a clear pattern of the colony distribution in Osijek: small colonies are situated deeper in the town, while few medium and large colonies are built on the south-western, southern and eastern outskirts of the town that are much closer to the feeding grounds. Colonies situated in the town are more prone to direct harassment and disturbance by humans. Since 1993, over 40 colony sites have been recorded in Osijek and its surroundings towards Vuka (Eršek *et al*. 1993, 1994, 1995, Jurčević 2002). During the past 23 years, the number of colonies per year fluctuated between 7 (1996) and 18 (2001), despite the fact that total population was not increasing. The frequent abandonment and disappearing of the existing colonies was primarily due to systematic persecution by man. Most of these colonies were intentionally harassed or destroyed by humans; thus, Rook were forced to change their breeding locations from one year to another. Direct disturbance by humans can lead to 17-19% breeding failures, lower breeding success and higher annual mortality of adult birds (Ena 1984).

The probability that a rookery would be abandoned is strongly negatively correlated with its size (Orłovski & Czapulak 2007). This was also evidenced in our situation. Average existence of ten abandoned colonies that had below ten pairs was 2.1 years, while average existence of nine abandoned colonies that had between 10-30 pairs was 3.8 years. To the contrary, the abandonment of large colonies was characterised by a slow shift between breeding sites that occurred during several consecutive years. For example, the largest colony of Rook that was situated in Ovčara park, Čepin village (8 km southwest from Osijek), and

which held 584 pairs in 1993 due to direct disturbance, changed place to the Mala Branjevina farm (5 km in the southwest direction) during 1995 (Eršek *et al*. 1993, 1994, 1995). By 1997, this colony contained 149 pairs (Jurčević 2002). During 1999, in the Vuka village (3 km in the southwest direction from the Mala Branjevina farm), 154 pairs started nesting. These birds, joined by the remaining pairs from the Čepin and Mala Branjevina colonies, formed the largest colony in the study area, numbering over 300 pairs (Jurčević 2002).

Another example of movement of Rook among nesting sites has been proved with colonies along L. B. Mandić Street. Depending on direct persecution or tree cutting, Rook would switch nesting sites; e.g. after removing supporting branches on the trees, birds from the Mačkamama colony moved to L. B. Mandić Street. Two years later, after new branches had developed, a part of the breeding population returned to the former nesting site at Mačkamama.

Long-term population trend shows a moderate decline of the Rook breeding population during past 22 years. This is in accordance with the population trend in Europe and the EU27, where the population size is estimated to be decreasing by less than 25% in three generations (21.9 years) (Birdlife International 2015). The decrease in the Rook breeding populations has also been confirmed in the neighbouring countries of Serbia (Tucakov *et al.* 2010) and Bosnia and Herzegovina (Birdlife International 2015, Kotrošan 2006, Mulaomerović 2005).

During this 22-year period, the breeding of Rook may be divided into 3 periods:

- 1993–2001: during this time, 29 active colonies were observed (Jurčević 2002) in total, with 8-17 colonies annually and 744-1118 pairs per year (Jurčević 2002). During this period, large colonies were active throughout (e.g. MIO Standard, Mačkamama, Čepin road, Livana), while the others existed only during the first couple of years and disappeared because of cutting down the trees (e.g. the Zaobilaznica colony), direct persecution (e.g. the Višnjevac colony), or unknown reasons (e.g. colonies at Klinička bolnica, Ortopedska bolnica or Zrinjevac Park). Some of the colonies were reduced by cropping the trees (e.g. Mačkamama). During the same period, new colonies were formed (e.g. colonies at Autoslavonija, HNK, "Tekos", or Šibicara) (Jurčević 2002). Despite the persecution, the Rook is a regular and numerous nesting bird species in Osijek. The colony in the Vuka village was formed in 1999 by the birds that most likely moved from Čepin.
- 2002–2010: during this period, monitoring of Rook colonies was neither constant nor systematic. In 2006, only 157 pairs in five colonies were counted, while during 2007, only 309 pairs in three colonies were counted. Colonies counted in 2007 were not the same ones noted the year before. From 2008 to 2010, colonies were not monitored. By using TRIM software, missing data were calculated for this period and 612-719 pairs were estimated per year.

- 2011–2014: by an increasing monitoring effort, better data were collected during this period. In 2011, nine active colonies with 482 pairs were counted (Mikuska, *unpublished data*). During 2013, in 11 active colonies 525 pairs were counted in total, which was a slight increase compared to 2011 (Mikuska, *unpublished data*). During 2014 and 2015, all colonies in Osijek and Vuka were counted, resulting in average 900 breeding pairs or 100 pairs less than during the first period.

The decrease in the Rook breeding population in Osijek and its surroundings necessitate the change of the current public perception. Previous persecution measures based on direct harassment and cutting down the trees in colonies caused a moderate decrease in the population, yet in the long run proved to be absolutely inefficient concerning the breeding on specific locations (e.g. the Mačkamama colony). It is therefore necessary to change the existing practice in such a way that areas along the edges of the town where Rook would be able to breed without disturbance should be defined. In practice, this would refer to the locations of existing middle- and large size colonies, where the rest of the breeding population would move, thus reducing the pressure from the inner parts of the town. By this measure, it would be possible to reduce the conflicts between humans and Rook, however at the same time keeping their breeding population safe and maintaining their significant role in the agricultural ecosystems.

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SAŽETAK

Gnijezdeća populacija gačca istraživana je tijekom 2014. i 2015. godine u Osijeku i Vuki. Tijekom 2014. godine ukupno su prebrojana 902 gnijezdeća para u 14 kolonija, dok je 928 parova prebrojano u 13 kolonija tijekom 2015. godine. Većina kolonija (10 u 2014-toj i šest u 2015-toj) su klasificirane kao male (manje od 50 parova), s prosječnih 24,5 i 19,1 gnijezdećih parova po godini. Broj srednje velikih kolonija (od 50 do 100 parova) kretao se između jedne (2014) i četiri (2015), dok su dvije velike kolonije (više od 100 parova) bile aktivno obje godine. U protekle 23 godine trend gnijezdeće populacije je umjereno opadajući ($p < 0.01$, $y = –0.0186$, $SD = 0.0060$). Glavni razlozi tome su protjerivanja kolonija, uništavanje gnijezdećih staništa na kojima su kolonije izgrađene, te namjerno uznemiravanje tijekom gniježđenja.