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BREEDING POPULATION OF THE ROOK *CORVUS FRUGILEGUS* IN THE ŚWIĘTOKRZYSKIE MOUNTAINS – CURRENT STATE AND TRENDS

ABSTRACT

In 2017-2019, a nesting survey of the Rook *Corvus frugilegus* was carried out in the Świętokrzyskie Mountains (14,400 km^2). The majority of controls were conducted in April. Overall, 15,622 nests were recorded at 166 sites. Mean density was 108.5 nests/100 km^2 and 1.2 colonies/100 km^2. Rooks most often nested in large colonies (101 to 500 nests), comprising 61.5% of all nests and 27.1% of all colonies. Most colonies were located on deciduous trees (77.1%), in contrast to the low number on coniferous trees (4.8%). The largest colonies were located in parks. This number was significantly higher than the number of nests in tree lanes, wooded land and single trees. Only one colony was located outside human settlements. There was a positive correlation between the number of inhabitants and the number of rooks breeding in the respective town or in its close vicinity.

Key words: Rook *Corvus frugilegus*, Świętokrzyskie Mountains, population size, population density, number and density, habitat preferences

INTRODUCTION

Currently, the population of the Rook in Europe shows a long-term decreasing trend (BirdLife International 2017). The Polish population is also characterized by a moderate decrease (Chodkiewicz *et al.* 2018). The survey of the Rook breeding population carried out in the Świętokrzyskie Mountains in 2017-2019 was the first complete census based on direct field counts in this region. To date its population was estimated at approximately 10,000 pairs (Błoński & Chmielewski 2005). Here we present the most recent data on the number and distribution of the Rook in the Świętokrzyskie Mountains, a part of the Mazowiecko-Świętokrzyski Ornithological Region (www.m-sto.org, access 29.07.2019).

STUDY AREA

The survey covered the Świętokrzyskie Mountains (South Poland, 50°40′50,9″N, 20°45′51,0″E), within the boundaries of the Mazowiecko-Świętokrzyski Ornithological Region (cf. http://m-sto.org/). This area is distinguished as a characteristic unit located in the forks of the Vistula and Pilica rivers, which main part are the Świętokrzyskie Mountains and their surrounding area (Chmielewski *et al.* 2005). The region of the Świętokrzyskie Mountains covers an area of 14,400 km^2, mainly located in the macroregions Kielecka Upland, Przedborska Upland, and Nidziańska syncline (Kondracki 2000). The Świętokrzyskie Mountains themselves are located in the central part of this region, with the Łysica as the highest point (612 m a.s.l.). Due to considerable difference in the height of the area (above sea level), the climate of this region is non-uniform – mean annual temperature ranges from 5.7°C in Łysogóry to 7.8°C in the Nida valley and 8.2°C near Opatówka. A river network of the studied region is well-developed and consists of 34 rivers. In the western and central parts there is a mosaic of agricultural land mixed with fields and forests and characteristic high fragmentation of crops. In the eastern and south-eastern parts of the region quite intensive agriculture dominates due to rich loess soils and rendzinas. Horticulture, vegetable farming and grassland agriculture are also well-developed. In the Świętokrzyskie Mountains forest coverage reaches about 32%. The largest and most dense forests are in the northern part of the area.

METHODS

The survey was done from 2017 to 2019 and covered the entire area of the Świętokrzyskie Mountains within the limits defined by Chmielewski *et al.* (2005); Fig. 1. The main method was conducting one nest count, excluding large woodland areas. The county was the basic unit controlled during the survey. As a rule, the entire county was surveyed during one particular year. The data from 2017 to 2019 were supplemented in a few cases with data collected on the boundary between the Mazovian Lowland and Świętokrzyskie Mountains in 2013-2014 (Chmielewski *et al.* 2017). The controls started on 1 April and finished on 13 May, most of which were conducted in April (83%). Also the by far highest number of nests was found during this month (90%). During each control the number of nests, geographic coordinates of the central part of the colony, microhabitat of the colony including the four categories park, tree lane, wooded land, and single tree, as well as the type of nesting trees, i.e., deciduous or coniferous, were recorded. In large built-up areas, nests quite often were dispersed, in which case clearly separated clusters were considered one colony isolated by, e.g., buildings, or it was assumed that 300 m distance between clusters determined separate colonies. It was also assumed that one nest corresponded to a breeding pair.

Basic descriptive statistics and the Kolmogorov-Smirnov test showed that the distribution of the number of nests was not normal and, therefore, non-parametric tests

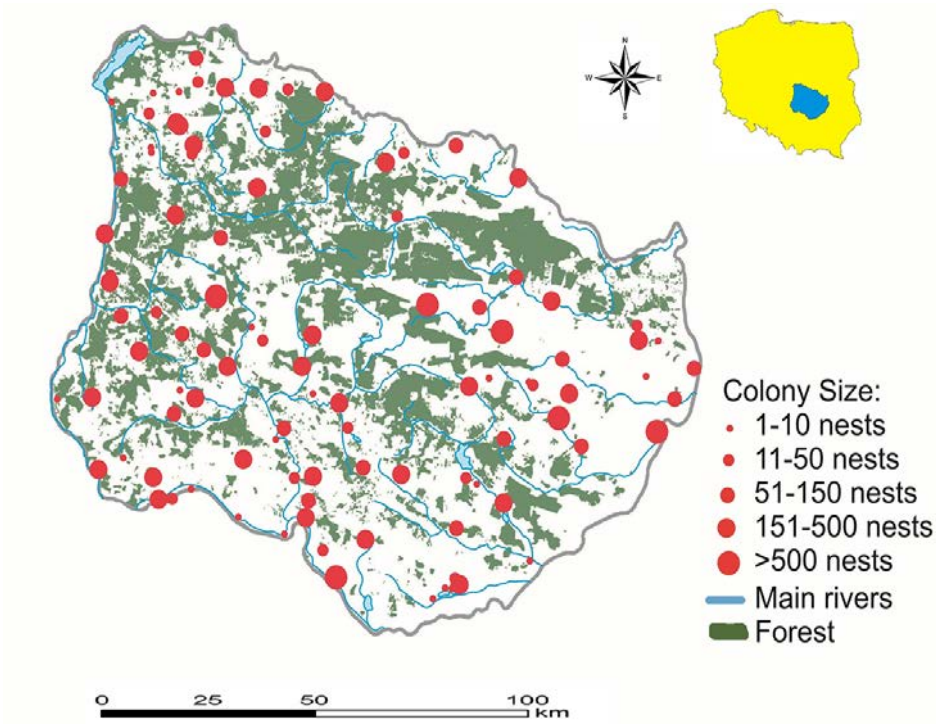

Fig. 1. Distribution of breeding sites of the Rook in the Świętokrzyskie Mountains in 2017-2019 (single colonies in larger towns were grouped)

were applied in the analyses, i.e. Kołmogorov-Smirnov test, Kruskal-Wallis test and Mann-Whitney U test (SPSS Statistics 23). We used **$\alpha = 0.05$** as the critical significance level and regarded.

RESULTS

During 2017-2019, 166 colonies and 15,622 nests of the Rook were found in the study area. Mean density of nests was 108.5/100 km^2. The species was less abundant in the central part of the region, i.e. in the uplands with dense forest cover (Fig. 1). Mean colony size was 94.1 nests (range 1 to 759, Me = 33; $Q_1 = 6$; $Q_3 = 123.5$). The largest colonies were located in Bodzentyn and Czajęcice with 759 nests each. There were only five colonies with over 500 nests, while single nests were found only at five sites, two nests at 14, and three nests at four sites (Table 1).

The colonies were mostly located on deciduous trees (n = 128, 77.1%), and only exceptionally on coniferous trees (n = 8, 4.8%). The number of colonies found in deciduous and mixed tree plots was 30 (18.1%); we considered a colony as located

Table 1. Size of Rook colonies in the Świętokrzyskie Mountains in 2017-2019. Size classes are defined according to Jakubiec (2005 a)

Size of the colony	1 to 2	3 to 10	11 to 50	51 to 100	101 to 500	>500
Number of colonies	21	36	42	17	45	5
Number of nests	35	212	1,169	1,230	9,608	3,368
% colonies	12.7	21.7	25.3	10.2	27.1	3.0
% nests	0.2	1.4	7.5	7.9	61.5	21.5

on a mixed plot even if only one nest was built on a coniferous tree and others on deciduous trees. The colonies located on deciduous trees consisted of a total of 8,727 nests (55.9%), on coniferous trees of 499 nests (3.2%), and on both deciduous and coniferous of 6,396 (40.9%).

The number of nests in the colonies located exclusively on deciduous (Me = 19; $Q_1 = 5$; $Q_3 = 92.3$) differed not significantly from those on coniferous trees (Me = 32; $Q_1 = 21.3$; $Q_3 = 64.8$); Mann-Whitney U test ($p = 0.567$).

Almost all colonies were located close to human settlements. Out of 166 breeding sites recorded during this survey only one (eight nests) was not situated in the vicinity of buildings. We considered colonies located at least 100 m from buildings as not neighbouring them. There was a significant positive relationship between the number of inhabitants of a site and number of rooks breeding at that site or in its close vicinity (Fig. 2).

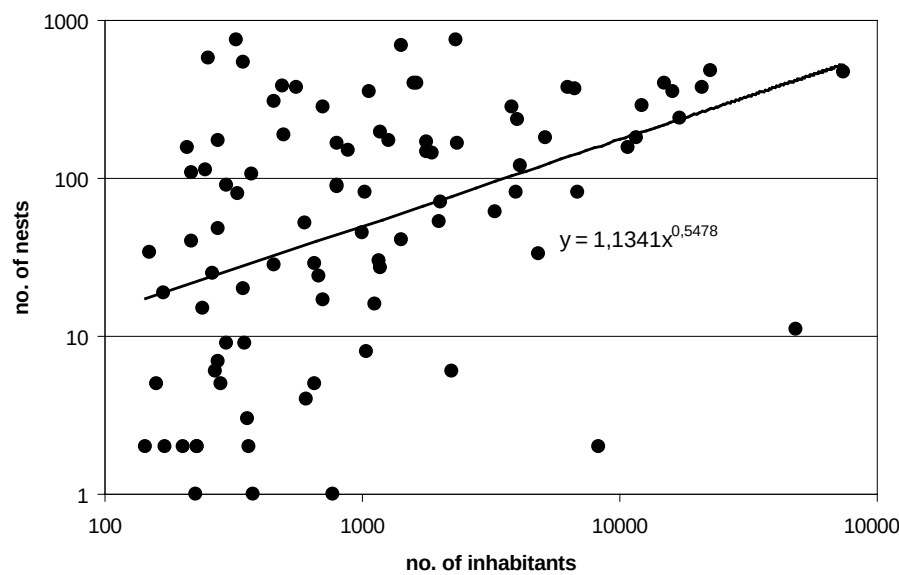

Fig. 2. Correlation between the number of nests in towns or in close vicinity and the number of town inhabitants. The town of Kielce was excluded (202,000 inhabitants, 282 nests)

The largest number of Rook colonies was recorded in wooded land (Table 2).The number of nests per colony differed significantly between tree lanes (Me = 8; $Q_1 = 2.8$; $Q_3 = 9.5$), parks (Me = 108; $Q_1 = 23.5$; $Q_3 = 215.5$), single trees (Me = 2; $Q_1 = 2$; $Q_3 = 3.5$), and wooded land (Me = 20; $Q_1 = 5$; $Q_3 = 63.5$); Kruskal-Wallis test: $p < 0.001$. A *post-hoc* applied Dunn-Sidak test revealed that the number of nest per colony in parks was significantly higher than in tree lanes ($p = 0.001$), wooded land ($p < 0.001$), and on single trees ($p = 0.012$). A statistically significant difference was also found between wooded land and single trees ($p = 0.039$). The difference between tree lanes and wooded land was almost significant ($p = 0.085$), but no significant difference was found between tree lanes and single trees ($p = 0.161$).

Table 2. Comparison of Rook colonies in different breeding locations

Habitat	Number of colonies		Number of nests		Mean colony size
	N	%	N	%	
Wooded land	90	54.2	4,786	30.6	53.2
Park	62	37.4	10,680	68.4	172.3
Tree lane	11	6.6	147	0.9	13.4
Single tree	3	1.8	9	0.1	3.0
Total\mean	166	100.0	15,622	100.0	94.1

DISCUSSION

Until the middle of the XIX century, the Rook did not breed in the Świętokrzyskie Mountains (Sapalski 1982). The first breeding was documented by Katin (1912) who found a nest on 16 September 1909. During the next decades breeding rooks were also reported, yet it seems that a clear increase in the number of colonies started in the 1950s, and then continued in the 1970s and 1980s (Błoński & Chmielewski 2005). A 1962/63 survey on the distribution of the Rook colonies in Poland based on a questionnaire revealed that the density of colonies was high in the Świętokrzyskie Mountains area and among the highest in entire Poland (Dyrcz 1966). In 1984-2000 the size of the breeding population of the Rook was estimated at approximately 10,000 pairs (Chmielewski 2005), a complete field survey, however, was still missing. Other field studies documented over 80 colonies and a total number of nests of about 5,100.

The entire European population of the Rook shows a decreasing trend. The studies of such trends based on direct field surveys provide well-documented data on the population size, a fundamental issue, particularly in the Rook which due to global warming probably will leave western Europe and considerable areas of its eastern part (Huntley *et al.* 2007 after Hordowski 2009). The population in the Świętokrzyskie Mountains accounts for over 5 % of the total national population, and ranks among the largest in Poland (Wylegała *et al.* 2013, Zbyryt *et al.* 2013, Ławicki *et al.* 2015, Chmielewski *et al.* 2017, Jerzak *et al.* 2017, Zbyryt *et al.* 2018). The population density documented in the study area in 2017-2019 (108.5 nests/100 km^2) was similar to the former regional

assessment that covered 51% of the area of Poland (106.6 pairs/100 km^2; Jakubiec 2005a). Currently the density recorded in the Świętokrzyskie Mountains is second only to that in the Mazovian Lowland (175 nests/100 km^2; Chmielewski *et al.* 2017, Zbyryt *et al.* 2018). Previous data also show that the Kielce and Mazovia regions have long been the areas of a high density of the Rook (cf. Dyrcz 1966, Pinowski & Zając 1990, Hordowski 2009). Recently, the decrease in the number of breeding pairs since the 1990s was documented in several regions of Poland. Probably the estimate given for the Świętokrzyskie Mountains in the end of the last century (Chmielewski 2005) was too low and the population actually reached about 20,000 pairs. E.g., in a 96 km^2 area of agricultural land near Kielce the density reached 181 pairs/100 km^2 in 1993-1994 (M. Polak, in litt.). However, mean colony size was lower with $\bar{x}$ =70.1; SD – 139 (M-ŚTO database). The largest colony in Piekoszów consisted of 850 nests in 1999. The largest two colonies found recently were smaller. Mean colony size was lower than in Silesia (Jerzak *et al.* 2017) and Mazovia (Chmielewski *et al.* 2017) and higher than in the remaining regions.

The Rook as synanthropic species is more abundant in areas of higher human density (Józefik 1976). In our study, only one colony was located outside human settlements). Similarly to the Mazovian Lowland, a positive correlation was found between the size of a town and the number of rooks breeding there. Most colonies were located in rural areas, ie. 8,308 nests (53.2%) in 70 colonies (classification according to the holding of town privileges). Several factors promote Rooks settling in towns, among them availability of nesting sites, anthropogenic food sources, more stable climatic conditions, and lower number of predators (Marzluff 2001). Lawns are also beneficial as they resemble meadows that are preferred by rooks as feeding sites (Jakubiec 2005b). E.g., 1,200 ha of lawns were mown in Warsaw in 2016 (http://zom.waw.pl/aktualnosci/w-warszawie-pachnie-swiezo-skoszona-trawa, access 24.08.2019), and about 180 ha in Kielce in 2019 (RPZiUK of Kielce, pers. comm). Lawns just mown are used by numerous rooks as feeding sites (S. Chmielewski, in litt.). The lawn area and their location may be important to maintain urban populations of the Rook. The distributions of the colony size and number of nests in the colonies (Table 2) in the Świętokrzyskie Mountains were similar to those reported from the Mazovian Lowland. Rooks most often built their nests on deciduous trees. The low number of the colonies where nests were located on both deciduous and coniferous trees (n = 30) and a high total number of nests (n = 6,396) indicate that rooks preferred deciduous trees to establish colonies in the Świętokrzyskie Mountains. The number of nests on either deciduous or coniferous trees in the colonies was similar, contrary to the Mazovian Lowland, where the colonies located in coniferous plots were larger than those in deciduous ones (Chmielewski *et al.* 2017). Yet these results may have been influenced by the sample size as only eight colonies were located in coniferous plots. Colony size differed between habitats, similarly to the Mazovia region, with colonies in parks being significantly larger than those located in tree lanes, wooded land or on single trees. The

Rook rarely nests outside forest stands. There are just a few reports on nests built on the power line poles. Such nest sites were recorded near Nowy Sącz (Hordowski 2009), in Świerże Górne (Chmielewski *et al.* 2017), and in Pawłów municipality near Jadowniki where, on 18 May 1997, 18 nests were found on high voltage powerline towers.

Due to a progressive decrease in the number of the Rook in Poland, regular monitoring of the breeding population of this species is recommended.

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