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# BREEDING POPULATION OF THE ROOK *CORVUS FRUGILEGUS* IN THE MAZOVIAN LOWLAND: CURRENT STATUS AND CHANGES

## ABSTRACT

In 2012–2015 nests of the Rook *Corvus frugilegus* were counted in the Mazovian Lowland area (42,379 km$^2$). A total of 69,442 nests on 693 sites were found. The overall population was estimated at 72,125-76,488 nests ($\bar{x}$ = 74,307, 175 nests/100 km$^2$). The average rookery size reached 100.2 nests (SD = 192.4). There were five colonies (0.7%) with at least 1,000 nests, 368 (52.4%) small colonies with up to 25 nests, 32 (4.6%) sites with single nests and 103 (14.9%) with up to 3 nests. 83% of all nests were located in rookeries with more than 100 nests (26% of all colonies). The rookeries were mostly situated on deciduous trees (82.5%). Colonies in coniferous stands ($\bar{x}$ = 166.3 nests) were significantly larger than those in the deciduous tree stands ($\bar{x}$ = 77.2 nests). 98.1% of all rookeries were located in the vicinity of human settlements. Colonies were characterized by unstable numbers of nests (years 2012–2014 vs 2013–2015). However, an analysis of population fluctuations in 75 colonies (about 8,000 nests) showed no directional trend, i.e. a decrease in number of nests in one location was compensated by an increase in another one. In large cities with several breeding colonies, populations appeared to be stable despite human disturbance. As the Rook nests in colonies, high densities can be recorded in relatively small areas. Therefore, to compare densities and to evaluate population trends for this species data from areas larger than 10,000 km$^2$ should be considered.

**Key words**: Rook, *Corvus frugilegus*, Mazovian Lowland, population size, population density, habitat preferences

## INTRODUCTION

The long-term trend of the European population of the Rook has currently revealed a moderate increase in number (PECBMS 2013). In Poland, during 2000–2014, there was a moderate decline in the Rook breeding population (Chodkiewicz *et al.* 2016). At the end of the last century, in south-western Poland, a decreasing trend was recorded in the "rural" populations (Jerzak *et al*. 2005, Tomiałojć 2009) as well as in the big cities of northern and western Poland. However, in the eastern part of the country the population of the Rook was regarded as stable or increasing (Jakubiec 2005).

Recently published evaluations of the current Rook population in Poland vary a lot, ranging from 150,000 to 200,000 pairs (Sikora *et al*. 2007) or from 250,000 to 310,000 (Chodkiewicz *et al*. 2015). Such diverse assessments suggest that a survey of the number of Rooks in Poland should be done in a short period of time, as in other European countries (Jakubiec 2005). It is proposed to repeat the survey according to a model by Dyrcz (1966) and Józefik (1976), while noting that the results obtained by this method are so divergent that obtaining an actual population size for the entire area of Poland will be difficult (Jakubiec 2005). Therefore, obviously the only effective way to gain reliable numbers are field studies.

So far, there has been no comprehensive study on the occurrence of the Rook in Southern Podlasie and Mazovia (Hordowski 2009). Random data were collected while conducting other studies (Chmielewski *et al.* 2004, Dombrowski *et al.* 2014). The longest investigations were done in the district of Siedlce (Luniak 1972, Kasprzykowski 2001, 2005) and in Warsaw (Luniak *et al*. 1964, 2001, Mazgajski 2001).

The survey of the Rook population in Mazovia and South Podlasie conducted in 2012–2015 is the first comprehensive number assessment based on direct field counts. It will allow for an accurate assessment of future changes in population size in the area. For some districts the data from 2012–2015 have already been published (Dombrowski *et al.* 2012, Dombrowski & Sikora 2014, Dombrowski & Trębicki 2014, Lewandowska 2014, Michałowski 2014, Redlisiak *et al*. 2014, Dombrowski *et al*. 2015, Łukaszewicz 2015).

## STUDY AREA

The survey covered the Mazovian Lowland (Central Poland, 52°22′08.0″N, 21°13′32.1″E), with a total area of 42,379 km$^2$. The Mazovian Lowland consists of four macro-regions and is large and uniform in structure and landscape. This area can be distinguished from the adjacent physiographic units by its characteristic features. It lacks natural lakes of glacial origin. The vast majority of standing waters are artificial reservoirs, fishponds, clay pits, flooded sandpits, gravel sites and peat excavations. The landscape includes broad valleys of the Vistula, Narew, Bug, Pilica, Bzura, Wkra, Radomka and Liwiec rivers. A significant part of the Mazovian Lowland comprises typically rural areas, in some places (former Płock, Skierniewice and Ciechanów

Voivodeships) significantly deforested. The agricultural landscape, especially in the central and eastern part of the region, is characterized by high fragmentation of fields, numerous buffer strips with trees, small woodlots and dispersed settlement. The soil is mainly podzolic or luvisolic, in some places gleyic chernozems occur, as well as silty-peaty and alluvial soils in the river valleys. The study area was mostly located within the borders of Mazovian Voivodeship, comprising also the northern part of Lublin Voivodeship, the eastern edge of Łódź Voivodeship and the southern edge of Warmian--Masurian Voivodeship. Most of the agricultural land of Mazovian Voivodeship, i.e. about 45%, is classified as poor or very poor (class V-VI), whereas medium quality land (class IV) comprises 37%. In the central part of the study area the rapidly developing Warsaw agglomeration is located. In the area of Grójec and Warka is the largest fruit--farming region in Poland, applying large amounts of pesticides. The main forest areas are Kampinos, Kozienice, Kurpie, White, Bolimów and Pilica Forest. Annual precipitation in the Mazovian Vovodeship ranges from 450 to 650 mm. Of the 33 categories of land cover occurring in Poland (Corine Land Cover database), agricultural areas occupy 67.2%, including meadows and pastures 12.4%, and forests 23.4%.

## MATERIAL AND METHODS

The basic approach was to check the entire district or municipality in only one season. The inventory of the rookeries started in 2012 and was completed in 2015. In some cases, a count was repeated in another year but always during the period 2012–2015 and within the limits of the entire administrative unit. In such a case, the results for the year closer to 2015 were used for calculating the total number of nests in the Mazovian Lowland. The most intense counting was carried out in 2014 and 2015 (79.6% of all found nests). The highest intensity of counts occurred from 27 March to 5 May, i.e. between the 18th and 25th week of the year (Busse 1973). Within this period of time, 91% of the field counts were performed. Within the same period, the highest numbers of the nests (93%) were detected.

During a count, the number of nests in a colony and the geographical coordinates of its centre was recorded. Furthermore, the microhabitat was classified into five categories cemetery, park, tree lane, woodlot (i.e. forest patch in the field) and single tree (colonies located on electric poles were omitted). The type of trees used for nesting was also recorded (with the two categories deciduous trees and conifers). Within large urban areas, where the maximum dispersion of nests was noted, a colony was defined as a clearly separated concentration of nests, isolated e.g. by buildings or more than 300 m. During field inspections, special attention was paid to flying or feeding birds, whose presence helped to detect colonies.

The influence of the type of nest tree (deciduous vs coniferous) on the size of colony was analyzed with the Mann-Whitney U test, because the variable in both groups, i.e. the number of nests in the individual colonies, was not normally distributed (Shapiro-

-Wilk test). In order to check whether the number of nests changed significantly in the 75 colonies with reported changes during a repeated count in 2012–2015, the measurable variable was the number of nests in individual colonies during 2012–2014 vs 2013–2015. A respective analysis was done with the Wilcoxon signed-rank test, since both variables were not normally distributed (Shapiro-Wilk test). To check whether the increase in the number of nests in colonies was associated with the initial size of the colonies, the Spearman's rank correlation test was used because the variable of an increase in the number of nests in the colonies was again not normally distributed (Shapiro-Wilk test). A general linear model was applied in order to clarify whether the size of a colony was related to the type of habitat. Within 75 analyzed colonies the data of 14 colonies (514 nests) located at the boundary of the Mazovian Lowland were also included.

## RESULTS

In 2012–2015, a total of 69,442 nests of rooks on 693 sites were found in the Mazovian Lowland. The overall breeding population was estimated at 72,125–76,488 nests. This value was obtained by a data correction considering the counts outside the main counting period, i.e. before the 17th week and after the breeding season. Taking into account the data from earlier publications, including those considering the rate of nest building (Busse 1965, Kawa & Pelc 2001, Hordowski 2009), the lower threshold of the population size for the Mazovian Lowland in the case of nests counted between 30 June and 25 March (3,532 nests) was increased by 50% and the upper threshold by 100%. The average density of nests was 175 nests/100 km$^2$. The Rook was less numerous on the Rawa Plateau, in the southern part of the Radom Plain, northern part of the Mława Hills, on the Kurpie Plain and Podlasie Bug Gorge (Fig. 1). The species was more numerous east of the Vistula. The average size of the rookeries was 100.2 nests (SD = 192.4). There were five colonies with at least 1,000 nests, the largest (2,180 nests) in the manor park in the village of Dębe Małe in the municipality of Latowicz (Mińsk Mazowiecki district). There were 368 (52.4%) small colonies (up to 25 nests), including 103 with up to 3 nests and 32 (4.6%) sites with single nests. In the rookeries with more than 100 nests (26% of all colonies) 83% of all nests were found (Table 1).

For 691 rookeries the observers identified the type of nest trees. Most colonies (n = 570) were located on deciduous trees (82.5%). 54 (7.8%) colonies were built both on deciduous trees and in mixed stands, with this second category including also the case of one nest located on conifers and the rest on deciduous trees. 67 colonies (9.7%) were located exclusively on coniferous trees. The largest rookery on conifers, with 1,523 nests, was located in Żuromin (Żuromin district). We found that the colonies placed on conifers were larger than those on deciduous trees (Mann-Whitney U test, $Z = 4.89$, $P < 0.001$). The average colony size both on deciduous and coniferous trees (excluding the colonies on mixed stands) was 86.5 nests.

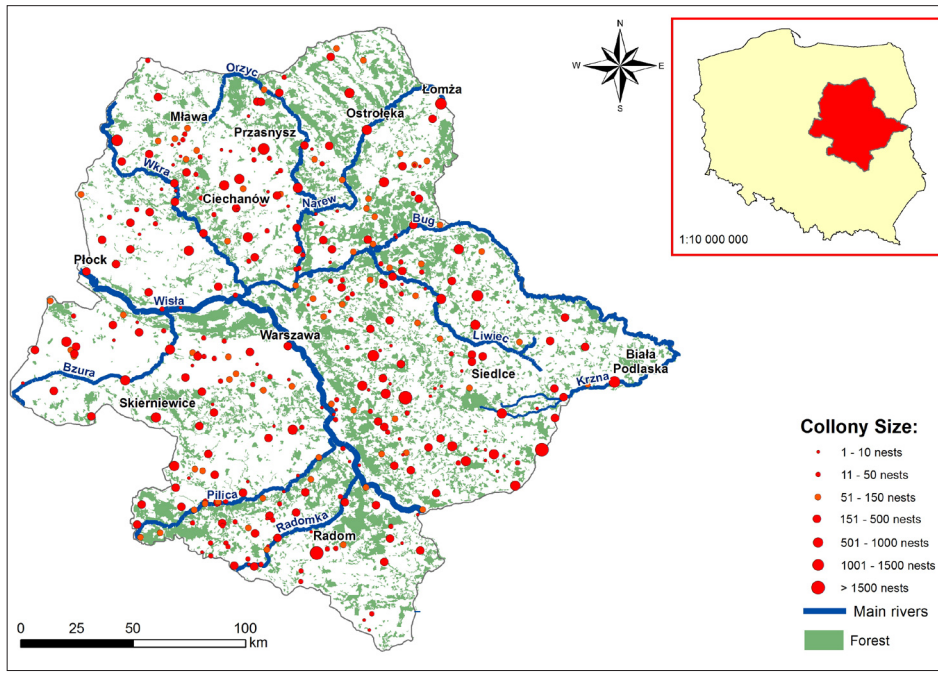


Fig. 1. Distribution of breeding aggregations of the Rook in the Mazovian Lowland in 2012–2015. Single colonies in larger towns were pooled

The vast majority of the rookeries were located in the vicinity of human settlements. The larger the number of inhabitants, the more rooks nested in it or in its close vicinity; $r = 0.33$, $P < 0.001$ (Fig. 2).

For 706 detected sites, only nine rookeries (1.3%) were not adjacent to a built-up area, i.e. were located more than 100 m from the nearest building. The total number of nests in these colonies was 1,436 (2.1%). Four of them were located on deciduous trees (1,144 nests) and five on conifers (292 nests). The colonies on deciduous trees ($\bar{x} = 286.0$ nests) were larger than those on conifers ( $\bar{x} = 58.4$ nests).

The number of nests in the rookeries fluctuated over the years, as documented for 75 colonies during repeated counts in 2012–2015 and for three colonies in 2009 and 2011 (Table 2). In 36 colonies the number of nests increased, in 39 it decreased and in three colonies there was no change. A similar total number of nests was recorded in the 75 analyzed rookeries in the compared years. The average number of nests was higher during the second count ($\bar{x} = 104.6$; SD = 195.6) in comparison to the first one ($\bar{x} = 89.6$; SD = 148.1), however the difference was non-significant, (Wilcoxon signed-rank test, $T = 0.40$, $P = 0.686$) (Table 2). This demonstrates the lack of a directional trend in these colonies, i.e. a decrease in the number of nests in one location was compensated by an increase in another one.

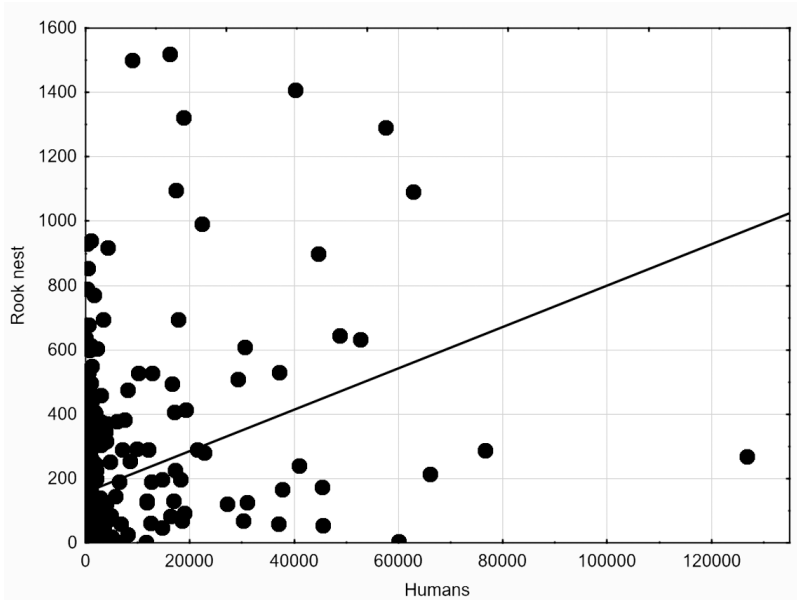


Fig. 2. Relationship between the number of Rook nests in a village/city or in its closest vicinity and the number of its human inhabitants (Pearson correlation coefficient PCC, r = 0.33; P < 0,001, N = 63702). Three extreme cases of colonies were omitted: Warsaw (1.7 million inhabitants, 301 nests), Radom (217,000 inhabitants, 2,277 nests) and Dębe Małe (428 inhabitants, 2,180 nests)

In order to check whether the increase in the number of nests was associated with the initial size of the colony, the averaged coefficient of change in the number of nests per year was calculated (data from Table 2). The distribution of this coefficient deviated significantly from a normal distribution (Shapiro-Wilk test, $p < 0.001$). Therefore, the obtained data were analyzed using Spearman's rank correlation. There was no evidence, however, for a relation between the initial size of the colony and the average annual change in the number of nests ($r_s = 0.01$, $P = 0.944$, $N = 75$). In a next step, the analysis was repeated separately for increasing and decreasing colonies. For a correlation between the average increase coefficient and the initial size of a colony, the Spearman rank correlation showed no statistically significant relation ($r_s = -0.21$, $P = 0.213$, $N = 36$). However, a significant correlation between the average decrease coefficient and the initial size of colony was found ($r_s = 0.48$, $P = 0.002$, $N = 39$). This correlation is positive, and thus with an increase in the initial colony size the increase coefficient is closer to value 1 (i.e. the decrease in the number of nests is smaller). The strength of this relation is moderate.

During the counts the observers noted disturbances of Rook colonies by calling raptors Accipitriformes, firecrackers, shooting birds with shotguns, building nests on young unstable trees, removal of nests, mainly in large cities, tree felling due to planned

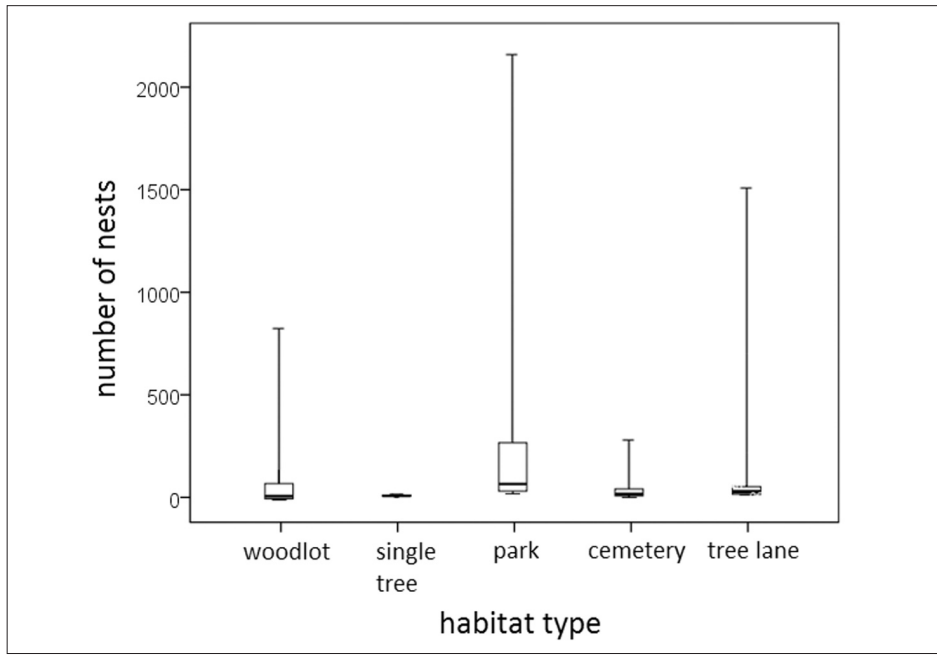


Fig. 3. Average Rook colony size in different types of habitat. Values shown are minimum, lower quartile, median, upper quartile, and maximum

construction works, renovation of historic parks connected with tree felling, cutting the whole tree stand with the colony. In order to assess whether the average colony size varies depending on the type of habitat, a general linear model was used, in which the dependent variable was the size of the colony, and the predictor the habitat type. This analysis demonstrated that the type of habitat determines the size of colonies significantly ($\chi^2 = 58.86$, df = 4, $P < 0.001$). The largest colonies were recorded in parks, slightly smaller ones in woodlots, and the smallest on single trees (Fig. 3). A pairwise comparison of different habitats using the Sidak correction showed that the number of nests in colonies in parks is significantly higher than in woodlots ($P < 0.001$), on single trees ($P = 0.007$), on cemeteries ($P = 0.005$) and in tree lanes ($P < 0.001$). Other differences were not statistically significant.

Some unusual colony locations were reported. At the edge of the town of Wierzbica, in an old orchard among the fields, 19 occupied nests were found in April 2013. Another unusual case was a colony of 85 nests built on electricity pylons at the power station in Świerże Górne in 2014. In 2015 there was also an interesting location of 130 nests on a wooded island in the Zegrze Reservoir near Rynia. There were also reports of nesting in clumps of the Mistletoe (*Viscum* sp.).

In larger cities, where rooks nested in several colonies, the population size remained on a similar level or even increased, despite intentional human disturbance.

However, in cities with single rookeries disturbance led to a decline or even complete extinction of colonies. For several major cities data were collected, which allowed to determine the direction of change in the Rook breeding population. During 1997–2015 the numbers of nests in Skierniewice were recorded (M. Nowicki unpubl.), with the size of the largest colony in the city park ranged from 434 nests in 1999 to 639 in 2012. In other locations of the same town colonies were small (up to 65 nests) and unstable, appearing and disappearing. In 2013–2014, in the park a large part of the trees with the largest number of nests were removed, which caused a decrease to 458 nests in 2015. In the town as a whole there was no clear direction of changes in the Rook population ($r = 0.21$, $P = 0.613$, $df = 6$). In Łuków there was a marked decline in the number of nests in 2008–2016 ($r = 0.95$, $P < 0.001$, $df = 7$) (Dombrowski & Sikora 2014; A. Dombrowski, M. Sikora unpubl.). In the park, trees with rook nests were cut. In 1998–2012 the status of rookeries in Siedlce was monitored (Wodecki *et al.* 2012). From 1998 to 2003, a moderate increase in the number of nests was noted ($r = 0.41$, $P = 0.422$, $df = 4$). Since 2008, systematic disturbance in the largest rookery located in the city park "Aleksandria" started. As a result, in 2012 the number of nests dropped to 290. The disturbance caused the dispersal of rookeries from three or four to eight breeding colonies, with a smaller overall number of nests. In Warsaw at about 1990, 650–700 pairs were nesting, at the end of the 20th century 300-400 (Luniak *et al.* 2001). The count made in 2013 revealed a minimum of 511 nests, and a year later only 301 (Redlisiak *et al.* 2014). In Mława, as a result of intense disturbance, the rookery decreased from 241 nests in 2012 to 127 in 2015 (P. Szczypiński unpubl.).

## DISCUSSION

The results of different studies indicate that an early rookery survey underestimates the number of nests (see Hordowski 2009). Also it is pointed out that rook density, calculated on the number of nests, is always higher than the effective number of nesting pairs (Mansfeld 1965: in Jabłoński 1977, Dyrcz 1966). Busse (1962, 1965) showed that a significant number of nests get destroyed, and that a significant number of old ones are not occupied. Malmberg (1971) indicates that the representativeness of results depends on the number of counts, i.e. the more counts, the smaller the error. In turn, according to Hordowski (2009), autumn counts underestimate the number of nests by 5–10%. Rookery surveys conducted in the UK in 1996 showed that the optimal time period for counts was the 2nd 10 days of April, and that earlier censuses may be subject to an error of up to 80%, compared to the maximum number of nests (Griffin 1999). A similar relationship was observed in the Rzeszów area (Kawa & Pelc 2001).

Information about the occasional nesting of the Rook in Mazovia was already given by Taczanowski (1882). In the middle of the 19th century in Warsaw, there was a colony in the Saxon Garden and then in the Wilanów Park. In 1860, rooks settled near the village of Bielawa in the district of Piaseczno and in the vicinity of Czernice near

Przasnysz. These were short-lived colonies. A first assessment of the overall population of Poland in 1963, using questionnaires, generated justified suspicion of underestimated results (Dyrcz 1966, Jabłoński 1977). The next evaluation of the countrywide Rook population, done in 1971, probably resulted in an overestimate (Józefik 1976). According to Dyrcz (1966), the Lowland of Mazovia and Podlasie belonged to the regions with the highest densities, and the data by Józefik from 1971 (see map no. 6 in Pinowski & Zając 1990) indicate that in most parts of the region the density reached about 300-500 pairs/100 km$^2$, which is about 2.5 times higher than the present one. The reliability of these data was undermined by Jabłoński (1977) who compared the results of the survey based on questionnaires with those obtained by direct field counts for the district of Ostrów Mazowiecka. Using questionnaires resulted in a density of 510 nests/100 km$^2$, which in fact was only 175 nests/100 km$^2$. The same author provides the following numbers: 398-411 pairs/100 km$^2$ for 1955–1958, 276 pairs/100 km$^2$ for 1963 and 141 pairs/100 km$^2$ for 1974, indicating a gradual decline. It is worth noting that in 2014 in the district of Ostrów Mazowiecka the density was 132 nests/100 km$^2$, and thus similar to that of the mid-1970s. The density in the district of Siedlce in 1970 reached 203 pairs/100 km$^2$ and in 1998 317 pairs/100 km$^2$, indicating an increase in the population (Kasprzykowski 2001). In 1999–2003, a decline from 232 pairs/100 km$^2$ in 2003 to 150 pairs/100 km$^2$ in 2012 was recorded (Kasprzykowski 2005, this study). Hordowski (2009) assessed the breeding pairs' density in the Mazovia region at the turn of the 21st century as more than 135 pairs/100 km$^2$. In 2012–2015 the Mazovian density (175 nests/100 km$^2$) was significantly higher than that assessed regionally (covering 51% of Poland), which was 106.6 pairs/100 km$^2$ (Jakubiec 2005). The exceptionally high density given for Lesser Poland, reaching 132–249 pairs/100 km$^2$, was not calculated on the results of a direct count, but on estimates (Walasz & Mielczarek 1992, Jakubiec 2005), and, therefore, may be flawed. According to Józefik (1976) the Rook has a very strong tendency to concentrate in large numbers in colonies, as evidenced by high densities in relatively small areas. Therefore, only counts in regions with a total area of over 10,000 km$^2$ were considered appropriate to compare densities in this study. In the Kuyavian-Pomeranian Voivodeship the population density was 62 pairs/100 km$^2$ in 2001–2002 (Indykiewicz 2005), in the Podlaskie Voivodeship 53 pairs/100 km$^2$ in 2012 (Zbyryt *et al.* 2013), in Silesia 45.6-49.3 pairs/100 km$^2$ in 1998–1999 (Czapulak & Betleja 2002), in the northern Greater Poland 36 pairs/100 km$^2$ in 2012 (Wylegała *et al.* 2013), and in the Lubusz Voivodeship only 13 pairs/100 km$^2$ (Jerzak & Piekarski 2005). Thus, the density of rooks in the Mazovia is almost three times higher than the recent values recorded in other Polish regions.

While the overall European Rook population is moderately increasing, (PECBMS 2013) a moderate decline has been shown for Poland, according to the nationwide bird monitoring scheme. The national breeding population index for the Rook in 2014 was almost half as low as in 2001 (Chodkiewicz *et al.* 2016). A similar trend has been recorded on the regional scale, e.g. in Greater Poland or Podlaskie Voivodeship

(Tobółka *et al.* 2011, Wylegała *et al.* 2013, Zbyryt *et al.* 2013). The above mentioned studies, however, investigated small populations, i.e. Greater Poland 4,771 nests, Podlaskie Voivodeship 10,666 nests, and Leszno region 1,706 nests. These data, therefore, may be subject to an error resulting from the small size of the estimated population and the influence of local factors. The problems in the assessment of trends for small populations are evident when comparing results obtained for some districts of the Mazovian Lowland. For example, in the Ostrów Mazowiecka district the density in 1974 (141 pairs/100 km$^2$, Jablonski 1977) was similar to that recorded in 2014 (132 nests/100 km$^2$). Similarly, in the district of Siedlce the density in 1970 was 203 pairs/100 km$^2$ and in 2012 149 pairs/100 km$^2$, although in 2003 the value was as high as 232 pairs/100 km$^2$ (Dombrowski *et al.* 2012). These comparisons indicate marked local fluctuations which do not necessarily mean a drastic decline of the whole Mazovian population. The results for the 78 colonies with a total of 7,000 to 8,000 nests within 2012–2015 showed no downward trend. This may indicate that the entire population of Mazovia is stable, although local declines in number are sometimes very pronounced. For example, in the district of Garwolin in 1984, the density was 489 pairs/100 km$^2$, and in 2015 only 163 pairs/100 km$^2$ (Dombrowski *et al.* 2015). Orłowski and Czapulak (2007) suggest that the recovery of the species in Poland, as in Western Europe, should be expected. Hence a field inventory in regions with large populations, e.g. Lesser Poland, should be recommended to determine the current trend of the Rook in Poland and to compare it with the results of Monitoring of Flagship Bird Species (Polish abbrev.: MFGP) (Chodkiewicz *et al.* 2016).

In large cities, where Rooks nest in several colonies and are not disturbed, the populations seem to be stable, or may even increase in number, as in Siedlce. In locations where Rooks concentrate in only one colony, disturbing birds or felling trees cause a significant decrease in their number, as noted, among others, in Łuków and Mława. In contrast, a lack of disturbance results in an increase, as indicated, e.g., by the Biała Podlaska population, with 528 nests in 2,000 and 1,291 in 2012 (Dombrowski *et al.* 2012).

The tendency of the Rook to settle in built-up areas or in their vicinity has been known for decades (Tomiałojć 1990, Tryjanowski & Rzępała 2007). This synanthropic species is common in areas with higher human population density (Józefik 1976). However, a distinction among colonies located in large cities, towns or villages, as well as their ecological analyses quoted in publications (e.g. Indykiewicz 2005, Kuźniak *et al.* 2005, Tobółka *et al.* 2011, Wylegała *et al.* 2013) are not justified in practice. The largest village in Poland (12,700 inhabitants) is several times larger than the smallest town (900 inhabitants), which of course is reflected in the size of built-up area. Thus, the connection of the Rook with human settlements should be considered according to the number of inhabitants, and not to their administrative classification. In Mazovia the vast majority of the rookeries were located in the vicinity of human settlements. The larger a settlement, the more rooks nests in the respective area or in the vicinity,

although this relationship is not applicable to large agglomerations (e.g. Warsaw or Radom). Of all detected colonies of the present study, only nine (1.3%) were not adjacent to a built-up area, at least to a single building. In the 1990s in Silesia only one rookery was found outside of human settlements (Czapulak & Betleja 2002). Also, all the colonies in the Podlaskie Voivodeship were located within a built-up area or in the vicinity of buildings, and the farthest colony was on a lake island at a distance of 160 m from buildings (Zbyryt *et al.* 2013). In the Leszno region, Lubusz Voivodeship and Koszalin Coastland no rookery was recorded outside of human settlements (Antczak 2005, Jerzak & Piekarski 2005, Tobółka *et al.* 2011). The most recent studies in the northern part of Greater Poland did not find any colony outside a built-up area (Wylegała *et al.* 2013), although in the 1980s they constituted even 1.8% (Ptaszyk & Winiecki 2005).

Formerly in Poland the number of colonies was small, but the number of nests in the colony was very large (Jabłoński 1977, Czapulak & Betleja 2002). At present, the number of colonies has significantly increased, but they are smaller. Considering only rookeries with 1 to 100 nests, in Silesia 58% of all colonies fell into that category, in the northern Greater Poland 72% (Czapulak & Betleja 2002, Wylegała *et al.* 2013), in the Kuyavian-Pomeranian Voivodeship 73% (Indykiewicz 2005), in the Lubusz Voivodeship 79% (Jerzak & Piekarski 2005), in the Podlaskie Voivodeship 81% (Zbyryt *et al.* 2013) and in Mazovia 74%. The number of colonies and their size seem to be important as far as an increase/decrease of the population in the respective region is concerned. Schoppers (2004) in his analysis of the Rook population in the Netherlands noticed that the increase in bird number was accompanied by an increase in average colony size, until the beginning of disturbance. Disturbance then did not inhibit population growth, but resulted in a decrease in the average colony size. Taking into account the data provided by Dyrcz (1966) for the former Mazovian Voivodeship (approximately corresponding to the boundaries of the current study), in the counted area the number of small colonies (≤19 nests) increased from 22% to 46%, whereas the number of medium and large ones decreased from 47% to 33% and from 31% to 20%, respectively.

The average size of a rookery in the Mazovian Lowland was twice as large as the average of 50–55 pairs in Poland given by Ptaszyk & Winiecki (2005) and Józefik (1976). The Rook breeding population in the Mazovian Lowland should thus be classified as stable, as 91% of nests were in colonies with more than 50 nests. According to Józefik (1976) stable rookeries (as long as their size does not fall below a critical level) may function without changing location for decades and maintain the tendency to grow to such a population in which the rate of natural increase reaches the maximum, but its size is stabilized. Overpopulation is minimized by the formation of smaller satellite colonies, often ephemeral, nearby. The larger average colony size recorded in Mazovia was so far found only in Silesia at the end of the 1990s, where it reached 145 nests (Czapulak & Betleja 2002). In other regions it was lower (Tobółka *et al.* 2011, Wylegała

*et al.* 2013, Zbyryt *et al.* 2013). The rookery in Dębe Małe with 2,180 nests is probably the largest in Poland at present. It seems likely that due to disturbance of rooks in breeding colonies and tree felling, there will be a reduction in the average rookery size.

In the Mazovian Lowland rooks nested mostly on deciduous trees (82.5% of colonies), but the second largest rookery in Mazovia, with more than 1,500 nests, was on pines. Moreover, in Mazovia the species formed larger colonies on conifers than on deciduous trees. According to Dyrcz (1966), among 2,389 rookeries recorded in the early 1960s in Poland, 26.2% were built on coniferous trees. In Greater Poland and in the Podlaskie Voivodeship 20-30% of nests were built on coniferous species (Ptaszyk & Winiecki 2005, Zbyryt *et al.* 2013), whereas in other regions only 1–5% used conifers (eg. Czapulak & Betleja 2002, Antczak 2005, Indykiewicz 2005, Jerzak & Piekarski 2005). The above mentioned small Rook colony in an orchard is the first documented case for this type of habitat in Poland. Exceptions in western and central Europe include rookeries located on the poles of power lines (Hordowski 2009). In eastern Europe, however, this type of nesting is quite common (Berezovikov 2011, Nadtočij & Ziomenko 2013, Muchametzjanova 2015). This may be explained by a lack of suitable locations for nesting in the steppes region. In Poland, a similar case was found in the vicinity of Nowy Sącz (Hordowski 2009). The rookery on electricity pylons in Świerże Górne is, therefore, the only existing one in the country.

Taking into account the Rook population in the Mazovian Lowland we recommend a constant monitoring of this species is necessary in the area.

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Table 1. Number and size of Rook colonies in the Mazovian Lowland in 2012–2015. Colony size classes according to Jakubiec (2005).

| | Number of nests in a colony | | | | | |
|---|---|---|---|---|---|---|
| | **1–2** | **3–10** | **11–50** | **51–100** | **101–500** | **> 500** |
| No. of colonies | 71 | 154 | 215 | 73 | 153 | 27 |
| No. of nests | 110 | 883 | 5 306 | 5 143 | 35 627 | 22 373 |
| % colonies | 10.3 | 22.2 | 31.0 | 10.5 | 22.1 | 3.9 |
| % nests | 0.2 | 1.3 | 7.6 | 7.4 | 51.3 | 32.2 |

Table 2. Changes in the number of nests for Rook colonies counted twice.

| Site | Municipality | 1st count | Number of nests | 2nd count | Number of nests | Change [%] |
|---|---|---|---|---|---|---|
| Żelechów1 | Żelechów | 7.05.2014 | 163 | 8.04.2015 | 270 | +66 |
| Żelechów2 | Żelechów | 7.05.2014 | 10 | 8.04.2015 | 70 | +600 |
| Sobolew1 | Sobolew | 19.04.2014 | 58 | 8.04.2015 | 90 | +55 |
| Sobolew2 | Sobolew | 19.04.2014 | 153 | 8.04.2015 | 256 | +67 |
| Sobolew3 | Sobolew | 27.03.2012 | 19 | 19.04.2014 | 24 | +26 |
| Ostrożeń Pierwszy | Sobolew | 23.04.2014 | 42 | 8.04.2015 | 52 | +24 |
| Korytnica | Trojanów | 5.05.2014 | 98 | 8.04.2015 | 386 | +294 |
| Wyszogród | Wyszogród | 2.05.2014 | 3 | 10.03.2015 | 4 | +33 |
| Gzowo | Pokrzywnica | 24.05.2014 | 159 | 2015 | 380 | +139 |
| Rajec Szlachecki | Jedlnia-Letnisko | 14.04.2014 | 26 | 24.04.2015 | 40 | +54 |
| Ruda Wielka | Wierzbica | 10.04.2012 | 26 | 1.04.2013 | 34 | +31 |
| Sadłowo-Parcela | Bieżuń | 1.05.2014 | 193 | 18.04.2015 | 440 | +128 |
| Żuromin | Żuromin | 2011 | 1 080 | 1.05.2014 | 1523 | +41 |
| Bukówno | Radzanów | 31.03.2012 | 10 | 7.05.2015 | 14 | +40 |
| Ojrzeń | Ojrzeń | 14.04.2014 | 24 | 26.04.2015 | 42 | +75 |
| Rydzewo | Ciechanów | 14.04.2014 | 5 | 26.04.2015 | 10 | +100 |
| Sanniki | Sanniki | 2013 | 69 | 29.03.2014 | 161 | +133 |
| Szydłowiec1 | Szydłowiec | 15.04.2012 | 196 | 19.04.2013 | 234 | +19 |
| Szydłowiec2 | Szydłowiec | 19.04.2014 | 5 | 19.04.2015 | 9 | +80 |
| Lipienie | Jastrząb | 10.04.2012 | 11 | 17.04.2013 | 17 | +55 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Łochów | Łochów | 31.03.2012 | 17 | 6.04.2014 | 22 | +29 |
| Ostrówek | Łochów | 31.03.2012 | 12 | 16.03.2014 | 14 | +17 |
| Kamionna | Łochów | 7.04.2012 | 212 | 6.04.2014 | 260 | +23 |
| Stoczek Węgrowski | Stoczek Węgr. | 8.04.2012 | 115 | 6.04.2014 | 125 | +9 |
| Węgrów1 | Węgrów | 21.04.2012 | 185 | 29.03.2014 | 225 | +22 |
| Węgrów2 | Węgrów | 21.04.2012 | 82 | 26.04.2014 | 150 | +83 |
| Węgrów3 | Węgrów | 21.04.2012 | 115 | 21.04.2014 | 280 | +143 |
| Miedzna | Miedzna | 12.04.2012 | 40 | 19.04.2014 | 165 | +312 |
| Gałki | Grębków | 3.05.2012 | 51 | 26.04.2014 | 120 | +135 |
| Wołomin1 | Wołomin1 | 22.04.2012 | 14 | 23.04.2013 | 41 | +193 |
| Wołomin2 | Wołomin2 | 22.04.2012 | 5 | 27.04.2013 | 7 | +40 |
| Wołomin3 | Wołomin3 | 15.04.2012 | 3 | 23.04.2013 | 9 | +200 |
| Tłuszcz | Tłuszcz | 22.04.2012 | 14 | 13.04.2013 | 26 | +86 |
| Jasienica | Tłuszcz | 22.04.2012 | 7 | 13.04.2013 | 15 | +114 |
| Ostrówek | Klembów | 22.04.2012 | 15 | 13.04.2013 | 37 | +147 |
| Dąbrówka | Dąbrówka | 10.04.2012 | 8 | 13.04.2013 | 12 | +50 |
| Żelechów | Żelechów | 7.05.2014 | 26 | 8.04.2015 | 9 | -65 |
| Gończyce | Sobolew | 23.04.2014 | 7 | 8.04.2015 | 3 | -57 |
| Korytnica | Trojanów | 2011 | 260 | 2012 | 90 | -65 |
| Górzno | Górzno | 6.05.2014 | 8 | 8.04.2015 | 3 | -62 |
| Zawady | Lipowiec Kościelny | 5.04.2012 | 63 | 2015 | 26 | -59 |
| Wyszogród1 | Wyszogród | 2.05.2014 | 62 | 10.03.2015 | 37 | -40 |
| Wyszogród2 | Wyszogród | 2.05.2014 | 8 | 10.03.2015 | 7 | -12 |
| Kol. Wola Kaszewska | Przytyk | 6.04.2014 | 44 | 7.05.2015 | 38 | -14 |
| Sokolniki Mokre | Wieniawa | 25.04.2012 | 271 | 5.05.2013 | 174 | -36 |
| Stawiszyn | Białobrzegi | 31.03.2012 | 47 | 27.04.2013 | 40 | -15 |
| Wieniawa | Wieniawa | 26.04.2012 | 42 | 5.05.2013 | 25 | -40 |
| Boguszyce | Łomża | 2009 | 495 | 3.04.2014 | 192 | -61 |
| Małkinia Górna | Małkinia Górna | 20.04.2012 | 155 | 11.04.2014 | 145 | -6 |
| Płońsk | Płońsk | 19.04.2014 | 248 | 26.04.2015 | 140 | -43 |
| Szydłowiec1 | Szydłowiec | 19.04.2014 | 221 | 19.04.2015 | 198 | -10 |
| Szydłowiec2 | Szydłowiec | 11.04.2012 | 79 | 16.04.2013 | 56 | -29 |
| Szydłowiec3 | Szydłowiec | 11.04.2012 | 21 | 16.04.2013 | 13 | -38 |
| Szydłowiec3 | Szydłowiec | 16.04.2014 | 4 | 16.05.2015 | 0 | -400 |
| Lipienice | Jastrząb | 10.04.2012 | 41 | 17.04.2013 | 34 | -17 |
| Łochów | Łochów | 31.03.2012 | 67 | 19.04.2014 | 33 | -51 |
| Ostrówek | Łochów | 31.03.2012 | 9 | 16.03.2014 | 3 | -67 |
| Turna | Korytnica | 1.04.2012 | 7 | 30.03.2014 | 2 | -71 |
| Kąty | Korytnica | 1.04.2012 | 8 | 30.03.2014 | 5 | -37 |
| Węgrów1 | Węgrów | 21.04.2012 | 37 | 21.04.2014 | 20 | -46 |
| Węgrów2 | Węgrów | 21.04.2012 | 65 | 26.04.2014 | 40 | -38 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Wołomin | Wołomin | 22.04.2012 | 7 | 23.04.2013 | 2 | -71 |
| Duczki | Wołomin | 22.04.2012 | 19 | 22.04.2013 | 2 | -89 |
| Ostrówek | Klembów | 22.04.2012 | 24 | 13.04.2013 | 17 | -29 |
| Radzymin1 | Radzymin | 10.04.2012 | 6 | 23.04.2013 | 2 | -67 |
| Radzymin2 | Radzymin | 14.04.2012 | 105 | 23.04.2013 | 102 | -3 |
| Radzymin3 | Radzymin | 10.04.2012 | 3 | 23.04.2013 | 1 | -67 |
| Radzymin4 | Radzymin | 14.04.2012 | 18 | 23.04.2013 | 16 | -11 |
| Słupno | Radzymin | 14.04.2012 | 16 | 23.04.2013 | 8 | -50 |
| Poświętne | Poświętne | 26.04.2012 | 64 | 22.04.2013 | 40 | -37 |
| Zacienie | Dąbrówka | 10.04.2012 | 242 | 13.04.2013 | 197 | -19 |
| Szczawnica | Jadów | 22.04.2012 | 102 | 22.04.2013 | 85 | -17 |
| Jadów | Jadów | 22.04.2012 | 82 | 22.04.2013 | 44 | -46 |
| Starowola | Jadów | 22.04.2012 | 240 | 22.04.2013 | 193 | -20 |
| Borki | Jadów | 22.04.2012 | 252 | 22.04.2013 | 238 | -6 |
| Szydłowiec | Szydłowiec | 16.04.2013 | 5 | 19.04.2014 | 5 | 0 |
| Łochów | Łochów | 9.04.2012 | 5 | 6.04.2014 | 5 | 0 |
| Radzymin | Radzymin | 10.04.2012 | 6 | 23.04.2013 | 6 | 0 |
| Total | | | 6 736 | | 7 860 | +14 |