BioOne COMPLETE

Nest-Site Selection in the Magpie Pica pica in a High-Density Urban Population of Sofia (Bulgaria)

Authors: Antonov, Anton, and Atanasova, Dimitrinka

Source: Acta Ornithologica, 37(2) : 55-66

Published By: Museum and Institute of Zoology, Polish Academy of Sciences

URL: https://doi.org/10.3161/068.037.0201

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

ACTA ORNITHOLOGICA
Vol. 37 (2002) No. 2

Nest-site selection in the Magpie *Pica pica* in a high-density urban population of Sofia (Bulgaria)

Anton ANTONOV* & Dimitrinka ATANASOVA

*Kozloduy 3320, bl. 64, ent. A, ap. 14, BULGARIA, e-mail: tonyant_bg@yahoo.com

Antonov A., Atanasova D. 2002. Nest-site selection in the Magpie *Pica pica* in a high-density urban population of Sofia (Bulgaria). Acta Ornithol. 37: 55–66.

Abstract. The study was carried out in 1999–2000 in a 405 ha area urban habitat and revealed one of the highest densities (56.8 pairs/km^2) for the species. Breeding density was best predicted by the diversity of trees in the plot and was not limited by the presence of tall trees. Birds used 69% of the available tree species and preferentially selected half of them. Taller tree species were preferred to shorter ones and coniferous trees were preferred to broadleaved ones. Nests higher above the ground were more likely to be successful than nests lower down. The greater the nest height, the earlier the Magpies laid eggs and the more fledglings they produced. Pairs nesting in conifers laid earlier than those in broadleaved trees but there were no significant differences in clutch-size, hatching or fledging success between the two habitats. The nest site preference was not well explained by the success rate. Regardless of species, not only tall trees, where success was greater, were preferred but also smaller ones, despite the lower success rate. Nests in conifers were no more successful than those in broadleaved trees, despite the marked preference for conifers. Magpies that succeeded in their final breeding attempts in one season were less likely to make a contrasting nest-site choice the following season. The lack of a clear adjustment between the nest-site selection pattern and breeding success was hypothesized to be due to two non-exclusive mechanisms: 1) either there are no strong selective pressures at any type of nest-site and on the behavioral plasticity of Magpies or else selective pressures may change during the season; 2) the dependence of nest-site selection on bird quality.

Key words: Magpie, *Pica pica*, nest-site selection, breeding density, nest height

Received — Aug. 2002, accepted — Oct. 2002

INTRODUCTION

Avian survival and reproduction can depend on habitat selection and specifically nest-site choice (Badyaev 1995, Clark & Shutler 1999). This explains the fact that birds preferentially select some microhabitats and avoid others. Some nest-sites within the territory that birds choose have characteristics that increase the probability of breeding success, while other sites are more likely to result in breeding failure (Norment 1993). Thus the process of nest-site selection is under strong selective pressures (Martin 1993). Natural selection leads to an establishment of nest-site optima which are used preferentially, and localities with more such nest-sites have greater densities (Petit & Petit 1996).

The Magpie is a widespread and numerous corvid species over most of the Palearctic (Cramp 1994). Its opportunistic diet (Tatner 1983) and habitat requirements (Birkhead 1991, Stepanyan 1997) have led to a substantial population increase in most parts of the species range but particularly in urban environments (Jerzak 2001). This primarily tree-nesting species shows great ecological plasticity and high adaptability in nest-site choice and utilises a wide variety of substrates. Its nest-site selection patterns may vary greatly spatially (Górska & Górski 1997). Magpies often have a great variety of available tree species and range of

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

heights for nesting in urban habitats. Thus, it is possible to explore the consequences of using various nest-sites on fitness. In their efforts to better understand the Magpies' large-scale successful colonization of cities better, researchers have shown much interest in its nest-sites. However, the majority of studies only provided the proportion of nests located in different substrates and the mean nest height. They did not consider to what extent nest-site selection was limited by the availability.

Nest-site selection typically implies that some nesting sites are preferred while others are avoided. The probability of successful breeding also varies among nest-sites. Thus for the nest-site selection to be adaptive, nest-sites associated with higher breeding success should be the preferred ones (Clark & Shutler 1999). In this paper we addressed the following questions to understanding the process and consequences of nest-site selection in birds (Clark & Shutler 1999):

1) preference for some nest sites and avoidance for others;

2) difference between successful and unsuccessful nest sites;

3) was the observed nest-site choice pattern adaptive, i.e. was the nest-site selection predicted by the rate of breeding success?

STUDY AREA, MATERIAL AND METHODS

The study was carried out in 1999–2000 in the southern part of city of Sofia (42°40′N 23°20′E, altitude 580 m.a.s.l.). The study area comprised 405 ha of urban habitat in the outskirt part of the city, and mainly included the district called "Student's town". It was chosen because of the extremely high density of local Magpie population, and the great diversity of the available nest substrata. Trees and bushes were abundant and represented a variety of species, heights and crown types. Trees formed rows along roads or were scattered over the study area. The area was mostly a homogeneous block district built up with 3–5-storeyed apartment blocks. Open lawn patches, an important source of invertebrate food (Tatner 1983), were available over most of the area. The human population density was very high and permanent presence of people was typical for most of the area. There were many open waste bins and scattered food scraps, which provided an abundant food supply for Magpies throughout the year. Thus we assumed food was not a limiting factor. No persecution by humans was recorded in this area and Magpies were habituated to humans.

Field procedures

To sample breeding density and habitat characteristics we used maps with a 300 m grid and a total of 36 plots 9 ha each were analysed.

The study area was systematically searched for nests since early February up to July and all the breeding attempts were plotted on the maps. Each nest was visited every 2–5 days and checked whether it was still active. The numbers of breeding pairs was determined by recording simultaneously occupied nests. More than half of nests were directly inspected by climbing for recording the breeding stage. In most cases it was easy to distinguish the successive breeding attempts of a pair after a failure, since the occupancy of nests in adjacent territories was known. Only replacements in some territories late in the season were not checked. The location of majority of breeding territories did not change in the following season.

For each accessible nest breeding parameters — laying date, clutch-size, number of young hatched and the number of young fledged, were recorded. Only original breeding attempts were included in the analyses of breeding parameters. Laying dates were standardized by setting the first laying date in the respective year to 1 and counting subsequent dates accordingly. Hatching success was defined as the number of young hatched, controlling for clutch-size, and fledging success similarly, as the number of young fledged controlling for the number of young hatched using partial correlation analysis or ANCOVA. Successful nests are those that produced at least 1 fledgling.

All trees were counted by species within each of 36 plots, and a measure of height for each was taken. For nest trees we recorded nest height and total height. Nest height and tree height were estimated with the help of a 5 m pole with bright color bands at 1 m intervals. One of the observers held the pole vertically beside a tree and the other assessed the height. To achieve consistency, the same person assessed all the heights.

Variables and statistical analyses

Seven independent variables were defined:

1. Type of tree (TYPE hereafter) — dichotomy variable describing if a tree is broadleaved (coded 0) or conifer (coded 1).

2. Tree numbers (TREENUM) — the total number of suitable trees in a plot.

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

3. Diversity index (DIV) — the Shannon-Weiner diversity index and calculated for each plot where the number of trees was known

$$DIV = 3.322(\log_{10} N\text{-}1/N\sum_{r=1}^{s} n_r \log_{10} n_r)$$

where s — number of tree species, n_r — number of individuals in the r^{th} species, N — total number of trees in the sample.

Since DIV takes into account both the number of species and their respective numbers, it was highly correlated with TREENUM. For this reason and to avoid multicollinearity problems (Pasinelli 2000) we first regressed DIV on TREENUM. In subsequent analyses we used DIV as it was, and unstandarised residuals (resTREENUM hereafter) in place of the original variable, i.e. variability that is not shared with DIV to asses the individual contribution of TREENUM.

4. Mean height of available trees (HEIGHT) and nest trees (NHEIGHT) in a plot. We also compared height of the available trees with those used for nesting.

5. Coefficient of variability of tree height (CVHEIGHT) — it was included as a measure of vertical structural diversity in the plots.

6. Leaf break order of tree species (LBR) — included to account for the importance of early cover of broadleaved trees.

7. Percentage of preferred tree species (PERCPREF). It was presumed to reflect the suitability and attractiveness of a plot. We chose 6 preferred tree species which also had a larger proportion of the nest attempts and also were represented in more than 50% of the plots.

The number of breeding pairs in 2000 was used in the analysis of habitat characteristics and density.

Multiple regressions were used to determine how a combination of independent variables explained breeding density and the different aspects of nest-site selection. Stepwise procedures were run to leave only variables that contributed significant predictive power to a model.

We tested factors (NHEIGHT, TYPE) discriminating between successful and unsuccessful nests using logistic regression. The common practice is to include only depredated unsuccessful nests since predation is considered the main factor for the evolution of nest-site selection (Martin 1993, Tarvin & Smith 1995). The cause of failure at the highest nests often was not possible to be determined with certainty. We first performed the model including only predated unsuccessful nests and then a second one with all the unsuccessful nests, irrespective of failure type. The two models agreed well, so we used the one including all types of failures. Moreover, predation accounted for most of the losses, so and it was the most likely reason for nest failure (own unpubl. data). When there was more than one breeding attempt per territory per season (original and 1–2 replacements), only one of them was chosen randomly to control for independence. Backward Log-likelihood ratio method was used as a stepwise procedure to retain significant variables. Cohen's kappa statistic (Titus et al. 1984) was used to determine if the logistic regression classified cases significantly better than by chance.

Statistical procedures were performed with SPSS 11.0. software (SPSS Inc. 2001). All tests are two-tailed. Means are reported with the respective standard deviations.

Contrast in nest site choice

An attempt in two ways was made to asses the degree of contrast in nest site selection in terms of nest height and tree type between successive breeding attempts. Firstly we considered breeding attempts within a season. They included desertions of nests – moving to another site before egg-laying, and replacements — moving to another site after eggs were laid.

Secondly, we compared the contrast in choice between the last breeding attempt in a given territory in 1999 and the first attempt in the same territory the next year. Only cases where the success of the last breeding attempt was known were included. We used this procedure assuming that at least one member of a pair would be alive in the following season and would influence the current choice of a nest site on the basis of success of the previous attempt. We had not marked individuals but pair members in Magpies are known to remain together on their territories year round and also distances between their successive nesting attempts are usually less than 27 m (Tatner 1982a, Birkhead et al. 1986).

Contrast of choice was classified with respect to two factors: TYPE change (conifer-broadleaved in either direction) and HEIGHT change. HEIGHT change was subdivided into three categories with respect to the difference between the heights of the respective two nests:

1) small difference (0–2 m);
2) medium difference (2.1–4.0 m);
3) large difference (> 4.1 m).

Combining the two factors, we defined two types of nest-site choices:

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

1) contrasting choice-either TYPE changed, or TYPE unchanged but large height difference;

2) similar choice-TYPE unchanged and small or medium height difference.

Following the definition of contrast of choices, only territories containing diverse substrata as for either TYPE or HEIGHT were included.

RESULTS

Density

In 1999 there were 210 breeding pairs (51.8 pairs/km^2) in the study area (405 ha), increasing to 230 in 2000 (56.8 pairs/km^2). The mean density per 9 ha plot was 5.23 ± 2.81 pairs (Fig. 1).

A stepwise multiple regression model on tree characteristics in the plots (DIV, HEIGHT, CVHEIGHT, PERCPREF and resTREENUM) and the density of breeding pairs found only DIV as a significant factor, explaining 40.8 % of the variance in the number of breeding pairs per plot (Table 1).

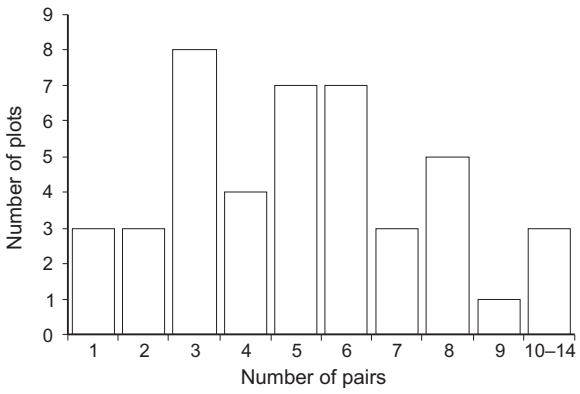


Fig.1. Distribution of breeding density in 9 ha study plots (n = 44 plots).

Preference for tree species

Fifty-eight different tree species were available in the study area, of which 40 (69%) were used by Magpies for nesting. A total of 11 236 trees and 607 breeding attempts were analysed. In order to explore the factors which contributed to the proportion of breeding attempts in the different tree species, a stepwise multiple regression was performed including HEIGHT, CVHEIGHT, TYPE, PERCTREES as independent variables. TYPE and HEIGHT were excluded as non-significant. The proportion of breeding attempts in a given tree species was best predicted by its proportion to the total number of trees and the variability of its height (Table 2). The more variable the height of a tree species was and the more numerous it was, the more breeding attempts it was likely to hold.

Eighteen tree species were not used at all by Magpies for nesting. They were represented in very small numbers, together constituting 1.6% of the total number of trees, and also occurred in only 2–10% of the plots.

Birds showed a preference for half of the used tree species (20), choosing them more often than expected by chance from their availability (χ^2 = 607.957, df = 39, $p < 0.0001$). The most strongly preferred tree species were the fastigiated cultivar of Black Poplar *Populus nigra*, Douglas Fir *Pseudotsuga menziesii* and the Blue Spruce *Picea pungens* (Table 3). Most breeding attempts were

Table 1. Tree characteristics affecting density of Magpies. Multiple stepwise regression. DIV — tree diversity index, HEIGHT — mean tree height, CVHEIGHT — coefficient of variability of mean tree height, PERCPREF — proportion of 6 preferred species, resTREENUM — residuals of the regression of tree numbers on DIV, B — regression coefficient; SE — standard error of the regression coefficients.

Variable	B	SE	ß	t	P
A. Full model R^2 = 0.472, R^2_{adj} .= 0.384, $F_{5.30}$ = 23.476, p = 0.001					
Constant	- 11.764	5.488		-2.444	0.020
DIV	1.857	0.477	0.844	3.889	0.001
HEIGHT	0.500	0.446	0.152	1.122	0.271
CVHEIGH	- 0.042	0.030	-0.209	-1.423	0.165
PERCPREF	0.0273	0.027	0.209	1.000	0.326
resTREENUM	0.338	0.762	0.069	0.443	0.661
B. Reduced model R^2 = 0.408, R^2_{adj}. = 0.391, $F_{1.34}$ = 23.476, p < 0.001					
Constant	-5.644	2.310		- 2.444	0.020
DIV	1.406	0.290	0.639	4.845	< 0.0001

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Table 2. Factors affecting tree species selection, multiple stepwise regression. Only finally selected models are shown.

Variables	Regr.	S.E.	ß-weight	R^2 change	t	P
A. Dependent variable: Proportion of breeding attempts in a tree species (Model: $R^2 = 0.706$, $R^2_{adj} = 0.682$, $F_{2.24} = 28.879$, $p < 0.0001$)						
Constant	-3.530	1.108			-3.185	0.04
CVHEIGHT	0.166	0.033	0.612	0.597	4.970	< 0.000
PERCTREES	0.517	0.173	0.368	0.109	2.989	0.006
B. Dependent variable: Choice index (Model: $R^2 = 0.477$, $R^2_{adj} = 0.433$, $F_{2.24} = 10.939$, $p < 0.0001$)						
TYPE	3.101	0.720	0.639	0.369	4.308	<0.000
HEIGHT	0.335	0.151	0.330	0.108	2.226	0.036

concentrated on poplars, both fastigiate cultivars and wide-crown hybrid forms (27.7%), and Blue Spruce (18.8%). Five of the used species readily available over the study area, were avoided (Table 3).

There was a marked preference for conifers over broadleaves ($\chi^2 = 107.371$, df = 1, $p < 0.0001$). Only 12 of the 31 broadleaved species were selected preferentially, against 8 of the 9 conifer species (Fisher exact test, p = 0.02). Proportions of nests located in broadleaved and coniferous trees did not differ significantly between the two seasons ($\chi^2 = 0.143$, df = 1, p = 0.705). The proportion of nests on conifers did not decline in the second half of the breeding season as compared to the first half (early nests: 78/152; late nests: 31/79; $\chi^2 = 1.606$, df = 1, p = 0.205).

Magpies preferred broadleaved trees with low to moderate foliage density (Table 3). There was a significant negative relationship between the LBR and choice index when conifers and broadleaved trees were combined ($r_s = -0.567$, p = 0.002, n = 27). When we considered only broadleaved trees, however, the choice index was no more significantly related to LBR ($r_s = -0.229$, p = 0.331, n = 20).

A multiple stepwise regression including TYPE, HEIGHT, LBR and CVHEIGH of the tree species as explanatory variables showed that choice index was best predicted by TYPE (broadleaved, conifer) and HEIGHT, which together explained 48 % of the variance (Table 2). CVHEIGHT and LBR were excluded as non-significant. HEIGHT brought less predictive power into the model as compared to TYPE (Table 2).

Table 3. Preference of tree species. Preferred — only species that occurred in more than 50 % of the plots, avoided — only species which constituted more than 5 % of the total numbers and occurred in more than 50 % of the plots, h — mean height, C — cover density, LB — order of leaf break, CV — coefficient of variability of height, T — total number of individual trees, N — number of breeding attempts, NE — expected number of breeding attempts as would be expected from availability of trees, CI — choice index (N/NE).

Tree species	h	CV %	C	LB	T	N	NE	CI
Preferred								
Blue Spruce *Picea pungens*	5.7	55.93	high	1.5	1192	114	65.41	1.74
Black Poplar *Populus nigra* (fastigiate cultivars)	11.5	80.01	low	5	420	102	23.05	4.43
Hybrid Poplars *Populus* sp. (wide crown)	10.2	68.41	low	6	1017	66	55.81	1.18
Douglas Fir *Pseudotsuga menziesii*	6.3	51.24	moderate	1.5	163	29	8.95	3.24
Black Locust *Robinia pseudoacacia*	6.9	52.33	low	11	375	27	20.58	1.31
Willows *Salix* spp.	6.7	45.07	low	3.5	276	19	15.15	1.25
Avoided								
Ashes *Fraxinus* spp. (*Fraxinus ornus* and *F. excelsior*)	6.6	36.44	moderate	10	856	43	46.98	0.92
Cherry Plum *Prunus cerasifera*	4.7	25.99	high	7	1139	32	62.51	0.51
Lime *Tilia* sp.	5.7	39.71	high	9	1020	17	55.98	0.30
Maples *Acer* spp. (*Acer platanoides* and *A. pseudoplatanus*)	6.3	23.91	high	8	616	14	33.80	0.41
Birch *Betula pendula*	8.1	29.37	low	3.5	598	13	32.82	0.40

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Nest height

The average nest height was 6.9 ± 3.15 (1.2–14.0) m. Most nests were placed 4–8 m above the ground. Nest height was strongly correlated with nest tree height ($r = 0.957$, $p < 0.0001$, $n = 663$), i.e. whatever the tree height, the nest was positioned in the top part.

The height distribution of trees used for nesting was similar to the height distribution of available trees (Fig. 2). However, lower (1–4 m) and higher (> 8 m) trees were preferred while medium ones (4.1–8.0 m) were used less often than expected from their availability ($\chi^2 = 67.73$, $df = 2$, $p < 0.0001$).

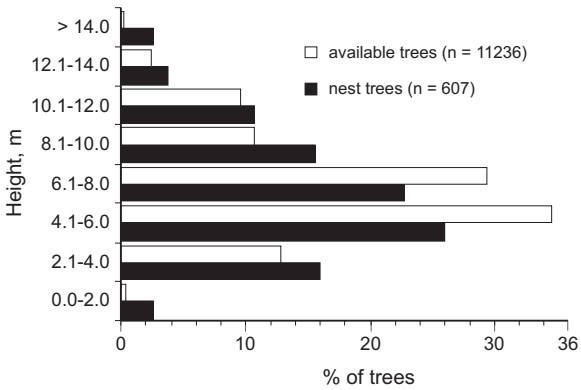


Fig. 2. Height distributions of available trees and actually choosen nest trees.

Across the 9 ha grid cells, there was not a significant correlation between the mean height of available trees in a plot and the height of those chosen for nesting ($r = 0.255$, $p = 0.153$, $n = 33$). Nest trees, 8.58 ± 1.578 m, were on average taller than other available trees, 6.19 ± 0.762 m (Paired t-test, $t = -8.777$, $df = 32$, $p < 0.0001$). Also, no correlation was found between the variability of available trees and those chosen by Magpies ($r_s = 0.127$, $p = 0.482$, $n = 33$). Nest trees varied less in height than available trees but the difference was not significant (Paired t-test, $t = 1.483$, $df = 32$, $p = 0.148$).

Breeding success in relation to nest-site selection

The probability of breeding success differed significantly between nests on preferred and avoided tree species ($\chi^2 = 7.51$, $df = 1$, $p = 0.006$). Nests on preferred trees were more likely to be successful (139 successful/55 unsuccessful) while those in avoided tree species had an equal chance of being successful or unsuccessful (28 successful/26 unsuccessful). Choice index was best explained by HEIGHT and TYPE (see above) and tree species in the preferred group were on average taller ($t_{25} = -2.195$, $p = 0.038$) and included more conifer species. The independent influence of HEIGHT and TYPE on the overall breeding success and breeding parameters thus was explored.

A logistic regression analysis exploring the relative importance of HEIGHT and TYPE on the probability of breeding success showed that only HEIGHT was a significant variable discriminating between successful and unsuccessful nests (Table 4). The model classified cases significantly better than would be expected by chance (Cohen's kappa $Z = 0.164$, $p = 0.02$). The relationship, however, was not very strong and the model classified correctly overall 63.6% of cases (84.1% successful nests and 31.5% unsuccessful nests). The rate of success varied significantly for the three defined categories of nesting tree height ($\chi^2 = 20.553$, $df = 2$, $p < 0.0001$). This was due to the high nest tree band, where success rate was higher. The ratio of successful and unsuccessful nests did not differ significantly from unity for the lower ($\chi^2 = 0.18$, $df = 1$, $p = 0.679$) and medium ($\chi^2 = 0.24$, $df = 1$, $p = 0.622$) nest tree height bands.

Table 4. Relationship between nesting success and nest-site features, as analyzed by stepwise logistic regression (Model: $\chi^2 = 27.114$, $df = 1$, $p < 0.0001$; 63.6 % correctly classified cases, Nagelkerke $R^2 = 0.107$, $n = 320$). B — logit coefficient, Wald statistic — tests the significance of logit coefficients, Exp (B) — exponent of the logit coefficients, i.e. odds ratio.

Variable	B ± SE	Wald statistic	df	Sig	Exp (B)
NHEIGHT	0.197 ± 0.041	23.492	1	0.000	1.218
Constant	-1.156 ± 0.342	11.429	1	0.001	0.315

Nest height also influenced breeding parameters of Magpies. There was a significant negative correlation between nest height and laying date ($r = -0.201$, $p = 0.002$, $n = 230$). Birds that laid earlier in the season built their nests higher above the ground. Clutch-size also increased with nest-height ($r = 0.156$, $p = 0.028$, $n = 199$). However, clutch-size also decreased significantly with laying date ($r = -0.294$, $p < 0.0001$, $n = 201$) and after controlling for laying date, the effect of nest-height was no more significant (Partial $r = 0.111$, $p = 0.109$, $n = 196$). Both hatching success and fledging success were positively and significantly related to nest height (hatching success: Partial $r = 0.154$, $p = 0.032$, $n = 192$; fledging success:

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Table 5. Breeding parameters of Magpies nesting in broadleaved and coniferous trees. ANCOVAs in which nest height was entered as a covariate. For clutch-size, hatching and fledging success, laying date was also controlled for. H — number of young hatched, Fl — number of young fledged, sample size in brackets, *p < 0.05.

Variable	Broadleaved	Coniferous	F	df	p
Laying date	27.7 ± 2.17 (122)	25.8 ± 10.54 (110)	2.693	1,227	0.102
Laying date (renovated nests excluded)	29.4 ± 11.18 (96)	25.7 ± 10.51 (104)	4.177	1,195	0.042*
Clutch-size	6.34 ± 1.19 (106)	6.53 ± 1.100 (95)	0.263	1,198	0.609
H/pair	2.61 ± 2.51 (116)	3.07 ± 2.47 (108)	2.047	1,190	0.154
H/pair with complete clutch	2.94 ± 2.48 (103)	3.53 ± 2.32 (94)	2.047	1,190	0.154
Fl/pair that hatched any young	1.96 ± 2.30 (117)	2.32 ± 2.29 (108)	0.008	1,130	0.927
Fl/successful pair	3.45 ± 2.05 (64)	3.49 ± 1.94 (72)	1.607	1,111	0.208

Partial r = 0.254, p = 0.003, n = 132). Fledging success also increased significantly with nest-height even for successful pairs only (Partial r = 0.247, p = 0.008, n = 113).

Controlling for nest-height, Magpies nesting on conifers laid eggs earlier, had slightly larger clutch-size, hatching and fledging success as compared to those nesting on broadleaved trees but the differences were not significant (Table 5). However, when the renovated nests were removed from the sample, the difference in laying dates became significant (Table 5). Renovated nests obviously masked the relationship firstly because Magpies renovating their nests laid significantly earlier in the study area and secondly, since nests on conifers were significantly less likely to be renovated (own unpubl. data). Despite the marked preference for conifers, breeding attempts in them were not significantly more likely to be successful than those in broadleaves since TYPE did not enter the logistic regression model.

Proportion of successful breeding attempts did not vary significantly among the commonly used tree species (Table 6; $\chi^2 = 10.0577$, df = 10, p = 0.435). The general relationship between the choice index and the proportion of successful nests for the different tree species was relatively weak and insignificant, though fastigiated cultivars of Black Poplar, on which birds had a high success rate, were most preferred, and the least successful Cherry Plums *Prunus cerasifera* were one of the avoided species (Fig. 3).

Table 6. Success rate in the most commonly used tree species by Magpies. Only tree species with more than 15 breeding attempts are included. T — total number of breeding attempts with known success, S — number of successful attempts, ES — calculated as number of breeding attempts in a tree species/T * total number of successful attempts. S/ES — index of the relative rate of success.

Tree species	T	S	ES	S/ES
Picea pungens	81	50	52.7	0.95
Populus nigra (fastigiate)	50	42	32.5	1.29
Populus sp. (broad crown)	36	30	23.4	1.28
Fraxinus sp.	20	13	13.0	1.00
Prunus cerasifera	21	6	13.7	0.44
Pseudotsuga menziesii	21	11	13.7	0.81
Robinia pseudoacacia	12	8	7.8	1.03
Salix sp.	7	4	4.6	0.88
Pinus sp.	17	10	11.1	0.90
Tilia sp.	10	6	6.5	0.92
Quercus sp.	8	4	5.2	0.77
Total	283	184		

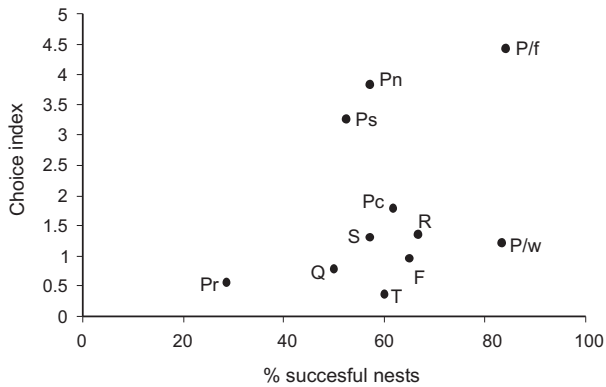


Fig. 3. Relationship between breeding success and choice index (Spearman rank correlation coefficient, $r_s = 0.373$, p = 0.259, n = 11). Only tree species for which there were > 8 breeding attempts with known success were included. F — *Fraxinus* sp., Pc — *Picea* sp., Pn — *Pinus* sp., P/f — *Populus* sp. (fastigiated), P/w — *Populus* sp. (wide), Ps — *Pseudotsuga menziessii*, R — *Robinia pseudoacacia*, S — *Salix* sp., T — *Tilia* sp., Q — *Quercus* sp.

Contrast of nest-site choice

Of 50 pairs which were successful the previous season, 33 made a similar nest site choice in the current year and 17 chose nest-sites that contrast-

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

ed with the previous year's nest-sites. Of 13 pairs that were known to be unsuccessful during the previous season, 6 made similar nest-site choice and 7 made a contrasting choice. Thus there was no association between success of the last breeding attempt at a territory and the probability of a contrasting choice the following season ($\chi^2 = 0.984$, df = 1, p = 0.189), but the sample of unsuccessful nests was small as compared to successful ones. Pairs that had success the previous year were more likely to use similar nest-sites the next season than to make a contrasting choice ($\chi^2 = 4.50$, df = 1, p = 0.024).

Among the subsequent breeding attempts within a season, pairs that switched to much different nest-sites were as likely to occur as those choosing non-contrasting sites ($\chi^2 = 0.053$, df = 1, p = 0.729).

Considering broadleaved trees, Magpies tended to site the replacement nest lower above the ground as compared to the corresponding original nest but the relationship was not significant (Paired t-test, $t_{19} = 1.854$, p = 0.079).

DISCUSSION

Density

The breeding density of Magpies (56.8 pairs/km^2), found in this study seems to be amongst the highest ever reported for the species. The closest figure (50 pairs/km^2) is reported from Warsaw in suburban allotments (Luniak et al. 1997). Magpies also reached high densities in Berlin (32 pairs/km^2, Witt 1997) and in Northern England (32 pairs/km^2, Goodburn 1991).

The density of pairs was best predicted by DIV while TREENUM had negligible contribution as a unique factor. Tatner (1982b) found that both TREENUM and DIV were significant factors in Manchester, explaining 35% of the variance in the number of pairs in plots. DIV was probably of more limited importance in Manchester due to the generally lower tree diversity there.

Tree species preference

Magpies selected for nesting a very wide array of tree species, using nearly 70% of all the available tree species which agrees with data from other studies (Tatner 1982b, Birkhead 1991, Vuorisalo et al. 1992). Further, as many as half of the tree species were preferred. In Manchester, of 16 tree species, seven (44%) were used preferentially, but most preferred were poplars and the Jersey Elm *Ulmus wheatleyi* (Tatner 1982b). The most common tree species used in Poland were poplar, maple *Acer*, birch *Betula* and lime *Tilia* (Górska & Górski 1997, Jerzak 1997, Jerzak 2001), but it is recognised that inter-regional differences are due to the local tree composition and the great ecological adaptability of Magpie (Górski & Górska 1997). Spruce *Picea* spp. and pine *Pinus* spp. were not selected at all in Zielona Góra, SW Poland (Jerzak 1997) and also avoided in SW Germany (Prinzinger & Hund 1981). Poplars were suggested as particularly important for Magpies since they were reported as common and occasionally preferred substrates over large geographic areas, but this might be due to their being commonly planted trees in many cities (Jerzak 2001).

The order of leaf-breaking was not a significant predictor of choice index when HEIGHT and TYPE were known. Similarly, Tatner (1982b) found that leaf-break order was not related to choice index in Manchester. A possible reason is that the importance of early cover is explained mainly by TYPE because the permanent cover of conifers is immediately available to the Magpies at the very start of the breeding season while the broadleaved trees leaf out gradually and there is overlap in the leaf-break periods of many species. This is corroborated by the finding that there was a significant negative correlation between choice index and leaf break when both conifers and broadleaved trees are combined, while the relationship was no more significant when only broadleaved trees were tested.

Magpies seemed to prefer broadleaved trees with relatively open cover. Coniferous trees have thicker cover but it is clumped and with gaps between branches allowing easy access to the nest. This indicates that a good view of the surroundings may also be important as well as nest concealment. Götmark et al. (1995) suggested that nest-site selection in birds may be a trade off between good concealment and sufficient view of the surroundings.

Nest height

The average nest height in this study was markedly lower than that reported from other cities (review in Jerzak 1997). It is often stressed that Magpies nest very high in cities and even that the presence of tall trees is an important factor permitting the colonisation of the urban environment (Jerzak 2001). However, the height of available trees was very rarely measured to show preference for tall trees. Magpies will site the nest in the top part of a tree (Jerzak 1997, this study), so if most trees are tall, this may be the reason of

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

the respective higher nest placement. Greater nest height in urban habitats was commonly attributed to the tendency to escape human disturbance (Knight & Fitzner 1985, Jerzak 2001). But Magpies also nest very high in some cities where persecution is very low or absent (Tatner 1982b). In such cases it may be the higher density of buildings that force birds to nest at the top of the tallest trees, thus escaping the highly fragmented maze-like space closer to the ground. Buildings in our study area were surrounded by large patches of open grassy terrain.

Adaptiveness of nest-site selection

Nest-site selection is considered adaptive, i.e. natural selection would lead to a preference for such sites where birds expect to have greater breeding success (Martin 1998, Clark & Shutler 1999). The probability that a breeding attempt finally succeeded varied significantly with preferred and avoided tree species with greater success on preferred species. This indicated that birds may adjust nest-site selection in relation to experienced breeding success. The latter implies that preferred and avoided species differed with some characteristics important for breeding success. We found that the mean height of trees and the proportion of coniferous trees were higher within the preferred group. Only tree height, however was a significant predictor of the probability of success. Controlling for height, nesting on conifers gave no advantages in terms of final success over nesting on broadleaved trees despite the strong preference for conifers. Species-specific features of trees independently of their height and type are possibly less important for the adaptive nest-site selection because: 1) most of the tree species in the study area were used and for half of them there was also preferred; 2) the proportion of successful nests neither differed significantly among species, nor was significantly related to choice index of the corresponding tree species.

Though nest height was a reliable predictor of breeding success, the relationship was not very strong. Disregarding the tree species, preference for taller trees should be expected since nests at taller trees were more successful. In this study not only were taller trees preferred as was found in other studies (Knight & Fitzner 1985, Jerzak 1995) but also shorter trees were preferred despite the lower breeding success. Given the influence of height on breeding success it could also be predicted that breeding density might be limited by the availability of tall trees (Jerzak 1997), but this was not the case. Birds just tended to use taller trees from what was available around, but were not limited by the presence of tall trees.

Further, since the probability of breeding success was not significantly different between broadleaved and coniferous trees, the strong preference for conifers is unexpected. The only benefit Magpies gained by nesting in conifers was the earlier onset of laying which should be attributable primarily to their permanent thick cover.

Thus, though there was some indication of adaptiveness of nest-site selection, the pattern of nest site preference was not well predicted by differences in the breeding success. Such a lack of finer adjustment, and greater variation in microhabitat use than should be expected based on the variation in breeding success, was also found in other passerines (Martin 1992, Martin 1998). We hypothesize it could arise by two possible non-exclusive mechanisms: 1) natural selection at any particular type of nest site may not be strong enough to produce a clear nest-site selection pattern or selective pressures may change over the season; 2) nest-site selection may depend on bird quality and/or experience.

According to the first hypothesis nest-site choice would depend on the behavioral plasticity as a function of previous success (Martin 1998). Pairs try alternative nest sites in their territories basing their nest-site choice on success of the last breeding attempt. Data on contrast of choice provide some supporting evidence for this hypothesis. Birds that had success with a particular nest-site the previous year were less likely to switch to an alternative site. Also, half the pairs that failed in their first breeding attempts sited the repeat nest in marked contrast to the previous one. The most extreme case illustrating this was a pair that initially built a nest 14.6 m at the top of a poplar. After an obvious failure, birds were seen transferring nest material to another site nearby, in a 3.3 m tall Blue Spruce.

Generally, as many as 46.5% of the breeding attempts were in poplars and spruces, and also there was a preference shown for these two species (Table 3). Poplars were the tallest species in the area, while Blue Spruces, with only half the average height of the poplars, ranged among the lower ones. Magpies were therefore attracted to two substrata with a marked contrast in TYPE and HEIGHT. What might the advantages and disadvantages of nesting in low spruces and tall poplars be? Siting nests high above the ground in poplars may help to avoid mammalian predators,

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

but such exposed and highly visible nests may be more susceptible to avian predation (Dhindsa et al. 1989), mainly crows which often depredate Magpie nests (Baeyens 1981, Vines 1981, Eguchi 1995, Eguchi & Takeishi 1997) and also conspecifics (Tatner 1982a). Hooded Crows *Corvus corvus cornix* were not very common in the study area, but we did observe several such intrusions at higher nests (own unpubl. data). On the other hand, lower nests, and especially those in spruces are more concealed, thus less likely to be discovered by avian predators. Nest building and chick feeding trip costs may be lower at lower heights which may partly explain extra breeding attempts on low trees, observed in this study. But here mammalian predators such as rats and weasels, both recorded in the study area, are likely to pose a threat. Assuming that food supply is not a limiting factor, it seems likely that territories with a greater diversity of trees are more attractive, since there are more alternative nest sites available. This might be indicative of why the diversity index was the only significant predictor of Magpie breeding density.

It could also be suggested that natural selection may favour higher nesting early in the season when nests could not be concealed by foliage and are highly visible but later on, when trees are in leaf and nests could be hidden by the foliage, higher nesting may no more be a particularly advantageous strategy. Changes in nest-site positioning over the season linked with the development of foliage are found in other early nesting species (Kosiński 2001). Magpies that failed on broadleaved trees and selected again broadleaved trees for re-nesting, tended to site the replacement nest lower above the ground than the corresponding original nest but the relationship failed to reach significance. Furthermore, since most nests failed early on the egg stage (own unpubl. data), not all the replacements coincided with the full tree leafing. Thus, we cannot be sure if lower height of replacements was due to the availability of tree cover or the tendency of birds to position the next breeding attempt in contrast to the previous one that failed. The usage of conifers as nest sites did not change with the season as was found in the urban Greenfinches (Kosiński 2001).

According to the bird quality hypothesis the pattern of nest-site selection could arise because experienced breeders are more likely select nesting places with high probability of success while inexperienced and/or young breeders may site the nest suboptimally. The variation of breeding parameters with nest height and tree type i.e. features which were related to breeding success and/or preference for nest-sites provides indirect evidence in support of this hypothesis. Experienced breeders occupy better sites with increased probability of success, start breeding earlier, lay larger clutches and produce more offspring (Klomp 1970, Verhulst & Tinbergen 1991). The increase of nest-height was associated with earlier laying, larger clutch-sizes and higher fledging success. Moreover, successful pairs produced more fledglings at higher nests (but see Jerzak 1995). This suggests that possibly experienced breeders nested more frequently higher above the ground and had higher breeding success there. If the quality of nest-sites is learned by experience then first time breeders are more likely to site the nest suboptimally in terms of probability of predation. Inexperienced breeders also may face greater costs of nest building and chick rearing by nesting higher above the ground and could be more prone to nest lower above the ground. Thus the occupation of lower trees mostly by inexperienced breeders may explain the observed preference for the low tree height band despite lower chance of success. Further, though conifers did not produce a significant increase in the probability of breeding success, they were strongly preferred over broadleaves. Conifers had a limited influence on breeding parameters but Magpies nesting in them laid significantly earlier. All the other reproductive features were not significantly different but clutch-size, hatching success and fledging success were consistently higher for birds nesting in conifers. Possibly conifers are attractive to Magpies by virtue of their permanent thick cover which hides nests well early in the season and high-quality breeders may nest more frequently in them. This may explain earlier laying in conifers. Since Magpies in this study were not individually marked, we are unable ascertain to what extent observed nest-site selection and the resulting implications on breeding success were due to nest-site features *per se* or bird quality. Further studies are needed to disentangle these effects.

ACKNOWLEDGMENTS

We are very grateful to Michael Frankis who improved the English. An anonymous reviewer provided helpful comments which improved this paper. Special thanks to Dr. Dimitar Dimitrov at

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

the Herbarium at Sofia University who ranked the tree species during the leaf-break periods.

REFERENCES

Badyaev A. V. 1995. Nesting habitat and nesting success of eastern Wild Turkey: potential causes and reproductive consequences. Condor 98: 589–594.

Baeyens G. 1981. Magpie breeding success and Carrion Crow interference. Ardea 69: 125–139.

Birkhead T. R. 1991. The Magpies. Poyser, London.

Birkhead T. R., Eden S. F., Clarkson K., Goodburn S. F., Pellatt J. 1986. Social organisation of a population of magpies *Pica pica*. Ardea 74: 59–68.

Clark R. G., Shutler, D. 1999. Avian habitat selection: pattern from process in nest-site use by ducks? Ecology 80: 272–287.

Cramp S. (ed.). 1994. The Birds of the Western Palearctic. Vol. 6: 54–75.

Dhindsa M. S., Komers P. E., Boag D. A. 1989. Nest height of Black-billed Magpies: is it determined by human disturbance or habitat type? Can. J. Zool. 67: 228–232.

Eguchi K. 1995. Seasonal change in breeding success of the Black-billed Magpie *Pica pica sericea*. Jap. J. Ornithol. 44: 73–80.

Eguchi K., Takeishi M. 1997. The ecology of the Black-billed Magpie *Pica pica sericea* in Japan. Acta Ornithol. 32: 33–37.

Goodburn S. F. 1991. Territory quality or bird quality? Factors determining breeding success in the Magpie *Pica pica*. Ibis 133: 85–90.

Górska E., Górski W. 1997. Nest sites of the Magpie *Pica pica* in urban and rural habitats in the Koszalin Region, NW Poland. Acta Ornithol. 32: 45–50.

Götmark F., Blomqvist D., Johansson O. C., Bergkvist, J. 1995. A trade-off between concealment and view of the surroundings? J. Avian Biol. 26: 305–312.

Jerzak L. 1995. Breeding ecology of an urban Magpie *Pica pica* population in Zielona Góra (SW Poland). Acta Ornithol. 29 : 123–133.

Jerzak L. 1997. Magpie *Pica pica* nest sites in urban habitats in Poland. Acta Ornithol. 32: 69–76.

Jerzak L. 2001. Synurbanization of the Magpie in the Palearctic. In: Marzluf J. M., Bowman R., Donnelly R. (eds). Avian Ecology and Conservation in an Urbanizing World. Kluwer Academ. Publ., pp. 403–425.

Klomp H. 1970. The determination of clutch-size in birds. A review. Ardea 58: 1–124.

Knight R. L., Fitzner R.E. 1985. Human disturbance and nest site placement in Black-billed Magpies. J. Field Ornithol. 56: 153–157.

Kosiński Z. 2001. The breeding ecology of the Greenfinch *Carduelis chloris* in urban conditions (study in Krotoszyn, W Poland). Acta Ornithol. 36: 111–121.

Luniak M., Kozłowski P., Nowicki W. 1997. Magpie *Pica pica* in Warsaw — abundance, distribution and change in its population. Acta Ornithol. 32:77–86.

Martin T. E. 1992. Breeding productivity considerations: what are the appropriate habitat features for management? In Hagan J. M., Johnston D. W. (eds). Ecology and conservation of neotropical migrants. Smithsonian Inst. Press, Washington, D.C., USA., pp. 455–473

Martin T. E. 1993. Nest predation and nest sites: new perspectives on old patterns. BioScience 43: 523–532.

Martin T. E. 1998. Are microhabitat preferences of coexisting species under selection and adaptive? Ecology 79: 656–670.

Norment C. J. 1993. Nest-site characteristics and nest predation in Harris' Sparrows and White-crowned Sparrows in the Northwest territories, Canada. Auk 110: 769–777.

Pasinelli G. 2000. Oaks (*Quercus* sp.) and only oaks? Relations between habitat structure and home range size of the middle spotted woodpecker (*Dendrocopos medius*). Biol. Conserv. 93: 227–235.

Petit L. J., Petit D. R. 1996. Factors governing habitat selection by Prothonotary Warblers: field tests of the Fretwell-Lucas models. Ecol. Monogr. 66: 367–387.

Prinzinger R., Hund K. 1981. Untersuchugen uber die okologischen Anspruche an den Nistbiotop bei Elster *Pica pica* und Rabencrache *Corvus corone cornix*. Okol. Vogel 3: 249–259.

SPSS Inc. 2001. SPSS/WIN. Chicago: SPSS Inc.

Stepanyan L. 1997. Some geographical variations of Magpie behaviour between European Russia, Middle and Central Russia and Korea. Acta Ornithol. 32: 132.

Tarvin A., Smith K. 1995. Microhabitat factors influencing predation and success of suburban Blue Jay *Cyanocitta cristata* nests. J. Avian Biol. 26: 296–304.

Tatner P. 1982a. The breeding biology of magpies *Pica pica* in an urban environment. J. Zool. (London) 197: 559–581.

Tatner P. 1982b. Factors influencing the distribution of Magpies *Pica pica* in an urban environment. Bird Study 29: 227–234.

Tatner P. 1983. The diet of urban Magpies. Ibis 125: 90–107.

Titus K., Mosher J. A., Williams B. K. 1984. Chance corrected classification for use in discriminant analysis: ecological applications. Amer. Midl. Nat. 111: 1–7.

Verhulst S., Tinbergen J. M. 1991. Experimental evidence for a causal relationship between timing and success of reproduction in the Great Tit *Parus major*. J. Anim. Ecol. 60: 269–282.

Vines G. 1981. A socio-ecology of Magpies *Pica pica*. Ibis 123: 190–202.

Vuorisalo T., Hugg T., Kaitaniemi P., Lappalainen J., Vesanto S. 1992. Habitat selection and nest sites of the Magpie *Pica pica* in the city of Turku, SW Finland. Ornis Fenni. 69: 29–33.

Witt K. 1997. One the abundance of magpie *Pica pica* during the breeding and wintering seasons in Berlin. Acta Ornithol. 32: 121–127.

STRESZCZENIE

[Wybiórczość miejsc gniazdowych u sroki w warunkach wysokiego zagęszczenia miejskiej populacji w Sofii]

Przedmiotem badań były następujące zagadnienia: 1) wybiórczość (preferencja lub unikanie) w stosunku do określonych miejsc lęgowych; 2) czy sukces lęgowy wiązał się z określonymi rodzajami miejsc gniazdowych; 3) czy wybiórczość w stosunku do miejsc lęgowych miała charakter przystosowawczy, tj. czy utrwalała się poprzez sukces lęgowy.

Badania prowadzono w latach 1999–2000 na obszarze 405 ha, w którym wydzielono 36 powierzchni próbnych, każda po 9 ha. Na każdej powierzchni liczono drzewa (ogółem 11.236) i oznaczano ich gatunek, wysokość oraz doku-

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

mentowano gnieżdżenie się srok (ogółem 607 zapoczątkowanych lęgów). Ponad połowa ogólnej liczby lęgów była badana przez bezpośrednie kontrolowanie gniazda. Za pomyślne uznano lęgi, z których wyszedł co najmniej jeden podlot.

W 1999 stwierdzono na badanym terenie 210 par, w 2000 — 230 (56.8 p/km^2), co jest jednym z najwyższych zagęszczeń znanych u sroki (Fig. 1). Spośród rozpatrywanych czynników zagęszczenie badanej populacji było najbardziej związane z różnorodnością drzewostanu (Tab. 1). Sroki wykorzystywały 40 (69%) gatunków drzew dostępnych na badanym terenie, a preferowały 20 gatunków (Tab. 3), preferowały szpilkowe w stosunku do liściastych i wyższe w stosunku do niższych (Tab. 2). Nie stwierdzono związku z terminem rozwijania się listowia u drzew liściastych. Nie miała też znaczenia bezwzględna wysokość drzew.

Pomyślność lęgów zależała od wysokości drzewa, a była niezależna od tego czy było ono szpilkowe czy liściaste (Tab. 4). Gniazda usytuowane wyżej miały wcześniejsze, większe i produktywniejsze lęgi. Lęgi na drzewach szpilkowych (wyraźnie preferowanych) były wcześniejsze, ale ich pomyślność nie była wyższa niż na liściastych (Tab. 5). Pomyślność lęgów nie wykazała istotnego związku z gatunkiem drzewa (Tab. 6, Fig. 3).

Prawdopodobieństwo założenia gniazda w tym samym miejscu było wyższe, gdy lęg odbyty tu w poprzednim roku był pomyślny.

Adaptatywna wybiórczość w stosunku do miejsc lęgowych u badanej populacji przejawiła się selektywnym wyborem gatunków drzew oraz tym, że drzewa z preferowanych gatunków miały średnią wysokość większą niż gatunków unikanych — a właśnie w gniazdach umieszczanych wyżej pomyślność lęgów była lepsza. Stwierdzono też jednak preferencję do drzew niższych, mniej sprzyjających sukcesowi lęgowemu. Podobnie preferencja w stosunku do drzew szpilkowych nie była powiązana z pomyślnością lęgów. Ten brak wyraźnego powiązania wybiórczości miejsc gniazdowych i pomyślności lęgów, można wyjaśnić nie dość silnym działaniem selekcyjnym czynnika miejsc lęgowych oraz znaczeniem osobniczej jakości gnieżdżących się ptaków.



T. Cofta

Downloaded From: https://complete.bioone.org/journals/Acta-Ornithologica on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use