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Colonisation and nest site selection in the urban landscape of Poltava, Ukraine by Eurasian Jay *(Garrulus glandarius)*: A case report study

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Abstract In recent decades, the Eurasian Jay *(Garrulus glandarius)* has been actively colonising urban areas; however, its adaptation to living near humans has been understudied. This study examines the nesting density, habitat preferences and the impact of urban landscape elements on nest site selection of Eurasian Jays in Poltava, Ukraine. The study covered over a 16.46 km^2 area in Poltava, comparing the coverage around Eurasian Jay nests to that of randomly selected points. Statistical analyses, including the Kruskal–Wallis-test and Bayesian logistic regression, suggested that tree cover slightly influences nest site selection, though no strong correlations with other urban variables were detected. Additionally, the distance of nests to roads and buildings did not significantly differ from random points, suggesting a tolerance of urban infrastructure. However, the overall low density of Eurasian Jays compared to other corvids in the city highlights their relatively limited adaptation to urban environments.

Keywords: birds, Eurasian Jay, urban landscape, habitat selection

Összefoglalás Az elmúlt évtizedekben a szajkó *(Garrulus glandarius)* benépesítette a városi területeket; az emberi környezethez való alkalmazkodását azonban kevéssé vizsgálták. Ez a tanulmány a szajkó fészkelési denzitását, élőhelypreferenciáját és a városi tájképi elemek fészelőhely-választására gyakorolt hatását vizsgálja az ukrajnai Poltavában egy 16,46 km^2-es területen. A kutatás során összehasonlították a fészkek körüli lefedettséget a véletlenszerűen kiválasztott pontokéval. A statisztikai elemzések, beleértve a Kruskal–Wallis-tesztet és a Bayes-féle logisztikus regressziót, azt mutatták, hogy a fák borítása enyhén befolyásolja a fészkek helyének kiválasztását, míg más változókkal nem mutattak erős korrelációt. Emellett a fészkek utaktól és épületektől való távolsága nem különbözött szignifikánsan a véletlenszerűen kiválasztott pontoktól, ami arra utal, hogy a madarak tolerálják a városi infrastruktúrát. Mindazonáltal a szajkók más varjúfélékhez képest alacsony denzitása rávilágít arra, hogy a városi környezethez való alkalmazkodásuk viszonylag korlátozott.

Kulcsszavak: madarak, szajkó, városi környezet, élőhelyválasztás

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Introduction

The Eurasian Jay *(Garrulus glandarius)* is a common sedentary and nomadic species with an extremely large range in Europe. It usually nests in various types of forest biotopes. The European population is estimated at 7,480,000–14,600,000 pairs, which equates to 15,000,000–29,300,000 mature individuals. In Ukraine, there are 225,000–320,000 estimated pairs, which accounts for about 2.2% of the European population (BirdLife International 2015). In Europe, the Eurasian Jay also usually chooses forests during the breeding season but can settle in windbreaks and urban areas (Gianpasquale & Meriggi 2019).

Approximately since the end of the 1960s, the species began to adapt to dwelling in anthropogenic landscapes, inhabiting green areas of settlements of various sizes and residential quarters (Knysh *et al.* 2010). This was reflected in the increase in population size and expansion of nesting sites in populated areas (Zimaroeva 2012). For example, in the city of Melitopol, the nesting of the species was first recorded in 2008, and by 2017–2019, the total number of breeding pairs reached 60–70 (Koshelev *et al.* 2020). In Lviv, during the late 1990s and early 2000s, an increase in the number of Eurasian Jays was also observed (Bokotey 2008). The exploitation of non-typical nesting places by Eurasian Jays was also documented. For example, in 2014 in the city of Melitopol, one pair built a nest behind the balcony cladding, on the third floor of a five-story residential building in the city centre (Koshelev *et al.* 2020). Nesting of Eurasian Jays on buildings was also recorded in other parts of their range (Krivickij 1989, Nadtochij & Ziomenko 1989, Rezanov & Rezanov 2007). However, compared to other corvid species such as the Hooded Crow *(Corvus cornix)*, Rook *(Corvus frugilegus)*, Western Jackdaw *(Coloeus monedula)* and Eurasian Magpie *(Pica pica)*, the Eurasian Jay is less synanthropic and remains primarily a forest species, preferring woodlands (Zimaroeva 2012, Gianpasquale & Meriggi 2019, Koshelev *et al.* 2020).

The biology and population aspects of common corvid species in cities that have rapidly colonised and inhabited anthropogenic landscapes have been studied over a large area of their range (Jerzak 2001, Vogrin 2003, Wang *et al.* 2008, Kövér *et al.* 2015, Jokimäki *et al.* 2017, Benmazouz *et al.* 2021). However, little is known about the gradual expansion of Eurasian Jays into cities and the processes of their urbanisation have received little attention.

For Poltava, the Eurasian Jay was a common bird during the winter in the first half of the 20th century. The first documented nesting of the species in the city dates back to 1954, when a pair built a nest in a spruce tree at the Fruit and Berry Technical College. Up to 1958, only one nesting pair was regularly observed there (Gavrilenko 1970). Currently, the Eurasian Jay is one of the most numerous forest-nesting species in the arboretum, which is located on the outskirts of the city (Slusar 2017). However, since the mid-20th century, no research has been conducted on the territory of residential areas of the city, and we lack data on the level of urban adaptation of this species.

The available literature on the distribution and abundance of the Eurasian Jay, especially in urban areas, is rather limited. Additionally, the extent to which Eurasian Jays have settled in cities and the preferences of their habitat choice in cities remain unclear.

In this preliminary study, we aim to analyse how the species exploits urban landscapes, identify their habitat preferences, and assess the influence of urban landscape elements on nest-site selection.

Material and Methods

The research was carried out in the territory of Poltava city. A complete survey of the area of 16.46 km^2, which is 15.8% of the entire city territory, was conducted. The surveyed territory of the city included its centre and central streets, the main green areas of the city and a significant part of the private buildings sector. The research was conducted from late March to mid-April in 2021 and 2022 by mapping Eurasian Jay nests, sometimes nesting pairs. The study area was surveyed at least once during the breeding season each year. The survey effort was evenly distributed across the area to ensure comparable detectability; every yard and every green space was inspected. Due to the conspicuous behaviour of Eurasian Jays during the breeding period, we estimated that the probability of detecting an active nest or nesting pair was high, although some nests may have been missed in densely vegetated or inaccessible areas, such as those concealed in mistletoe clusters. Nest coordinates were recorded in the field using the open navigation system of Google Maps.

To find out the characteristics of the distribution of the species' nesting sites, the survey area was divided into three categories according to different urban landscapes, types of vegetation, and anthropogenic pressure:

(I) Areas with high-rise buildings (more than two floors) and commercial buildings (7.71 km^2, 46.84% of the study area). These areas are often close to the main streets of the city (with continuous and regulated traffic) and have high traffic intensity. Dense low-rise buildings, such as city markets and garage cooperatives are also included in this category.

(II) Private sectors with one- and two-storey buildings (6.68 km^2, 40.56%). This category of sites includes suburbs, away from main roads with heavy and regulated traffic.

(III) Parks and green spaces (2.07 km^2, 12.6%), also including cemeteries and the university botanical garden.

To estimate the area of land cover type around nests we used land cover map created in our previous study (Dupak & Telizhenko 2023). Six habitat variables were chosen for the analysis: (i) proportion of tree cover, (ii) proportion of grass and ground, (iii) proportion of artificial ground covers, i.e. asphalt and tiles, (iv) proportion of high-rise buildings, which was defined as having more than two floors, (v) proportion of low buildings (up to 2 floors) and (vi) proportion of water surface. In this case, we relied on the classifications proposed in the studies of Jokimäki *et al.* (2017) and Sakhvon and Kövér (2020). In addition, we categorized buildings into high-rise (multistorey, higher than two floors) and low-rise, considering that, depending on height, they might create distinct 3D environments for birds.

To investigate bird nesting habitat selection, we used 75-m radius plots around the nests and control points. Such a radius was used by Jokimäki *et al.* (2017) for similar studies of nest-site selection by Eurasian Magpies. The relatively small area for the analysis of habitat selection is explained by the fact that the foraging activity of solitary corvid birds is concentrated, first of all, around the nest, and the staying of birds in this area is necessary for its protection (Högstedt 1980). Therefore, in our opinion, birds are guided by surrounding landmarks in a relatively small range during the choice of a nest site.

Thirty random control points were generated within the tree cover layer (to account for the fact that Eurasian Jays build nests only in trees) using the "Random Points Inside Polygons" tool in QGIS 3.26.3. The percentage of each habitat variable was calculated and visualized using 'Field Calculator' in QGIS and custom Python scripts.

We measured the distance from the Eurasian Jay nesting site to the nearest road and the building to investigate the effects of buildings and roads on the location of nest sites. Such measurements were also performed for randomly generated points (n = 30).

Statistical analyses

To compare breeding densities in different urban areas, the Kruskal–Wallis H-test (Kruskal & Wallis 1952) with Dunn's *post hoc* test and Bonferroni adjustment (Dunn 1961) were used. The kernel density estimation of Eurasian Jay nesting in Poltava city was calculated using the STATS package in R v4.4.0 (R Core Team 2023).

We then evaluated differences in habitat (land cover) variables between the nesting sites of Eurasian Jay and random control points. To examine how close the sample data fitted a normal distribution the Shapiro–Wilk-test (Shapiro & Wilk 1965) was performed. Since the Shapiro–Wilk-test revealed that the data were not normally distributed, we used the Mann–Whitney U-test for further analysis.

Additionally, we modelled the probability that a sampling point represents an Eurasian Jay nest (versus a randomly selected control site) using Bayesian logistic regression implemented in R via the 'brms' package (Bürkner 2017, Carpenter *et al.* 2017). A Bayesian approach was adopted because it often provides more reliable estimates than traditional methods when dealing with relatively small sample sizes. We modelled whether a point is an Eurasian Jay nest (1) or a control site (0) based on the land cover percentages (scaled from 0 to 1). Weakly informative normal priors (mean = 0, SD = 1) were specified for both the intercept and regression coefficients. Model estimation was performed using Markov Chain Monte Carlo sampling with four chains, each run for 10,000 iterations, including a 4,000-iteration burn-in. Convergence was assessed using R-hat values and effective sample sizes (ESS), and model fit was evaluated through posterior predictive checks.

Finally, the distances from Eurasian Jay's nests to the nearest road and building were compared with those from randomly generated points in the tree cover to the nearest road and building. Since the data did not follow a normal distribution, the Mann–Whitney U-test was used to compare these distances. Additionally, rank-biserial correlation was calculated to assess the strength of the differences between groups. The analysis and visualisations were performed using the 'ggstatsplot' package (Patil 2021).

Results

Number and density

A total of 16 Eurasian Jay pairs were registered in the study area. The largest number of nests, 8 (50.0%) was found in parks and green spaces. In private sector plots, 7 pairs (43.7%) were recorded, and 1 pair (6.3%) was in the first zone (plots with high-rise, industrial, and commercial buildings).

The average nesting density of the species in the study area was 0.97 pairs/km^2. The highest density in parks and green spaces was 3.8 pairs/km^2. In the private sector plots, the density was 1.05 pairs/km^2, and the lowest one was for territories covered by high-rise buildings and by industrial and commercial buildings, the estimated nesting density here was 0.1 pair/km^2.

More than half of the nests found (55.5%) were built inside the mistletoe.

Breeding density differed significantly among site categories (Kruskal–Wallis-test: $H = 24.153$, $p < 0.01$). *Post hoc* pairwise comparisons using Dunn's test with Bonferroni adjustment showed that breeding densities in green areas were significantly higher than in both high-density ($Z = 4.91$, $p < 0.01$) and low-density building areas ($Z = 3.96$, $p = 0.01$). No significant difference was found between high-density and low-density sites ($Z = -1.36$, $p = 0.52$).

Habitat selection

The analysis of land cover variables within a 75 m radius around nests *(Figure 1A)* showed that Eurasian Jays prefer habitats with a higher percentage of water (Mann–Whitney U-test: $U = 515$, $p < 0.05$). Among all cover types, only water exhibited significantly higher values around nests compared to random points. Additionally, the test suggested a tendency toward a preference for tree cover, although this was not statistically significant.

The Bayesian analysis *(Figure 1B)* of Eurasian Jay nest presence suggests slightly positive effects of tree cover on nesting probability, as indicated by posterior distribution shifted above zero. However, credible intervals for these variables overlap zero, indicating uncertainty in the effect sizes. Other habitat variables show high uncertainty, with their distributions spanning both negative and positive values, suggesting that they do not strongly influence nest selection in our dataset. The trace plots that support Bayesian analysis are in the Supplementary Data.

Our analysis revealed no significant difference in the median distances between nests and random points to the nearest road or building *(Figure 2)*.

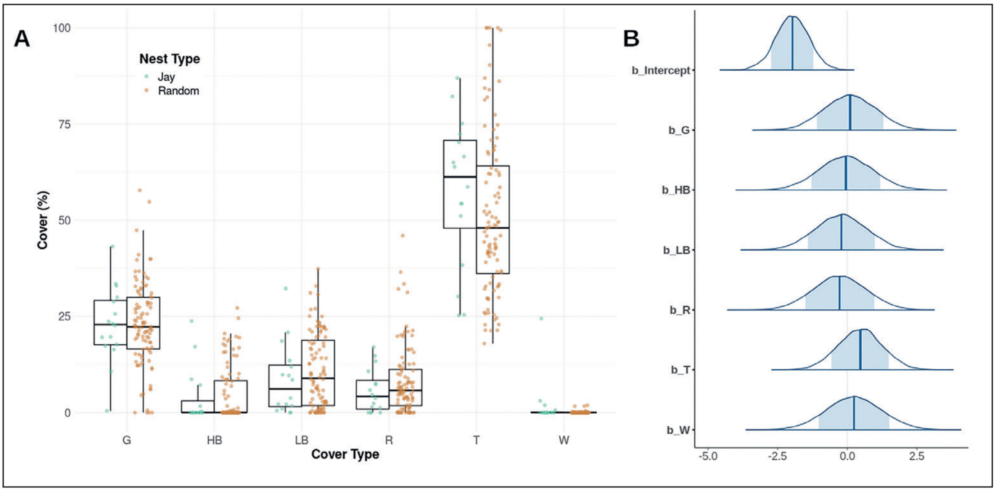

Figure 1. Analysis of habitat variables. A – Differences in habitat variables between Eurasian Jay nest sites and random points. B – Posterior distributions of regression coefficients for habitat variables in the Bayesian model predicting Jay nest presence. The density curves represent the posterior distributions of each coefficient, with shaded areas indicating 80% uncertainty intervals. G – grass/ground, HB – high buildings, LB – low buildings, R – roads/pavements, T – tree cover, W – water

1. ábra Az élőhelyváltozók elemzése. A – Különbségek az élőhelyváltozókban a random pontok és a szajkó fészkek között. B – Az élőhelyváltozók regressziós együtthatóinak eloszlása a szajkó fészkek jelenlétét előrejelző Bayes-i modellben. A sűrűségi görbék az egyes együtthatók becsült értékének eloszlásait mutatják, az árnyékolt területek a 80%-os bizonytalansági intervallumokat jelzik. G – fű, talaj, HB – magas épület, LB – alacsony épület, R – utak, járdák, T – faborítás, W – víz

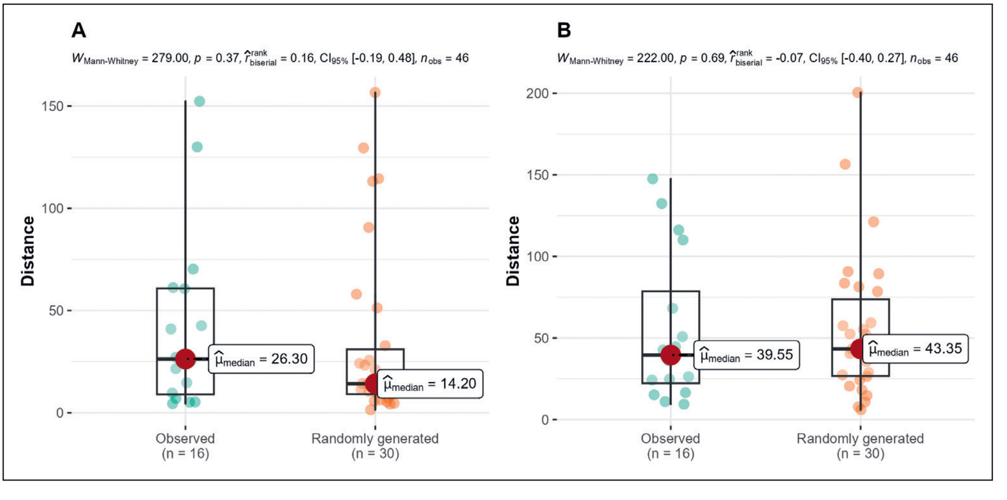

Figure 2. Comparative analysis of median distances from observed nests and randomly generated points to the nearest road (A) and to the nearest building (B)

2. ábra A megfigyelt fészkek és a véletlenszerűen generált pontok legközelebbi úthoz (A) és legközelebbi épülethez (B) mért távolságának mediánjainak összehasonlítása

Discussion

The total density of Eurasian Jays (0.97 pairs/km^2) in the surveyed area was the lowest compared to other corvid species found in this monitoring area. At the same time, the highest number and density of nesting was recorded for Eurasian Magpies (368 nests; the average nesting density of 22.4 pairs/km^2), the next most numerous were Western Jackdaws (147 pairs; 9.8 pairs/km^2) and Hooded Crow (41 nests; 2.5 pairs/km^2) (Dupak & Telizhenko 2023, unpublished data). In the number gradation of corvids in the city of Sumy (Ukraine) in the 2000s, the Eurasian Jay also took ranked place after the Western Jackdaw, Rook and Eurasian Magpie (Knysh *et al.* 2010).

The Eurasian Jay demonstrated a strong tendency to camouflage its nests, as evidenced by 55.5% of nests being built in mistletoe. Such a high percentage was not observed for other corvid species in the study area; for the Hooded Crow, it was 14.6%, and for the Eurasian Magpie, only 1.6% (unpublished data). While this nesting behaviour likely provides effective camouflage from predators, it may also reduce nest detectability during field surveys. Although the area was thoroughly surveyed and the observer carefully inspected tree crowns, it is possible that some nests concealed within dense mistletoe clusters were overlooked. This potential detection bias should be taken into account when interpreting the results or conducting similar studies.

The Eurasian Jay is the only one of the "urban" species of Corvidae of Ukraine (Eurasian Magpie, Western Jackdaw, Hooded Crow, Rook), whose numbers in natural biotopes exceed its population in anthropogenic landscapes. For example, in the ravine forests of the Sumy region in the 1960s, the recorded number of this species was 40 individuals/km^2, and in mixed and pine forests 20–26 individuals/km^2 (Matvienko 2009). At least as of the 2000s, this state of the number of Eurasian Jays for these territories has been preserved (Knysh *et al.* 2010). The species' density in Europe can also be quite high. For example, a record number of Eurasian Jays was registered in July in a pine forest in the Maremma Natural Park (Tuscany, Italy) ranged from 347 to 676 (on average 484) birds per km^2 (Patterson *et al.* 1991). In a mixed forest in Sweden in the 1980s, for 5 years, the density of the species fluctuated around 8–13 birds km^2 (average 11) (Grahn 1990).

Half of all nesting pairs of Eurasian Jays in the city of Poltava (50%) were in parks and green squares where the density of birds was significantly higher compared to building areas. The concentration of Eurasian Jays in parks and green areas was also observed in other settlements. In the 1980s, during the growth of the number of Eurasian Jays in the city of Kharkiv, most of the birds were concentrated in the central city park. Nesting of the species was also recorded in building areas of the city, but these were rare cases, mainly in the areas adjacent to the park (Nadtochij & Ziomenko 1989). In Zhytomyr, the Eurasian Jay nests were most densely located in the green areas surrounding the city, with 3.5 pairs/km^2. In the city of Zhytomyr, most nests were in old blocks of high-storey buildings. These blocks had numerous trees, and the average density of its nests here comprised 0.75 pair/km^2 (Zimaroeva 2012).

On the one hand, no significant difference was observed in the distances between nests and random points when analysing their proximity to the nearest roads and buildings. According to our data, Eurasian Jays tolerate buildings and roads with their associated traffic. On the other hand, nesting habitat selection analysis showed that the birds prefer habitats with a higher percentage of water. However, due to the low number of water bodies in the city and their rare occurrence near nests, this association cannot be considered reliable.

The Mann–Whitney U-test and Bayesian analysis of habitat variables indicate that most habitat types do not significantly influence nest site selection in Eurasian Jays. Both methods revealed an insignificant but clear tendency toward selecting tree-covered areas. However, high uncertainty in the posterior distributions suggests that the effects of habitat variables remain inconclusive, likely due to a limited sample size or overlapping habitat preferences.

In our opinion, this suggests that the Eurasian Jay is tolerant of urban landscape elements. However, the presence of a high number of trees remains a key factor in nest site selection, which should be considered in the management and planning of urban forest and park areas. Further research on synanthropization in different regions is crucial for attracting this species to green spaces and urban outskirts. Additionally, Jays may play an important role in the dispersal of oak trees in these areas (Kurek *et al.* 2018, Mitrus & Szabo 2020). Therefore, we believe that future research should focus on the role of the Eurasian Jay in urban ecosystems.

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References

Benmazouz, I., Jokimäki, J., Lengyel, Sz., Juhász, L., Kaisanlahti-Jokimäki, M.-L., Kardos, G., Paládi, P. & Kövér, L. 2021. Corvids in Urban Environments: A Systematic Global Literature Review. – Animals 11: 3226. DOI: 10.3390/ani11113226

BirdLife International 2015. European Red List of Birds. – Luxembourg: Office for Official Publications of the European Communities

Bokotey, A. A. 2008. Hnizdova ornitofauna mista Lvova ta osnovni prychyny yii zmin (za rezultatamy skladannia hnizdovykh atlasiv ptakhiv u 1994–1995 ta 2005–2007 rr.) [Changes in breeding avifauna of Lviv City and their causes (basing on the results of compiling the ornithological atlases in 1994–1995 and 2005–2007)]. – Scientific Bulletin of the Uzhhorod University. Series Biology 23: 17–25. (in Ukrainian)

Bürkner, P.-C. 2017. brms: An R Package for Bayesian Multilevel Models Using Stan. – Journal of Statistical Software 80(1): 1–28. DOI: 10.18637/jss.v080.i01

Carpenter, B., Gelman, A., Hoffman, M. D., Lee, D., Goodrich, B., Betancourt, M., Brubaker, M., Guo, J., Li, P. & Riddell, A. 2017. Stan: A probabilistic programming language. – Journal of Statistical Software 76(1): 1–32. DOI: 10.18637/jss.v076.i01

Dunn, O. J. 1961. Multiple comparisons among means. – Journal of the American Statistical Association 56(293): 52–64. DOI: 10.1080/01621459.1961.10482090

Dupak, V. S. & Telizhenko, V. S. 2023. Interactions between Hooded Crows *(Corvus cornix)* and Eurasian Magpies *(Pica pica)* and their nesting site preferences in anthropogenic landscapes. – Écoscience 30(3–4): 210–222. DOI: 10.1080/11956860.2023.2300758

Gavrilenko, N. I. 1970. Pozvonochnye zhivotnye i urbanizaciya ikh v usloviyakh goroda Poltavy [Vertebrates and their urbanization in the conditions of Poltava city]. – Kharkiv, State University Publication (in Russian)

Gianpasquale, C. & Meriggi, A. 2019. The occurrence and density of three sympatric corvids in a Mediterranean agroecosystem explained by land use. – Journal of Ornithology 160(4): 1133–1150. DOI: 10.1007/s10336-019-01679-2

Grahn, M. 1990. Seasonal changes in ranging behaviour and territoriality in the European Jay *Garrulus g. glandarius*. – Ornis Scandinavica 21(3): 195–201. DOI: 10.2307/3676779

Högstedt, G. 1980. Resource partitioning in Magpie *Pica pica* and Jackdaw *Corvus monedula* during the breeding season. – Ornis Scandinavica 11(2): 110–115. DOI: 10.2307/3675916

Jerzak, L. 2001. Synurbanization of the Magpie in the Palearctic. – In: Marzluff, M. J., Bowman, R. & Donnelly, R. (eds.) Avian Ecology and Conservation in an Urbanizing World. – Springer, Boston, MA. DOI: 10.1007/978-1-4615-1531-9_19

Jokimäki, J., Kaisanlahti-Jokimäki, M. L. & Suhonen, J. 2022. Long-term winter population trends of corvids in relation to urbanization and climate at northern latitudes. – Animals 12(14): 1820. DOI: 10.3390/ani12141820

Jokimäki, J., Suhonen, J., Vuorisalo, T., Kövér, L. & Kaisanlahti-Jokimäki, M.-L. 2017. Urbanization and nest-site selection of the Black-billed Magpie *(Pica pica)* populations in two Finnish cities: From a persecuted species to an urban exploiter. – Landscape and Urban Planning 157: 577–585. DOI: 10.1016/j.landurbplan.2016.08.001

Knysh, N. P., Hryshchenko, V. N. & Statyva, A. Y. 2010. Sojka v Lesostepi Severo-Vostochnoj Ukrainy [Jay in the forest-steppe of North-Eastern Ukraine]. – Proceedings of the IX International Conference: Corvidae of Northern Eurasia. Omsk, pp. 71−74. (in Russian)

Koshelev, A., Koshelev, V., Kopylova, T. & Borisov, V. 2020. Monitorynh voronovykh ptakhiv u misti Melitopoli: hnizdovyi i zymovyi aspekty [Monitoring of Crowbird in Melitopol: nest and winter aspects]. – Ecological Sciences 2(29): 31–39. DOI: 10.32846/2306-9716/2020.eco.2-29.2.5 (in Ukrainian)

Kövér, L., Gyüre, P., Balogh, P., Huettmann, F., Lengyel, Sz. & Juhász, L. 2015. Recent colonization and nest site selection of the Hooded Crow (*Corvus corone cornix* L.) in an urban environment. – Landscape Urban Planing 133: 78–86. DOI: 10.1016/j.landurbplan.2014.09.008

Krivickij, I. A. 1989. Vranovye pticy Khar'kovskoj oblasti i kharakter ikh urbanizacil [Corvidae of the Kharkiv region and the nature of their urbanization]. – Proceedings of the Scientific and Practical Conference "Corvidae in Natural and Anthropogenic Landscapes". – Lipetsk, pp. 130–132. (in Russian)

Kruskal, W. H. & Wallis, W. A. 1952. Use of ranks in one-criterion variance analysis. – Journal of the American Statistical Association 47(260): 583–621. DOI: 10.2307/2280779

Kurek, P., Dobrowolska, D., Wiatrowska, B. & Dylewski, L. 2018. What if Eurasian Jay *Garrulus glandarius* would larder acorns instead of scatter them? – iForest – Biogeosciences and Forestry 11: 685–689. DOI: 10.3832/ifor2793-011

Matvienko, M. E. 2009. Ocherki raspostraneniya i ehkologii ptic Sumskoj oblasti (60-e gody KHKH st.) [Essays on the distribution and ecology of birds in the Sumy region (1960s)]. – Sumy: Universitetskaya Kniga (in Russian)

Mitrus, C. & Szabo, J. 2020. Foraging Eurasian Jays *(Garrulus glandarius)* prefer oaks and acorns in central Europe. – Ornis Hungarica 28(1): 169–175. DOI: 10.2478/orhu-2020-0010

Nadtochij, A. S. & Ziomenko, S. K. 1989. Adaptacii sojki k gnezdovaniyu v urbanizirovannom landshafte [Adaptations of the Jay to nesting in an urban landscape]. – Proceedings of the Scientific and Practical Conference "Corvidae in Natural and Anthropogenic Landscapes". – Lipetsk, pp. 140–141. (in Russian)

Patil, I. 2021. Visualizations with statistical details: The 'ggstatsplot' approach. – Journal of Open Source Software 6(61): 3167. DOI: 10.21105/joss.03167

Patterson, I. J., Cavallini, P. & Rolando, A. 1991. Density, range size and diet of the European Jay *Garrulus glandarius* in the Maremma Natural Park, Tuscany, Italy, in summer and autumn. – Ornis Scandinavica 22(2): 79–87. DOI: 10.2307/3676537

R Core Team 2023. R: A Language and Environment for Statistical Computing. – R Foundation for Statistical Computing, Vienna https://www.R-project.org/

Rezanov, A. G. & Rezanov, A. A. 2007. Gnezdovanie sojki *(Garrulus glandarius)* na postrojkakh cheloveka i process urbanizacii vida [Nesting of the Eurasian Jay *(Garrulus glandarius)* on human structures and the process of urbanization of the species]. – Proceedings of the International Conference "Ecology of Crows in Natural and Anthropogenic Landscapes". – Stavropol, pp. 139–142. (in Russian)

Sakhvon, V. & Kover, L. 2020. Distribution and habitat preferences of the urban Woodpigeon *(Columba palumbus)* in the north-eastern breeding range in Belarus. – Landscape and Urban Planning 201(1): 103846. DOI: 10.1016/j.landurbplan.2020.103846

Shapiro, S. S. & Wilk, M. B. 1965. An analysis of variance test for normality (complete samples). – Biometrika 52(3–4): 591–611. DOI: 10.2307/2333709

Slusar, M. V. 2017. Fauna khrebetnykh Poltavskoho miskoho parku [Vertebrate fauna of the Poltava city park]. – Biology and Ecology 3(1–2): 86–103. DOI: 10.33989/2414-9810.2017.3.1-2.180273 (in Ukrainian)

Vogrin, M. 2003. Common Magpie *Pica pica*, Western Jackdaw *Corvus monedula* and Hooded Crow *Corvus cornix* in Some Towns in North-eastern Slovenia (Central Europe). – Journal of Biological Sciences 3: 688−693. DOI: 10.3923/jbs.2003.688.693

Wang, Y., Chen, S., Jiang, P. & Ding, P. 2008. Black-billed Magpies *(Pica pica)* adjust nest characteristics to adapt to urbanization in Hangzhou, China. – Canadian Journal of Zoology 86: 676−684.

Zimaroeva, A. A. 2012. Zminy hnizdovoi ekolohii soiky *(Garrulus glandarius)* u ziazku z yii urbanizatsiieiu (na prykladi naselenykh punktiv Zhytomyrskoi oblasti) [Changes of Jay *(Garrulus glandarius)* nesting ecology in connection with its urbanization (based on the example of Zhytomyr region settlements)]. – Pryrodnychyi Almanakh. Seria Biolohicni Nauky 17: 127–135. (in Ukrainian)