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Activity of bird assemblages and distribution of birds of different nesting types in garden squares and parks of the right-bank part of Dnipro City

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Abstract. The species composition and activity of birds in urban ecosystems largely depend on the level of anthropogenic impact, vegetation structure, and the availability of nesting sites and vary depending on landscape characteristics. Our analysis of the bird communities revealed that the large areas and diverse natural conditions provided higher species diversity compared with smaller areas with a high level of urbanization. This study analyzed the species composition of birds in garden squares and parks of the city of Dnipro and identified the features of their spatial distribution depending on the biotopes of the area. The research results indicate that the most active species were *Columba livia*, *Sturnus vulgaris*, *Parus major*, *Passer montanus*, and *Turdus pilaris*. The analysis of ecological groups of birds in the studied areas was conducted according to the M. Akimov's system, considering the nesting characteristics of different bird species. The birds recorded in the city parks may indicate the presence of favorable conditions in the studied areas, although not all of them nested directly within park boundaries. The garden squares and parks with diverse biotopes and adjacent natural areas promoted higher bird activity and species richness, creating optimal conditions for the existence of bird species of different nesting types. Among the 13 identified bird groups based on nesting type, the most active were the "anthropogenic-substrate", "hollow-nesting, anthropogenic-substrate", and "tree-canopy" groups. In the parks, the least active groups of birds by nesting type were the "tree-canopy, anthropogenic-substrate" and "riparian". The greatest diversity of groups of birds by nesting type was recorded in the Divkski Plavni floodplains. The presence of two-layered forest stands with a diverse composition of trees contributed to a higher number of bird species. Landscape diversity, such as the presence of sandy or clay cliffs and water bodies, created favorable conditions even for bird groups of specific nesting types, with low species richness. Urbanized areas located near the garden squares and parks served as important biodiversity hotspots, as they integrated anthropogenic and natural environments, providing nesting sites for various forest, synanthropic, and waterfowl species.

Keywords: biodiversity; bird activity; species diversity; nesting substrates; urban areas, landscape gardens; garden and park management; urban avifauna.

Introduction

The ornithofauna of urban areas is significantly different from that of natural ecosystems, as birds adapt to the specific living conditions of the urban environment, perceiving it as part of their natural range. Species diversity in urban areas depends on various factors, such as the city's geographical location, climate, level of anthropogenic impact, the presence of green spaces and water bodies, as well as the overall environmental condition (Shydlovskyy et al., 2021; Zymaroieva et al., 2022). The city represents a unique type of ecosystem characterized by complex dynamics, dependence on adjacent natural areas, imbalance of biotic and abiotic components, and limited development of producers and decomposers (Shupova & Chaplygina, 2021).

Urban parks, garden squares, and suburban forested areas are crucial in maintaining biodiversity. Birds inhabiting these areas perform key ecological functions, including controlling insect pests, dispersing seeds, and creating conditions for the aesthetic enjoyment of city residents. The conditions of urbanization make their role in maintaining the natural balance even more significant (Dubovyk et al., 2020). Green space planning and the formation of sustainable ecological landscapes in cities should take ornithological aspects into account, which will contribute to enhancing the effectiveness of conservation efforts (Robinson et al., 2021). Studying bird communities in parks is of great importance for preserving biodiversity and maintaining natural habitats in urban landscapes (Fernández-Juricic & Jokimäki, 2001).

The study of the ornithofauna of urban parks and suburban forested areas has garnered significant interest from scientists in various countries worldwide. For example, such research has been conducted in Austria (Sasvari, 1990), Germany (Abs & Bergen, 2008), Canada, and the USA (Cicero, 1989; Morneau et al., 1999; Oliver et al., 2011), to name a few. These studies have focused on the structure of bird assemblages, their adaptive potential, and their impact on ecosystem processes. In Ukraine, the ornithofauna of parks, garden squares, and forested areas has been studied in cities such as Chernihiv, Lviv, Cherkasy, Kharkiv, Melitopol, Kryvyi Rih, (Gapanovich et al., 2019; Shupova & Chaplygina, 2021), as well as Dnipro (Komlyk & Ponomarenko, 2023).

Despite the significant interest in studying birds in urbanized ecosystems, the species composition and bird activity within urban and suburban areas in Ukraine remain insufficiently explored. The existing research primarily focuses on specific aspects such as behavior, adaptation, or the ecological role of species. However, comprehensive studies aimed at determining the spatial activity of birds, the structure of assemblages, and their dependence on habitat types in small and medium-sized settlements require further development.

The relevance of such studies is linked not only to the need for biodiversity conservation but also the necessity of improving the quality of life for urban residents. Birds are an essential component of urban ecosystems, and their study can help develop conservation programs that will contribute to the preservation of unique biodiversity and the creation of sustainable ecological landscapes within urbanized areas.

Materials and methods

The bird surveys were conducted in accordance with ethical principles of wildlife research. We employed non-intrusive observation methods to minimize any impact on bird behavior and natural activity.

No techniques that could cause harm or stress to the birds were used during the surveys. The observations were carried out in the garden squares and parks, without the use of bait or environmental manipulation.

The study covered the major parks and garden squares of the right-bank part of the city of Dnipro. The data were collected under field conditions during the breeding seasons from 2022 to 2024. The bird observations were conducted from April to July, during the morning hours between 6:00 and 11:00, when bird activity is at its peak, under clear and calm weather conditions to ensure maximum accuracy. The presence and behavior of birds were recorded both visually and through their singing.

The study was conducted using transect survey methods (Huzyi, 1997; Bibby et al., 1998) and mapping (Vergeles, 1994), with modifications according to the Ponomarenko's methodology (Ponomarenko, 2017). Bird identification and taxonomic classification were carried out in accordance with the National Nomenclature of Birds of the World (Fesenko, 2018). The transect survey method involves the quantitative registration of all bird species encountered along a chosen route, within a designated length and width, where the survey strip acts as a continuous sampling section. This method is ideal for observing both mobile and conspicuous bird species, as well as those that may be easily startled. During the survey, the observer moves along the route, recording all bird species encountered. The method allows for the collection of a large amount of data in a short time, providing a complete list of bird species inhabiting the study area. The optimal movement speed is determined by the terrain and bird visibility, usually ranging from 0.75 to 1.0 km/hour. To achieve more accurate species identification or count, brief stops can be made, with the avoidance of frequent pauses during movement.

According to the mapping method, each bird observation point was marked on the map. Each record included information about the bird species, the type of tree on which it was seen, the tree's height, and the height at which the bird was located in meters, the tree's age, the substrate used by the bird, as well as the presence of undergrowth and its species composition. The primary methodology of the study was based on the O. L. Ponomarenko's method for studying bird activity in forest stand, which involved recording the bird species and the type of tree on which they were active, the tree's height, the bird's location, and the tree's age. Birds are recorded on each substrate where they were observed. The substrates included various parts of the tree structure, such as branch tips, thick branches, skeletal branches, and the trunk. Additionally, other substrates were recorded, such as the ground, water, riverbank, anthropogenic elements like asphalt, fences, streetlights, structures, and the airspace.

The total length of the routes was 90.03 km, and the surveyed area on the right bank accounted for 724.37 ha. The parks with small areas were fully surveyed, while in larger parks, which gradually transition into transformed natural forests, the research was conducted in sections located near the city. A total of 3,453 bird documentations were made (Ponomarenko & Komlyk, 2025), covering 17 green spaces on the right bank of the city of Dnipro (Table 1) during the breeding seasons of 2022–2024. Those areas are depicted on the schematic map (Fig. 1). These areas include urban parks, garden squares, natural forest-park zones, and the riverbanks of the Dnipro River. The map visualizes the spatial distribution of the studied territories and contributes to the analysis of their impact on the formation of ornithocomplexes in an urbanized environment.

The objectives of this study were determining the species diversity and analyzing the activity of bird assemblages in the garden squares and parks of the right bank of the city of Dnipro, as well studying the relationship between the species richness and specific parameters of the parks.

Results

In the 17 studied zones, 62 bird species were recorded, belonging to various orders. The highest number of species was found for the order Passeriformes, with 35 species, accounting for 58.2% of the total. The order Piciformes was represented by 5 species (8.1%), Charadriiformes by 4 species (6.5%), Columbiformes and Pelecaniformes by 3 species (4.8%), and Coraciiformes and Falconiformes each by 2 species (3.2%). The remaining orders, including Cuculiformes, Anseriformes, Gruiformes, Podicipediformes, Apodiformes, Strigiformes, and Galliformes, were each represented by a single species (1.6% each).

The most active species recorded were *Columba livia* (J. F. Gmelin, 1789), with 670 records; *Sturnus vulgaris* (Linnaeus, 1758), with 472 records; *Parus major* (Linnaeus, 1758), with 343 records; *Passer montanus* (Linnaeus, 1758), with 324 records; and *Turdus pilaris* (Linnaeus, 1758), with 268 records.

The order Passeriformes was recorded in all of the studied areas and proved to be the most active among all the orders. Of this order, the most represented families were the Muscicapidae and Sylviidae, each with 5 species (13.8% of the total number of families in the order). The Corvidae family was also represented significantly, by 4 species (11.0%), as well as the Fringillidae, Turdidae, and Hirundinidae families, each by 3 species (8.3%). Other families, such as Passeridae, Motacillidae, and Paridae, were represented by 2 species (5.6%) each. The smallest representation came from the Acrocephalidae, Oriolidae, Emberizidae, Phylloscopidae, Remizidae, Laniidae, and Sturnidae families, with one species (2.8%) each.

The most active representative among the Muscicapidae was *Ficedula albicollis* (Temminck, 1815), with 133 records (58.8% of the total species in the family). Of the Fringillidae family, the dominant species were *Fringilla coelebs* (Linnaeus, 1758) and *Chloris chloris* (Linnaeus, 1758), with 117 (56.0%) and 78 records (37.3%), respectively. From the Corvidae, the most numerous species was *Corvus cornix* (Linnaeus, 1758), recorded 111 times (47.0%). Other representatives of this family were: *Pica pica* (Linnaeus, 1758), with 81 records (34.3%); *Garrulus glandarius* (Linnaeus, 1758), with 35 records (14.8%); and *Corvus corax* (Linnaeus, 1758), with 9 records (3.8%). Of the Hirundinidae family, the commonest species were *Riparia riparia* (Linnaeus, 1758) and *Delichon urbicum* (Linnaeus, 1758), with 50 (69.4%) and 13 records (18.1%), respectively.

Table 1
Surveyed areas of the right-bank part of the city of Dnipro in 2022–2024

No.	Place of registration	Dates of the study	Area of the surveyed territory, ha	Length of the route, km	Number of records
1.	Diivski Plavni	29.05.2024 – 25.06.2024	226.5	19.4	344
2.	Zelenyi Hai Park	30.04.2022 – 30.05.2022	31.4	7.4	247
3.	Mandrykivska Kosa	06.05.2023	36.1	6.8	203
4.	Novokodatskyi Youth Park of Leisure and Recreation	11.05.2024	22.4	3.2	190
5.	Monastyrskyi Island	14.05.2023 – 25.06.2023	22.9	4.2	176
6.	Memorialnyi Park	07.05.2023	10.7	2.4	106
7.	Taras Shevchenko Park	02.05.2022 – 16.07.2022	19.4	6.0	322
8.	Studentskyi Park	26.05.2022 – 28.05.2022	10.5	3.1	227
9.	Bohdan Khmelnytsky Park	04.06.2023	9.5	3.6	129
10.	Lazar Hloba Park	21.05.2023	26.2	4.8	412
11.	Lev Pysarzhevskyi Park	04.06.2023	8.1	2.1	174
12.	Pamiati ta Prymyrennia Park	18.06.2023	4.7	1.7	112
13.	Heroes Square	21.05.2023	5.8	1.4	42
14.	Metalurhiv Garden Square	13.05.2023	4.0	1.1	84
15.	Soborna Square	20.05.2024	7.4	1.8	194
16.	Sukhachivskyi Forest Park	23.05.2024 – 26.05.2024	196.0	7.5	207
17.	Tonelna Balka Tract	12.05.2024	82.7	13.5	284
Total		–	724.4	90.0	3453

Note: numbers correspond to those marked on the Figure 1.

Fig. 1. Schematic map of the surveyed areas in the right-bank part of the city of Dnipro: *1* – Diivski Plavni, *2* – Zelenyi Hai Park, *3* – Mandrykivska Kosa, *4* – Novokodatskyi Youth Park of Leisure and Recreation, *5* – Monastyrskyi Island, *6* – Memorialnyi Park, *7* – Taras Shevchenko Park, *8* – Studentskyi Park, *9* – Bohdan Khmelnytskyi Park, *10* – Lazar Hloba Park, *11* – Lev Pysarzhevskyi Park, *12* – Pamiati ta Prymyrennia Park, *13* – Heroiv Square, *14* – Metalurhiv Garden Square, *15* – Soborna Square, *16* – Suhachivskyi Forest Park, *17* – Tonelna Balka Tract

Certain families often had one dominant species. For example, in the Sturnidae family, *Sturnus vulgaris* was recorded 472 times; within the Paridae family, *Parus major* accounted for 98.6% of the observations (343 records); of the Passeridae family, *Passer montanus* dominated, with 324 records (94.2%). Among the Turdidae, *Turdus pilaris* accounted for 94.7% of the records (268). For the Motacillidae family, *Motacilla alba* (Linnaeus, 1758) was the most numerous, accounting for 97.4% of the observations (38 records).

Other orders were represented by fewer families and species, with most families represented by only one species. The most numerous species in terms of records were *Columba livia,* with 670 records (92.6% of the total bird sightings of this order); followed by *Streptopelia decaocto* (Frivaldszky, 1838), with 31 records (4.3%); and *Columba palumbus* (Linnaeus, 1758), with 22 records (3.1%), all belonging to the order Columbiformes. The most numerous species of the Anseriformes order was *Anas platyrhynchos* (Linnaeus, 1758) from the family Anatidae, encountered 74 times. Within the Piciformes order, the most abundant species were *Dendrocopos major* (Linnaeus, 1758) and *D. syriacus* (Hemprich & Ehrenberg, 1833), with 40 (43.5%) and 37 records (40.2%), respectively, both from the family Picidae. Among the Pelecaniformes, *Phalacrocorax carbo* (Linnaeus, 1758) from the family Phalacrocoracidae was most frequently documented, comprising 38 records. Of the order Gruiformes, 38 records of *Fulica atra* (Linnaeus, 1758) from the family Rallidae were made. *Podiceps cristatus* (Linnaeus, 1758) from the family Podicipedidae, belonging to the order Podicipediformes, was recorded 30 times (Table 2).

An analysis of the ecological groups of birds of the studied areas in the city of Dnipro was conducted, taking into account the nesting characteristics of different bird species. A table was created to demonstrate the diversity of nesting groups in the surveyed areas (Table 3).

Table 2

Species composition, number of observed individuals, and their distribution among bird groups defined by nesting type in the garden squares and parks of the right-bank part of the city of Dnipro

Species	Nesting types	Registration site of bird activity																	To-tal
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Acrocephalus arundinaceus (Linnaeus, 1758)	Riparian	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
Alcedo atthis (Linnaeus, 1758)	Burrow-nesting	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
Anas platyrhynchos (Linnaeus, 1758)	Ground-riparian	12	–	22	–	2	–	–	–	–	37	–	–	–	–	–	1	–	74
Anthus trivialis (Linnaeus, 1758)	Ground-nesting	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Apus apus (Linnaeus, 1758)	Anthropogenic-substrate	–	–	–	–	–	–	–	–	–	21	–	–	–	–	–	–	6	27
Ardea cinerea (Linnaeus, 1758)	Tree-canopy	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	7
Asio otus (Linnaeus, 1758)	Tree-canopy	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1
Carduelis carduelis (Linnaeus, 1758)	Tree-canopy	–	2	–	–	1	–	–	5	–	2	–	1	–	–	–	2	1	14
Charadrius dubius (Scopoli, 1786)	Ground-nesting	1	–	–	–	2	–	–	–	–	–	–	–	–	–	–	1	–	4
Chloris chloris (Linnaeus, 1758)	Undergrowth	4	14	3	1	2	3	11	15	–	7	3	1	–	–	–	12	2	78
Chroicocephalus ridibundus (Linnaeus, 1766)	Ground-riparian	3	–	–	–	4	–	–	–	–	2	–	–	–	–	–	–	–	9
Circus cyaneus (Linnaeus, 1766)	Ground-nesting	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Columba livia (J. F. Gmelin, 1789)	Anthropogenic-substrate	26	20	51	8	7	18	39	22	16	182	78	48	17	9	127	–	2	670
Columba palumbus (Linnaeus, 1758)	Tree-canopy	–	2	1	2	2	1	–	4	–	1	1	–	–	–	2	–	6	22
Corvus corax (Linnaeus, 1758)	Tree-canopy anthropo-genic-substrate	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7	2	9
Corvus cornix (Linnaeus, 1758)	Tree-canopy anthropo-genic-substrate	7	7	11	7	14	10	8	3	3	15	7	6	1	2	4	1	5	111
Cuculus canorus (Linnaeus, 1758)	Tree-canopy	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	7

Species	Nesting types	Registration site of bird activity																	To-
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	tal
Curruca curruca (Linnaeus, 1758)	Canopy-shrub	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	2
Cyanistes caeruleus (Linnaeus, 1758)	Hollow-nesting	–	2	–	–	2	–	–	–	–	–	–	–	–	–	–	–	1	5
Delichon urbicum (Linnaeus, 1758)	Anthropogenic-substrate	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	11	–	13
Dendrocopos major (Linnaeus, 1758)	Hollow-nesting	5	3	1	–	1	4	2	2	–	2	–	–	–	2	–	8	10	40
Dendrocopos medius (Linnaeus 1758)	Hollow-nesting	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Dendrocopos syriacus (Hemprich et Ehrenberg, 1833)	Hollow-nesting	–	12	–	7	–	1	9	2	1	–	–	2	1	1	1	–	–	37
Emberiza citrinella (Linnaeus, 1758)	Ground-nesting	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–	2	–	7
Erithacus rubecula (Linnaeus, 1758)	Ground-nesting	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	2	4	7
Falco tinnunculus (Linnaeus, 1758)	Tree-canopy, anthropogenic-substrate	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	4
Ficedula albicollis (Temminck, 1815)	Hollow-nesting	7	6	9	5	4	12	24	11	16	10	8	1	3	7	6	3	1	133
*Fringilla coelebs (*Linnaeus, 1758)	Tree-canopy	11	6	4	2	5	11	29	13	6	4	4	–	–	3	2	13	4	117
Fulica atra (Linnaeus, 1758)	Floating-substrate	37	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	38
Garrulus glandarius (Linnaeus, 1758)	Tree-canopy	–	9	–	1	1	–	1	5	–	–	–	1	–	1	–	–	16	35
Hippolais icterina (Vieillot, 1817)	Undergrowth	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
*Hirundo rustica (*Linnaeus, 1758)	Anthropogenic-substrate	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9	–	9
*Jynx torquilla (*Linnaeus, 1758)	Hollow-nesting	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	1	–	3
*Lanius collurio (*Linnaeus, 1758)	Canopy-shrub	–	5	–	–	–	–	–	1	–	–	–	–	–	–	–	14	–	20
Larus cachinnans (Pallas, 1811)	Ground-riparian	8	–	4	–	–	–	–	–	–	–	–	1	–	–	–	–	–	13
Luscinia luscinia (Linnaeus, 1758)	Ground-nesting	6	–	1	–	–	–	–	–	–	–	–	–	–	–	–	8	3	18
*Motacilla alba (*Linnaeus, 1758)	Ground-nesting	6	1	–	2	3	7	–	5	4	1	2	–	2	2	–	1	2	38
Muscicapa striata (Pallas, 1764)	Tree-canopy	2	3	–	–	5	1	2	5	1	5	8	1	–	–	1	5	–	39
Nycticorax nycticorax (Linnaeus, 1758)	Tree-canopy	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	3
*Oriolus oriolus (*Linnaeus, 1758)	Tree-canopy	2	4	–	–	–	–	4	1	1	–	–	–	–	–	–	5	10	27
Parus major (Linnaeus, 1758)	Hollow-nesting, anthropogenic-substrate	39	29	24	6	18	6	34	23	13	11	30	4	–	6	8	30	62	343
Passer domesticus (Linnaeus, 1758)	Anthropogenic-substrate	1	–	9	–	1	–	1	–	–	4	–	–	–	–	–	–	4	20
Passer montanus (Linnaeus, 1758)	Anthropogenic-substrate	6	27	35	33	35	3	40	1	3	21	5	14	9	11	18	33	30	324
Phalacrocorax carbo (Linnaeus, 1758)	Tree-canopy	32	–	–	–	5	–	–	–	–	–	–	–	–	–	–	1	–	38
Phasianus colchicus (Linnaeus, 1758)	Ground-nesting	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	4	6
Phoenicurus ochruros (S. G. Gmelin, 1774)	Anthropogenic-substrate	2	1	–	2	–	–	7	–	–	8	1	1	–	3	1	3	–	29
Phylloscopus collybita (Vieillot, 1817)	Ground-nesting	5	5	2	–	–	–	–	1	–	–	–	–	–	–	–	7	9	29
Pica pica (Linnaeus, 1758)	Tree-canopy	3	19	1	7	5	–	4	8	1	2	–	–	–	–	–	–	31	81
*Picus canus (*J. F. Gmelin, 1788)	Hollow-nesting	2	4	1	1	–	–	–	–	–	–	–	–	–	–	–	1	1	10
Podiceps cristatus (Linnaeus, 1758)	Floating-substrate	25	–	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Remiz pendulinus (Linnaeus, 1758)	Tree-canopy	9	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	10
Riparia riparia (Linnaeus, 1758)	Burrow-nesting	50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
Sterna hirundo (Linnaeus, 1758)	Floating-substrate	6	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	9
Streptopelia decaocto (Frivaldszky, 1838)	Undergrowth, anthropogenic-substrate	1	3	–	3	3	–	5	1	–	4	–	5	–	5	–	1	–	31
*Sturnus vulgaris (*Linnaeus, 1758)	Hollow-nesting, anthropogenic-substrate	1	41	14	101	22	17	21	29	44	40	18	21	5	14	22	6	56	472
Sylvia atricapilla (Linnaeus, 1758)	Canopy-shrub	1	1	1	–	1	–	1	7	–	–	–	–	–	–	–	3	2	17
Sylvia borin (Boddaert, 1783)	Canopy-shrub	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2
Sylvia communis (Latham, 1787)	Canopy-shrub	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	6	8
Turdus merula (Linnaeus, 1758)	Undergrowth	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
*Turdus philomelos (*C. L. Brehm, 1831)	Undergrowth	–	5	–	–	–	–	–	6	–	–	–	–	–	–	–	3	–	14
*Turdus pilaris (*Linnaeus, 1758)	Tree-canopy	–	16	–	–	19	12	78	51	20	32	8	5	4	18	2	–	3	268
*Upupa epops (*Linnaeus, 1758)	Hollow-nesting	–	–	2	2	2	–	1	–	–	–	–	–	–	–	–	1	1	9
Total		344	247	203	190	176	106	322	227	129	412	174	112	42	84	194	207	288	3457

Note. 1 – Diivski Plavni, 2. – Zelenyi Hai Park, 3 – Mandrykivska Kosa, 4 – Novokodatskyi Youth Park of Leisure and Recreation, 5 – Monastyrskyi Island, 6 – Memorialnyi Park, 7 – Taras Shevchenko Park, 8 – Studentskyi Park, 9 – Bohdan Khmelnytskyi Park, 10 – Lazar Hloba Park, 11 – Lev Pysarzhevskyi Park, 12 – Pamiati ta Prymyrennia Park, 13 – Heroiv Square, 14 – Metalurhiv Garden Square, 15 – Soborna Square, 16 – Suhachivskyi Forest Park, 17 – Tonelna Balka Tract.

Table 3

Distribution of the number of bird registrations in the garden squares and parks during the breeding periods according to the nesting groups during 2022–2024 in the right-bank part of the city of Dnipro

Nesting groups	Number of birds																	Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Anthropogenic-substrate	35	48	95	43	45	21	87	23	19	236	84	63	26	23	146	56	42	1092
Burrow-nesting	53	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	53
Canopy-shrub	1	6	1	–	5	–	1	8	–	–	–	–	–	–	–	19	8	49
Tree-canopy	68	61	6	12	44	25	118	92	29	46	22	8	4	22	7	32	73	669
Tree-canopy anthropogenic-substrate	8	7	11	7	14	10	8	3	3	15	7	6	1	2	4	11	7	124
Hollow-nesting	16	27	14	15	9	17	37	15	17	12	8	3	4	10	7	14	14	239
Hollow-nesting anthropogenic-substrate	40	70	38	107	40	23	55	52	57	51	48	25	5	20	30	36	118	815
Floating-substrate	68	–	5	–	3	–	–	–	–	1	–	–	–	–	–	–	–	77
Ground-nesting	18	6	4	2	5	7	–	12	4	1	2	–	2	2	–	22	24	111
Ground-riparian	23	–	26	–	6	–	–	–	–	39	–	1	–	–	–	1	–	96
Riparian	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
Undergrowth	6	19	3	1	2	3	11	21	–	7	3	1	–	–	–	15	2	94
Undergrowth, anthropogenic-substrate	1	3	–	3	3	–	5	1	–	4	–	5	–	5	–	1	–	31
Total	344	247	203	190	176	106	322	227	129	412	174	112	42	84	194	207	288	3457

Note: see Table 2

Discussion

Activity of the bird communities in the large garden squares and parks in the right-bank part of the city of Dnipro. The analysis of the bird assemblages demonstrated how species composition and bird activity change depending on the landscape. It was found that large areas and diverse natural landscapes had a significantly higher species composition than small, highly urbanized areas. A similar effect has been observed in many scientific studies (Seress & Liker, 2015; Isaksson, 2018; Santos et al., 2024).

The largest surveyed areas were the Diivski Plavni floodplains and Suhachivskyi Forest Park. This floodplain area is predominantly located near the river and contains dense stands of natural riparian forest vegetation. It is a part of the Dnipro River floodplain and is situated near the single-family residential area of Diivka and the multifamily residential area of the Parus residential complex. The bird species inhabiting this area belong to various ecological complexes. The most frequently recorded birds were *Columba livia* and *Corvus cornix*, which can be attributed to the proximity to urbanized areas. *Riparia riparia* nested in sand dumps left after technical works. Among the waterfowl, the most active species were *Fulica atra*, *Phalacrocorax carbo*, and *Anas platyrhynchos*. The records of waterbirds also included chicks from broods. In the forested area, the birds were most active at the forest edge and along the riverbank. The most active among the recorded species was *Parus major*. Also, other species were observed, such as *Fringilla coelebs*, *Motacilla alba*, *Luscinia luscinia* (Linnaeus, 1758), *Phylloscopus collybita* (Vieillot, 1817), and *Dendrocopos major*. Favorable habitat conditions were found for species such as *Turdus merula* (Linnaeus, 1758), *Remiz pendulinus* (Linnaeus, 1758), *Nycticorax nycticorax* (Linnaeus, 1758), *Alcedo atthis* (Linnaeus, 1758), and *Charadrius dubius* (Scopoli, 1786). Among the less numerous species, *Hippolais icterina* (Vieillot, 1817) was recorded.

Suhachivskyi Forest Park is a part of the Diivski Plavni complex. In addition to the natural floodplain forest along the riverbank, the area of Suhachivskyi Forest Park includes dry areas with dry glades, dominated by shrub vegetation and scattered trees. The greater diversity of habitats has resulted in a different composition of the avifauna compared with Diivski Plavni. The area is located far from human residences; however, in the recreational zone along the riverbank, species such as *Passer montanus*, *Delichon urbicum*, and *Hirundo rustica* (Linnaeus, 1758), and *Phoenicurus ochruros* (S. G. Gmelin, 1774) were observed. Within the forest complex, *Parus major*, *Fringilla coelebs*, *Chloris chloris*, *Luscinia luscinia*, *Dendrocopos major*, *Corvus corax*, and *Phylloscopus collybita* were recorded. On sandy soils near the forest edge, where psammophytic steppe vegetation with shrubs and scattered trees has formed, *Lanius collurio* (Linnaeus, 1758) and *Falco tinnunculus* (Linnaeus, 1758) were found. Near the riverbank, species such as *Nycticorax nycticorax* and *Charadrius dubius* were observed.

The Tonelna Balka Tract is the third largest area we surveyed. Located in the city center, the Tonelna Balka Tract is a unique natural landmark with a complex ravine-gully system. Its slopes are covered with dense and diverse tree stands, mostly planted, while forest-edge glades are often found at the bottom of the ravine. Its significance is emphasized by the fact that it is one of the few minimally urbanized areas within the city environment. This natural area serves as a crucial habitat for various birds, including both synanthropic and rare forest and forest-edge species. The most numerous species was *Parus major*, which can be attributed to the dense undergrowth present in the ravine's forests, which is one of the species' favorite settings. *Sturnus vulgaris* ranked second in abundance. The Tonelna Balka Tract provides *Sturnus vulgaris* with abundant nesting sites and numerous clearings for foraging. *Passer montanus* was also frequently recorded. Many Corvid species were observed in the area: *Pica pica*, *Garrulus glandarius*, *Corvus cornix*, and *Corvus corax*. The dense two-layered forest structure allowed for the presence of species such as *Oriolus oriolus* (Linnaeus, 1758) and *Dendrocopos major*, *Phylloscopus collybita*, *Sylvia communis* (Latham, 1787). During the study, species that are rare for the urban environment were also observed, including *Anthus trivialis* (Linnaeus, 1758) and *Circus cyaneus* (Linnaeus, 1766). The appearance of *Circus cyaneus* was incidental. This species is listed in *The Red Book of Ukraine* and does not breed in urban conditions. The observed individual was a nomadic male attracted to the Tonelna Balka Tract for hunting.

Mandrykivska Kosa on the Dnipro River is a sand spit that combines both an area developed for leisure and an area rarely visited by people. These areas feature two-layered riparian vegetation, including moisture-loving plants and psammophytic grass communities. Due to its proximity to densely built-up districts of Dnipro, synanthropic bird species such as *Columba livia* and *Passer montanus* were frequently observed on the spit. *Parus major* was often recorded in the shoreline shrubs. The spit extends into the river, forming an extensive shoreline with shallow waters, providing shelter for waterfowl. Among them, the most frequently observed species were *Anas platyrhynchos*, along with *Podiceps cristatus* and *Larus cachinnans* (Pallas, 1811). The presence of two-layered tree stands creates favorable conditions for many forest and forest-edge-dwelling species, including *Sturnus vulgaris*, *Corvus cornix*, *Passer domesticus* (Linnaeus, 1758), *Ficedula albicollis*, and *Fringilla coelebs*.

Not far from Mandrykivska Kosa is Monastyrskyi Island. Despite their close proximity and location near the right bank of the Dnipro River, the bird diversity on these two areas differed. The territory of Monastyrskyi Island can be divided into two parts: a heavily visited developed area and a scarcely visited part. The part of the island with low recreational pressure has wide sandy shores with shrub and grass vegetation. Sparse forests are also present on the island. The most frequently recorded species were *Passer montanus*, *Sturnus vulgaris*, *Turdus pilaris*, *Parus major*, *Corvus cornix*, and *Columba livia*. Various waterfowl were observed along the shores, including the *Phalacrocorax carbo*, *Chroicocephalus ridibundus* (Linnaeus, 1766), *Sterna hirundo* (Linnaeus, 1758), *Anas platyrhynchos*, and *Charadrius dubius*, which is rarely encountered within the city. Among the shoreline vegetation and sparse forests, forest and forest-edge birds were sometimes found, including *Fringilla coelebs*, *Muscicapa striata* (Pallas, 1764), and *Ficedula albicollis*.

Taras Shevchenko Park, located next to Monastyrskyi Island, had a lower species diversity compared with the island. However, the same synanthropic and forest species were recorded more often. Taras Shevchenko Park is a highly managed area, frequently visited by people. The ornithological situation in Taras Shevchenko Park was similar to that of the managed part of Monastyrskyi Island, as the most commonly encountered species were those frequently found in urban environments. However, the total number of the recorded birds was higher, and included *Turdus pilaris*, *Passer montanus*, *Columba livia*, and *Parus major*. Due to the presence of tall trees with a complete absence of understory, many ground-feeding species were observed on open soil and short grass, such as *Sturnus vulgaris*. The dense canopy and height of the trees create favorable conditions for forest and forest-edge species, which are particularly active in this park. Among them were *Fringilla coelebs*, *Ficedula albicollis*, *Chloris chloris*, *Dendrocopos syriacus*, *Corvus cornix*, *Phoenicurus ochruros*, and *Streptopelia decaocto*.

Zelenyi Hai Park and Lazar Hloba Park have certain similarities and differences. These two green areas are located in highly urbanized districts of the city, are frequently visited by people, and take up significant areas. Zelenyi Hai Park is located on the slopes of a ravine, where the bottom is the least developed and retains dense tree stands. Lazar Hloba Park, although highly developed, still has sufficient areas with trees with a dense canopy and open ground. These two areas provide habitats for species that forage on open ground, thanks to the large areas without undergrowth. Among such species, two were the most active, namely *Sturnus vulgaris* and *Turdus pilaris*.

A distinctive feature of Lazar Hloba Park was the high number of *Columba livia*. Most likely, the park's location in the city center, along with an abundance of food and people feeding the birds, contributed to the high number of individuals. However, other synanthropic species were observed in approximately equal numbers; for example, *Passer montanus*. Another difference is that Lazar Hloba Park contains a lake, which attracts waterfowl species: *Anas platyrhynchos*, *Chroicocephalus ridibundus*, and *Fulica atra*.

On the other hand, Zelenyi Hai Park hosted more forest and forest-edge species and in greater numbers. In Zelenyi Hai Park, we observed *Parus major*, *Pica pica*, *Chloris chloris*, and *Dendrocopos syriacus*. Conversely, some species were observed more frequently in Lazar Hloba Park, for instance, *Ficedula albicollis* and *Corvus cornix*. This may indicate the adaptation of these two species to the urban environment (Zeid et al., 2023).

The last surveyed area with a significant size was Novokodatskyi Youth Park of Leisure and Recreation. This is one of the largest green zones in the area, but had the lowest species diversity of avifauna. This may be due to the park's proximity to Diivski Plavni, the presence of private houses around the park, which reduces the number of synanthropic species, and the fact that the park is bordered on two sides by streets with heavy traffic. The area is partially urbanized; however, a large part consists of

tree stands with short mowed grass, where human activity is relatively low. The park was dominated by typical synanthropic species and birds that have long adapted to urban conditions. The open-ground areas proved attractive to *Sturnus vulgaris*. Among other species, the most active birds were *Passer montanus*, *Columba livia*, *Corvus cornix*, *Dendrocopos syriacus*, *Pica pica*, *Parus major*, and *Ficedula albicollis*.

The aforementioned green zones are the largest in the city, with the surveyed area of over 19 hectares. The green spaces described below are smaller.

Activity of the bird communities in the small garden squares and parks in the right-bank part of the city of Dnipro. Three small parks are located near Zelenyi Hai Park: Memorialnyi Park, Bohdan Khmelnytskyi Park, and Lev Pysarzhevskyi Park. However, each of these areas has its own distinct features.

Memorialnyi Park had the smallest number of recorded bird species, although the surveyed area is the largest among the three green zones located nearby. This could be attributed to its surroundings; unlike Bohdan Khmelnytskyi Park and Lev Pysarzhevskyi Park, Memorialnyi Park is bordered by an avenue and a highway with heavy traffic, generating frequent and intense winds within the park, further influenced by nearby buildings. The trees in the park are sparsely planted and lack undergrowth, which has resulted in a low number of forest and forest-edge birds. The most commonly recorded species included *Columba livia*, *Sturnus vulgaris*, *Ficedula albicollis*, *Turdus pilaris*, *Fringilla coelebs*, *Corvus cornix*, *Motacilla alba*, and *Parus major*.

Lev Pysarzhevskyi Park is situated between two major avenues, making it an important pedestrian zone for residents who cross the park when moving between districts. Due to its convenient location and well-developed infrastructure, the park is popular among city dwellers. The park's territory is conditionally divided into two parts, one with broadleaf tree plantings and the other with coniferous trees. The commonest species included *Columba livia*, *Parus major*, *Sturnus vulgaris*, *Ficedula albicollis*, *Turdus pilaris*, *Corvus cornix,* and *Passer montanus*. Interestingly, *Muscicapa striata* was observed most often in Lev Pysarzhevskyi Park, compared with other surveyed areas. Moreover, *Asio otus* (Linnaeus, 1758) was found in the coniferous plantings.

Bohdan Khmelnytskyi Park differs from the other compared areas due to the significant presence of tree species with dense canopies. The trees are planted sparsely, and the park lacks undergrowth while featuring open spaces. It is partially landscaped, with grass regularly mowed across the entire area. The park's conditions support the prevalence of two ground-feeding species: *Sturnus vulgaris* and *Turdus pilaris*. All other species present were typical park inhabitants, including *Columba livia*, *Ficedula albicollis*, *Parus major*, and *Fringilla coelebs*.

Studentskyi Park is located near the previously described green spaces but was found to have higher diversity and activity of birds. A small part of the park is landscaped; at the entrance, trees are sparsely planted, with no undergrowth and a considerable amount of open ground. The park contains a variety of tree species with different canopy densities – open, semi-dense, and dense – creating favorable conditions for a greater diversity of birds. Due to the fact that the park has been created on the territory of the upper reaches of the ravine, it has uncultivated slopes with natural dense growth of vegetation of different layers. This factor contributes to the park's high abundance of forest and forest-edge-dwelling birds, for instance, *Sylvia atricapilla* (Linnaeus, 1758), *Turdus philomelos* (C. L. Brehm, 1831), *Emberiza citrinella* (Linnaeus, 1758), and *Carduelis carduelis* (Linnaeus, 1758). The counts of these birds were the highest among all the surveyed parks, where such species were not recorded in similar numbers. The most abundant species in this area were *Turdus pilaris*, *Sturnus vulgaris*, *Parus major*, *Columba livia*, *Chloris chloris*, *Fringilla coelebs*, *Ficedula albicollis*, and *Pica pica*.

Areas such as Soborna Square, Heroiv Garden Square, Pamiati ta Prymyrennia Park, and Metalurhiv Garden Square were the smallest surveyed areas. All these areas were inhabited by species commonly found in urban parks, including *Columba livia*, *Sturnus vulgaris*, *Passer montanus*, *Turdus pilaris*, *Ficedula albicollis*, and *Corvus cornix*.

Distribution of nesting groups in the garden squares and parks of the right-bank part of Dnipro. The selection of nesting sites is one of the key factors determining the success of bird communities within urban areas. The characteristics of available nesting substrates influenced both species diversity and bird abundance. By identifying dominant substrates and assessing their diversity, it is possible to determine the most favorable areas for nesting by different bird groups. This approach reveals how the presence or absence of specific substrates influences the formation of bird communities and which green spaces provide the best conditions for bird reproduction in the urban environment.

Analysis of nesting groups of birds is an important tool in animal ecology that allows for the identification of key ecosystem characteristics. This method can also reveal features relevant to specific animal groups. Moreover, such analysis aids in assessing the functional diversity of species within ecosystems and can be used for biodiversity conservation (Akimov, 1954; Ponomarenko, 2005; Andryushchenko, 2021). This approach enabled an assessment of the ecological role of each park in supporting the avifauna. Within the framework of the study, we analyzed the distribution of bird groups of different nesting types in the right-bank areas of Dnipro, including the quantitative ratio of birds according to different nesting groups. This analysis allows for conclusions to be drawn about the ecological significance of these areas for species with varying habitat requirements.

The birds recorded in the parks may indicate the possible presence of favorable conditions in the surveyed areas, although not all of them nested directly within the park territory. Parks with a diversity of biotopes and adjacent areas contribute to maintaining biodiversity by providing optimal conditions for the existence of various nesting groups of birds.

The most numerous nesting group was the "anthropogenic-substrate". Such birds were most frequently recorded in Lazar Hlohla Park and Soborna Square. These areas are located in the city center and contain a significant number of anthropogenic substrates, including buildings and structures that create favorable conditions for representatives of this group. This group included synanthropic species, primarily *Columba livia*, as well as *Phoenicurus ochruros*, *Passer montanus*, *Passer domesticus*, *Delichon urbicum*, *Hirundo rustica*, and *Apus apus* (Linnaeus, 1758) (Nath et al., 2022; Douini et al., 2023; Xiao-Ru Liu & Zhong-Qiu Li, 2024).

Another numerous group was the "hollow-nesting, anthropogenic-substrate". The highest number of individuals was recorded in the Tonelna Balka Tract and Novokodatskyi Park. This group comprised two species: *Parus major* and *Sturnus vulgaris*. These species, which are commonly found in urban areas, utilize both natural and anthropogenic substrates for nesting. Birds of this group typically build their nests in natural tree hollows as well as in anthropogenic structures such as cracks, nest boxes, technological openings in concrete structures, and holes in metal pipes. Their ability to nest in both natural hollows and artificial structures provides them with considerable flexibility in habitat selection, allowing them to be observed in all surveyed areas, regardless of the degree of urbanization (Sandoval et al., 2021).

The "tree-canopy" group ranked third. The highest number of individuals was recorded in Taras Shevchenko Park and Studentskyi Park. Dense and semi-dense canopies provide reliable protection and a stable food supply consisting of diversity of insects. By contrast, semi-open and open canopies allow birds to navigate more easily, offering convenient vantage points for surveying the area, resting, and foraging. The commonest species that build nests in tree canopies include *Turdus pilaris*, *Fringilla coelebs*, *Pica pica*, and other (Wood, 2020).

The "hollow-nesting" group was formed by *Dendrocopos major*, *Dendrocopos syriacus*, *Picus canus* (J. F. Gmelin, 1788), and *Ficedula albicollis*. The highest number of records was made in Taras Shevchenko Park and Zelenyi Hai Park. The high number of species in this group can be attributed to the presence of a sufficient number of mature and old trees with natural hollows, which provide a perfect habitat for representatives of this group. It is also worth noting that Taras Shevchenko Park and Zelenyi Hai Park are distinguished by a variety of habitats within these areas, ranging from dense tree vegetation to forest edges and open spaces, offering birds a wide range of substrates for their life activities.

The "tree-canopy, anthropogenic-substrate" group included birds that, in addition to tree crowns, use anthropogenic substrates such as building cornices, rooftops, high-voltage power line supports, water towers, and technical floors of tall buildings. The highest number of records was in Lazar Globa Park, on Monastyrskyi Island, Mandrykivska Kosa, and in Sukhachivskyi Forest Park. This group included two species from the Corvidae family – *Corvus cornix* and *Corvus corax* – as well as *Falco tinnunculus*. Since *Corvus cornix* is commonly found in urban areas, its presence was recorded at each surveyed site. The presence of *Corvus corax* and *Falco tinnunculus* in Suhachivskyi Forest Park indicates a diversity of habitats, ranging from dense, tall forest stands to extensive open areas.

Species that typically nest on the ground, ground substrates, or under shrub and understory vegetation form the "ground-nesting" group. The highest number of observations was recorded in the areas with multiple vegetation layers and dense tree stands. Representatives of this group

were most frequently observed in the Tonelna Balka Tract, Sukhachivskyi Forest Park, and Diivski Plavni. The key species representing the "ground-nesting" group included *Motacilla alba*, *Phylloscopus collybita*, *Erithacus rubecula* (Linnaeus, 1758), and *Luscinia luscinia*. The presence of species within this group is directly dependent on the availability of understory vegetation and shrubs.

Species that typically nest in undergrowth or shrub canopy were relatively few in number, due to the lack of undergrowth or shrubs in some of the areas surveyed.

The species belonging to the "undergrowth" group included those that typically build nests on low trees. The highest number of species was observed in Studentskyi Park, Zelenyi Hai Park, and Suhachivskyi Forest Park. These areas are characterized by the presence of multiple vegetation layers, including young low trees combined with mature generative trees and shrubs. Such vegetation structure creates favorable conditions for the existence of representatives of the "undergrowth" group, providing a diversity of habitats and resources. Of this group, the most frequently encountered species was *Chloris chloris*.

Birds of the "canopy-shrub" group were recorded most often in Suhachivskyi Forest Park, with slightly fewer in the Tonelna Balka Tract and Studentskyi Park. These areas feature a two-layered forest structure with shrubs and young trees. Such vegetation diversity provides optimal conditions for birds that prefer the lower forest layer. Among the species representing this group, all the observed species of the *Sylvia* genus were recorded, as well as *Lanius collurio*.

The "undergrowth, anthropogenic-substrate" group includes species that nest in the understory but do not avoid anthropogenic substrates such as balconies, windowsills, and poles. This group accounted for 31 bird records and was represented by a single recorded species – *Streptopelia decaocto*. It was most frequently observed in Taras Shevchenko Park (5 records), Pamiati ta Prymyrennia Park (5 records), Metalurhiv Garden Square (5 records), Lazar Hloba Park (4 records), on Monastyrskyi Island (3 records), in Novokodatskyi Park (3 records), and Zelenyi Hai Park (3 records). The presence of diverse substrates for nesting, along with available food resources, may have contributed to the occurrence of this species in the surveyed areas.

The representatives of the "burrow-nesting" group were recorded only in Diivski Plavni, with a total of 53 records. Among them were *Alcedo atthis*, observed near the river, and *Riparia riparia*, whose presence was associated with anthropogenic sand embankments that provided favorable nesting conditions for this species.

The representatives of the "ground-riparian" group were species that nest on the ground near shorelines. Among them were *Anas platyrhynchos* and two species from the Laridae family: *Chroicocephalus ridibundus* and *Larus cachinnans*. The presence of birds belonging to the "ground-riparian" group was observed in Lazar Hloba Park, on Mandrykivska Kosa, and in Diivski Plavni. Only Diivski Plavni hosted all three species of this group, while Mandrykivska Kosa, Monastyrskyi Island, and Lazar Hloba Park each had two species recorded. It is worth noting that all species within the "ground-riparian" group are quite common in urbanized areas and may occasionally use anthropogenic substrates for nesting (Shearer, 2022; Goumas, 2024). Birds observed in Lazar Hloba Park settled on artificial substrates within the lake in the park's center. We recorded one species of this group in Pamiati ta Prymyrennia Park, despite the park lacking direct access to a water body. This bird was likely an accidental visitor to this area, as the park is located 1.5 km from the nearest body of water.

The representatives of the "riparian" group were recorded in Diivski Plavni. This group included *Acrocephalus arundinaceus* (Linnaeus, 1758), which builds its nests using riparian vegetation, particularly reedbeds growing near water bodies.

Most representatives of the "floating-substrate" group were recorded in Diivski Plavni. This group is characterized by birds nesting on water among dense aquatic vegetation. Three species belonged to this group: *Sterna hirundo*, *Fulica atra*, and *Podiceps cristatus*. These birds were most frequently observed in Diivski Plavni, but they were also recorded on Mandrykivska Kosa, Monastyrskyi Island, and in Lazar Hloba Park.

Among all the studied sites, the greatest diversity of groups was recorded in Diivski Plavni, where all the listed groups were observed. This diversity is due to the complex combination of various habitat types. The area includes a two-layered forest with a diverse tree composition. The presence of sand dumps and proximity to water bodies create optimal conditions even for the rare "burrow-nesting" group. Additionally, Diivski Plavni are located near the city, which allows bird groups to utilize anthropogenic substrates to find suitable nesting sites. The proximity to the river with riparian vegetation further enhances the habitat opportunities for wetland birds.

Monastyrsky Island ranked second in the group diversity among the studied areas. The "burrow-nesting" and "riparian" groups were not recorded on this site. Their absence can be explained by the lack of suitable natural conditions, particularly the island's specific topography, which does not include sandy or clay cliffs for burrow nesting, as well as the insufficient development of reed thickets necessary for the "riparian" group. However, the diversity of the tree stand, partial landscaping, and the presence of understory, shrubs, young trees, and shoreline vegetation contributed to the overall group diversity on the island.

The territories of Mandrykivska Kosa, Lazar Hloba Park, and Suhachivsky Forest Park ranked third in the group diversity. The total number of groups recorded in these areas is 10 out of 13. The "riparian" and "burrow-nesting" groups were absent. Additionally, representatives of the "undergrowth, anthropogenic-substrate" group were not recorded on Mandrykivska Kosa, the "canopy-shrub" group was missing in Lazar Hloba Park, and the "floating-substrate" group was absent in Suhachivsky Forest Park. Mandrykivska Kosa combines various habitat types, including cultivated and less-frequented areas, as well as multi-layered riparian plant communities. Lazar Hloba Park, located in the city center, is characterized by an urbanized environment, the presence of a lake, and trees of various ages. Suhachivsky Forest Park, located on the edge of the city, combines natural biotopes such as floodplain forests, dry glades, and riparian vegetation. Despite their ecological differences, these areas exhibit a combination of biotopes that support a significant number of species from the studied groups.

The areas with the fewest nesting groups were Bohdan Khmelnytsky Park and Heroiv Garden Square, where 6 nesting groups have been recorded, as well as Soborna Square, where representatives of 5 nesting groups were found. The absence of water bodies nearby, as well as the lack of understory with bushes or young trees, explains such a limited diversity. The present groups are mainly associated with the use of anthropogenic substrates, indicating their significant presence in these areas, as these sites are highly cultivated.

Conclusions

The study found that the nesting avifauna in the suburban forest zones, city parks, and garden squares on the right-bank part of the city of Dnipro included 62 bird species belonging to 17 orders, with the order Passeriformes being the most dominant among the registered species. The species composition and abundance are largely influenced by environmental factors such as the level of anthropogenic impact, vegetation structure, and the availability of suitable nesting sites. This was confirmed by the variations observed among the synanthropic, forest, and waterfowl species.

The commonest groups were "anthropogenic-substrate", "hollow, anthropogenic-substrate", and "tree-canopy". The least numerous were "undergrowth, anthropogenic-substrate" and "riparian".

The greatest diversity of nesting types was recorded in Diivski Plavni, where all of the listed groups were observed, which is due to the combination of different biotopes, a forest with several tiers and proximity to water bodies. Monastyrsky Island ranked second in the diversity, although the “burrow” and “riparian” groups were absent due to the specific relief and insufficiently developed reed thickets. Mandrykivska Kosa, Lazar Globa Park, and Sukhachiv Forest Park had 10 out of 13 groups, with the absence of some groups, such as “riparian”, “burrow”, “crown-shrub” and “floating-substrate”. These territories combine different ecological conditions that contribute to the presence of representatives of a large number of nesting groups.

The areas with the fewest groups were Bohdan Khmelnytskyi Park, Heroiv Garden Square, and Soborna Square, where the low diversity can be explained by the absence of water bodies and understory with bushes or young trees. Meanwhile, the present nesting groups were mainly associated with anthropogenic substrates, indicating a high level of land development in these areas.

Territories with large areas and diverse habitats have significantly higher species diversity. The restoration of understory and shrubs would promote the presence of a greater number of bird groups. Multi-layered vegetation, particularly dense shrubs and young trees, creates favorable conditions for many bird species, including those belonging to the "canopy-shrub" and "understory" groups. The diverse forms of relief promoted

a greater number of species from the "ground" group. A significant number of birds have adapted to urban environmental conditions, and locations near the city provide convenient places for nesting. Proximity to water bodies adds opportunities for wetland birds. Uncultivated riverbanks with natural riparian vegetation support the presence of the "riparian" group.

The results of the study highlight the important ecological role of green spaces in maintaining biodiversity and facilitating birds' adaptation to urban environments. This underscores the necessity of preserving and restoring various types of nesting substrates to create optimal conditions for birds' survival. The collected data will contribute to the development of effective conservation measures, support of biodiversity, and creation of resilient ecosystems within urbanized areas. Emphasizing the preservation of natural landscapes and the creation of new ecologically sustainable landscapes will promote the harmonious coexistence of humans and nature.

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