

## FLOODPLAIN FORESTS AND URBAN PARKS – A BRIEF COMPARISON OF BIRD DIVERSITY

IVO MACHAR<sup>1\*</sup>, KAREL POPRACH<sup>2</sup>, LUDEK PRAUS<sup>3</sup>, LUBOŠ ÚRADNÍČEK<sup>4</sup>

<sup>1,2</sup>*Faculty of Science, Palacky University, 17 listopadu 12, 771 46 Olomouc, Czech Republic*

<sup>3,4</sup>*Faculty of Forestry and Wood Technology, Zemedelska 3, 613 00 Brno, Czech Republic*

*\*Corresponding Author: ivo.machar@upol.cz*

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### ABSTRACT

Urbanization in cultural landscapes generally tends to select for omnivorous, granivorous, and cavity/hole nesting bird species in green urban areas. Studies on bird diversity in the cities are important to better understanding to the ecology of urban and sub-urban landscapes. The aim of this study was research on bird diversity in urban parks in Olomouc city in order to brief comparison with bird diversity in hardwood floodplain forest habitats based on our older above-mentioned study. Bird diversity in urban parks was very similar to the bird diversity in some localities of floodplain forests from the Czech Republic. Comparison between urban parks and hardwood floodplain forests in the vicinity of the city revealed a high similarity of alpha-diversity and diversity indexes. These results indicated that large urban parks have nearly the same importance for bird diversity such as managed hardwood floodplain forests. Results highlighted an importance of urban green areas for biodiversity maintaining in European cultural landscapes.

**Keywords:** Biodiversity of bird nesting communities, Line transect, Olomouc city, Urban green area.

### INTRODUCTION

Urbanization produces various effects on landscape level, including biodiversity changes (Elands *et al.*, 2019). Birds are very suitable species for environmental assessment of urbanization impact to biota because of there is a well knowledge on bird communities in different habitats world-wide. The number of studies describe bird responses to urbanization on landscape level (Marzluff *et al.*, 2001). Urbanization in cultural landscapes generally tends to select for omnivorous, granivorous, and cavity/hole nesting bird species, as revealed a review of Chace & Walsh (2006). Diversity of nesting birds is usually lower in green urban areas (such as urban parks, urban forests, tree alley etc.) then in the surrounding native or semi-natural habitats out of the city border (Lancaster & Rees, 1979). General pattern of bird diversity structure in urban environment is based on dominance by a few local common species. But, if urban green areas in the cities include some native vegetative characteristics (such as veteran trees with cavities), they can support maintaining more native bird species, such as hole-nesters (Liu *et al.*, 2019). It suggests a great importance of very large old trees in urban environment (Daniels & Kirkpatrick, 2006).

Individual old-growth trees that have been protected under sustainable forest management (or have survived natural disturbances in natural forests) are referred to as “legacy trees” (Mazurek & Zielinski, 2004). Presence of old legacy trees is typical for European temperate hardwood floodplain forests (Klimo & Hager, 2001), which are habitats with extraordinary avian diversity (Hudec, 2001).

Results of our previous study (Machar *et al.*, 2018) on bird communities in hardwood floodplain forests of Litovelske Pomoravi Protected Landscape Area (LP) indicated that forest bird diversity significantly responds to presence of individual legacy Pedunculate oak trees retaining through forest management practice. This is not surprising because of relationship between forest bird diversity and forests vegetation heterogeneity has been widely accepted (Angelstam *et al.*, 2004). In hardwood floodplain forests in LP, forester using clear-cutting management create an open canopy structure by retaining individual legacy old trees on clear cutting areas for a limited time (during early stages of forest stands). These managed forest structures are very similar to the current vegetation structure of urban parks in Olomouc city nearby the LP, which are connected via river stream to floodplain forests in LP. Thus, we wanted to know, if there would be any similarity also between bird diversity in semi-natural habitats of hardwood floodplain forests and man-made habitats of urban parks.

The aim of this study was research on bird diversity in urban parks in Olomouc city in order to brief comparison with bird diversity in hardwood floodplain forest habitats based on our older above-mentioned study.

## METHODS

### Study area

We studied bird communities in urban green areas of Olomouc city, which is a heritage city in the eastern part of the Czech Republic. This city was established in 9<sup>th</sup> century on small rocky hills in the large floodplain of River Morava (Kilianova *et al.*, 2017). Study area in about 220 metres above sea level, in central-European temperate climate zone. Study area included two urban parks in the proximity of Olomouc city centre: Smetanovy Sady (SS) urban park (20 ha) and Bezručovy Sady (BS) urban park (12 ha). Distance between the borders of both parks is 800 metres, but urban area between parks is not probably very important there is a migration barrier for resident birds. Both parks are similar to each other and have sparse tree vegetation (including individual very large deciduous trees, such as oaks and ash), herbaceous layer of parks is dominated by cultivated lawns. About 5 % of area of both parks cover shrubs, which are planted in the form of bush strips along path and pavements. In BS park, there is a slowly meandering small river stream Mlýnský Potok. In SS park, there is a small lake (0,3 ha). Vegetation in both parks is dominated by native deciduous tree species with minority of exotic tree species. Generally, the character of park's vegetation reminds a hardwood floodplain forest with open canopy, but without a typical forest herbaceous and shrub vegetation layer. Both parks are surrounded by urban area of the city.

### Bird Field Census

We studied bird species in study areas using line-transect counting method (Bibby *et al.*, 2007) during the period of 2013 - 2014 years. One line-transect was established in the SS (1.58 km) and second one was established in the BS (1.42 km). Each of these years we counted birds during breeding season twice (early in the morning in the end of April and the

middle of May). Birds detected (acoustic and visually) only within 50 m of research were counted. For bird communities, we analysed standard diversity index  $H'$  (Shannon & Weaver, 1949) and equitability index  $J'$  (Sheldon, 1969). The analysis was carried out using the Stata 12 program (StataCorp, 2017). We calculated the commonly used Jaccard index (Jaccard, 1901) to compare the similarity and diversity of nesting bird communities between urban parks (our results) in the study area, and in hardwood floodplain forest in the LP.

## RESULTS

A total of 34 nesting bird species were investigated in the SS urban park (Tab. 1) and 30 nesting bird species in the BS urban park (Tab. 2). The predominant species (> 5 % dominance in community) were in both of parks common bird species (4 species in the SS and 5 species in the BS). *Columba palumbus* and *Turdus merula* were the most dominant species in both parks. Other species with relatively high abundance were *Streptopelia decaocto*, *Turdus philomelos*, *Parus caeruleus*, *Fringilla coelebs*, *Sylvia atricapilla*, *Phylloscopus collybita*, *Sitta europaea*. In the SS, there was detected *Ficedula albicollis* as nesting species (bird species indexed in Annex I of Bird Directive), and *Accipiter gentilis* and *Muscicapa striata* in both of urban parks (endangered species in national scale of the Czech Republic).

Indexes diversity (Tab. 3) indicated in both urban parks (SS and BS) high bird diversity ( $H'$  reaches a value typical for floodplain forests, see also Tab.5) with relatively high proportion of equitability (close to the 0.8 value) of species distribution in the community (Tab. 3).

**Table 1: Bird richness in Smetanovy Sady urban park**

Bird species	Abundance ( $\Sigma$ )	Dominance (%)
<i>Anas platyrhynchos</i>	5	2.37
<i>Accipiter nisus</i>	1	0.47
<i>Columba palumbus</i>	53	25.12
<i>Streptopelia decaocto</i>	10	4.74
<i>Strix aluco</i>	2	0.95
<i>Asio otus</i>	2	0.95
<i>Picus viridis</i>	1	0.47
<i>Prunella modularis</i>	1	0.47
<i>Erithacus rubecula</i>	1	0.47
<i>Phoenicurus ochruros</i>	1	0.47
<i>Phoenicurus phoenicurus</i>	1	0.47
<i>Turdus merula</i>	37	17.54
<i>Turdus pilaris</i>	2	0.95
<i>Turdus philomelos</i>	10	4.74

<i>Hippolais icterina</i>	3	1.42
<i>Sylvia curruca</i>	1	0.47
<i>Sylvia atricapilla</i>	5	2.37
<i>Phylloscopus collybita</i>	5	2.37
<i>Muscicapa striata</i>	7	3.32
<i>Ficedula albicollis</i>	1	0.47
<i>Parus palustris</i>	1	0.47
<i>Parus caeruleus</i>	11	5.21
<i>Parus major</i>	8	3.79
<i>Sitta europaea</i>	3	1.42
<i>Certhia familiaris</i>	1	0.47
<i>Oriolus oriolus</i>	1	0.47
<i>Garrulus glandarius</i>	2	0.95
<i>Sturnus vulgaris</i>	4	1.90
<i>Passer domesticus</i>	4	1.90
<i>Fringilla coelebs</i>	11	5.21
<i>Serinus serinus</i>	4	1.90
<i>Carduelis chloris</i>	3	1.42
<i>Coccothraustes coccothraustes</i>	9	4.27
Total of species	34	

**Table 2: Bird richness in Bezručovy Sady urban park**

<b>Bird species</b>	<b>Abundance (<math>\Sigma</math>)</b>	<b>Dominance (%)</b>
<i>Anas platyrhynchos</i>	4	2.55
<i>Accipiter nisus</i>	1	0.64
<i>Phasianus colchicus</i>	1	0.64
<i>Columba palumbus</i>	30	1,11
<i>Streptopelia decaocto</i>	1	0.64
<i>Strix aluco</i>	1	0.64
<i>Picus canus</i>	1	0.64
<i>Picus viridis</i>	1	0.64
<i>Dendrocopos major</i>	3	1.91
<i>Troglodytes troglodytes</i>	1	0.64
<i>Prunella modularis</i>	1	0.64

<i>Erithacus rubecula</i>	1	0.64
<i>Phoenicurus phoenicurus</i>	4	2.55
<i>Turdus merula</i>	28	17.83
<i>Turdus pilaris</i>	1	0.64
<i>Turdus philomelos</i>	6	3.82
<i>Hippolais icterina</i>	2	1.27
<i>Sylvia curruca</i>	2	1.27
<i>Sylvia atricapilla</i>	14	8.92
<i>Phylloscopus collybita</i>	12	7.64
<i>Muscicapa striata</i>	8	5.10
<i>Parus caeruleus</i>	5	3.18
<i>Parus major</i>	4	2.55
<i>Sitta europaea</i>	7	4.46
<i>Certhia familiaris</i>	2	1.27
<i>Passer domesticus</i>	1	0.64
<i>Passer montanus</i>	1	0.64
<i>Fringilla coelebs</i>	7	4.46
<i>Serinus serinus</i>	4	2.55
<i>Carduelis chloris</i>	3	1.91
Total of bird species	30	

**Table 3: Indexes of diversity ( $H'$ ) and equitability ( $J'$ ) in Smetanovy Sady and Bezrucovy Sady urban parks**

Line-transect	SS urban park		BS urban park	
	$H'$	$J'$	$H'$	$J'$
Value of index	3.97	0.79	4.01	0.82

## DISCUSSION AND CONCLUSION

### Comparison of bird diversity in urban parks and floodplain forests in the Czech Republic

Comparison of bird diversity between urban parks in Olomouc city and hardwood floodplain forests in the proximity of the city, using Jaccard index, indicated high faunistic similarity for comparison between SS urban park and floodplain forests (Tab. 4). Results have shown a low faunistic similarity between BS urban park and floodplain forests.

**Table 4: Comparison faunistic similarity of birds between two urban parks in Olomouc city and three localities of hardwood floodplain forests in Litovelske Pomoravi Protected Landscape Area**

Jaccard Index (%)	SS urban park	BS urban park	Hardwood floodplain forest Vrapac	Hardwood floodplain forest Sargoun	Hardwood floodplain forest Panensky Les
SS urban park	-	60	51	56	49
BS urban park	60	-	38	48	45

Data sources for hardwood floodplain forest Vrapac and hardwood floodplain forest Sargoun – Machar (2010); data sources for hardwood floodplain forest Panensky Les – Machar (2012).

Bird diversity in urban green areas has been widely studied (Ortega-Alvárez & MacGregor-Fors, 2009). Bird diversity in urban parks is more associated with natural factors than anthropogenic factors, however man is a key biological species in these man-made habitats (Liu *et al.*, 2020). This is very similar to ecological conditions in hardwood floodplain forests, which are considered as man-made habitats as urban park (Cupa & Madera, 2019).

Birds respond to vegetation composition and structure (Yang *et al.*, 2015). Plant species composition, particularly native tree and shrub species is critical for the functional composition of resident birds in green patches (Nava-Díaz *et al.*, 2020). Bird species richness in urban areas is probably influenced by local rather than landscape variables (Guo *et al.*, 2019). Urban green areas with presence of native vegetative structures support more native bird species than those that not. This is related to bird communities in temperate hardwood forests, which benefit from various local native features such as individual very large living mature trees and shrub ecotones (Kilianova *et al.*, 2009). Despite of forests, species composition of urban parks influences a movement of some bird species, e.g., by *Streptopelia decaocto* and *Columba palumbus* (Sakhvon & Kövér, 2020).

As shown in the Table 5, bird diversity revealed in our studied urban parks in Olomouc city was very similar to the results of research on bird diversity in some localities of floodplain forests from the Czech Republic. Both obvious similarity of alpha-diversity and diversity indexes between our results and results of some authors (Tab. 5) clearly indicated that large urban parks have nearly the same importance for bird diversity maintaining such as floodplain forests.

**Table 5: Comparison of original results from SS and BS urban parks in Olomouc city with results of bird studies in floodplain forests in the Czech Republic**

Author of results (see References)/locality studied	Study area (ha)	Edge effects Y – yes, results can be influenced by edge effect N – influence of edge effect was excluded	Total amount of nesting bird species	H'	J'
SS urban park	20	Y	34	3.97	0.79
BS urban park	12	Y	30	4.01	0.82
Bureš & Maton (1984)	15	N	39	3.08	0.84
Bureš (1986)	5	N	48	3.01	0.81
Horák (1998)	10	N	44	4.72	0.86
Chytil (1981)	10	N	37	4.54	0.89
Lemberk (2001)/Bošín	32	N	44	4.65	0.85
Lemberk (2001)/Dubno	51	N	40	4.20	0.79
Lemberk (2001)/Choltice	52	N	42	4.39	0.81
Lemberk (2001)/Zbytka	43	N	41	4.39	0.82
Machar (2012)	9	N	31	4.32	0.87
Machar (2010)	12	Y	33	4.46	0.89
Machar (2008)	13	Y	31	4.35	0.88
Pavelka (1987)	10	Y	25	4.02	0.87
Polášek (1991)	10	Y	23	3.76	0.85
Pykal (1991)	22	N	36	4.30	0.83
Růžička (1985)	10	Y	23	3.87	0.88
Storch (1998)	12	N	30	3.86	0.79
Toman (1984)	5	N	30	4.19	0.85

### Conclusion

Our results of bird survey in SS and BS urban parks in Olomouc city can be considered only as indicative, because of more precise results should be revealed method of mapping nest territories, which has not been used because of time limit. However, our result from line-transect method using for bird counting are in accordance with studies, which found out a close relationship between bird diversity and size area of urban parks (Lepczyk *et al.*, 2017), presence of native features in urban green areas (Kümmerling & Müller, 2012; Lehmann, 2021), and proximity of urban parks to natural habitats out of city's border (MacGregor-Fors & Ortega-Alvarez, 2011).

These findings also generally support a new emerging concept of Biocultural Diversity (Kučera *et al.*, 2015), which is challenge for better future understanding to the role of man in cultural landscapes. Under this concept, bird studies on urban environment are very important (Machar, 2009; Pavlik & Pavlik, 2000; Pellissier *et al.*, 2012).

Results of our recent study (Machar *et al.*, 2019) on bird communities in floodplain forests of Litovelske Pomoravi Protected Landscape Area highlighted that forest bird diversity significantly responds to presence of individual legacy Pedunculate oak trees retaining through forest management practice. But an important knowledge-gap is an ecological role of these retaining legacy trees as potential ecological traps for nesting birds in the context of nest-predation, which can be an important constraint of bird nesting success. It should be a topic of future research to better understand to importance of native vegetation features for bird diversity.

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## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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