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MONTH-TO-MONTH VARIATIONS IN DENSITIES AND DOMINANCE OF BIRDS BREEDING IN AN EXTENSIVE PINE FOREST

G. Kopij

Department of Vertebrate Ecology, Wrocław University of Environmental and Life Sciences, ul. Kożuchowska, 5b, 31-051 Wrocław, Poland
E-mail: gkopij@unam.na

Month-to-Month Variations in Densities and Dominance of Birds Breeding in an Extensive Pine Forest. Kopij, G. — Month-to-month changes in avian assembages are considerable in forest habitats. In this study such changes were studied by means of the line transect method (eight transect with total length of 77.7 km) in lowland coniferous forest in SW Poland (dominant forest type in Central European Plain), in three consecutive spring months: April, May and June. Shannon's diversity index varied between 1.31 and 2.25 in particular month, while Simpson's diversity index and Pielou's evenness index were almost identical everywhere: H' = 0.92–0.93 and J' = 0.74–0.78, respectively. In overall, the differences in mean densities of breeding species between three months on all transects pooled were not statistically significant, as were also not statistically significant such differences on particular transects. Month-to-month variations in densities in all transects pooled were statistically significant in the case of 26 out of 54 species (48.1 %). Month-to-month changes in population densities recorded on transects, only partly conform to the arrival patterns. Two counts, instead of three, would sufficed for precise estimation of bird population densities in Central European lowland pine forests: one count should be conducted in April, to register mainly resident species, and the second one in May to count mainly the migrant species.
Key words: community ecology, population densities, temporal variations, line transect method.

Introduction

All long-term (year-to-year) studies have shown that densities of breeding pairs of most bird species vary considerably both in forests and in 'open' habitats (e. g. Alatalo and Alatalo, 1980; Wesołowski et al., 2010; Kopij, 2014, 2015; Tomiałojć, 2011). The main factors causing such variations are natural succession of vegetation or changes in land use; density-dependent winter mortality of both resident and migrant species (especially young individuals); climate changes; impact of competitors and predators. In most habitats, diversity, densities and dominance structure of birds varies also seasonally within the same year. In the temperate and boreal zones, such changes are especially pronounced between winter and summer, as most breeding bird species are partial or total migrants.

Month-to-month changes in avian assemblages are also considerable in forest habitats, especially in the coniferous forests. It is because avian assemblages are usually dominated in such habitats by migrant species (Niemi et al., 1998). This may have serious methodological implications for precise population estimations. If counts are conducted once only, the line transect method may seriously underestimate densities of many bird species (e. g. Tiainen, 1980; Grabiński and Stawarczyk, 1986). On the other hand, surveys repeated on the same transect in the same breeding season over and over again, may not necessary increase the accuracy of the estimate (Bibby et al., 1992). It is important to know, therefore, how many repetitions are necessary for reliable bird population estimation in a given habitat.

In Poland, forests comprise 31 % of the total surface area, while the lowland coniferous forests comprise 51 % of all afforested areas (Wasiak, 2015). They constitute, therefore, once of the most important habitats of birds in this country. The coniferous forests are dominated by the Scots pine *Pinus sylvestiris* and are often left unfragmented in the form of extensive blocks of several hundred to several thousand km^2 surface area. Only c. 3 % of Polish forests are left unmanaged as national parks and nature reserves, all others are managed by state (77 %) or are private (19 %) (Wasiak, 2015). For their common occurrence and relative homogeneousity, managed lowland coniferous forests are especially suitable and important for the study of month-to-month variation in diversity, density and dominance structure, what constitutes the aim of this study.

Study area

The study area comprised an extensive coniferous forest, called Niemodlin Forest, situated in Opole Silesia, SW Poland. Most studies were conducted in Proszków Forest Inspectorate (transects III–VIII), with only two transects (transects I–II) designed in Tułowice Forest Inspectorate.

Prószków Forest Inspectorate with an afforested surface area of 180 km^2 comprises mainly Fresh Mixed Coniferous Forest (63.8 % of all afforested surface), and Fresh Mixed Deciduous Forest (26.8 %). The Alder comprises only 0.6 %. The Scots Pine, *Pinus sylvestris,* constitutes 82.2 % of the total afforested surface area, while the English Oak, *Quercus robur,* and Beech, *Fagus sylvatica* — together 8.2 %. Other tree species include *Picea abies*, *Larix decidua*, *Betula verrucosa, Acer platanoides, Acer pseudoplatanus, Fraxinus excelsior, Tilia cordata, Ulmus glabra, Carpinus betulus,* and *Robinia pseudoaccacia*. About 79000 m^3 of the wood is harvested annually, and 173 ha are again afforested in this inspectorate. Most tree stands are 41–60 (III class) and 81–100 (V class) years old (25.0 % and 17.2 % respectively). Old tree stands (VI class: age 101–120 years, and older) comprised 13.5 %.

Tułowice Forest Inspectorate, with an afforested surface area of 173.6 km^2 comprises mainly so called Fresh Mixed Coniferous Forest (47.9 %), Fresh Mixed Deciduous Forest (46.8 % of all afforested surface), and Alder (5.3 %). The Scots Pine, English Oak and Common Birch are the most common tree species (62.4 %; 17.4 % and 6.9 % respectively of total afforested surface area). Most tree stands are 41–80 years old (42.6 %), with 14 % tree stands older than 100 years. About 68 000 m^3 of the wood is harvested annually.

Methods

The line transect method (Bibby et al., 1992) was employed to estimate population densities and dominance of all breeding bird species. Birds were censused on eight transects, which run on the border lines between particular forest plots. Each transect was divided into sections. Each such section was about 0.4 km long in transects # 1–6, and 0.6 km long in transects # 7–8. An average length of all these sections was 0.47 km (SD = 0.09; n = 165). The total number of sections of all transects was 165, and the total length of all transects — 77.7 km (table 1).

Birds were counted separately on each section. Transect length ranged from 8 to 14.7 km (table 1). Birds were counted on each transect within a belt c. 100 m width (50 m on each side of the transect). Therefore, a transect 1 km long was an equivalent of c. 10 ha. Each transect was surveyed three times in the breeding season, once in each month: April, May and June. Counts were conducted in the mornings, under sunny and windless weather conditions. Transects # 1–4 were surveyed in 2002, while transects # 7–8 in 2004. As recommended for the line transects method (Bibby et al., 1992), a breeding pair, not an individual, was a census unit.

Number of breeding pairs was estimated for each section. Maximal number of breeding pairs on whatever survey on each section was assumed as the real number of breeding pairs. The total number of breeding pairs of each species on a particular transect, was calculated as the sum of maximal numbers recorded on each section within the transect.

The following guilds were distinguished:

Foraging: G — granivores; I — insectivores (lg — ground-feeders; lb — bark-feeders; lf — foliage-feeders); O — all others;

Nesting: G — on the ground; V — in herbaceous vegetation; T — in trees or shrubs; H — in tree holes;

Migration: L — long-distance migrant (wintering mostly in Africa south of Sahara); S — short-distance migrant (wintering mostly in southern Palearctic region); R — resident (wintering within the breeding range).

The following indices were used to characterize the diversity and evenness of the communities:

Shannon's diversity index: $H' = -\sum p_i \log p_i$,

where: p_i is the proportion of breeding pairs belonging to the *i*th species;

Simpson's diversity index: $D = ((\sum n (n-1)) / N (N-1)$;

where: n — total number of breeding pairs belonging to a given species, N — total number of breeding pairs of all species;

Pielou's evenness index: $J' = (-\sum p_i \log p_i) / \log S$;

where: p_i is the proportion of breeding pairs belonging to the *i*th species; S — total number of species. J' varies between 0 and 1. The less variation between species in a community, the higher J' is.

Dominance was calculated as the percentage of breeding pairs of a given species in relation to all breeding pairs of all species. Dominant species comprises 5–9.99 % of all breeding pairs recorded, eudominant — 10 % and more, while subdominant — 2–4.99 %.

The differences between the mean densities of breeding species in three months on all transects were tested by ANOVA. Month-to-month variation in densities and other parameters in all transects pooled were tested with χ^2-test.

Results

The number of species recorded on each transects in all three months varied from 37 to 44 (x = 40.8; SD = 2.61). Shannon's diversity index varied between 1.20 and 1.38, Simpson's diversity Index between 0.93 and 0.95, and Pielou's evenness index from 0.73 to 0.86 (table 1).

The total number of species recorded on all transects in all three months was 54; in April — 48, in May — 54, and in June — 49 (χ^2-test, $\chi^2 = 0.41$; $p > 0.05$). The Chaffinch, *Fringilla coelebs,* and Chiffchaff, *Phylloscopus collybita,* were the most numerous bird species, recorded as eudominant in all three months (table 2). The Willow Warbler, *Phylloscopus trochilus*, Blackcap, *Sylvia atricapilla,* and Blackbird, *Turdus merula,* were recorded as dominants in all three months, while the Robin, *Erithacus rubecula,* was dominant in April and June, the Coal Tit, *Parus ater,* in April and the Yellowhammer, *Emberiza citrinella,* in June (table 2). The Graet Spotted Woodpecker, *Dendrocopos major*, Tree Pipit, *Anthus trivialis*, Great Tit, *Parus major,* and Song Thrush, *Turdus philomelos,* were subdominants in each month, while Wood Warbler, *Phylloscopus sibilatrix*, Coal Tit and Goldcrest, *Regulus regulus* — in two months (table 2).

Shannon's diversity index varied between 1.31 and 2.25 in particular month, while Simpson's diversity index and Pielou's evenness index was almost identical everywhere: H' = 0.92–0.93and J' = 0.74–0.78, respectively (table 3).

In overall, the differences between the mean densities of breeding species in three months on all transects pooled were not statistically significant ($F_{2, 159} = 0.097$, $p = 0.908$), as were also not statistically significant such differences on particular transects (table 4).

Some of the migration, feeding and nesting guilds differed significantly between the months (table 2). The long distance migrants were most abundant in May, while residents were most abundant in April. Only in the case of the short distance migrant, month-to-month differences were not statistically significant. Granivores and insectivores gleaning leaves were more abundant in May than in other months, but proportions of other feeding guilds did not change significantly. Proportions of all nesting guilds, except for those nesting in herbaceous vegetation, differed significantly (table 2).

Month-to-month variation in densities in all transected pooled were statistically significant in the case of 26 out of 54 species (48.1 %). For 16 of them (Common Swift, *Apus apus*, Turtle Dove, *Streptopelia turtur*, Black Woodpecker, *Dryocopus martius*, Tree Pipit,

Table 1. General characteristic of avian assemblages on particular transects

No.	Number of sections	Total length, km	Number of breeding pairs	Number of species	H'	J'	D
I	22	9.1	529	38	1.31	0.83	0.93
II	22	9.5	485	37	1.28	0.82	0.93
III	22	8.8	530	44	1.38	0.84	0.94
IV	20	8.8	543	42	1.38	0.85	0.94
V	18	8.0	432	43	1.38	0.84	0.94
VI	20	8.0	599	43	1.20	0.73	0.95
VII	23	14.7	885	40	1.37	0.86	0.94
VIII	18	10.8	705	39	1.37	0.86	0.94

Table 2. Number of breeding pairs tested with the χ^2-test (χ^2 — values for each transect are shown)

Species	χ^2 — value between three months on each transect								Number of breeding pairs (N) and dominance (D)						
									April		May		June		χ^2-test
	1	2	3	4	5	6	7	8	N	D	N	D	N	D	
Accipiter gentilis (L., 1758)	2.0	-	-	2.0	-	-	-	-	0	0.0	1	0.0	1	0.0	
Accipiter nisus (L., 1758)	-	-	2.0	-	-	-	-	-	0	0.0	1	0.0	0	0.0	
Aegithalos caudatus (L., 1758)	-	-	-	-	1.0	2.0	-	-	2	0.1	3	0.1	2	0.1	
Anas platyrhynchos L., 1758	-	-	4.0	2.0	2.0	-	-	-	3	0.1	1	0.0	0	0.0	
Anthus trivialis (L., 1758)	0.6	3.8	6.3	2.2	1.2	3.0	2.1	3.8	117	4.9	92	3.4	72	3.1	10.9*
Apus apus (L., 1758)	-	2.0	2.0	18.0*	2.0	4.0	-	-	0	0.0	1	0.0	13	0.6	22.4*
Buteo buteo (L., 1758)	2.0	-	-	-	-	-	3.5	-	2	0.1	3	0.1	0	0.0	
Carduelis spinus (L., 1758)	-	2.0	-	-	-	-	-	-	1	0.0	2	0.1	0	0.0	
Certhia brachydactyla Brehm 1820	-	1.0	4.0	4.0	4.0	0.4	3.9	2.0	10	0.4	12	0.4	5	0.2	2.9
Certhia familiaris L., 1758	1.0	6.0	2.0	4.0	1.0	1.0	5.0	2.0	4	0.2	13	0.5	4	0.2	7.7
Coccothr. coccothraustes (L.,1758)	2.8	2.0	-	-	5.4	2.0	4.5	24.0*	24	1.0	6	0.2	6	0.3	18.0*
Columba oenas L., 1758	-	-	0.0	2.4	2.8	3.0	-	8.0	9	0.4	20	0.7	8	0.3	7.2
Columba palumbus L., 1758	2.0	2.0	3.5	3.0	6.0	2.6	2.9	0.4	12	0.5	13	0.5	14	0.6	0.2
Corvus corax L., 1758	1.0	2.0	2.0	1.6	0.4	0.4	-	2.0	11	0.5	19	0.7	7	0.3	6.1
Cuculus canorus (L., 1758)	0.3	1.6	5.1	3.5	0.7	4.0	5.1	10.8*	11	0.5	47	1.8	19	0.8	27.8*
Dendrocopos major (L., 1758)	1.1	2.4	2.6	0.7	1.5	0.5	2.6	11.2*	90	3.8	59	2.2	78	3.3	6.5
Dryocopus martius (L., 1758)	1.0	-	3.5	2.0	0.5	5.1	10.0*	2.8	9	0.4	22	0.8	8	0.3	9.4*
Emberiza citrinella L., 1758	1.4	0.2	2.7	1.8	2.5	2.2	2.3	1.6	106	4.5	108	4.0	**119**	**5.1**	0.9
Erithacus rubecula (L., 1758)	5.2	19.0*	10.2*	2.3	2.8	5.7	24.1*	11.2*	**176**	**7.4**	92	3.4	**153**	**6.6**	26.9*
Ficedula hypoleuca (Pallas 1764)	-	-	2.0	-	-	-	2.0	-	0	0.0	3	0.1	0	0.0	
Fringilla coelebs L., 1758	5.0	12.6*	4.0	20.9*	3.7	3.4	11.8*	2.4	**355**	**15.0**	**482**	**18.1**	**487**	**20.9**	25.4*
Garrulus glandarius (L., 1758)	0.8	4.3	0.2	4.9	1.0	1.3	4.1	2.6	28	1.2	44	1.6	42	1.8	4.0
Grus grus (L., 1758)	-	2.0	-	2.0	2.0	-	1.2	-	2	0.1	2	0.1	0	0.0	
Jynx torquilla (L., 1758)	-	1.0	2.0	-	-	2.0	-	-	2	0.1	1	0.0	1	0.0	
Lanius collurio (L., 1758)	-	-	2.0	-	0.0	1.0	-	-	1	0.0	3	0.1	2	0.1	
Lullula arborea (L., 1758)	2.0	2.0	1.0	2.0	1.0	5.2	-	2.8	7	0.3	9	0.3	1	0.0	6.1
Motacilla alba L., 1758	-	-	-	-	-	2.0	-	2.0	0	0.0	1	0.0	1	0.0	
Muscicapa striata (Pallas, 1764)	2.0	-	4.0	1.0	-	4.0	-	3.0	0	0.0	10	0.4	8	0.3	9.3

Oriolus oriolus (L., 1758)	2.0	1.0	2.0	6.0	4.0	4.0	-	0.5	6	0.3	20	0.7	11	0.5	8.2
Parus ater (L., 1758)	4.8	1.3	5.4	2.1	1.8	2.0	7.3	15.5*	**132**	**5.6**	126	4.7	66	2.8	24.7*
Parus caeruleus L., 1758	-	2.0	2.0	6.0	-	3.5	1.7	2.7	13	0.5	8	0.3	6	0.3	2.9
Parus cristatus (l., 1758)	0.9	1.0	0.2	2.0	1.5	4.5	5.9	3.9	40	1.7	45	1.7	30	1.3	3.0
Parus major L., 1758	4.3	4.2	3.5	1.0	8.0	1.3	4.4	4.4	99	4.2	70	2.6	64	2.7	9.0
Parus montanus (Baldenstein, 1827)	-	-	3.5	2.0	2.0	2.0	-	2.0	7	0.3	3	0.1	2	0.1	
Parus palustris L., 1758	2.0	-	-	-	-	-	1.1	-	2	0.1	1	0.0	1	0.0	
Phoenicurus phoenicurus (L., 1758)	2.0	-	2.6	4.0	2.0	0.0	-	2.0	12	0.5	12	0.4	2	0.1	7.7
Phylloscopus collybita (Vieillot, 1817)	0.9	1.2	8.3	3.9	2.4	9.0	2.6	5.5	**276**	**11.7**	**298**	**11.2**	**238**	**10.2**	6.8
Phylloscopus sibilatirx (Bechstein 1793)	3.5	1.0	0.5	7.0	7.0	7.4	-	9.6*	14	0.6	63	2.4	59	2.5	32.7*
Phylloscopus trochilus (L. 1758)	0.2	3.7	3.3	7.8	1.4	4.2	1.1	6.2	**185**	**7.8**	**239**	**9.0**	**173**	**7.4**	12.4*
Picus canus Gmelin, 1788	-	-	1.0	4.0	2.0	-	-	-	4	0.2	1	0.0	0	0.0	
Prunella modularis (L., 1758)	0.7	2.9	8.0	3.9	10.8*	3.5	1.8	6.0	36	1.5	26	1.0	16	0.7	7.7
Pyrrhula pyrrhula (L. 1758)	2.0	2.0	2.0	2.0	-	-	-	-	2	0.1	2	0.1	2	0.1	
Regulus ignicapillus (Temminck, 1820)	-	2.0	0.0	1.6	1.0	2.0	2.1	3.5	5	0.2	12	0.4	6	0.3	3.7
Regulus regulus (L. 1758)	2.0	5.2	2.0	0.1	3.7	11.1*	-	5.3	60	2.5	55	2.1	40	1.7	4.2
Sitta europaea L., 1758	0.3	1.6	4.0	2.0	3.5	0.3	3.3	11.4*	34	1.4	13	0.5	31	1.3	9.9*
Streptopelia turtur (L., 1758)	8.0	3.7	0.2	11.7*	1.8	11.0*	4.6	12.5*	16	0.7	66	2.5	31	1.3	35.0*
Sturnus vulgaris L., 1758	3.5	-	2.0	2.0	5.2	4.7	7.6	2.8	12	0.5	27	1.0	3	0.1	21.0*
Sylvia atricapilla (L., 1758)	0.7	7.1	5.8	12.8*	0.8	5.3	8.5	6.9	**138**	**5.8**	**192**	**7.2**	**139**	**6.0**	12.2*
Sylvia communis Latham, 1787	2.0	-	2.0	0.5	0.0	4.0	10.5*	3.5	3	0.1	11	0.4	10	0.4	4.8
Sylvia curruca (L., 1758)	4.0	2.0	0.3	-	1.1	2.6	2.6	4.0	11	0.5	16	0.6	6	0.3	4.5
Troglodytes troglodytes (L. 1758)	2.8	3.4	1.7	2.0	4.0	2.9	0.7	4.6	75	3.2	45	1.7	43	1.8	11.8*
Turdus merula L., 1758	12.9*	12.8*	8.7	6.4	13.2*	4.1	5.7	1.0	**126**	**5.3**	**170**	**6.4**	**211**	**9.0**	21.4*
Turdus philomelos Brehm, 1831	2.5	11.9*	1.2	8.8	1.8	4.3	0.2	9.9	74	3.1	78	2.9	94	4.0	2.7
Turdus viscivorus L., 1758	2.0	2.0	-	-	2.0	-	-	-	2	0.1	1	0.0	0	0.0	
Total	2.1	11.1*	11.8*	2.0	0.1	25.9*	4.3	22.5*	2366		2670		2335		126.6*

Note. N — total number of breeding pairs; D — dominance, %; χ^2 — values marked with an asterisk, *: $p < 0.01$; χ^2 — values underlined: $p < 0.05$; others: $p > 0.05$. Dominant species indicated with bold case.

Table 3. Comparison of the parameters and indices of the avian assemblage in particular month

Parameter	April	May	June	χ^2	p
Dominance					
Cumulative dominance	58.6	51.9	65.2	128.7	< 0.001
No. of dominant species	7	5	7	0.4	> 0.05
Total no. of all species	48	54	49	0.4	> 0.05
Indices					
Shannon's Diversity	1.31	1.31	2.25		
Simpson's Diversity	0.93	0.93	0.92		
Pieleou's Evenness	0.78	0.76	0.74		
Migration guilds					
Long-distance	11.0	18.4	14.3	77.6	< 0.001
Resident	27.7	22.4	21.5	15.7	< 0.001
Short-distance	61.3	58.7	64.0	4.8	> 0.05
Feeding guilds					
Granivores	6.1	7.7	7.3	11.8	< 0.001
Insectivores (bark)	6.4	4.4	5.3	4.1	> 0.05
Insectivores (leaves)	60.9	65.8	60.5	48.6	< 0.001
Insectivores (ground)	24.7	19.1	24.6	5.7	> 0.05
Others	1.9	2.5	2.1	6.9	< 0.05
Nesting guilds					
Ground	5.3	3.8	3.1	14.4	< 0.001
Hole	20.3	16.4	13.9	29.4	< 0.001
Trees/shrubs	42.2	50.6	53.6	56.3	< 0.001
Vegetation (herbaceous)	32.3	28.7	29.2	5.9	> 0.05

Raven, *Corvus corax*, Hawfinch, *Coccothraustes coccothraustes*, Robin, Chaffinch, Coal Tit, Wood Warbler, Willow Warbler, Nuthatch, *Sitta europaea*, Blackcap, Wren, *Troglodytes troglodytes,* and Blackbird) the differences were statistically highly significant ($P < 0.01$) (table 2). It is interesting to note that such differences were less pronounced when month-to-moth analysis was limited to one transect only (table 2).

Discussion

There is a number of species resident in the lowland pine forests throughout the year, i. e. Black Woodpecker, Great Woodpecker, Nuthatch, Coal Tit, Crested Tit, *Parus cristatus*, Goldcrest, and Treecreepers, *Certhia* spp. Other species may be partly replaced by northern populations in winter, i. e. Common Buzzard, *Buteo buteo*, Mistle Thrush, *Turdus viscivorus*, Bullfinch, *Pyrrhula pyrrhula*, Siskin, *Carduelis spinus*, Wren, Jay, *Garrulus glandarius*. Most individuals belonging to species, such as the Yellowhammer, Great Tit, Blue Tit, *Parus caeruleus*, Marsh Tit, *Parus palustris* or Blackbird vacate their territories in pine forests in late summer and move to other, more suitable habitats within their breeding range. Species in these groups are the first, which start to breed. Some of them, like the Raven, Common Buzzard or Black Woodpecker, perform breeding display already in the first half of March, most others, in the second half of March and first half of April.

In pine forests, most breeding species are, however, short-distance migrants (Grabiński and Stawarczyk, 1986; Wesołowski et al., 2010). They overwinter in southern Europe, northern Africa or in the Middle East. So, they vacate their territories in pine forests in July/August, and appear there again in March/April. Among those who arrive early (usually in late March) are the Starling, *Sturnus vulgaris*, Wood Lark, *Lullula arborea*, Chaffinch, Chiffchaff, and Song Thrush. The other short-distance migrant (e. g. Robin and Blackcap) appears in the first half of April.

The long-distance migrants overwinter in sub-Saharan Africa. In pine forest they usually appear in the end of April (e. g. Turtle Dove, Willow Warbler, Wood Warbler, Pied Flycatcher, *Ficedula hypoleuca*). Among the latest migrants (first half of May) are the Golden Oriole, *Oriolus oriolus*, Cuckoo, *Cuculus canorus*, Common Swift and Spotted Flycatcher, *Muscicapa striata*.

Table 4. Differences in densities of breeding species between April, May and June on particular transects

Transect	SS	MS	F	p
I	11.15	5.57	0.051	0.95
II	52.75	26.38	0.238	0.79
III	58.81	29.41	0.351	0.70
IV	169.83	84.91	1.026	0.36
V	0.60	0.30	0.005	0.99
VI	141.93	70.97	0.779	0.46
VII	76.31	38.15	0.149	0.86
VIII	159.26	79.63	0.473	0.62

Note. ANOVA: df = 2; critical value for F is 3.05.

Month-to-month changes in population densities recorded on transects in this study, only partly conform the above-outlined arrival patterns. Among residents, the highest densities were recorded in April only for the Black Woodpecker, Nuthatch, Blue Tit, and Great Tit. Most long-distance migrants were most numerous in May, and only the Common Swift was more numerous in June than in May.

As expected, the insectivores gleaning the leaves were more numerous in May than in April and June. It is because most birds belonging to this guild have chicks in May, and

Table 5. Recommended and highly recommended months for counting birds by means of line transect method in pine forests

Species	April	May	June
Anthus trivialis	■		
Certhia brachydactyla	▒	▒	▒
Certhia familiaris		■	
Coccothraustes coccothraustes	■		
Columba oenas		■	
Columba palumbus	▒	▒	▒
Corvus corax		▒	
Cuculus canorus		■	
Dendrocopos major	▒		▒
Dryocopus martius		■	
Emberiza citrinella	■	■	■
Erithacus rubecula	■		■
Fringilla coelebs		■	■
Garrulus glandarius	■	■	■
Lullula arborea	▒	▒	
Muscicapa striata		▒	▒
Oriolus oriolus		▒	
Parus ater	■	■	
Parus caeruleus	■		
Parus cristatus	■	■	■
Parus major	■		
Phoenicurus phoenicurus	▒	▒	
Phylloscopus collybita	■	■	
Phylloscopus sibilatrix		■	■
Phylloscopus trochilus		■	
Prunella modularis	▒		
Regulus ignicapillus		▒	
Regulus regulus	■	■	
Sitta europaea	■		■
Streptopelia turtur		■	
Sturnus vulgaris		■	
Sylvia atricapilla		■	
Troglodytes troglodytes	■		
Turdus merula			■
Turdus philomelos	■	■	■

Note. Grey — months recommended for counts; black — months highly recommended for counts.

vacate their territories already in June. Since seeds become available from May, granivores were more numerous in May and June than in April. Arthropods living under or on the surface of the bark, in the litter or in soil are common and available to the birds from spring through late autumn. Birds feeding on them did not show, therefore, statistically significant month-to-month changes in population densities.

Since the foliage of most trees develops in May, the early breeders in forests hide their nests mainly in the holes, few on the ground. Therefore, in the first half of the breeding season they numerically overnumber other nesting guilds. When the foliage is fully developed in the second half of the breeding season, birds nesting on trees and shrubs overnumber all other nesting guilds. Contrary to expectations, birds nesting in low herbaceous vegetation did not show seasonal changes in numbers. The herbaceous vegetation (forbs, grasses and sedges) is fully developed only in the end of May and in June. Birds nesting in such vegetation may, however, select for dry vegetation from the previous year.

The findings on month-to-month variations in the structure of avian communities have important methodological implications. One of the recommendations for the line transect method is that at least three counts, each one in April, May and June, should be conducted to estimate population densities of breeding birds (e. g. Bibby et al., 1992). However, this study clearly shows that two such counts would suffice in pine forests: one in April, to register mainly resident species, and the second one in May to count mainly migrant species. If only one survey is conducted in April, population estimate will be relatively accurate for 20 out of 35 (57.1 %) common forest bird species (table 5). If one such survey in conducted in May, the population estimates will be accurate for 25 (71.4 %) of those species; and if only one survey will be conducted in June — population estimates will be accurate for only 13 (37.1 %) species. There are only few species which can be counted in pine forest with a similar precision in any spring month: the Short-toed Treecreeper, *Certhia brachydactyla*, Wood Pigeon, *Columba palumbus*, Yellowhammer, Jay, Crested Tit and Song Thrush; in May and/or June: Chaffinch, Spotted Flycatcher and Wood Warbler. April and/or May are most suitable for counting species, such as the Wood Lark, Coal Tit, Chiffchaff, and Goldcrest; in April and/or June: Great Woodpecker, Robin and Nuthatch. Therefore, out of 35 common breeding forest species, June count was necessary for precise estimation of the Blackbird only. For all other species, two counts, one in April and the other in May would be sufficient (table 5).

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