FOLIA OECOLOGICA – vol. 43, no. 1 (2016). ISSN 1336-5266

Bird community structure and population trends in the Little Carpathians Mts vineyard area

Peter Puchala

ŠOP SR, Administration of CHKO Malé Karpaty, Štúrova 115, 900 01 Modra, Slovak Republic

Abstract

Puchala, P., 2016. Bird community structure and population trends in the Little Carpathians Mts vineyard area. *Folia Oecologica*, 43: 42–49.

The birds of the vineyards on the eastern slopes of the Little Carpathians Mountains (south-western Slovakia) were studied during breeding seasons between the years 2010 and 2015. A point census method was used to count birds once or twice in May on two study sites (a transect in the vicinity of Modra town and a transect between Bratislava-Rača and Svätý Jur). The whole study area was designated as an Important Bird Area and established as a Special Protected Area according to the Bird Directive. Individual counting points were situated in different habitats including suburban areas, green lines with scrubs, the edges of small forest patches, forest edges, small gardens, cultivated vineyards, etc. 62 and 53 bird species were found in the first and the second transect, respectively (64 birds in total). The total number of all individuals was 2,383 at the Modra site and 972 at the Rača-Svätý Jur site. The most abundant species on both transects was *Sturnus vulgaris* (21 and 36%, respectively). Another abundant species at the Modra site (dominance between 5 and 7%) were *Turdus merula*, *Passer montanus*, *Passer domesticus* and *Delichon urbicum*, while at the Rača-Svätý Jur site *Fringilla coelebs* and *Apus apus* were abundant. Several species with higher conservation importance were found: *Upupa epops*, *Lullula arborea*, *Pernis apivorus*, *Jynx torquila*, *Lanius collurio* and *Sylvia nisoria*. A decline of some species like *Chloris chloris*, *Delichon urbicum*, *Emberiza citrinella*, *Fringilla coelebs*, *Saxicola torquata*, *Sylvia atricapilla* and *Upupa epops* was recorded since the beginning of the study. Continuous and long-term monitoring may bring important data about the population status of birds in human-affected landscape.

Keywords

birds, Malé Karpaty Mts, monitoring, vineyards

Introduction

European farmlands have been changed a lot in recent decades. These historical changes in agricultural practices have been linked to a farmland biodiversity including bird species and their population trends (Siriwardena et al., 2000; Vretenberg et al., 2006). Generally, avian abundance and biomass are both declining with the most of the decline being attributed to more common species (Inger et al., 2014). Analysis of an extensive European dataset confirms the large decline of widespread farmland birds in Europe. Common farmland birds have on average fallen in number by nearly half (Voříšek et al., 2010). Population declines and range contractions were significantly greater in countries with more intensive agriculture, and significantly higher in the former European Union countries (Donald et al., 2001). Local and regional differences in biodiversity patterns and in land use history within European farmlands can provide differences in species dynamics and

Correspondence:
e-mail: peter.puchala@sopsr.sk

species-habitat interactions (Tryjanowski et al., 2011). One of the biggest causes of the farmland biodiversity decline is the loss of ecological heterogeneity at multiple spatial and temporal scales (Benton et al., 2003).

Vineyards and viticulture are regarded as a minor part of the agricultural landscape. In Slovakia, vineyards are part of the historical structures of the cultural landscape. Usually they create a mosaic of dominant vineyards, often combined with orchards, grasslands and seldomly ploughed fields (Špulerová et al., 2011). Studies on the specific role of viticulture in the maintenance of farmland biodiversity are relatively rare and have been focused on different groups of animals (Bruggisser et al., 2010; Tanadini et al., 2012) and some of them on the role of biodiversity in the biological protection of viticultures (Ponti et al., 2005). Several studies have provided data about biodiversity of vineyard habitats in Little Carpathians area as well (Majzlan 2011; Mihál et al., 2014).

Extensive farmlands contain patches of rich biodiversity, including birds that are known as indicators of high nature value farmlands (Morelli et al., 2014). Some of the very valuable farmland areas for birds have been included in important bird areas in Slovakia (Rybanič et al., 2004). One of these areas is also the Little Carpathians Mts area, especially its south-eastern slopes, which are historically managed as the vineyards for a long period. There has been not so much attention given to ornithological studies in farmlands and especially not in vineyard areas in Slovakia. The present study is a result of continuous survey within this area and gives results of this monitoring since 2010.

Material and methods

The study area is situated on the south-eastern slopes of Little Carpathians Mts in south-western Slovakia at an altitude from 150 to 270 m asl. The area represents a vineyard landscape characterized with intensive or abandoned vineyard fields combined with green lines, small forest patches, forest edges and gardens. Birds were studied at two different sites (transects), the first one in the vicinity of Modra town and the second between the towns of Bratislava-Rača and Svätý Jur (Fig. 1). The study area and both sites are parts of important areas for the conservation of birds in Slovakia. The Little Carpathians were designated as an Important Bird Area (Rybanič et al., 2004) and later established as a Special Protected Area according to the Directive on the conservation of wild birds (Directive 2009/147/EC).

Birds were studied during breeding seasons between the years 2010 and 2015 – the site Modra was studied during this period, while the site Rača-Svätý Jur was studied during the period 2010–2013. A point census method, with 20 point counts per transect, was used. At each point all birds heard or seen were counted during a 5-min period in a distance 100 meters from the counting point and additionally in a distance more than 100 m. Both transects were censused once or twice during May or the beginning of June at both sites in morning hours between 6 and 10 AM. The survey was a part of PECBM (Pan-European Common Birds Monitoring) (Voříšek et al., 2010). Counting points were distributed at least in 300 m distances in different habitats including the edges of vineyard plots, green lines, small

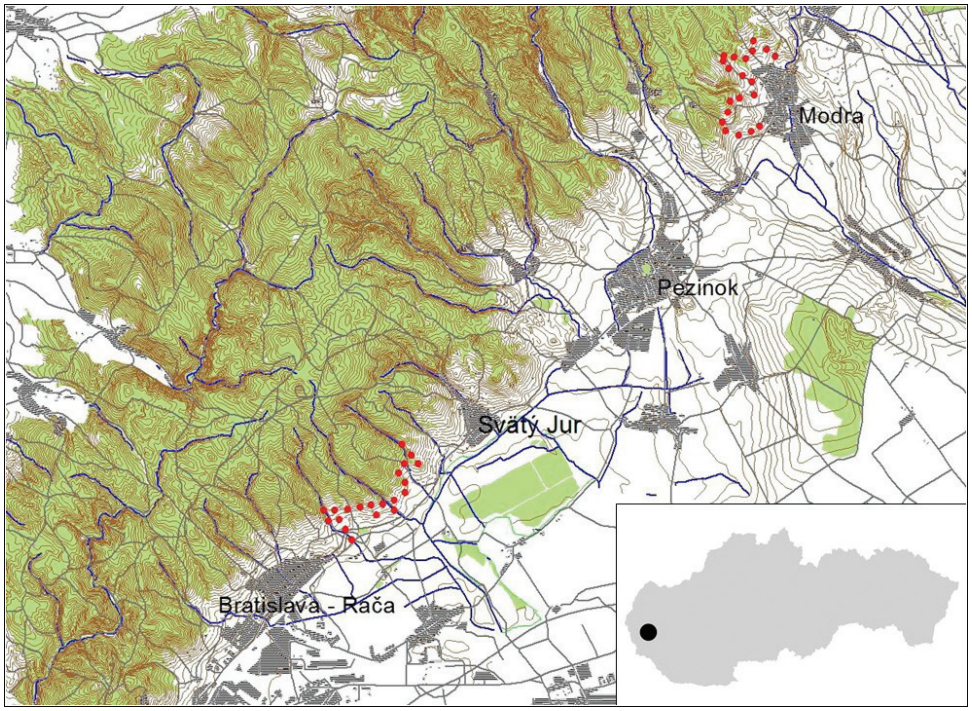

Fig. 1. Locations of individual census points within both transects in the study area.

forests, the edges of forested areas, suburban areas, and gardens, in order to cover a variety of specific environments. Each counting point consists of two or more of the above mentioned habitats with different proportions of them in 100 meter distances.

In order to analyse count data from both sides and produce estimates of yearly indices and trends, the program TRIM was used (van Strien et al., 2004). The program can be used to estimate indices trends and analyse time series of counts with missing observations (Pannekoek and van Strien, 2001). For the analysis of trends and indices, 32 species were selected. Species with a higher dominance and frequency, as well as several other common birds and species occurring in farmland habitats, were included into this analysis. The data of species composition at both study sites were analysed using non-metric multidimensional scaling (NMDS) and Bray-Curtis index in order to analyse similarities between the two studied sites and individual counting points according bird community composition. The Bray-Curtis index is suitable for quantification of the compositional dissimilarity of communities of species on different sites based on counts at each site. Each counting point of studied transects in each particular studied year was used as an individual sample. Statistical analysis was done using the statistical software, PAST (Hammer 2015).

Results and discussion

Totally, 64 bird species were found on both study sites. A higher number of species (62) was found at the Modra site while at the sites Bratislava-Rača and Svätý Jur only 53 species were found. A checklist of species and their dominance and frequency is in Table 1.

The total number of species is not so high compared to other studies conducted in vineyard areas within Europe. During the study in a wine-growing area in Loire valley (France), a total number of 93 species was found (Pithon et al., 2015). This difference in results is caused by a different methodology of data sampling with higher frequency of sampling visits in that study. There is a significant difference between extensive, intensive and abandoned vineyards. Extensively used vineyards have significantly more bird species than abandoned and extensively used ones. Abandoned vineyards were rich in species and individuals, mainly woodland species, whereas intensively used vineyards had both fewer species and individuals (Verhulst et al., 2004). Both study sites in the Little Carpathians area consist of intensively used vineyards and abandoned ones. Several woodland species were found. The reason for that is the composition of habitats surrounding some census points including forest edges, gardens and small forest patches.

The most abundant species at both sites was the starling (*Sturnus vulgaris*). The dominance of the species was 21% at the Modra site and at Rača-Svätý Jur even higher at 36%. The total number of individuals at the Modra site was 498 and at Rača-Svätý Jur 348. Other dominant species at the Modra site were: *Turdus merula* (7%), *Passer montanus* (6%), *Passer domesticus* and *Delichon urbicum* (each 5%). The situation was a bit different at Rača-Svätý Jur. Other dominant species were *Fringilla coelebs* (6%) and *Apus apus* (5%). The swift (*Apus apus*) was recorded also at the Modra site but was not so abundant. Vineyard countryside is not a breeding habitat for this species but is very suitable feeding habitat. Higher dominance at Rača-Svätý Jur site was caused by the vicinity of Bratislava city with higher breeding possibilities for the species than in the Modra site. Similarly for *Delichon urbicum* and *Hirundo rustica,* both sites are feeding habitats only. The house sparrow (*Passer domesticus*) was found to be a dominant species at the Modra site but was absent at the Rača-Svätý Jur site. Another species that was found only in Rača-Svätý Jur site was *Pica pica*. Higher occurrence of *Corvus cornix* was found in this site, while at the Modra site only one observation of this species was made. The differences in bird composition between both studied sites in individual years are shown with the results of NMDS analysis and based on Bray-Curtis similarity measures (Fig. 2). The stress value (0.4349) is rather high, which indicates a low quality of the model. Some of counting points within both sites are overlapping indicating a similarity of bird composition. However several counting points at the Rača-Svätý Jur site have different bird compositions caused by a higher abundance of species related to urban environment. The configuration of local habitat within the landscape may be as critical for bird community composition as the composition of the local habitat itself (Melles et al., 2003).

The most frequent species that were found within all visits and both sites (100% frequency) were 14 species (*Phasianus colchicus, Streptopelia turtur, Cuculus canorus, Lanius collurio, Parus major, Sylvia atricapilla, Sturnus vulgaris, Turdus merula, Turdus philomelos, Luscinia megarhynchos, Fringilla coelebs, Serinus serinus, Carduelis carduelis, Emberiza citrinella*; Table 1). The highest frequency (100%) at the Modra site had 9 species (*Streptopelia decaocto, Jynx torquila, Oriolus oriolus, Hirundo rustica, Delichon urbicum, Hippolais icterina, Passer montanus, Carduelis cannabina, Miliaria calandra*). The highest frequency at the Rača-Svätý Jur site had 6 species (*Apus apus, Corvus cornix, Lullula arborea, Sylvia communis, Chloris chloris, Coccothraustes coccothraustes*). Several species had very occasional occurrence and vineyards are not typical habitats for them. Those species were: *Anas platyrhynchos, Phalacrocorax carbo* and *Merops apiaster*. The bee-eater (*Merops apiaster*) was found only once in the Modra site. There are not any known breeding sites of this species in the vicinity. However, vineyards could be a breeding habitat for this species. There has

Table 1. Checklist of species within both sites with their dominance and frequency

Site	Modra		Rača-Svätý Jur	
Species	Dominance (%)	Frequency (%)	Dominance (%)	Frequency (%)
Phasianus colchicus	2.5	100	2.0	100
Anas platyrhynchos	0.1	12.5	0.2	25
Ciconia nigra	0.1	25	0.2	50
Phalocrocorax carbo	0.1	12.5	–	–
Accipiter nisus	0.0	12.5	–	–
Buteo buteo	0.5	62.5	1.7	75
Pernis apivorus	0.0	12.5	0.1	25
Falco tinnunculus	0.2	37.5	0.1	25
Crex crex	0.0	12.5	–	–
Columba palumbus	0.7	75	0.1	25
Streptopelia decaocto	1.3	100	0.1	25
Streptopelia turtur	3.1	100	2.4	100
Cuculus canorus	0.9	100	0.8	100
Apus apus	1.0	37.5	4.9	100
Merops apiaster	0.4	12.5	–	–
Upupa epops	0.1	12.5	0.1	25
Dendrocopos major	0.3	62.5	0.6	75
Dendrocopos medius	0.0	12.5	0.3	50
Dendrocopos minor	–	–	0.6	50
Dryocopus martius	0.1	12.5	–	–
Picus viridis	0.0	12.5	0.2	50
Jynx torquila	1.4	100	0.6	50
Lanius collurio	1.8	100	1.2	100
Oriolus oriolus	2.1	100	1.1	75
Corvus corax	0.1	12.5	–	–
Corvus cornix	0.0	12.5	1.0	100
Garrulus glandarius	0.0	12.5	–	–
Pica pica	–	–	0.7	75
Aegithalos caudatus	0.1	12.5	–	–
Cyanistes caeruleus	0.5	87.5	0.7	75
Parus major	4.1	100	4.2	100
Poecile palustris	0.1	25	0.1	25
Lullula arborea	0.4	75	0.9	100
Hirundo rustica	0.8	100	0.7	25
Delichon urbicum	4.7	100	0.6	25
Phylloscopus colybita	0.2	50	0.3	50
Phylloscopus sibilatrix	0.3	75	–	–
Hippolais icterina	0.9	100	0.1	25
Sylvia atricapilla	2.9	100	4.4	100
Sylvia borin	0.5	87.5	0.4	75
Sylvia communis	0.8	87.5	0.9	100
Sylvia curruca	0.3	62.5	0.3	75
Sylvia nisoria	0.2	62.5	0.4	50
Sitta europea	0.5	75	0.4	25
Sturnus vulgaris	20.9	100	35.8	100
Turdus merula	7.3	100	3.3	100
Turdus philomelos	3.4	100	1.6	100
Erithacus rubecula	0.1	37.5	0.2	50
Luscinia megarhynchos	2.6	100	2.9	100
Phoenicurus ochruros	0.3	50	0.1	25
Saxicola torquata	0.4	75	1.1	75
Ficedula albicollis	0.0	12.5	0.1	25
Muscicapa striata	0.1	25	–	–
Passer domesticus	5.4	100	–	–
Passer montanus	6.3	100	1.1	75
Motacilla alba	0.2	37.5	–	–
Motacilla cinerea	–	–	0.1	25
Fringilla coelebs	3.6	100	6.3	100
Serinus serinus	2.5	100	0.9	100
Chloris chloris	3.4	87.5	2.8	100
Carduelis cannabina	1.4	100	0.7	U5
Carduelis carduelis	3.2	100	2.5	100
Coccothraustes coccothraustes	0.3	75	2.0	100
Miliaria calandra	1.1	100	0.8	50
Emberiza citrinella	3.2	100	3.8	100

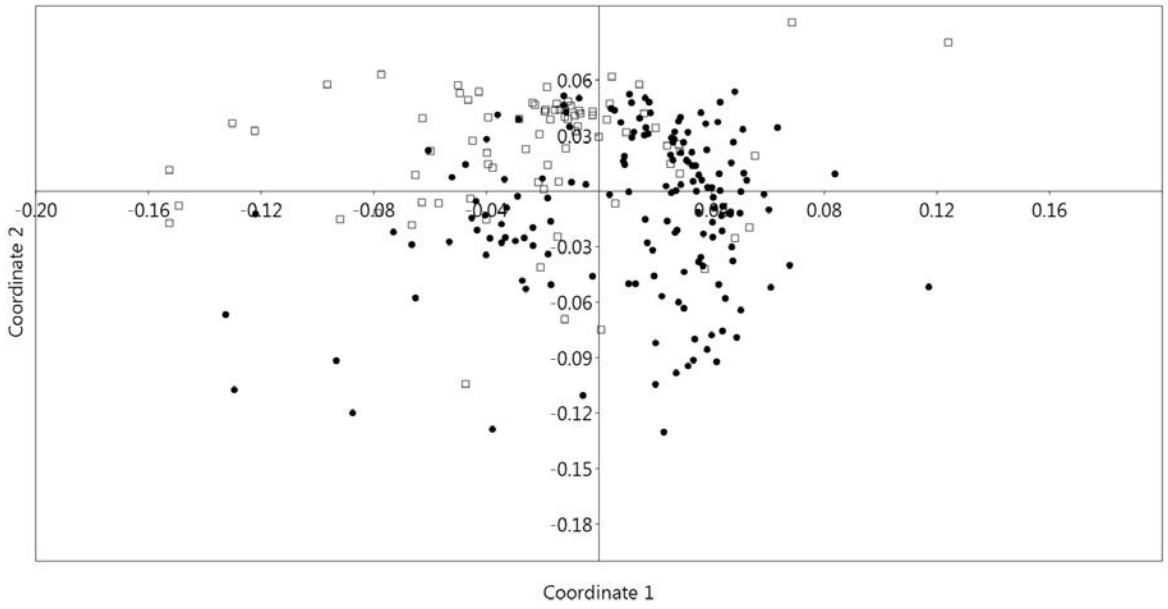

Fig. 2

Fig. 2. Non-metric multidimensional scaling ordination of sites based on Bray-Curtis similarity measures representing the variation in bird communities in two transects. Modra (dots) and Rača-Svätý Jur (open squares). Stress=0.4349.

been evidence for the breeding of the species in vineyard area in the vicinity of Dolné Orešany village (Králiková and Králik, 2005).

Regarding conservation status vineyards on Little Carpathians, the foothills sheltered quite a high number of different species with higher conservation priority. Some of those species (5 species) are listed in a current national red list of birds (Demko et al., 2013). One species *Hirundo rustic*a is listed as vulnerable (VU) and 4 in the category of near threatened (NT): *Apus apus*, *Upupa epops*, *Lullula arborea* and *Delichon urbicum*. From the total number of 64 bird species, 11 (17%) of them are regarded as objectives of established SPA Little Carpathians and 8 (*Pernis apivorus*, *Dendrocopos medius*, *Dryocopus martius*, *Ciconia nigra*, *Ficedula albicollis*, *Jynx torquila*, *Lanius collurio*, *Sylvia nisoria*) are included in Annex I. of the Directive on the conservation of wild birds (Directive 2009/147/EC).

The results of the analysis of trends and indices using the TRIM program showed that the majority of species demonstrate uncertain population trends (Table 2). Five species showed a significantly moderate decline during the studied period (*Chloris chloris*, *Delichon urbica*, *Emberiza citrinella*, *Fringilla coelebs*, *Sylvia atricapilla*). Two of these species *Chloris chloris* and *Emberiza citrinella* have shown decline also on European level (Voříšek et al., 2008) but in long-term trends *Chloris chloris* has showed a moderate increase (Voříšek et al., 2010). *Parus major* has shown in the study area a moderate increase that is similar to short-term trends on the European level (Voříšek et al., 2010). The Great Tit is not a typical farmland species but was found quite abundant at both study sites. It is a result of a heterogeneous mosaic of habitats at the study sites with small forests and forest edges. Two species (*Lullula arborea*, *Passer montanus*) showed a strong increase. The Woodlark (*Lullula arborea*) responds positively to increasing vineyard cover in the landscape and inhabits intensive vineyard fields. The species positively selects vineyards as opposed to semi-natural habitats but there are no consistent selection criteria between different vineyard habitat variables (Pithon et al., 2015). The Tree Sparrow (*Passer montanus*) has shown on the European level a moderate and continuous decline (Voříšek et al., 2008; Voříšek et al., 2010). The population of Tree Sparrow has increased significantly in Finnish farmland. The species colonized places where the House Sparrow was present but species did not compete with each other (Vepsäläinen et al., 2005). Only two species, *Upupa epops* and *Saxicola torquata*, showed a significantly steep decline at study sites. The Hoopoe was registered only in the first studying years. A similar situation was found also in another transect close to the Modra site situated in oak forests (unpubl. data). Trends of both steep declining species on the European level are uncertain (Voříšek et al., 2010).

Thus according to the presented results, vineyards in the Little Carpathians area, which is characterized by its heterogeneous mosaic habitats, and connections to suburban areas and forested areas, represents an important area for bird diversity. In comparison, other types of farmlands like abandoned arable fields

Table 2. Results of analysis of trends and indices of selected bird species

Species	Trend (±SE)	Trend classification
Apus apus	1.3063 (0.2244)	Uncertain
Carduelis cannabina	1.0342 (0.1670)	Uncertain
Carduelis carduelis	1.1482 (0.1083)	Uncertain
Cucullus canorus	0.9407 (0.1227)	Uncertain
Chloris chloris	0.8424 (0.0716)	Moderate decline (P < 0.05)
Delichon urbica	0.835 (0.0612)	Moderate decline (P < 0.01)
Miliaria calandra	1.1825 (0.1598)	Uncertain
Emberiza citrinella	0.9271 (0.0251)	Moderate decline (P < 0.01)
Fringilla coelebs	0.9467 (0.0211)	Moderate decline (P < 0.05)
Hippolais icterina	1.2973 (0.1526)	Uncertain
Hirundo rustica	1.1423 (0.3102)	Uncertain
Jynx torquila	0.9721 (0.1177)	Uncertain
Lanius collurio	0.9878 (0.0982)	Uncertain
Lullula arborea	1.2315 (0.0812)	Strong increase (P < 0.05)
Luscinia megarhynchos	0.9250 (0.04)	Uncertain
Oriolus oriolus	1.0439 (0.1262)	Uncertain
Parus major	1.0594 (0.0212)	Moderate increase (P < 0.01)
Passer domesticus	1.0968 (0.0653)	Uncertain
Passer montanus	1.4096 (0.1045)	Strong increase (P < 0.01)
Phasianus colchicus	1.0506 (0.0653)	Uncertain
Serinus serinus	1.0516 (0.0644)	Uncertain
Streptopelia decaocto	1.0464 (0.0896)	Uncertain
Streptopelia turtur	0.9878 (0.0672)	Uncertain
Sturnus vulgaris	1.0005 (0.1243)	Uncertain
Sylvia atricapilla	0.8753 (0.0474)	Moderate decline (P < 0.01)
Turdus merula	0.9663 (0.0442)	Uncertain
Turdus philomelos	1.0607 (0.0635)	Uncertain
Upupa epops	0.1879 (0.2408)	Steep decline (P < 0.01)

are characterized by relatively uniform communities of birds with distinctive groups of dominant species (Orlowski 2005). Farmland patches with abundant tree and shrub cover score the highest on abundance and species richness especially during breeding season (Telleria et al., 2008). The bird community patterns are usually related to vegetation succession and land productivity (Nikolov et al., 2011). Bird composition and diversity is closely related to management practices and landscape use. There are several threats which affect the area including loss of historical structures of vineyard areas, strong pressure for urbanization, and abandonment of farming practices. Further continuous and long-term monitoring of these areas is necessary and brings important data about the population status of birds in human-affected landscape.

Acknowledgements

I would like to thank Jozef Ridzoň from SOS/Birdlife Slovensko for help with the statistical analysis in the TRIM program, Danka Haruštiaková from Masaryk University for advice and help with other statistics, Ben Sweeney for proof reading and an anonymous reviewer for comments to an earlier version of this manuscript.

References

Benton, T.G., Vickery, J.A., Wilson, J.D., 2003. Farmland biodiversity: is habitat heterogeneity the key? *Trends in Ecology and Evolution*, 18: 182–188.

Bruggiser, O.T., Schmidt-Entling, M.H., Bacher, S., 2010. Effects of vineyard management on biodiversity at three trophic levels. *Biological Conservation,* 143: 1521–1528.

Demko, M., Krištín, A., Puchala, P., 2013. Red list of birds in Slovakia. *Tichodroma*, 25: 69–78.

Donald, P.F., Green, R.E., Heath, M.F., 2001. Agricultural intensification and the collapse of Europe's farmland bird populations. *Proceedings of the Royal Society B,* 268: 25–29.

Hammer, Ø., 2015. *PAST. Reference manual*. Oslo: Natural History Museum, University of Oslo.

Inger, R., Gregory, R., Duffy, J.P., Stott, I., Voříšek, P., Gaston, K.J., 2015. Common European birds are declining rapidly while less abundant species' numbers are rising. *Ecology Letters*, 18: 28–39.

Králiková, A., Králik, T., 2005. New breeding locality of the Bee-eater (Merops apiaster) in the Malé Karpaty Mts. (W Slovakia). *Tichodroma*, 17: 94.

Orłowski, G., 2005. Endangered and declining bird species of abandoned farmland in south-western Poland. *Agriculture, Ecosystems and Environment*, 111: 231–236.

Majzlan, O., 2011. A coenosis of beetles (Coleoptera) of vineyards in Sv. Jur village near Bratislava. *Naturae Tutela*, 15/2: 163–180.

Melles, S., Glenn, S., Martin, K., 2003. Urban bird diversity and landscape complexity: species-environment associations along a multiscale habitat gradient. *Conservation Ecology*, 7(1): 5.

Mihál, I., Gajdoš, P., Dankaninová, L., Černecká, Ľ., 2014. Harvestmen (Opiliones) of fragmented communities of the vineyard landscape in Svätý Jur (Little Carpathians). *Folia Faunistica Slovaca*, 19: 9–14.

Morelli, F., Jerzak, L., Tryjanowski, P., 2014. Birds as useful indicators of high nature value (HNV) farmland in Central Italy. *Ecological Indicators*, 38: 236–242.

Nikolov, S.C., Demerdzhiev, D.A., Popgeirgiev, G.S., Plachiyski, D.G., 2011. Bird community patterns in sub-Mediterranean pastures in Bulgaria. *Animal Biodiversity and Conservation*, 34: 11–21.

Pannekoek, J., van Strien, A., 2001. *TRIM 3.0 for Windows (Trend & Indices for Monitoring data)*. Voorburg: Statistics Netherlands.

Pithon, J.A., Beaujouan, V., Daniel, H., Pain, G., Vallet, J., 2015. Are vineyards important habitats for birds at local or landscape scales? *Basic and Applied Ecology*, 17: 240–251.

Ponti, L., Ricci, C., Veronesi, F., Torricelli, R., 2005. Natural hedges as an element of functional biodiversity in agroecosystems: the case of a Central Italy vineyards. *Bulletin of Insectology*, 58: 19–23.

Rybanič, R., Šutiaková, T., Benko, Š. (eds), 2004. *Important bird areas of European Union importance in Slovakia*. Bratislava: Society for Protection of Birds in Slovakia. 219 p.

Siriwardena, G.M., Baillie, S.R., Crick, H.Q.P., Wilson, J.D., 2000. The importance of variation in the breeding performance of seed-eating birds in determining their population trends on farmland. *Journal of Applied Ecology*, 37: 128–148.

Špulerová, J., Dobrovodská, M., Lieskovský, J., Bača, A., Halabuk, A., Kohút, F., Mojses, M., Kenderessy, P., Piscová, V., Barančok, P., Gerhátová, K., Krajčí, J., Boltižiar, M., 2011. Inventory and classification of historical structures of agricultural landscape in Slovakia. *Ekológia (Bratislava)*, 30: 157–170.

Tanadini, M., Schmidt, B.R., Meier, P., Pellet, J., Perrin, N., 2012. Maintenance of biodiversity in vineyard-dominated landscapes: A case study on larval salamandres. *Animal Conservation*, 15: 136–141.

Telleria, J.L., Ramírez, A., Galarza, A., Carbonell, R., Pérez-Tris, J., Santos, T., 2008. Geographical, landscape and habitat effects on birds in northern Spanish farmlands: implications for conservation. *Ardeola*, 55: 203–219.

Tryjanowski, P., Hartel, T, Báldi, A., Szymański, Tobolka, M., Herzon, I., Goławski, A., Konvička, M., Hromada, M., Jerzak, L., Kujawa, K., Lenda, M., Orłowski, G., Panek, M., Skórka, P., Sparks, T. H., Tworek, S., Wuczyński, A., Żmihorski, M., 2011. Conservation of farmland birds faces different challenges in Western and Central-Eastern Europe. *Acta Ornithologica*, 46: 1–12.

van Strien, A., Pannekoek, J., Hagemeijer, W., Verstrael, T., 2004. A loglinear Poisson regression method to analyse bird monitoring data. In Anselin, A. (ed.). *Bird numbers 1995, Proceedings of the International Conference and 13th Meeting of the European Bird Census Council, Pärnu, Estonia*. Bird Census News, 13 (2000): 33–39.

Vepsäläinen, V., Pakkala, T., Tiainen, J., 2005. Population increase and aspects of colonization of the Tree Sparrow Passer montanus, and its relationships with the House Sparrow Passer domesticus, in the agricultural landscapes of Southern Finnland. *Ornis Fennica*, 82: 117–128.

Verhulst, J., Báldi, A., Kleijn, D., 2004. Relationship between land-use intensity and species richness and abundance of birds in Hungary. *Agriculture, Ecosystems and Environment*, 104: 465–473.

Voříšek, P., Gregory, R. D., van Strien, A. J., Gmelig Meyling, A., 2008. Population trends of 48 common terrestrial bird species in Europe: results from the Pan-European Common Bird Monitoring Scheme. *Revista Catalana d'Ornitologia*, 24: 4–14.

Voříšek, P., Jiguet, F., Van Strien, A., Klváňová, A., Gregory, R.D., 2010. Trends in abundance and biomass of widespread European farmland birds:

how much have we lost? In Proceedings of the 2009 *BOU conference: Lowland Farmland Birds III* [cit. 2016-02-12]. http://www.bou.org.uk/bouproc-net/lfb3/vorisek-etal.pdf

Vretenberg, J., Lindstrom, A., Svensson, S., Thierfelder, T., Pärt, T., 2006. Population trends of farmland birds in Sweden and England: similar trends but different patterns of agricultural intensification. *Journal of Applied Ecology*, 43: 1110–1120.

Received March 14, 2016
Accepted May 3, 2016