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THE IMPACT OF FLOODPLAIN FOREST HABITAT CONSERVATION ON THE STRUCTURE OF BIRD BREEDING COMMUNITIES

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Abstract

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The presented article describes the changes in the structure of nesting bird populations in the floodplain forest locality in the model area of the Bird Area Litovelské Pomoraví in the Czech Republic during a period of about 20 years. Possible causes for changes in the structures of nesting bird populations within these floodplain forests and the development of forest geobiocenoses are discussed. These possible causes are based on the comparison of our research data results with older data from these locations. The long-term protection of the mature floodplain forest geobiocenosis in this nature reserve has had impacts which are clearly recognizable in the significant increase in the nesting bird population. This applies especially to those bird communities nesting in tree hollows and in the shrub layer.

Key words: birds, density comparison, forest management, nature reserve, bird area Litovelské Pomoraví

Introduction

The geobiocenoses of floodplain forests within Central Europe are distinguished by an unusually high biodiversity (Klimo, Hager, 2001), and are therefore important from the point of view of protection (Míchal et al., 1992; Konvička et al., 2006), even when anthropogenic factors play a crucial role in the development of the floodplain (Lipský, 2008). The landscape structure of the floodplain forest is significantly influenced by forest management policy, including regeneration processes, cultivation and harvesting (Oszlányi, 2000). The forest management of the floodplain forests also has a significant effect on the biodiversity of the geobiocenoses, which within Central Europe, is ranked among the important biotope types at the European level in the Natura 2000 system (Machar, 2007a). Because knowledge of biological principles of landscape ecosystems (Ružička, 1965) is a basis for landscape-ecological planning (Ružička, 2000), the formulation of care principles concerning various floodplain biotope types must be preceded by study of the

ecological processes taking place within them (Newton, 2007). Bird populations are considered a suitable model for applied ecological studies of forested environments (habitat) (Wiens, 1989a). A number of studies have investigated the ecological relationship between forest composition concerning species and age (which is significantly influenced by forest management) and bird population diversity (Berg , 2002; DeGraaf et al., 1998; King et al., 1996, 2000; Laiolo, 2002; Wendy et al., 2003; Yahner, 2000). The awareness of how bird populations are influenced by various forms of forest management is important for the biology of nature protection when the principles of the protective management of forest ecosystems are formulated (Thompson, 1993; Fuller, 1990; Krementz, Christie, 2000), with birds being used as bio-indicators (Zasadil, 2001; Šťastný et al., 2004; Šťastný et al., 2005), as well as for the protection of some of the bird species within the localities of the Natura 2000 system (Machar, 2007b). Literature searches of this topic were carried out by Petty, Avery (1990), Sallabanks et al. (2000), Venkrbcová (2005), Korňan (2006) and Lišková (2007). It is apparent that in Central European forests, the overall heterogeneity of the forest environment is the overriding factor exercising the greatest influence on the structure and diversity of bird populations. (Zasadil, 2003). This is in line with the findings of Adamík et al. (2003), according to which the insectivorous birds have much larger feeding niches in the forest stand than in a monoculture (production) forest.

The aim of this paper is to assess the influence of the floodplain forest geobiocenosis protection in the form of a nature reserve on the structure of the nesting bird populations over a period of ca. 20 years, in the model locality of Bird Area Litovelské Pomoraví in the Czech Republic.

Material and methods

Study area

The study of the floodplain forest nesting bird populations was carried out in 2006 and 2007 in two study areas within the Bird Area Litovelské Pomoraví (Fig. 1). The basic biogeographical characteristics of the area and the biota of the bird area are determined by its geographical position within the Litovel bioregion (for more, see Culek, 1995).

The study areas of Šargoun and Vrapač are large complexes of mature forest stands of the geobiocene type *Ulmi-fraxineta carpini* of a higher class which are classified in forestry as alder-elm-lime-plain type on alluvial deposits (Machar, 2001). According to the biotopes typology of Natura 2000 (Chytrý et al., 2001) this belongs to the biotope type alluvial hardwood forest of lowland rivers.

The Vrapač locality, which is protected as a national nature reserve of the same name, is located 2 km west of the town of Litovel at an altitude of 236 m. The organism mapping quadrate is 6268, coordinates 17°02´ E, 49°42´ N. A closer description of the reserve area and its biota can be found in the work of Montágová (1999). A study area of 12.7 ha was set up in the Vrapač locality. The vegetation coverage within this area consisted of 95% herb layer, 30% shrub layer and 100% tree layer. The age of the upper storey of the forest stand (prevailing *Quercus robur* and *Fraxinus excelsior*) is 150 years and the age of the lower storey (prevailing *Tilia* sp., *Carpinus betulus, Acer* sp., *Alnus glutinosa*) is 80 years.

The Šargoun locality forms part of the nature reserve Floodplain of Litovel and it is located 2,5 km east of the town of Litovel at an altitude of 225 and on the organism mapping quadrate 6168, coordinates 17°08´ E, 49°38´ N. For a closer description of the reserve and its biota see Machar, Rybka 1994. The study area of 12.1 ha was set up there. The vegetation coverage within this study area is 95% herb layer, 30% shrub layer and 100% tree layer. The age of the upper storey of the forest stand (prevailing *Quercus robur, Acer pseudoplatanus* and *Fraxinus excelsior*) is 120 years and the age of the lower storey of the forest stand (prevailing *Tilia* sp., *Carpinus betulus, Acer* sp., *Ulmus* sp.) is 80 years.

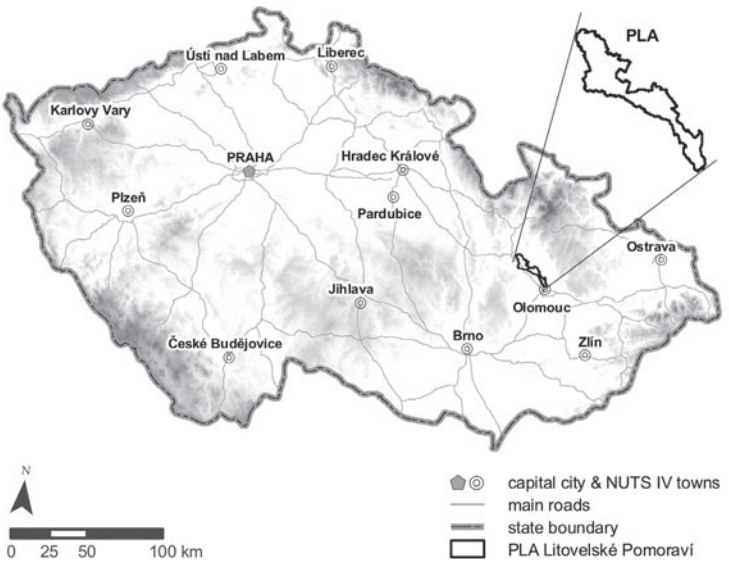

Fig. 1. Location of study area.

Both study areas were set up in large complexes of mature floodplain forest stands, and in order to avoid the edge effect, the boundary of the study area is at least 50 m from the border of continuous forest complex. The study area within the Vrapač locality has not been subject to any forest management since 1989. The forest stand in the north part of the area was damaged by a whirlwind in 2001, thus acquiring "native forest" characteristics. During clearing, only those trees which had fallen on roads were removed. The study area within the Šargoun locality has not been managed since 1988, when the shrub layer and an extensive selection in the lower tree storey were cleared.

Methods

Research on the species composition and density of the nesting bird populations in both study areas was carried out in 2006 and 2007 by mapping the nest domains in the combined version according to Tomialojć (1980). In both years, between the second week of April and the third week of June, 7 mapping checks were carried out in the morning and 2 mapping checks were carried out in the evening with each of these checks lasting about 3 hours.

Based on Losos (1992), the following quantitative characteristics of the nesting bird populations were used: abundance, density, dominance, the species diversity index according to Shannon-Weaver and species equitability index according to Sheldon. The graphs describing the distribution of dominance were processed according to Bejček, Šťastný (1984). In order to carry out a comparison of the results for the Vrapač locality with the work of Polášek (1991) and of the results for the Šargoun locality with the work of Bureš (1986), the similarity indices QS, Re and CD and their critical values according to Janda, Řepa (1986) were used. The species *Cuculus canorus* was not included in calculations of overall density of the nesting bird community. Within the Vrapač study area, a likely occurrence of the *Scolopax rusticola* was found, but was not included in the calculations of the nesting bird populations. The species classification into four nesting ecological guilds (hole nesting, ground nesting, shrub nesting, and treetop nesting) was carried out *a priori* (Wiens, 1989b) based on prior knowledge of the area and on the literature (Hudec, Šťastný, 2005). The statistical evaluation of the data using the *t*-test for two specimens was carried out using the program application of Minitab 15.1.1.

Results

The structure of the floodplain forest bird nesting populations for the years 2006–2007

During the years 2006–2007, the nests of 31 bird species were found within the Vrapač study area and 33 nesting bird species were found in the Šargoun study area. Tables 1

T a b l e 1. Structure of the bird community – locality Vrapač.

Species	Polášek (1991)		Authorś results		Change of density (%)
	Mean density (pairs/10ha)	Mean dominance (%)	Mean density (pairs/10ha)	Mean dominance (%)	
Parus major	7.5	8.1	13.8	11.1	184
Sturnus vulgaris	19.0	20.7	13.0	10.4	68
Sylvia atricapilla	9.0	9.7	10.7	8.6	119
Ficedula albicollis	7.5	8.1	9.9	7.9	132
Fringilla coelebs	9.5	10.4	9.1	7.3	96
Turdus pilaris			7.1	5.7	N
Parus caeruleus	3.5	3.8	7.1	5.7	203
Turdus merula	1.0	1.1	6.7	5.4	670
Troglodytes troglodytes	3.0	3.3	5.9	4.7	197
Phylloscopus collybita	3.5	3.8	5.5	4.4	157
Sitta europaea	6.0	6.6	5.1	4.1	85
Cocc. coccothraustes	5.5	6.0	4.0	3.2	73
Prunella modularis	0.5	0.6	3.6	2.9	720
Erithacus rubecula	3.0	3.3	3.2	2.6	107
Dendrocopos major	2.5	2.7	2.8	2.2	112
Turdus philomelos	1.5	1.6	2.8	2.2	187
Parus palustris	0.5	0.6	2.0	1.7	400
Certhia brachydactyla	2.5	2.7	2.0	1.7	80
Hippolais icterina			1.6	1.2	N
Luscinia megarhynchos			1.6	1.2	N
Muscicapa striata			1.2	+ 1	N
Columba palumbus	2.2	2.4	1.2	1.1	55
Steptopelia turtur			0.8	0.5	N
Dendrocopos medius	0.5	0.6	0.8	0.5	160
Anthus trivialis	0.5	0.6	0.8	0.5	160
Phylloscopus sibilatrix	1.0	1.1	0.8	0.5	80
Oriolus oriolus	1.5	1.6	0.8	0.5	53
Garrulus glandarius			0.8	0.5	N
Picus viridis			0.4	0.2	
Aegithalos caudatus			0.4	0.2	N
Certhia familiaris	0.5	0.6	0.4	0.2	80
Cuculus canorus			+		
In total	91.7	100	125.9	100	
Total change of density (%)					137

T a b l e 2. Structure of the bird community – locality Šargoun.

Species	Bureš (1986)		Authorś results		Change of density (%)
	Mean density (pairs/10ha)	Mean dominance (%)	Mean density (pairs/10ha)	Mean dominance (%)	
Sturnus vulgaris	6.0	7.6	13.7	10.2	228
Parus major	8.0	10.2	12.9	9.6	161
Sylvia atricapilla	6.0	7.7	11.2	8.4	187
Ficedula albicollis	8.0	10.2	10.4	7.8	130
Passer montanus	4.0	5.1	8.7	6.5	217,5
Parus caeruleus	6.0	7.7	8.3	6.2	138
Fringilla coelebs	10.0	12.6	7.9	5.9	79
Prunella modularis	0.6	0.8	6.3	4.7	1050
Turdus philomelos	0.9	1.1	5.4	4.1	600
Turdus pilaris			4.6	3.3	N
Phylloscopus collybita	6.0	7.6	4.6	3.3	77
Sitta europaea	4.0	5.1	4.6	3.3	115
Erithacus rubecula	2.0	2.5	4.2	3.1	210
Troglodytes troglodytes	0.9	1.1	3.7	2.7	411
Turdus merula	0.9	1.1	2.9	2.2	322
Parus palustris	0.3	0.4	2.9	2.2	967
Cocc. coccothraustes	0.6	0.8	2.9	2.2	483
Anthus trivialis	0.6	0.8	2.5	1.9	417
Dendrocopos major	1.5	1.9	2.1	1.6	140
Muscicapa striata	0.3	0.4	2.1	1.6	700
Certhia brachydactyla	4.0	5.1	2.1	1.6	52,5
Dendrocopos medius	0.9	1.1	1.7	1.3	189
Luscinia megarhynchos			1.7	1.3	N
Hippolais icterina	0.9	1.1	1.7	1.3	189
Columba palumbus	0.6	0.8	0.8	0.5	133
Streptopelia turtur	0.6	0.8	0.8	0.5	133
Phylloscopus trochilus	0.6	0.8	0.8	0.5	133
Oriolus oriolus	0.6	0.8	0.8	0.5	133
Garrulus glandarius	0.4	0.4	0.8	0.5	200
Jynx torquilla			0.4	0.3	N
Dendrocopos minor	0.3	0.4	0.4	0.3	133
Phoenicurus phoenicurus			0.4	0.3	N
Sylvia borin	0.4	0.4	0.4	0.3	0
Cuculus canorus	+		+		
Anas platyrhynchos	0.6	0.8			E
Picus canus	0.3	0.4			E
Picus viridis	0.4	0.4			E
Locustella fluviatilis	0.4	0.4			E
Acrocephalus palustris	0.4	0.4			E
Phylloscopus sibilatrix	0.6	0.8			E
Certhia familiaris	0.4	0.4			E
Emberiza citrinella	0.4	0.4			E
Total	79.2	100	134.7	100	
Total change of density (%)					171

Notes for Table 1 and 2 : N – new species; E – disappeared species.

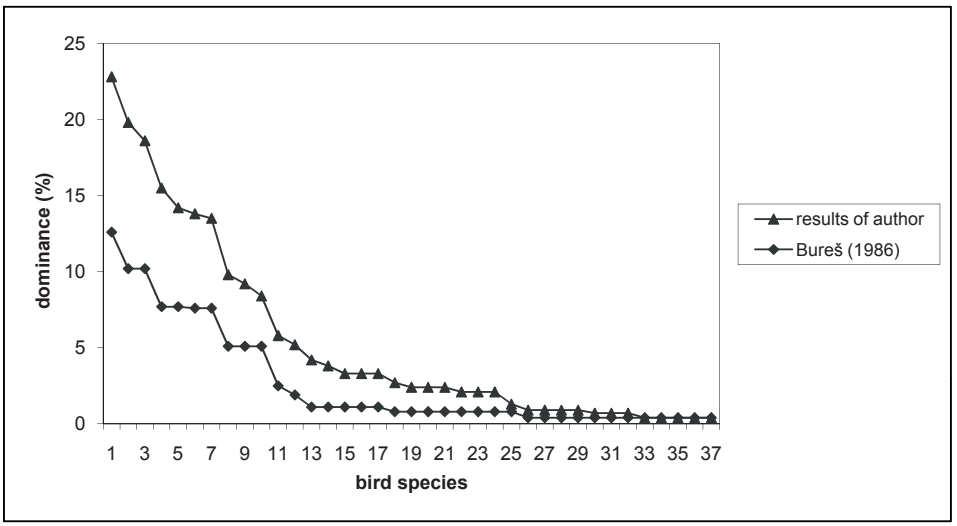

Fig. 2. Distribution of the dominance of the bird community – locality Vrapač.

and 2 give overviews of the nesting bird species in each area with their density calculated over an area of 10 ha, and the dominance of a particular species in the population. The markedly dominant species of the floodplain forest bird population in the Vrapač locality are *Parus major, Sturnus vulgaris, Sylvia atricapilla, Ficedula albicollis,* and *Fringilla coelebs*. A similar situation was found in the Šargoun locality, where the dominant species are *Sturnus vulgaris, Parus major, Sylvia atricapilla, Ficedula albicollis, Parus caeruleus* and *Fringilla coelebs*. The dominance of these species can be explained by the character of the forest stands which have a large number of suitable nesting hollows in mature broadleaved trees and a richly structured tree and shrub layer. As Table 3 clearly shows,

T a b l e 3. Basic characteristics of breeding bird communities in the localities Vrapač and Šargoun.

Characteristics	Locality Vrapač		Locality Šargoun	
	Polášek (1991)	Authors' results	Bureš (1986)	Authors' results
Total amount of bird species	24	37	48	43
Abundance	23	31	37	33
Density (pairs/10 ha)	91.70	125.9	79.2	134.7
Amount of dominant species	7	8	10	7
Amount of influent species	7	8	1	10
Amount of accessory species	9	15	26	15
Diversity index H´	3.76	4.35	3.00	4.46
Equitability index J´	0.85	0.88	0.81	0.89

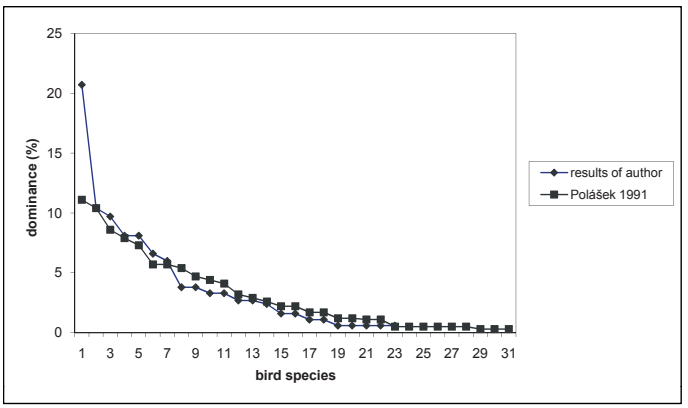

Fig. 3. Distribution of the dominance of the bird community – locality Šargoun.

the wide species variety of the bird populations in both areas is attributable to accessory species. This situation concurs with the general trend, according to which the dominance of the most numerously occurring species in zoocenoses with wide species variety is relatively low (Wiens, 1989b). The curves of dominance distribution (Figs 2 and 3) in both areas are without significant deviation from the normal course and this suggests a favourable dominance distribution and considerable stability of the bird element of the geobiocenoses in the study areas.

The values of the diversity index for the nesting bird populations in the Vrapač locality within the studied period (H´= 4.35 the balance degree J´= 0.88) and also in the Šargoun locality (H´= 4.46, J´= 0.89) show a wide species variety in the bird populations and a high relative balance which are typical features of mature and richly structured floodplain forests (Table 3).

The changes in floodplain nesting bird population structures at the community level

Vrapač locality: Because of the long-term forest protection of the Vrapač locality due to its status as a nature reserve, the woody layer of the geobiocenosis has developed spontaneously. Gradually, the number of tree hollows has been increasing (old, declining trees, which generally have most hollows, were not harvested). The area of the shrub layer has also increased. While Polášek reported a 10% coverage of shrub layer coverage in 1991, the current amount in the study area is 30%. The natural regeneration of the stands within this locality is subject to the selection pressure of hoofed game (Čermák, Mrkva, 2006). The increase in the spatial heterogeneity of the forest corresponds to changes in the characteristics of the nesting bird populations (Table 1). In the compared time periods, the number of nesting species has increased by 34% as also has the density in a statistically significant way (Fig. 4, T = 2.071; P = 2.014), and this in turn is mirrored by the change in the value of the nesting bird population diversity index from 3.76 to 4.35, whereas the balance index

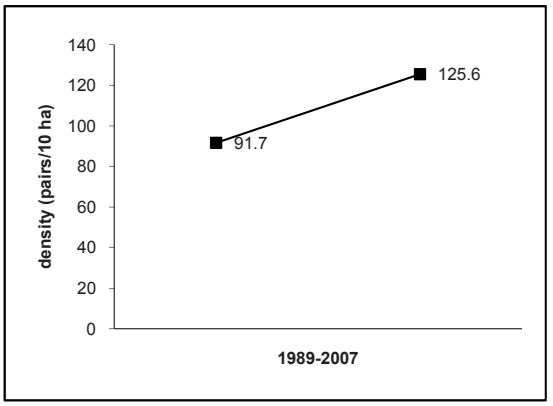

Fig. 4. Changes of values of the density of the bird community – locality Vrapač.

has remained virtually the same. The dominance distribution, however, has partly changed with a significant increase in accessory species and this comparison is shown in Figs 2 and 3. When changes in the nesting bird populations from the point of view of similarity are compared (Table 4), the critical values of all three indices are within the "close similarity – similarity" range. This assumes stability in the composition of nesting bird populations within the locality concerning of the floodplain forest geobiocenosis development for approximately 20 years.

Šargoun locality: Due to the exclusion of forest management methods, this area has exhibited changes in forest heterogeneity over a period of 20 years. Bureš reported a shrub layer coverage not exceeding 2%; in 1988, whereas the present coverage is 30%. In contrast to the Vrapač area, the natural stand regeneration here does not suffer from hoofed game browsing (Čermák, Mrkva, 2006), and the declining trees with hollows remain in the stands. Changes in the characteristics of the nesting bird population from 1986 (Bureš, 1986) to 2006/2007 (own data) can be summed up as follows: Although the number of nesting species has decreased from 37 species to 33, the level of population diversity has increased in a statistically significant way (see Fig. 5, T = 2.97; P = 2.004). Additionally, the overall diversity level of bird populations has increased with the diversity index value increasing from 3.00 with an equitability of 0.81 to 4.46 with an equitability of 0.89 (Table 3). The similarity of nesting bird populations in Table 4, herein shows that the values of

T a b l e 4. Species similarity index values between localities Vrapač and Šargoun.

Locality	X	QS 2006–2007	RE 2006–2007	CD 2006–2007
Vrapač	Polášek (1991)	85.2	74.3	44.0
Šargoun	Bureš (1986)	81.2	73.9	10.7

Notes: OS – Sörensen similarity index (Sörensen, 1948); RE – Renkonen similarity index (Janda, Řepa, 1986).

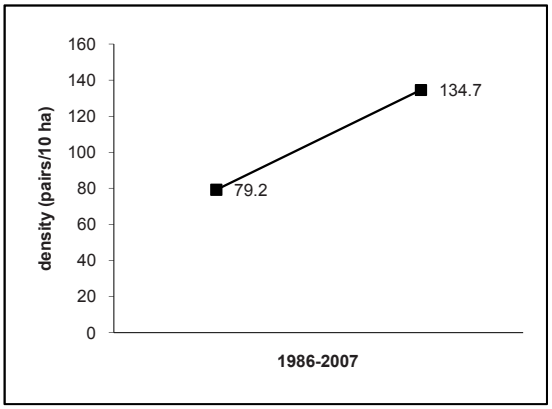

Fig. 5. Changes of values of the density of the bird community – locality Šargoun.

all indices have "strong similarity". Therefore, it is possible to deduce that changes in forest heterogeneity in this locality have primarily led to changes in the density of nesting birds, while changes in the qualitative structure of the nesting bird populations, such as species diversity, are not significant.

Changes in the floodplain forest nesting bird population structure at the species level

Vrapač locality: The causes of the significantly increased number of 31 nesting species in 2006–2007 from the 23 species reported by Polášek in1991 may be found in the increased heterogeneity of the forest environment, and also in the general trends demonstrated by the spread of certain species, e.g. *Luscinia megarhynchos* (Šťastný et al., 2004). The regular nesting of *Turdus pilaris* in the floodplain forest of Litovelské Pomoraví has been recorded since 1995 (Bureš, 1995). While the increase in density of some species nesting in the shrub layer such as *Troglodytes troglodytes, Prunella modullaris,* and *Turdus merula* is almost certainly related to increased shrub layer coverage, a plausible explanation for hollow-nesting species such as *Parus palustris and P. caeruleus* is the protection of den trees within the reserve (Fig. 6).

Šargoun locality: The lower number of nesting species in the Šargoun locality during 2006–2007 at 33 single species, in comparison with the 37 species recorded by Bureš (1986), may be the result of edge effect. This is due to the fact that no previously unrecorded species preferring the younger seral stages of floodplain forests, forest edges, or open floodplain such as *Locustella fluviatilis, Acrocephalus palustris and Emberiza citrinella* were found. Within the Šargoun study area, *Dendrocopos syriacus* was repeatedly recorded during the nesting period in 2006, although nesting itself was not confirmed. The significant increase in the density of both ground nesting and shrub nesting species such as *Anthus trivialis, Troglodytes troglodytes, Prunella modullaris, Erithacus rubecula, Turdus merula, T. philomelos,* and *Coccothraustes coccothraustes*, and also hole nesting species including *Muscicapa striata, Parus palustris,*

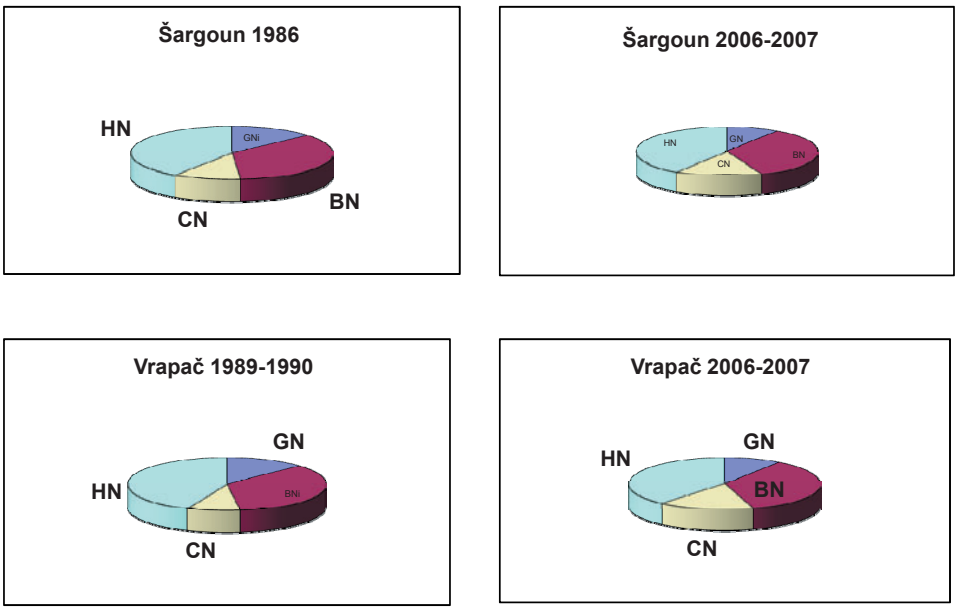

Fig. 6. Structure of nesting guilds in the localities Vrapač and Šargoun.
Notes: HN – hole neslers; GN – ground neslers; CN – canopy neslers; BN – bush neslers.

Sturnus vulgaris and Passer montanus depicted on Fig. 6 may be connected to the increased heterogeneity of the forest landscape, including the protection of den trees, as is the case in the Vrapač locality.

Changes in the occurrence of species important at the European level

The floodplain forest bird species subject to the protection of the Bird Area Litovelské Pomoraví are *Dendrocopos medius* and *Ficedulla albicollis.* The geobiocenoses of the mature and spatially differentiated floodplain forest in both the Vrapač and Šargoun study areas may be considered optimal for the nesting of both species, especially due to the presence of a great number of tree hollows. The results in Tables 1 and 2 show that the nesting populations of both species in this biotope type have remained stable over the 20 year period examined.

Discussion

The mature stand of species- and age-differentiated floodplain forest, which is the subject of this study, was analysed according to the model of seral changes within forest ornitocenoses (Glowaczinski, 1975; Glowaczinski, Weiner, 1983; Moskát, Székely, 1986; Helle, Monkonen,

1990; Lešo, 2003), and it was found to be nearing the idealized image of a climax stage. Although nature protection biology logically questions the concept of the climax stage as the single aim of preferred nature protection because certain species are bound to the early or continuously distributed seral stages of biotopes (e.g. Fiedler, Jain, 1992), it is apparent in the Central European floodplain forest geobiocenosis that woody bird species reach their highest density precisely in those stands with climax character (i.e. in richly structured stands with high heterogeneity of stand environment). At the same time, it is important to realize that all the floodplain forests in Central Europe represent geobiocenoses that are significantly structured by anthropic factors (Řehořek, 2001). The results presented in this paper show that even those geobiocenoses that are strongly anthropogenically influenced may reach high biodiversity as is typical in the floodplain forest geobiocenoses (Maděra, 2003). The nesting bird populations of the mature floodplain forests stands, considering the species composition, have remained fairly stable during the compared period of 20 years. It is reasonable to assume that the increased heterogeneity of the floodplain forests geobiocenosis, by means of its long-term protection in the form of a reserve, has led to an increase in nesting bird population densities. These findings agree with results already published by Bureš (1988) and Toman (1984). The acquired values of the nesting bird population density in the mature and heterogeneous floodplain forest of Litovelské Pomoraví are in line with the data obtained in the floodplain forests of Central Moravia, gained by means of mapping methods in segments of mature stands (Bureš, Maton, 1985; Chytil, 1984; Kubečka, 2003; Poprach, 1995; Růžička, 1985). However, the comparison of the species range of the mature floodplain forest nesting bird populations in various locations shows that the species structure of the bird community is influenced by the character and heterogeneity of the forest geobiocenosis as well as by the individual location of the study area within the observed forest segment. Nesting areas of those bird species which typically occur in the open floodplain landscape (e.g. *Locustella fluviatilis, Acrocephalus palustris, Sylvia borin,* and *Emberiza citrinella*), can be found only within 25–30 m of the mature forest border. The edge effect on floodplain forest nesting bird populations increases the number of nesting species. This corresponds to the findings of Hubálek (1997) from research carried out in the Dyje River floodplain near Břeclav. Based on this work, he links the higher density of the bird community in the floodplain forest, when compared to that of an open floodplain landscape, to the rich (multi-layered) structure of forest vegetation.

Minor changes in the species richness of nesting bird populations and the numerous fluctuations of certain species may, in the long-term, be connected to general developmental trends concerning the numbers of forest birds in the whole of the Czech Republic, (Šťastný et al., 2006). This paper confirmed Hudec's 2001 research findings in the floodplain forest of south Moravia, and in this paper, density (VanHorne, 1983; Bock, Jones, 2004) was used to determine the relationship between forest biotope and nesting bird populations because it articulates the value of avian nature reserves within the field of nature protection. (Virkkala et al., 1994). The present discussion, however, (Adamík, 2005) makes it apparent that without its correlation with other demographic and community ecological characteristics, the value of density as an indicator of environment quality is undermined.

Conclusion

The results of the study on the structure of nesting bird populations within two areas of floodplain forest in the Bird Area Litovelské Pomoraví during 2006–2007 by means of a combined mapping method are presented herein. Based on a comparison of this obtained data with data previously acquired from the same locations (Bureš, 1986; Polášek, 1991), and taking into account the development of the floodplain forest geobiocenoses, possible factors causing changes in the structure of the nesting bird populations of the floodplain forests during a period of about 20 years have been discussed.

This 20 year long-term protection of the mature floodplain forest geobiocoenosis has had an impact on the structure of the nesting bird populations whose density has increased in a statistically significant way. This especially applies to those bird communities nesting in hollows and in the shrub layer. This change may be attributed to the protection of the geobiocoenoses in the form of nature reserves. Due to the absence of forest management within these protected areas, natural regeneration has occurred accompanied by the development of the shrub layer, and these have led to an increased number of nesting hollows in older and declining trees which were not removed from the area. It is important from the point of view of the protection of a bird area belonging to the Natura 2000 system that this research data has established the long-term stability in the numbers of *Ficedula albicollis* and *Dendrocopos medius*. The species composition of the nesting bird populations did not change significantly, remaining fairly stable during the time period analyzed.

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