

Breeding bird communities and non-breeding bird communities in study plots under poplar plantations and cultivated fields nearby

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Synopsis: Quantitative results of investigations of breeding bird communities and non-breeding bird communities revealed potential abilities to increase in number of species and abundance of birds in rural environment due to implementation of poplar plantations. Field research was carried out in two poplar plots and adjacent cultivated fields. Breeding bird communities consisted of 32 and 30 species inhabiting the plots, and density index for these communities was 77.6 and 88.4 pairs/10 hectares respectively. On these plots in the period from 24 October to 24 February there were 17 and 14 species registered during four censuses. Mean value of density index of these communities was 58.7 and 53.6 individuals/10 hectares. Breeding bird communities and non-breeding bird communities recorded in cultivated fields were very low in number of species and with very low density.

Key words: breeding birds, non-breeding birds, poplar plantations.

INTRODUCTION

Transformation of natural habitats into cultivated fields was strictly connected to the rapid decrease in their biodiversity, as the point of agrotechnical procedures is the reduction of interspecies competition for the cultivated plant species. What is more, agricultural mechanization stimulated formation of the large cultivated fields. This process was connected to the removal of intra-field forestations, small watercourses and water reservoirs as well as marginal plant aggregations from the agricultural landscape. As a result, those procedures led to the homogenization of the agricultural landscape and an extremely poor biodiversity of agrocenoses. Discussions about the necessity of increasing the heterogeneity of this landscape and biodiversity of agrocenoses had been commenced already in the beginning of the 20th century and intensified in several last decades. In the countries of Western Europe, the postulates of ecologists were significantly applied in the manner of agricultural resources management no sooner than in the end of the 20th century, and an essential spur that had stimulated that process was the overproduction of food. One of the manners of agricultural landscape diversification and agrocenoses biodiversity improvement and simultaneously, exclusion of arable lands from agricultural production is implementation of poplar plantations (e.g. Czarnecki and Corry 1997, De Wit 1988, Armstrong ed. 1999, Sobków and Czarnecki

2000). This research presents quantitative results of investigations of breeding bird communities and non-breeding bird communities carried out within the project „Poplars: a multiple-use crop for European arable farmers” (FAIR6-CT98-4193). The aim of the investigations was to compare the avifauna inhabiting poplar plantations and the adjacent cultivated fields.

RESEARCH AREA

According to the methodology adapted by the participants of the project „Poplars: a multiple-use crop for European arable farmers” (FAIR6-CT98-4193), in April 2000, two study plots for intensive flora and fauna research were selected and marked. Each study plot consisted of two trial areas: an area marked out within a poplar plantation and an area delimited in the adjacent cultivated field. The first study plot (area No. 1 and area No. 2) was marked out nearby the Vistula River, in the neighbourhood of the city of Bydgoszcz, on the area of Strzyżawa Forest Inspectorate (Ostromecko Grounds), and the second (area No. 3 and area No. 4) between Toruń and Inowrocław, on the area of Wierzbiczany Forest Inspectorate.

On the area of Strzyżawa Forest Inspectorate, the area of poplar plantation covered 10.31 ha (area No. 1). It was situated on the flood plain of Vistula. This 39-year-old plantation was managed in an extensive manner. The current structure and composition of the poplar plantation shows that the plantation were established on the area of prospective habitats of elm and ash riparian forest *Ficario-Ulmetum campestris*. A developed community has a four-layer structure. The upper layer of trees with density of 50-70 % is formed almost exclusively by poplars *Populus sp.*, and the lower layer with density of 5-25 % concentration, the most common plant is field elm *Ulmus minor*. A characteristic feature of the community is a rich layer of the undergrowth, in which density of shrubs reaches up to 90 %. That layer is formed mainly by common dogwood *Cornus sanguinea*, bird cherry *Prunus padus*, common hop *Humulus lupulus*, common hawthorn *Crataegus monogyna* and younger specimen of field elm *Ulmus minor*. The layer of undergrowth develops in two fenologic aspects: early spring is dominated by lesser celandine *Ranunculus ficaria*, whereas in summer the most common are specimens of the following classes: *Artemisietea*, *Quercu-Fagetea*, *Salicetea purpurea* i *Molinio-Arrhenatheretea*. In early spring, dependent on a level of water in a river Vistula in a given year, between 20 and 70 % of the study area becomes periodically flooded.

Area No. 2 including agricultural cultivation covered 12.64 ha. The distance between area No. 2 and area No. 1 (poplar plantation) equalled 280 m, and between area No. 2 and Vistula 300 m. In some years, when water level on Vistula is extremely high, the whole area is periodically flooded (e.g. in 2000) in spring. For that reason, farming on that area is of an

extensive character. As much as 59.0 % of the study area (7.46 ha) is formed by untended, greatly marshy meadows, on which no agricultural works have been performed for several years now. On the remaining area, there was grown winter wheat (2.47 ha), barley (2.47 ha) and potatoes (0.24 ha). The western boundary of the area is marked by a drainage ditch, whose edges are grown by common hawthorn, grey willow *Salix cinerea* and bay willow *Salix pentandra*.

Area No. 3 included 40-year-old poplar plantation (6.11 ha) situated within a dense complex of forest plantations in the Wierzbiczany Forest Inspectorate. It was located around 260 m away from the cultivated fields. A current structure and composition of the poplar plantation indicates that it occupies potential habitats of oak-hornbeam forest *Tilio-Carpinetum stachyetosum*. The community has a four-layer structure. The upper layer of trees with density of 50-90 % is composed only by poplar. In the lower layer of trees (density 20-70 %) there are specimen typical for natural forests of fresh and moderately humid habitats: European ash *Fraxinus excelsior*, field elm, common hawthorn, pedunculate oak *Quercus robur*, bird cherry and other. Density of brush layer within the study area is highly diversified (10-95 %). The layer is composed by: underbrush of the above-mentioned species of trees, as well as common buckthorn *Rhamnus cathartica*, common dogwood, blackthorn *Prunus spinosa* and wild pear *Pyrus pyraster*. The layer of undergrowth is typically covered in more than 80 %. It is dominated by grass and sedge (high degree of sod formation – grass covering). Poplar plantation is of an extensive character.

Area No. 4 includes agriculture crops (8.39 ha) and it was situated at a distance of 260 m away from the area No. 3 (poplar plantation). From its eastern and southern side it was adjacent to the forest plantations complex of Wierzbiczany Forest Inspectorate. In 2000 there were cultivated spring wheat (4.22 ha) and winter wheat (3.55 ha), whereas in the southern part adjacent to the forest – potatoes (0.62 ha).

METHODS

Quantitative research of avifauna conducted in the marked test areas included breeding and non-breeding periods. It was done on the basis of methodical standards elaborated by the participants of the project “Poplars: a multiple-use crop for European arable farmers” (FAIR6-CT98-4193), consistent with guidelines provided by the International Bird Census Committee (1970).

Research on sets of breeding birds was carried out between 1.05 and 15.07.2000 with use of cartographic method (Enemar 1959, Tomiałoć 1980, Bibby at al. 2000). There were two exceptions from the traditional method: scheduling a fewer number of inspections as well as

marking smaller areas than required by the minimum. Such exceptions were acceptable, since the research was basically aimed at comparison of avifauna living in poplar plantations and in adjacent cultivated fields. On each area there were 6 sessions of bird counting conducted: five in the morning and one in the evening.

Quantitative research of birds' concentration in a non-breeding season was conducted with use of a modified method of line taxation (Järvinen and Väisänen 1973, Emlen 1977). The main exception from the classical version of the method was an established width of the taxation area. In that research, birds were counted within a 100-metre-wide area. In each area there were four inspections carried out in the following dates: 24 and 25.10.2000, 14 and 15.12.2000, 18 and 19.01.2001, 23 and 24.02.2001.

RESULTS

The results of quantitative research on sets of breeding birds received from six inspections (5 in the morning and 1 in the evening) conducted between 1st May and 15th July indicate that an established number of inspections made it possible to register all breeding birds from the areas with cultivated fields. However, there is a high probability that in the areas marked within poplar plantations several the least numerous species were not registered. Nonetheless, the six inspections were sufficient to register the actual structure of sets of breeding birds living in the above-mentioned areas. The results of quantitative research are listed in tables 1 – 3.

A group of breeding birds registered on the study area delimited within poplar plantation on the territory of Strzyżawa Forest Inspectorate (area No. 1) amounted to 32 species. A density indicator of the whole set had value of 77.6 breeding couples / 10 ha. A dominant group included 8 species: chaffinch *Fringilla coelebs*, starling *Sturnus vulgaris*, blackcap *Sylvia atricapilla*, chiffchaff *Phylloscopus collybita*, great tit *Parus major*, spotted flycatcher *Muscicapa striata*, blackbird *Turdus merula* and blue tit *Parus caeruleus*. In that set there were also registered 10 species from a subdominant group, 13 species from an influent group and 1 accessory species (table 1). In the area No. 1, species nesting the most frequently were the ones making open nests among the branches of the trees and in the layer of brushwood (table 3). There was also a high percentage of birds living in holes (38.7 % of breeding couples). Species making their nests on the ground were represented only by 2 species, and their percentage was 7.5 %. In a set of breeding birds from the area No. 1 there were registered a considerable number of species associated with a border line sphere between a forest and open territories. Species characteristic for a forest margin include: carrion crow *Corvus corone*, greenfinch *Carduelis chloris*, goldfinch *Carduelis carduelis*, yellowhammer

Table 1. Breeding birds communities in poplar plantations

N – number of breeding pairs, D – density [pairs / 10 ha], % - share [%]

Species	Study plot N° 1			Study plot N° 3		
	N	D	%	N	D	%
<i>Fringilla coelebs</i> L.	9	8,7	11,2	5	8,2	9,3
<i>Sturnus vulgaris</i> L.	8	7,8	10,0	6	9,8	11,1
<i>Sylvia atricapilla</i> (L.)	5	4,8	6,2	4	6,5	7,4
<i>Phylloscopus collybita</i> (Vieill.)	5	4,8	6,2	3	4,9	5,6
<i>Parus major</i> L.	5	4,8	6,2	4	6,5	7,4
<i>Muscicapa striata</i> (Pall.)	4	3,9	5,0	3	4,9	5,6
<i>Turdus merula</i> L.	4	3,9	5,0	2	3,3	3,7
<i>Parus caeruleus</i> L.	4	3,9	5,0	2	3,3	3,7
<i>Dendrocopos major</i> (L.)	3	2,9	3,7	1	1,6	1,9
<i>Hippolais icterina</i> (Vieill.)	3	2,9	3,7	2	3,3	3,7
<i>Coccothraustes coccothraustes</i> (L.)	3	2,9	3,7	2	3,3	3,7
<i>Troglodytes troglodytes</i> (L.)	2	1,9	2,5	1	1,6	1,9
<i>Prunella modularis</i> L.	2	1,9	2,5	-	-	-
<i>Erithacus rubecula</i> (L.)	2	1,9	2,5	1	1,6	1,9
<i>Turdus philomelos</i> C.L.Brehm	2	1,9	2,5	1	1,6	1,9
<i>Parus palustris</i> L.	2	1,9	2,5	2	3,3	3,7
<i>Sitta europaea</i> L.	2	1,9	2,5	-	-	-
<i>Certhia brachydactyla</i> C.L.Brehm	2	1,9	2,5	2	3,3	3,7
<i>Columba palumbus</i> L.	1	1,0	1,2	-	-	-
<i>Cuculus canorus</i> L.	1	1,0	1,2	+	+	+
<i>Oriolus oriolus</i> (L.)	1	1,0	1,2	1	1,6	1,9
<i>Garrulus glandarius</i> (L.)	1	1,0	1,2	1	1,6	1,9
<i>Corvus corone</i> L.	1	1,0	1,2	-	-	-
<i>Acrocephalus palustris</i> (Bechst.)	1	1,0	1,2	-	-	-
<i>Sylvia borin</i> (Bodd.)	1	1,0	1,2	1	1,6	1,9
<i>Sylvia communis</i> Lath.	1	1,0	1,2	1	1,6	1,9
<i>Ficedula hypoleuca</i> L.	1	1,0	1,2	-	-	-
<i>Luscinia luscinia</i> (L.)	1	1,0	1,2	1	1,6	1,9
<i>Carduelis chloris</i> (L.)	1	1,0	1,2	1	1,6	1,9
<i>Carduelis carduelis</i> L.	1	1,0	1,2	-	-	-
<i>Emberiza citrinella</i> L.	1	1,0	1,2	2	3,3	3,7
<i>Anthus trivialis</i> (L.)	-	-	-	1	1,6	1,9
<i>Phylloscopus trochilus</i> (L.)	-	-	-	1	1,6	1,9
<i>Aegithalos caudatus</i> (L.)	-	-	-	1	1,6	1,9
<i>Luscinia megarhynchos</i> C.L.Brehm	-	-	-	1	1,6	1,9
<i>Certhia familiaris</i> L.	-	-	-	1	1,6	1,9
<i>Strix aluco</i> L.	+	+	+	+	+	+
Total	80	77,6	100,0	54	88,4	100,0

Emberiza citrinella, whitethroat *Sylvia communis*, garden warbler *Sylvia borin*, as well as starling. The value of a species diversity indicator of breeding birds living in the area No. 1 was elevated and it amounted to 4.53.

Within the area No. 2 including cultivated fields and meadows at a distance of 280 m from the area No. 1, there were registered 8 breeding species (table 2). A density indicator of breeding birds had the value of 12.7 couples / 10 ha. Apart from species typical for cultivated fields and meadows, there were registered 3 species associated with areas of brushes which constituted some segments of a borderline of the studied plot: marsh warbler *Acrocephalus palustris*, corn bunting *Emberiza calandra* and reed bunting *Emberiza schoeniclus*. Nesting of corn crake *Crex crex* and grasshopper warbler *Locustella naevia* on that area undoubtedly resulted from a close neighbourhood of the Vistula river (300 m). Both species live in marshy meadows, and the studied area is periodically flooded by water from the Vistula (in some years in the early spring). A set of breeding birds registered in that area was characterized by a low value of species diversity indicator (table 4).

Table 2. Breeding birds communities in the cultivated fields

N – number of breeding pairs, D – density [pairs / 10 ha], % - share [%]

Species	Study plot N° 2			Study plot N° 4		
	N	D	%	N	D	%
<i>Motacilla flava</i> L.	4	3,2	24,9	2	2,4	40,0
<i>Saxicola rubetra</i> (L.)	3	2,4	18,7	1	1,2	20,0
<i>Crex crex</i> (L.)	2	1,6	12,5	-	-	-
<i>Alauda arvensis</i> L.	2	1,6	12,5	2	2,4	40,0
<i>Locustella naevia</i> (Bodd.)	2	1,6	12,5	-	-	-
<i>Acrocephalus palustris</i> (Bechst.)	1	0,8	6,3	-	-	-
<i>Emberiza calandra</i> L.	1	0,8	6,3	-	-	-
<i>Emberiza schoeniclus</i> L.	1	0,8	6,3	-	-	-
Total	16	12,7	100,0	5	6,0	100,0

Within the area No. 3 grown by poplar plantation on the territory of Wierzbiczany Forest Inspectorate there nested 30 species, and a density indicator of the whole set had the value of 88.4 couples / 10 ha. The set consisted of 6 dominant species: (starling, chaffinch, blackcap, great tit, chiffchaff and spotted flycatcher), 7 species from a subdominant group, 15 species from an influent group and 2 accessory species (table 1). The structure of nesting bird groups within the studied area (table 3) was the following: 17 species making open nests above the ground (48.1 % of all the breeding couples), 9 species nesting in holes (38.9 %) and 4 species nesting on the ground (13 %). Within the area No. 3 there nested 5 species associated with a borderline zone between a forest and an open territory: yellowhammer, garden warbler,

whitethroat, greenfinch and starling. The value of the species diversity indicator of that set of birds was high (4.52).

A set of breeding birds living in the area No. 4 covering cultivated fields situated in the neighbourhood of the area No. 3 consists of 3 species only (table 2). Its density (6.0 couples / 10 ha) and species diversity indicator (1.52) were extremely low, which is typical of arable crops of the central Europe.

Table 3. Share of nesting groups in breeding bird communities in investigated study plots
L1 – birds nesting on ground or in herb layer, L2 – birds nesting in shrub layer or on trees,
H – birds nesting in hollows

Study plot	N° 1	N° 2	N° 3	N° 4
Number of species:				
L1	2	7	4	3
L2	20	1	17	-
H	10	-	9	-
Density index [breeding pairs / 10 ha]:				
L1	5,8	11,9	11,5	6,0
L2	41,7	0,8	42,6	-
H	30,1	-	34,4	-
Share [%]:				
L1	7,5	93,7	13,0	100,0
L2	53,7	6,3	48,1	-
H	38,7	-	38,9	-

Table 4. Value of species-diversity index by Schannon-Weaver (H') for breeding bird communities

Study plot	H'
N° 1 (poplar plantation - forest department Strzyżawa)	4,53
N° 2 (arable field)	2,83
N° 3 (poplar plantation - forest department Wierzbiczany)	4,52
N° 4 (arable field)	1,52

In a non-breeding season, as a result of inspections conducted within the marked areas in the poplar plantations, there were registered 17 species of birds. In the area No. 1, there were registered 17 species (table 5), and in the area No. 3 – 14 species (table 6). In both studied areas the highest number of species (15 and 14) and the highest density (105.7 and 93.3 individuals / 10 ha) of sets of birds was registered in October, that is in the period of migration of many species of birds to winter habitats. In winter time (January, February) the

studied area was occupied by a set of birds with the lowest diversity of species (between 4 and 6 species) and the lowest number of individuals (between 32.7 and 40.7 individuals / 10 ha). Both areas in winter time were dominated by blue tit, great tit and hawfinch *Coccothraustes coccothraustes*. An average value of density indicator of groups of birds within the area No. 1 in 4 conducted inspections amounted to 58.7 individuals / 10 ha, whereas in the area No. 3 amounted to 3-53.6 individuals / ha.

Within the areas including arable lands in a non-breeding period, the birds occurred only sporadically (table 7 and 8). Principally, in such habitats there were registered no dominant groups of birds with a developed structure of domination. During 4 inspections on the area No. 2 there were registered 9 species, whereas on the area No. 4 – only 5 species.

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Table 5. Species composition and abundance of the bird communities in non-breeding season in study plot N° 1

N – number of individuals, D – density [individuals / 10 ha], % - share [%]

Species	25.10.2000			15.12.2000			19.01.2001			24.02.2001			Mean values		
	N	D	%	N	D	%	N	D	%	N	D	%	N	D	%
<i>Parus caeruleus</i> L.	23	22,3	21,1	14	13,6	25,0	14	13,6	40,0	12	11,6	28,6	15,8	15,3	26,0
<i>Parus major</i> L.	20	19,4	18,4	15	14,5	26,8	11	10,7	31,4	14	13,6	33,3	15,0	14,5	24,8
<i>Coccothraustes coccothraustes</i> (L.)	10	9,7	9,2	9	8,7	16,1	7	6,8	20,0	10	9,7	23,8	9,0	8,7	14,9
<i>Fringilla coelebs</i> L.	11	10,7	10,1	-	-	-	-	-	-	-	-	-	2,8	2,7	4,5
<i>Pyrrhula pyrrhula</i> (L.)	2	1,9	1,8	3	2,9	5,4	2	1,9	5,7	-	-	-	1,8	1,7	2,9
<i>Regulus regulus</i> (L.)	16	15,5	14,7	-	-	-	-	-	-	-	-	-	4,0	3,9	6,6
<i>Certhia brachydactyla</i> C.L.Brehm	9	8,7	8,3	11	10,7	19,6	-	-	-	3	2,9	7,1	5,8	5,6	9,5
<i>Aegithalos caudatus</i> (L.)	8	7,8	7,3	-	-	-	-	-	-	-	-	-	2,0	1,9	3,3
<i>Turdus merula</i> L.	2	1,9	1,8	2	1,9	3,6	-	-	-	-	-	-	1,0	1,0	1,7
<i>Dendrocopos major</i> (L.)	1	1,0	0,9	-	-	-	-	-	-	-	-	-	0,3	0,2	0,4
<i>Garrulus glandarius</i> (L.)	-	-	-	1	1,0	1,8	-	-	-	1	1,0	2,4	0,5	0,5	0,8
<i>Sitta europaea</i> L.	3	2,9	2,8	1	1,0	1,8	1	1,0	2,9	2	1,9	4,8	1,8	1,7	2,9
<i>Erithacus rubecula</i> (L.)	2	1,9	1,8	-	-	-	-	-	-	-	-	-	0,5	0,5	0,8
<i>Dendrocopos minor</i> (L.)	1	1,0	0,9	-	-	-	-	-	-	-	-	-	0,3	0,2	0,4
<i>Troglodytes troglodytes</i> (L.)	1	1,0	0,9	-	-	-	-	-	-	-	-	-	0,3	0,2	0,4
<i>Corvus corax</i> L.	+			-	-	-	-	-	-	+			+		
<i>Buteo buteo</i> (L.)	-	-	-	+			-	-	-	-	-	-	+		
Total	109	105,7	100,0	56	54,3	100,0	35	33,9	100,0	42	40,7	100,0	60,5	58,7	100,0

Table 6. Species composition and abundance of the bird communities in non-breeding season in study plot N° 3

N – number of individuals, D – density [individuals / 10 ha], % - share [%]

Species	24.10.2000			14.12.2000			18.01.2001			23.02.2001			Mean values		
	N	D	%	N	D	%	N	D	%	N	D	%	N	D	%
<i>Parus caeruleus</i> L.	10	16,4	17,5	8	13,1	26,7	9	14,7	37,5	8	13,1	40,0	8,8	14,3	26,7
<i>Parus major</i> L.	8	13,1	14,0	10	16,4	33,3	7	11,5	29,2	6	9,8	30,0	7,8	12,7	23,7
<i>Coccothraustes coccothraustes</i> (L.)	7	11,5	12,3	4	6,5	13,3	6	9,8	25,0	5	8,2	25,0	5,5	9,0	16,8
<i>Fringilla coelebs</i> L.	11	18,0	19,3	-	-	-	-	-	-	-	-	-	2,8	4,5	8,4
<i>Pyrrhula pyrrhula</i> (L.)	3	4,9	5,3	3	4,9	10,0	2	3,3	8,3	1	1,6	5,0	2,3	3,7	6,9
<i>Regulus regulus</i> (L.)	6	9,8	10,5	-	-	-	-	-	-	-	-	-	1,5	2,5	4,6
<i>Certhia brachydactyla</i> C.L.Brehm	4	6,5	7,0	2	3,3	6,7	-	-	-	-	-	-	1,5	2,5	4,6
<i>Aegithalos caudatus</i> (L.)	4	6,5	7,0	-	-	-	-	-	-	-	-	-	1,0	1,6	3,1
<i>Turdus merula</i> L.	1	1,6	1,8	1	1,6	3,3	-	-	-	-	-	-	0,5	0,8	1,5
<i>Dendrocopos major</i> (L.)	1	1,6	1,8	1	1,6	3,3	-	-	-	-	-	-	0,5	0,8	1,5
<i>Garrulus glandarius</i> (L.)	1	1,6	1,8	1	1,6	3,3	-	-	-	-	-	-	0,5	0,8	1,5
<i>Troglodytes troglodytes</i> (L.)	1	1,6	1,8	-	-	-	-	-	-	-	-	-	0,3	0,4	0,8
<i>Corvus corax</i> L.	+			-	-	-	+			+			+		
<i>Buteo buteo</i> (L.)	+			+			-	-	-	+			+		
Toatal	57	93,3	100,0	30	49,1	100,0	24	39,3	100,0	20	32,7	100,0	32,8	53,6	100,0

Table 7. Species composition and abundance of the bird communities in non-breeding season in study plot N° 2

N – number of individuals, D – density [individuals / 10 ha], % - share [%]

Species	25.10.2000			15.12.2000			19.01.2001			24.02.2001			Mean values		
	N	D	%	N	D	%	N	D	%	N	D	%	N	D	%
<i>Carduelis carduelis</i> L.	5	4,0	29,4	8	6,3	61,5	-	-	-	-	-	-	3,3	2,6	37,1
<i>Pica pica</i> (L.)	3	2,4	17,6	2	1,6	15,4	-	-	-	2	1,6	100,0	1,8	1,4	20,0
<i>Corvus corone cornix</i> L.	2	1,6	11,8	-	-	-	2	1,6	66,7	-	-	-	1,0	0,8	11,4
<i>Garrulus glandarius</i> (L.)	4	3,2	23,5	-	-	-	-	-	-	-	-	-	1,0	0,8	11,4
<i>Emberiza citrinella</i> L.	3	2,4	17,6	-	-	-	-	-	-	-	-	-	0,8	0,6	8,6
<i>Parus major</i> L.	-	-	-	2	1,6	15,4	-	-	-	-	-	-	0,5	0,4	5,7
<i>Phasianus colchicus</i> L.	-	-	-	1	0,8	7,7	1	0,8	33,3	-	-	-	0,5	0,4	5,7
<i>Corvus corax</i> L.	+			-	-	-	-	-	-	-	-	-	+		
<i>Buteo buteo</i> (L.)	+			+			+			-	-	-	+		
Total	17	13,4	100,0	13	10,3	100,0	3	2,4	100,0	2	1,6	100,0	8,8	6,9	100,0

Table 8. Species composition and abundance of the bird communities in non-breeding season in study plot N° 4

N – number of individuals, D – density [individuals / 10 ha], % - share [%]

Species	24.10.2000			14.12.2000			18.01.2001			23.02.2001			Mean values		
	N	D	%	N	D	%	N	D	%	N	D	%	N	D	%
<i>Carduelis carduelis</i> L.	6	7,2	60,0	-	-	-	-	-	-	-	-	-	1,5	1,8	50,0
<i>Carduelis chloris</i> (L.)	4	4,8	40,0	-	-	-	-	-	-	-	-	-	1,0	1,2	33,3
<i>Phasianus colchicus</i> L.	-	-	-	1	1,2	100,0	-	-	-	1	1,2	100,0	0,5	0,6	16,7
<i>Corvus corax</i> L.	-	-	-	+			-	-	-	+			+		
<i>Buteo buteo</i> (L.)	+			+			+			-	-	-	+		
Total	10	11,9	100,0	1	1,2	100,0	0	0,0	0,0	1	1,2	100,0	3,0	3,6	100,0

DISCUSSION

Groups of breeding birds registered on the areas with poplar plantations (areas No.1 and No. 3) are characterized by an elevated number of species and a high value of density indicator. Those characteristics are approximate to values registered in broadleaved and mixed forests on the territory of Poland, which are rich in species: in the Niepołomice Forest (Głowaciński 1975, 1978, 1981, Głowaciński and Weiner 1977), in the Białowieża Forest (Tomiałojć at al. 1977, Tomiałojć at al. 1984, Wesołowski at al. 2001), in the broadleaved forest at the Odra river in the neighbourhood of the mouth of the Kaczawa river (Ranoszek 1969), w rezerwacie „Dębina” pod Wągrowcem (Bogucki 1977), in small forest complexes near Legnica (Tomiałojć 1974), in the reservation “Las Piwnicki” near the city of Torun (Kartanas 1995). Such an elevated number of species and such a high value of density indicator of breeding birds groups in poplar plantations came as a result of two factors: structure of phytocenose and a close neighbourhood of a borderline between the forest and open territory. Phytocenose of the both studied areas was characterized by a high density of multi-species undergrowth. A well-developed layer of undergrowth makes ecological niches for many species of birds, which influences a number of species and a high number of the whole group of breeding birds (Røv 1975, Nilson 1979, Tomiałojć at al. 1984, Kartanas 1995, Newton 1998, Fuller 2000). An abundance of holes in a tree stand had also a significant influence on above-mentioned numbers, which is proved by numerous nesting specimens living in holes (table 4). Close neighbourhood of a borderline between the forest and the open territory was the other obvious factor (occurrence of species associated with a borderline zone of the forest). A hundred-fifty-long segment of a borderline of the area No. 1 was adjacent to meadows, whereas the northern boundary of the area No. 3 was located at the distance of 260 m from the forest complex with cultivated fields.

The structure of domination (table 1), the structure of nesting groups (high percentage of birds living in holes and a low percentage of species making nests on the ground) and the high value of species diversity indicator (table 4) of the registered communities of breeding birds refer to groups typical for seral stadiums of successive series of broadleaved forests (Głowaciński 1975, 1981, Głowaciński and Weiner 1977), even though the age of studied poplar populations was relatively young (39 and 40 years).

A community of breeding birds registered in the area No. 1 (poplar plantation in the neighbourhood of the Vistula River) was formed by more species than community living within the area No.3 (poplar plantation on the territory of Wierzbiczany Forest Inspectorate, yet it had a considerably lower value of a density indicator. In early spring each year around 30 % of the area No. 1 is subject to being flooded with water from the Vistula River. Underwood is developed here much poorer. It had an impact on a reduced number of species associated with that forest layer. What is more, periodical flooding has a negative influence on species making nests on the ground (too high humidity of a surface layer of the ground). At the same time, higher humidity of an environment in the

area No. 1 created favourable conditions for nesting of such birds as marsh warbler, wren *Troglodytes troglodytes*, robin *Erithacus rubecula*, dunnock *Prunella modularis*.

Communities of breeding birds registered in the areas including cultivated fields and meadows (areas No. 2 and No.4) were characterized by a low number of species and extremely low value of a density indicator (table 2). The considerable difference in characteristics of both communities and in value of species diversity indicator (table 4) resulted from a density indicator. In early spring the area No. 2 is regularly flooded by water of the Vistula River, which shaped flora of the meadow untended by the owner of meadow. In that area nested corncrake and grasshopper warbler. What is more, a higher number of species and higher density of the community was influenced by the presence of shrub zones. In shrub zones nested 3 species: marsh warbler, corn bunting and reed bunting. Extremely low number of species and a high density of a community were registered in the area No. 4 including spring wheat, winter wheat and potatoes cultivation are typical for intensive arable crops in southern and northern Poland (Kartanas 1989, 1996, Kujawa and Tryjanowski 2000).

In Central Europe, when breeding season finishes, a number of species and a quantity of birds living in the forests and agriculturally developed areas become reduced, reaching the minimum in winter period. Straight majority of species living in those habitats spend winter in regions at great distance from breeding areas. That is why in a non-breeding season a number of species and a population of communities of birds registered on the studied areas with poplar plantations were by far less from the values noted in the breeding season (table 5 and 6). Comparison of received results with communities of birds registered in broadleaves forests in Poland (Głowaciński and Weiner 1975, Kartanas 1993) makes it possible to find out that communities of birds living in the poplar plantations were formed by a lower number of species and that they had a lower value of a density indicator.

In a non-breeding season on the areas including arable lands, the birds occurred sporadically (table 7 and 8). Habitats of that sort in a non-breeding season, and especially in winter time do not provide conditions for nesting of birds. A bit higher number of species and larger population of birds registered in non-breeding season on the area No. 2 resulted from the presence of shrub zones between the fields.

Results of the quantitative research of birds conducted on two areas marked within poplar plantation and on two areas including cultivated fields situated in the neighbourhood reveal a great difference between communities of breeding birds and groups of non-breeding birds living in two studied types of habitats. On the area with poplar plantation, a six and fifteen times higher density than on the areas including adjacent cultivated fields was registered (table 1 and 2). It is reflected in values of a species diversity indicator of studied groups of breeding birds (table 4). Differences registered in a non-breeding season were equally high (table 5 - 8).

On the basis of conducted research it is possible to say that introduction of poplar plantations to the agricultural landscape shall considerably increase a population size and diversity of species of birds in that habitat. It is, however, important to emphasize that the results presented in the present paper can

be the basis to define the maximum increase of biodiversity. Areas including poplar plantation were marked in plantations developed in an extensive manner. Those plantations took potential habitats of riparian forests (area No. 1) and low broadleaved forests (area No. 3). For that reason its undergrowth and underbrush were rich in species and characterized with a great density. Besides, a considerable age of those plantations generated creation of natural holes and enabled woodpeckers to peck holes. Poplar plantations created as a part of transforming arable lands are subject to intensive care, which disables to form rich undergrowth and eliminates a possibility of underbrush layer formation. Thanks to the use of selected, fast growing hybrids of poplars, their felling age is relatively low. For that reason, in communities of breeding birds living in fast growing poplar plantations, there are no species nesting in holes. The above-mentioned qualities of poplar plantations – formed as a part of arable lands transformation process – determine a lower number of species living there – communities of breeding and non-breeding birds and also determine a lower density (Hanowski et al. 1997). The number of species and the population of birds living in those poplar plantations depend also on their size. Increase in sizes of forest islands is accompanied by increase in number of birds' species and indicator of species diversity of groups, whereas an indicator of birds groups density (Whitcomb et al. 1981, Zenker 1982, Cieślak 1985, Cieślak and Dombrowski 1992, 1993). Another essential factor influencing a population of breeding birds in poplar plantations is the shape of area occupied by the plantation. Cieślak (1985) proved that extension of a borderline of a forest island in relation to its area (up to 30 ha) increases a number of bird species, indicator of density and indicator of species diversity of the community.

The results of quantitative research of birds described in the present paper indicate the importance of creating extensive poplar populations in the agricultural landscape in order to increase its biodiversity. When transforming arable lands into poplar plantations, it is recommended to incur additional expenses excluding at least 5 % of poplar plantations from extensive form of cultivation. Lack of intensive cultivation activities on excluded poplar plantations would make it possible to form a layer of underbrush and a multi-species undergrowth with high degree of underwood. Rising the felling age would increase attractiveness of a particular habitat for birds nesting in holes. A number of species and a population of breeding birds' communities and groups of non-breeding season in the range of extensive cultivation would have an approximate value to values registered in the studied areas No. 1 and No. 2.

SUMMARY

Quantitative results of investigations of breeding bird communities and non-breeding bird communities carried out in two plots under poplar plantations and two plots under cultivated fields indicated potential ability to increase the number of species and abundance of birds due to introduction to the agricultural environment poplar plantations. Breeding bird communities were made by five and

ten times higher number of species (32 and 30) as compared with bird communities inhabiting adjacent cultivated fields (8 and 3). Also the differences in abundance were very distinct (poplar plantations - 77.6 and 88.4 pairs/10 hectares; cultivated fields - 12.7 and 6.0 pairs/10 hectares). Great differences were also stated in non-breeding season. During four censuses 17 and 14 species were recorded in poplar plantations and only 9 and 5 species in plots under cultivated fields. Mean value of density index of these communities was 58.7 and 53.6 individuals/10 hectares (poplar plantations) and 6.9 and 3.6 individuals/10 hectares (cultivated fields).

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