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IMPORTANCE OF YOUNG SHELTERBELTS FOR BREEDING AVIFAUNA IN AGRICULTURAL LANDSCAPE (TUREW AREA, WEST POLAND)

ABSTRACT: Protection of high biodiversity in an intensively farmed areas is strongly related to managing the diverse structure of a landscape, for example by planting shelterbelts. The study was aimed at recognition of avifauna dynamics in young (with the age of 1–4 years at the beginning of the study) shelterbelts (N=9) and at estimation of their importance for farmland birds. Bird density was estimated by mapping method in successive years 1996–2001 and the data were combined and analysed in respect to age of shelterbelts. Eighteen breeding species were found (5–8 pairs km⁻¹), among them most abundant were Corn Bunting (*Miliaria calandra*) (with dominance of 33%), Yellow Wagtail (*Motacilla flava*) (19%) and Whitethroat (*Sylvia communis*) (12%). No trend in the changes of species richness and total density was recorded. The density of species preferring building nests and/or feeding in herb layer (like Yellow Wagtail, Skylark *Alauda arvensis* and Whinchat *Saxicola rubetra*) decreased during study period while the density of species associated to higher layers of vegetation like Yellowhammer (*Emberiza citrinella*), Red-backed Shrike (*Lanius collurio*) increased. According to earlier study, bird species richness and abundance in studied young shelterbelts were lower than in several dozens years old ones. However, in relation to species colonization both classes of shelter-

belts (species building their nests on the ground or in low shrubs), young shelterbelts were as important as old ones.

KEY WORDS: agricultural landscape, shelterbelts, biodiversity, breeding avifauna, landscape management

1. INTRODUCTION

Intensification of farming has been indisputably recognised as one of the most important factors affecting breeding avifauna in Europe (Tucker *et al.* 1994, Tucker and Evans 1997). Therefore, protection of European avifauna diversity depends on proper, ecologically-oriented land use (Heath and Evans 2000). Large number of declining species (e.g., Partridge – *Perdix perdix*, Quail – *Coturnix coturnix*, Corncrake – *Crex crex*, Skylark – *Alauda arvensis*, Red-backed Shrike – *Lanius collurio*, Great Grey Shrike – *Lanius excubitor*, Linnet – *Carduelis cannabina*, Ortolan Bunting – *Emberiza hortulana*, Corn Bunting – *Miliaria calandra*) endangered by intensification of farming was recorded in Europe (Tucker *et al.* 1994).

Protection of high biodiversity in intensively farmed areas is strongly related to preservation of highly diverse, mosaic-like structure of agricultural landscape. Due to presence of many semi-natural elements of landscape, the negative effects of farming intensification on biota are mitigated. Especially midfield afforestations are important for the protection of biodiversity in agricultural landscape (Ryszkowski *et al.* 1999).

Midfield afforestations are very important in respect to birds. In comparison with other elements of agricultural landscape in European lowlands, breeding bird communities in midfield afforestations are characterised by high species richness as well as by high densities (Bezzel 1982). For example, in the neighbourhood of Turew (Wielkopolska region, 50 km south of Poznań, West Poland), midfield afforestations cover only 4% of total area but provide nesting sites for 60% of all breeding pairs recorded in whole landscape (Kujawa 1994). Also the results of another studies carried out on a set of sampling plots in Wielkopolska region (Kujawa and Tryjanowski 2000) as well as in other European countries (Flade 1994, Petersen 1998, Fuller *et al.* 2001) allow to regard midfield afforestations as the most important factor shaping diversity of breeding avifauna in an agricultural landscape (O'Connor and Shrubbs 1986).

At present, the necessity of introducing afforestations to agricultural landscape is claimed and in some areas the afforestations have been recently planted. In the area of Turew (Gen. D. Chłapowski Landscape Park) since 1992 as much as 40 km of linear afforestations, including shelterbelts containing several rows of trees, were introduced. However, the estimation of the effects of newly introduced afforestations for bird diversity and abundance are still lac-

king because there is no data on the rate of colonization of young shelterbelts by breeding birds. It is not known how long time introduced shelterbelts have to function as an effective biocenotic sites (e.g. constituting ecological niches for breeding birds) similar to that of an old afforestations.

The aim of this study was to recognise the changes in species composition of bird communities and in bird densities in young, fast developing shelterbelts and an estimation of importance of that kind of habitat for bird communities in an agricultural landscape.

2. STUDY AREA AND METHODS

Bird density was estimated in 1996–2001, initially in six, then in seven (since 1998) and finally (since 2000) in nine young shelterbelts (Fig. 1) located in neighbourhood of Turew locality (16°49'E, 52°03'N – West Poland). These shelterbelts differed in respect to age, size (Table 1) as well as vegetation cover (Table 2). Tree stand of these shelterbelts consisted mostly of deciduous species with admixture of some coniferous species. Shrub layer differed strongly between individual shelterbelts. Some of them were characterised by occurrence of small gaps, i.e. areas without trees and shrubs. Each shelterbelt was covered by the study as the one sampling area.

The study was done with the mapping method (Tomiałojć 1980). According to this method, bird density is estimated on the basis of localisation of breeding territories and/or nests. Each shelterbelt was visited early morning, 9-times per year, since the last decade of April or first decade of May to first decade of July. Taking into ac-

Table 1. General characteristics of studied shelterbelts (A–I) (see Fig.1).

Name	Time of planting	Number of tree rows*	Length [m]	Width [m]	Area [ha]	Number of tree and shrub species
A	MAR 1995	11	1100	21	2.31	11
B	APR 1996	3-7	700	7	0.49	9
C	DEC 1993	11	400	16	0.64	12
D	DEC 1993	7	450	12	0.54	7
E	DEC 1993	11	380	17.5	0.67	12
F	OCT 1998	7	800	12	0.96	17
G	APR 1996	3	620	5	0.31	12
H	OCT 1996	4-10	1210	12	1.45	21
I	APR 1994	11	700	15	1.05	23

* Trees have been planted in parallel rows, which number are given in the column

Table 2. General description of vegetation cover in studied shelterbelts (A – I, see Table 1, Fig. 1).

Trees		Shrubs			
Co- ver (%)	Species and dominance in % (rough estimation is given in brackets for the group of species with similar share)	Co- ver (%)	Species	Gaps ¹⁾	Height (m)
A 40	<i>Populus</i> sp., <i>Quercus robur</i> , <i>Ulmus minor</i> (20) <i>Acer pseudoplatanus</i> , <i>Fagus sylvatica</i> (10) <i>Pinus sylvestris</i> , <i>Picea abies</i> , <i>Fraxinus excelsior</i> , <i>Betula pendula</i>	–		Nume- rous	>10 mean >5
B 90	<i>Populus</i> sp., <i>Larix decidua</i> (25) <i>Acer pseudoplatanus</i> , <i>Betula pendula</i> , <i>Picea abies</i> , <i>Ulmus minor</i> (10) <i>Fraxinus excelsior</i> , <i>Quercus robur</i> , <i>Sorbus</i> sp.	–		No	>10
C 50	<i>Larix decidua</i> , <i>Pinus sylvestris</i> , <i>Picea abies</i> , (30) <i>Ulmus minor</i> , <i>Fraxinus excelsior</i> , <i>Tilia cordata</i> , <i>Betula pendula</i>	–		Nume- rous	>10
D 70	<i>Populus</i> sp., <i>Tilia cordata</i> , <i>Larix decidua</i> (20) <i>Pinus sylvestris</i> , <i>Picea abies</i> (10) <i>Acer pseudoplatanus</i> , <i>Quercus robur</i>	–		No	>10
E 100	<i>Larix decidua</i> , <i>Pinus sylvestris</i> , <i>Picea abies</i> , <i>Betula pendula</i> (20) <i>Tilia cordata</i> , <i>Populus</i> sp. (10) <i>Salix</i> sp., <i>Sorbus</i> sp., <i>Prunus</i> sp., <i>Quercus robur</i> , <i>Ulmus minor</i> , <i>Fagus sylvatica</i>	–		No	>10
F 50	<i>Carpinus betulus</i> , <i>Acer campestre</i> , <i>Larix decidua</i> , <i>Betula pendula</i> , <i>Picea abies</i> (10) <i>Sorbus</i> sp., <i>Tilia cordata</i> , <i>Acer pseudoplatanus</i> , <i>Quercus robur</i> , <i>Pinus sylvestris</i> , <i>Quercus rubra</i> , <i>Pirus communis</i> , <i>Acer platanoides</i>	40	<i>Rosa rugosa</i>	Rare	<i>Betula</i> > 5 others < 5
G 40	<i>Robinia pseudacacia</i> , <i>Acer platanoides</i> , <i>Tilia cordata</i> (20) <i>Salix</i> sp., <i>Betula pendula</i> , <i>Carpinus betulus</i> , <i>Fraxinus excelsior</i>	<10	<i>Prunus</i>	Nume- rous	Max > 10 Mean < 5
H 90	<i>Alnus glutinosa</i> (30) <i>Tilia cordata</i> , <i>Betula pendula</i> , <i>Pinus sylvestris</i> (15) <i>Acer campestre</i> , <i>Acer platanoides</i> , <i>Robinia pseudacacia</i> , <i>Fagus sylvatica</i> , <i>Fraxinus excelsior</i> , <i>Picea abies</i> , <i>Larix decidua</i> , <i>Populus</i> sp., <i>Quercus robur</i>	60	<i>Cornus alba</i> , <i>Ribes aurea</i> , <i>Prunus</i> sp., <i>Sambucus nigra</i> , <i>Berberis</i> sp.	No	Max ~ 10
I 80	<i>Pinus sylvestris</i> (30) <i>Betula pendula</i> , <i>Populus</i> sp., <i>Larix decidua</i> (15) <i>Carpinus betulus</i> , <i>Quercus robur</i> , <i>Robinia pseudacacia</i> , <i>Picea abies</i> , <i>Fagus sylvatica</i>	30	<i>Prunus</i> sp., <i>Crataegus monogyna</i> , <i>Sambucus nigra</i> , <i>Cornus alba</i>	Rare	Max. >10 (<i>Populus</i>) Mean > 5

¹⁾ Gaps – places without trees and shrubs.

count low height of vegetation, the birds were likely detected with high effectiveness and accuracy. If nest or nesting behaviour was not observed, a cluster of bird localisation was interpreted as a breeding territory when territorial behaviour of male (singing, fighting) was observed at least three times. As the territories of birds were distributed linearly along the shelterbelts, their density was expressed as number of pairs per km. The species were assigned to two nest-guilds according to Tomiałojć (1970): birds building nests on the ground

and birds building nests near ground in low vegetation.

The changes in species richness and bird densities were analysed basing on the data from all shelterbelts. Collected data have been grouped and analyzed in respect to recognize the influence of age of shelterbelt on avifauna richness and abundance. The analysis of trends in respect to given species or nest-guilds was done using the data from five shelterbelts (A, C, D, E, I) (Fig. 1, Table 1). When the study started (in 1996) their age was very similar (shel-



Fig. 1. Location of studied shelterbelts (black areas) in Turew area – A, B, C, D, E, F, G, H, I. Dotted areas – woods and other shelterbelts, lines – roads. Large black dot – Turew locality.

terbelt C, D, E and I – 3rd year of growth and A – 2nd year of growth) and all of them were consecutively studied for five years.

Statistical analysis (t-test, U Mann-Whitney test, and trend analysis) was performed with the aid of software “Statistica 5.5 PL”.

3. RESULTS

3.1. Species richness and composition

Eighteen breeding species were observed in all the shelterbelts. Three most abun-

dant species (Corn Bunting, Yellow Wagtail and Whitethroat) represented almost 2/3 of all breeding pairs (Table 3). Number of species recorded in single shelterbelt per year did not exceeded 9 (Table 4).

No trend in species number (richness) in relation to age of shelterbelt was found. The changes in the number of species were unpredictable (Fig. 2). For example, mean number of species in 2-years old shelterbelts was very similar to that found in 8-years old ones. Also in respect to individual shelterbelt no trend in species richness was observed.

Table 3. Bird community of young shelterbelts; the density of birds (pairs km⁻¹) is the mean value of all years and all shelterbelts (A – I) (Table 1).

Species	Pairs km ⁻¹	%
<i>Miliaria calandra</i> (Corn Bunting)	2.78	33
<i>Motacilla flava</i> (Yellow Wagtail)	1.59	19
<i>Sylvia communis</i> (Whitethroat)	1.05	12
<i>Lanius collurio</i> (Red-backed Shrike)	0.63	7
<i>Alauda arvensis</i> (Skylark)	0.61	7
<i>Emberiza citrinella</i> (Yellowhammer)	0.54	6
<i>Carduelis cannabina</i> (Linnet)	0.34	4
<i>Saxicola rubetra</i> (Whinchat)	0.33	4
<i>Acrocephalus palustris</i> (Marsh Warbler)	0.26	3
<i>Turdus merula</i> (Blackbird)	0.08	1
<i>Phylloscopus trochilus</i> (Willow Warbler)	0.05	<1
<i>Sylvia curruca</i> (Lesser Whitethroat)	0.05	<1
<i>Carduelis carduelis</i> (Goldfinch)	0.03	<1
<i>Emberiza hortulana</i> (Ortolan Bunting)	0.03	<1
<i>Emberiza schoeniclus</i> (Reed Bunting)	0.03	<1
<i>Galerida cristata</i> (Crested Lark)	0.03	<1
<i>Turdus philomelos</i> (Song Thrush)	0.03	<1
<i>Perdix perdix</i> (Partridge)	0.03	<1
Total	8.5	100

Table 4. The number of bird species (species richness) recorded in shelterbelts (A – I) (see Table 1, Fig. 1) in the years 1996–2001.

Year	A	B	C	D	E	F	G	H	I
1996	8	0	3	2	4				2
1997	7	3	2	4	1				6
1998	8	1	2	1	5			5	3
1999	9	1	1	1	0			4	5
2000	3	1	2	1	5	2	2	5	4
2001	4	2	5	2	5	3	2	5	6
Mean	6.5	1.3	2.5	1.8	3.3	2.5	2.0	4.8	4.3

3.2. Bird density

During first 7 years of shelterbelt growth mean density of birds showed almost stable level of 5–8 pairs km⁻¹. In 8th year it increased to 13 pairs km⁻¹ (Fig. 3) but that increase was mostly linked to strong increase of Yellowhammer density. Excluding that species, mean total density of bird community in 8th year of shelterbelt growth was similar to that observed in former seven years. Relatively stable mean total density of birds resulted from chaotic,

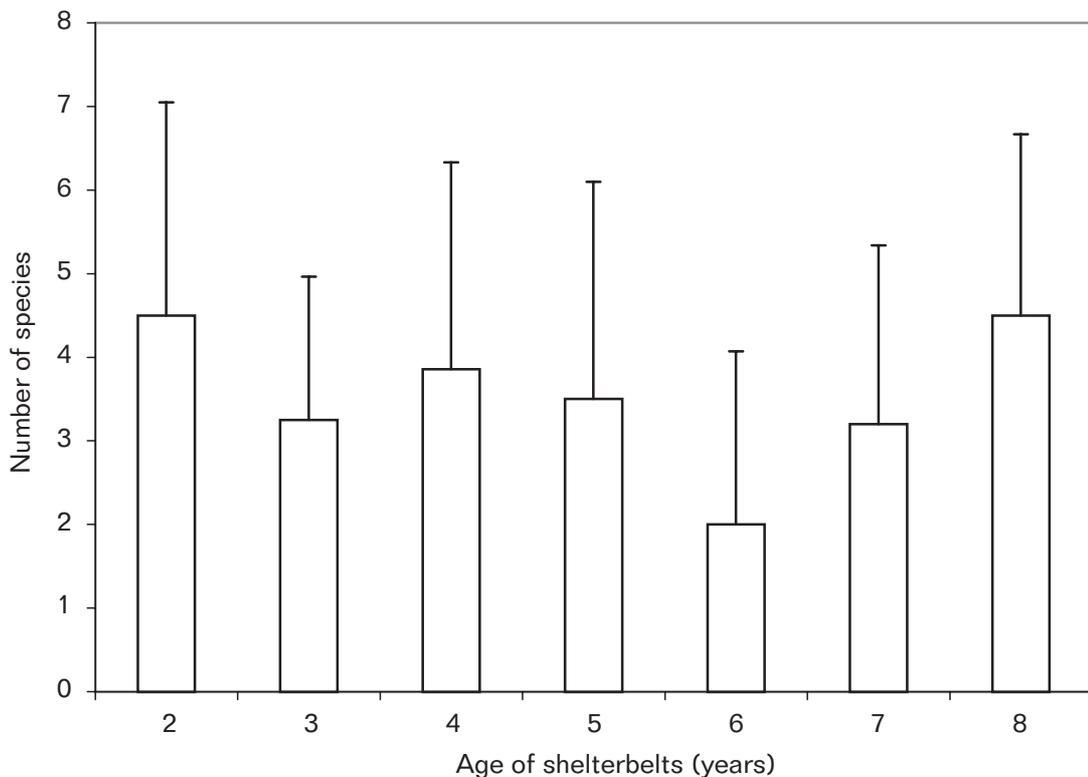


Fig. 2. Mean number of breeding bird species in relation to age of shelterbelts.

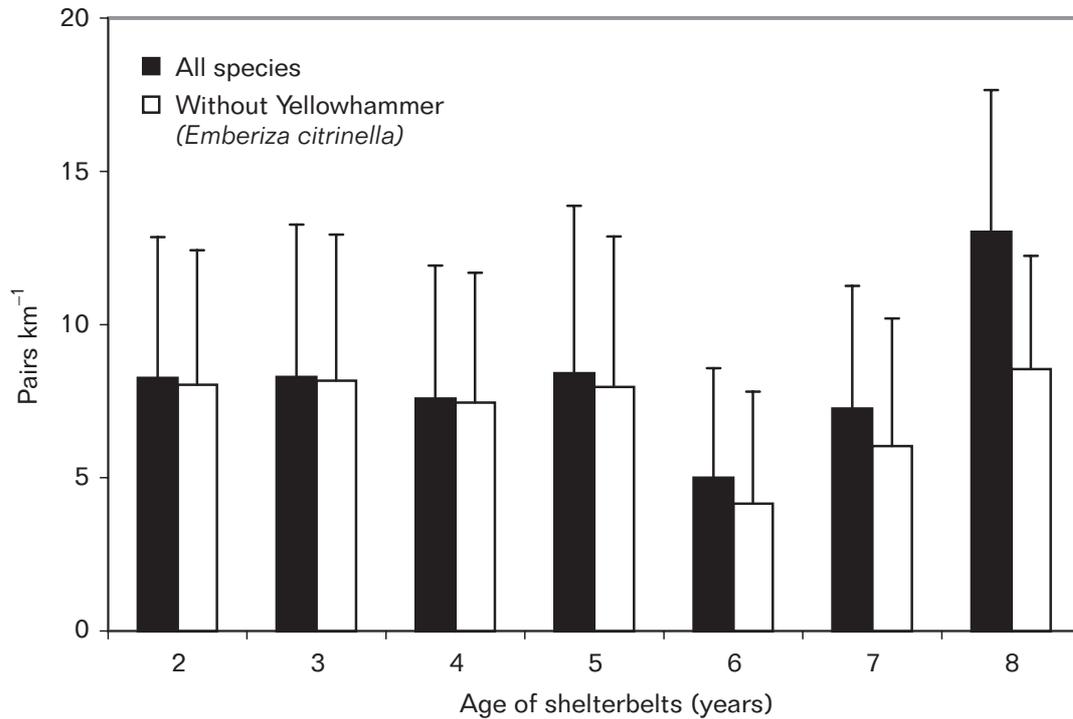


Fig. 3. Mean density of breeding birds in relation to age of shelterbelts.

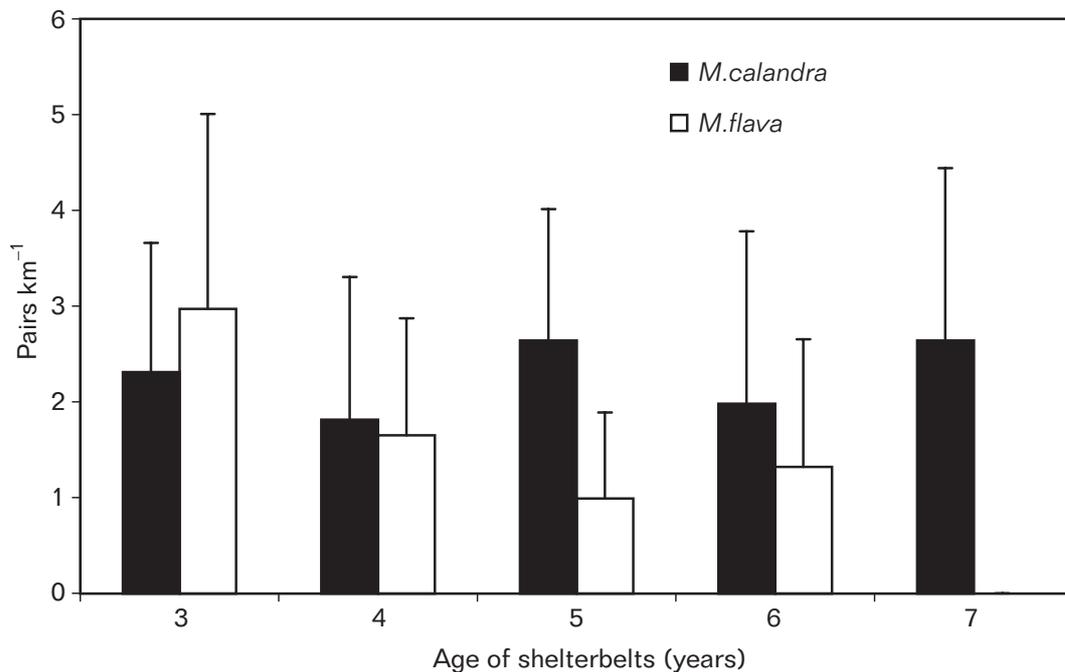


Fig. 4. Mean density of Corn Bunting (*Miliaria calandra*) and Yellow Wagtail (*Motacilla flava*) in relation to age of shelterbelts.

non-correlated changes in density, which had occurred in particular shelterbelts.

On the other hand, some trend occurred in respect to individual species or

guilds. For two most abundant species (Corn Bunting and Yellow Wagtail) opposite trends were recognised (Fig. 4). Density of Corn Bunting slightly insignificantly

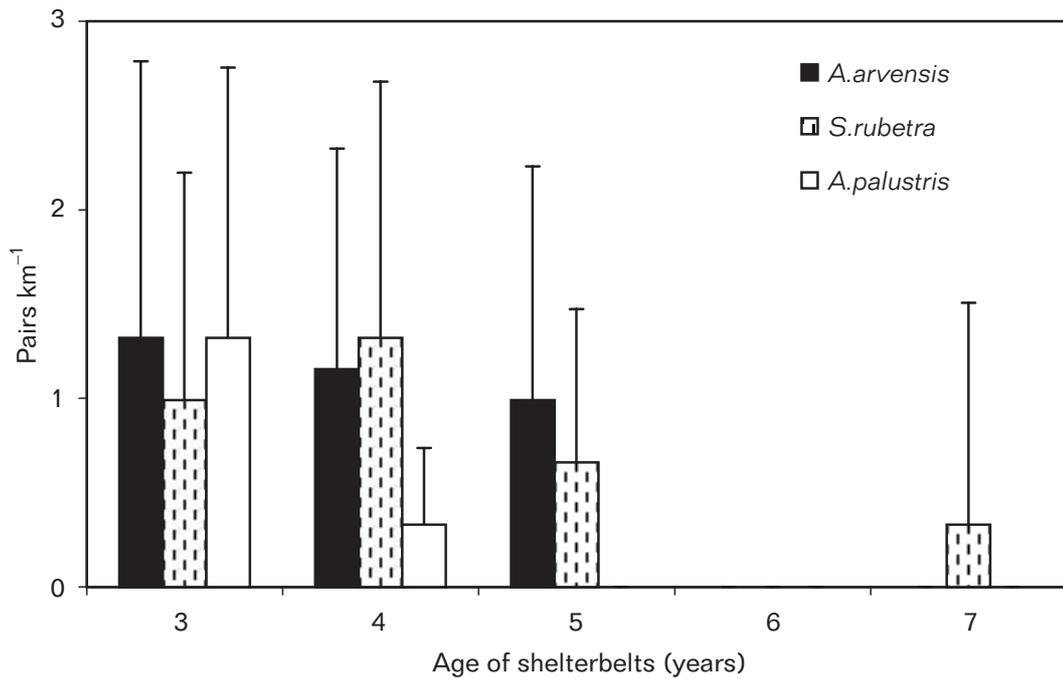


Fig. 5. Mean density of Skylark (*Alauda arvensis*), Whinchat (*Saxicola rubetra*) and Marsh Warbler (*Acrocephalus palustris*) in relation to age of shelterbelts.

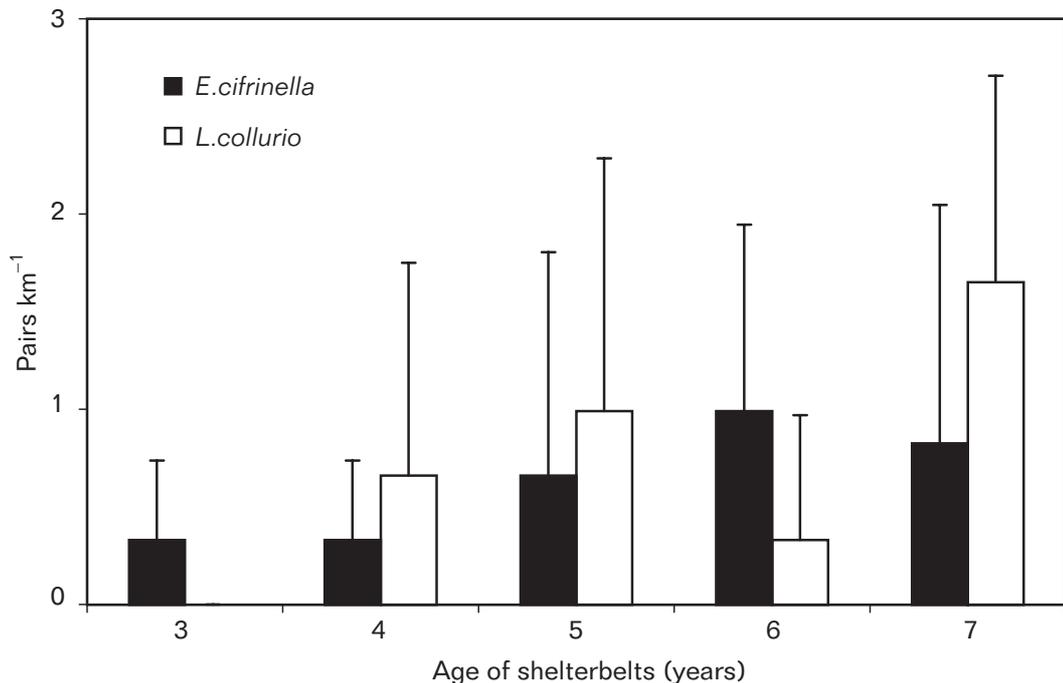


Fig. 6. Mean density of Yellowhammer (*Emberiza citrinella*) and Red-backed Shrike (*Lanius collurio*) in relation to age of shelterbelts.

increased (trend analysis: $r = 0.35$, $P > 0.1$) while density of Yellow Wagtail rapidly decreased from 3 to 0 pairs km^{-1} ($r = -0.92$, $P < 0.05$). That pattern of changes in population density may be explained by habitat

preferences of both species. Corn Bunting nest very close to afforested areas (tree-rows, shelterbelts, woodlots etc.), because it needs a highly positioned places for singing. Yellow Wagtail avoids afforested habi-

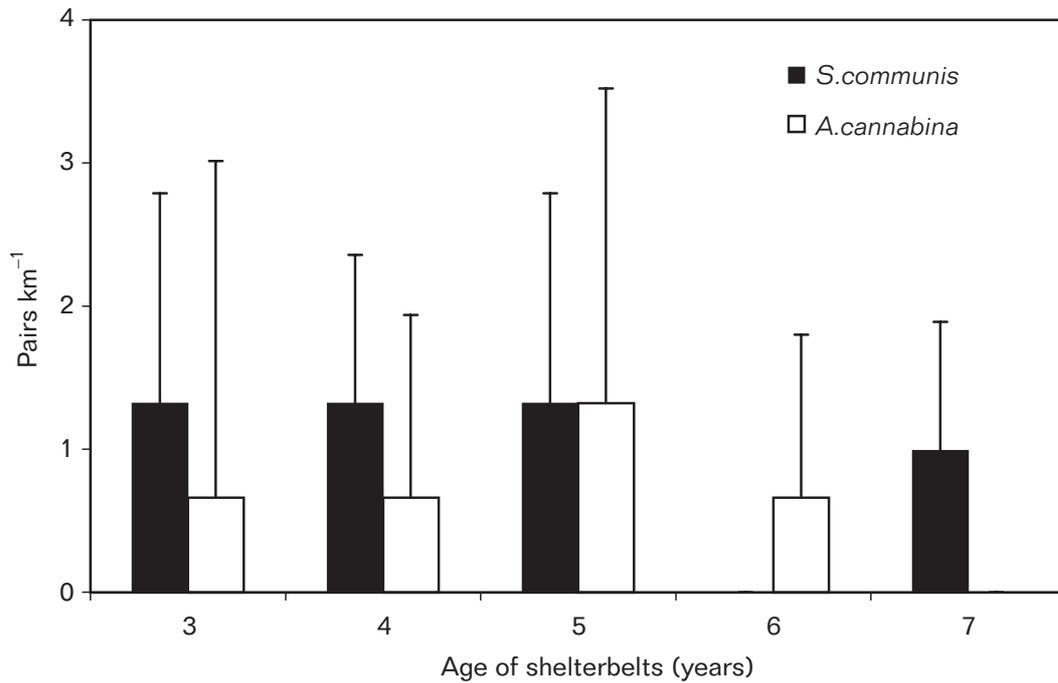


Fig. 7. Mean density of Whitethroat (*Sylvia communis*) and Linnet (*Carduelis cannabina*) in relation to age of shelterbelts.

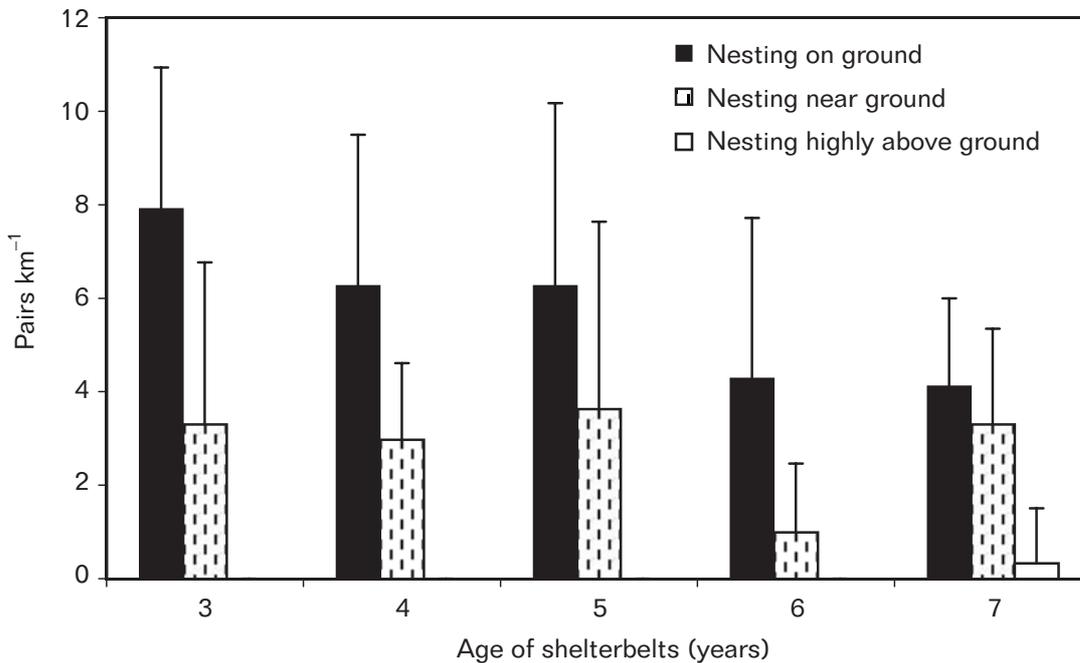


Fig. 8. Mean density in nest-guilds in relation to age of shelterbelts.

tats. Its high density during first three years (Kujawa 1997a) resulted from high habitat similarity of these very young shelterbelts (with very low trees and shrubs) to grasslands, which are preferred by that species. Later, when tree and shrub layer was devel-

ped, density of Yellow Wagtail has been decreasing. Similar pattern of density changes was recorded also for two other grassland species – Whinchat ($r = -0.8, P < 0.05$) and Skylark ($r = -0.93, P < 0.05$) as well as for one species – Willow Warbler which prefers

dense and low undergrowth and tall herb-layer ($r = -0.82$, $P > 0.05$) (Fig. 5). The increase of density was recorded also for Yellowhammer ($r = 0.88$, $P < 0.05$) and Red-backed Shrike ($r = 0.74$, $P > 0.1$) (Fig. 6). In case of Linnet and Whitethroat the changes were unpredictable (Fig. 7).

In respect to two compared nest-guilds, the trends in density changes differed too (Fig. 8). Birds building their nests on the ground decreased sharply ($r = -0.96$, $P < 0.05$), mainly due to decline of Skylark and Yellow Wagtail. For the group of species building their nests near ground no significant trend was detected ($r = 0.28$, $P > 0.6$).

During first eight years of development of shelterbelts the succession of bird community was noted. Up to 4th year the high contribution of species typical for "open" habitats (meadows and crop fields) was recorded, of which the most abundant were the species: Skylark, Yellow Wagtail and Whinchat. In this period they were dominant species (40–50% of total community density). After that, their population density (and dominance) was decreasing while population size (and dominance) of species typical for shrubs or afforested areas was increasing (Fig. 9). Among them most abundant were following species: Yellowhammer, Corn Bunting, Red-backed

Shrike and Whitethroat. It should be stressed that first group contains the species which are very rare in intensively farmed areas (Whinchat and Reed Bunting). Thus, young afforestations are very valuable for these species because they supply the breeding sites, which are not common in intensively used farmland. However, due to quick development of vegetation these breeding sites persist only in short period of several years.

In order to estimate the importance of young shelterbelts as a factor influencing diversity of breeding avifauna in an agricultural landscape, the study results were compared to the data of birds breeding in older, well-developed shelterbelts occurring in neighbourhood of Turew area too (Table 5). Size of young and old shelterbelts was similar – length amounted to 710 and 570 m, and width – 13 and 14 m, respectively.

Mean annual number of breeding bird species (estimated from total number of species recorded in individual shelterbelt) in young shelterbelts was markedly lower compared to that occurred in old shelterbelts. That result was expected because the structure of vegetation in young shelterbelts (low height of trees and lack of holes) make impossible to nest there for species

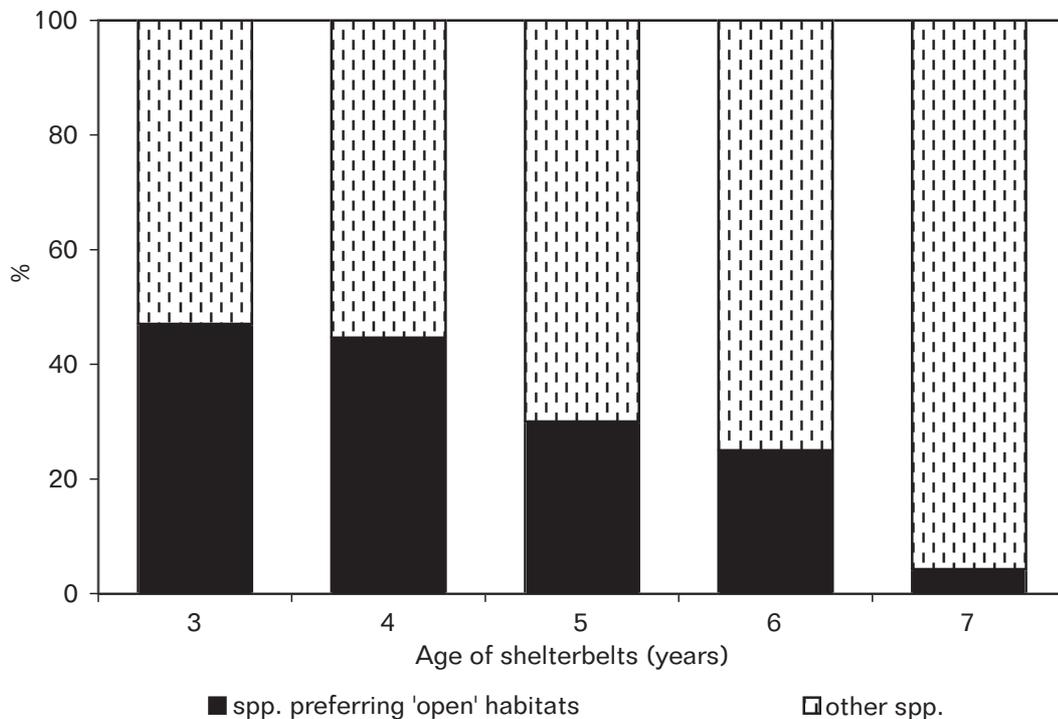


Fig. 9. Contribution (%) of species preferring 'open' habitats (without trees and tall shrubs) to total bird density in relation to age of shelterbelts.

which built their nests highly in tree-crowns or in tree-holes. However, when the comparison is made only in respect to species which are able to colonize young shelterbelts (i.e. for species nesting on ground or in low vegetation), then young shelterbelts seem to be at least as important as old ones. Mean number of species in young shelterbelts (8.1) was significantly higher (t-test, $t = 3.3$, $df = 38$, $P < 0.01$) than in old ones (5.0). In result, it may be concluded that for the group of several species of birds, young shelterbelts are at least as important as old, well-developed shelterbelts (Table 5).

The density of birds in young shelterbelts was much lower when compared to the bird density recorded in old shelterbelts. For all species it amounted to 8.2 and 33.6 pairs km^{-1} , and for species nesting on ground or in low vegetation – 6.3 and 13.3 pairs km^{-1} , respectively (Table 5). Both differences are statistically significant (U Mann-Whitney test: $U = 11$, $P < 0.001$ and $U = 43$, $P < 0.01$, respectively). So, though vegetation structure of young shelterbelts facilitates breeding there for relatively long list of species, their population density is much lower when compared to density in old shelterbelts.

No trend in time for species richness and abundance in respect to whole community was recorded. Species number and abundance were changing irregularly, more or less around the stable level. This is unexpected result remembering a high rate of vegetation development in initial stages of shelterbelts. For example, the height of trees increased several-fold during several years of study period. So, presumably, number of niches for birds should increase markedly but they remained not used. Similar results, but in a study carried out in other habitats (big complex of semi-natural forests), were gained by Głowaciński (1981). In his research the number of spe-

cies and total bird density initially increased very slowly. Only after 10 years the increase of both species richness and bird density was faster. Thus, results of this study suggest that pattern of early successional changes in bird community is very similar for shelterbelts and woods, even though their habitat structure and origin are extremely different.

4. CONCLUSIONS

1. During first seven years of shelterbelt growth no trends in species richness or in total bird density were found.
2. In the study period a decrease of the density was recorded in respect to species which prefer grasslands (Yellow Wagtail, Skylark and Whinchat) and area with dense and tall herbs and low undergrowth (Willow Warbler). From the other hand, the density of species linked to tree and shrub habitats (Corn Bunting, Yellowhammer, Red-backed Shrike) increased.
3. A following succession was observed: group of species typical for open habitats and dense and tall herbal plants fall down (in terms of their density and dominance) while the species linked to higher layer of vegetation became more abundant and dominating.
4. Total species richness and densities of birds in young shelterbelts were markedly lower when compared to those recorded in old shelterbelts. However, in respect to a group of species which are able to colonize young shelterbelts (i.e. species which nest on ground or in low vegetation) young shelterbelts are at least as important as old ones.
5. The rate of changes in bird community (species richness and birds density) colonizing young shelterbelts seems to be similar to that observed in forests. It

Table 5. Mean number of species and density of birds in young (2–8 years) and old (several ten years) shelterbelts (according to Kujawa 1997b).

Age of shelterbelts	Number of species		Density of birds (Pairs km^{-1})	
	All species	Species nesting on the ground or in low vegetation	All species	Species nesting on the ground or in low vegetation
Young (N = 9)	16.0	5.0	8.2	6.3
Old (N = 33)	8.9	8.1	33.6	13.3

means that in spite of small size and anthropogenic origin of shelterbelts, forming of bird communities in shelterbelts runs similarly as it is going on in big, more natural forest (at least during initial stages).

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