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Krzysztof KUJAWA

# Relationships between the structure of mid-field woods and their breeding bird communities

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**Abstract.** Work done in the years 1991–1994 involved an assessment of breeding bird density and numbers of species in relation to habitat structure in 74 plots located in mid-field woods in an agricultural landscape 50 km south of Poznan (W Poland). A total of 68 breeding species were recorded, with a density of 14.6 pairs/ha. The dominants in the community were: *Fringilla coelebs* (15.7%), *Emberiza citrinella* (12.8%), *Passer montanus* (7.4%), *Miliaria calandra* (5.1%). In the avenue-shaped woods the density (9.8 p/ha) and mean number of species (10) were lower than in wood belts (where the respective figures were 18.3 p/ha and 16 species) or clumps (14.9 and 21). The densities of birds expressed per unit of length were 13.8 p/km in avenues compared with 33.6 p/km in belts. It was found that 74–91% of differences in the numbers of species and densities in the different types of woods could be related to just several habitat parameters, above all the age of tree stand, the percentage cover of tree stand and shrub layers and the area of the given wood.

**Key words**: breeding bird community, woods, habitat structure, farmland, multi-factor analysis

Field Station of the Research Centre for the Agricultural and Forest Environment, Polish Academy of Sciences, Szkolna 4, 64–003 Turew, POLAND

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## INTRODUCTION

Mid-field woods are the element of the landscape upon which the diversity of the breeding avifauna in agricultural areas is very largely dependent (Bezzel 1982, Flade 1994). Work done in Western and Central Europe has shown that woods in particular fragments of agricultural landscape may support several tens of breeding species (Flade 1994, O'Connor & Shrubb 1986, Straka 1991), while Bezzel (1982) gave figures of up to 85. Foremost among the factors influencing the richness of the breeding avifauna in such woods are their dimensions and vegetational structure (Bastian *et al.* 1989, Cieślak & Dombrowski 1993, Gromadzki 1970, Janda 1985 and Osborne 1984). A certain influence on bird densities is also exerted by the locations of woods in respect to one another (Lack 1988). The research done has mostly involved correlation analysis of the influence of few selected features of habitat structure on communities of birds, and has usually been confined to selected types of woods (e.g. clumps of trees or shelter belts).

The aims of the work described here — which was carried out in the years 1991–1994 — were thus to characterise the breeding bird communities in a variety of woods (in the form of belts, clumps or avenues), to define the relationships between habitat structure in these woods and the richness of the avifauna, and to express these relationships through mathematical models based on multi-factor analysis.

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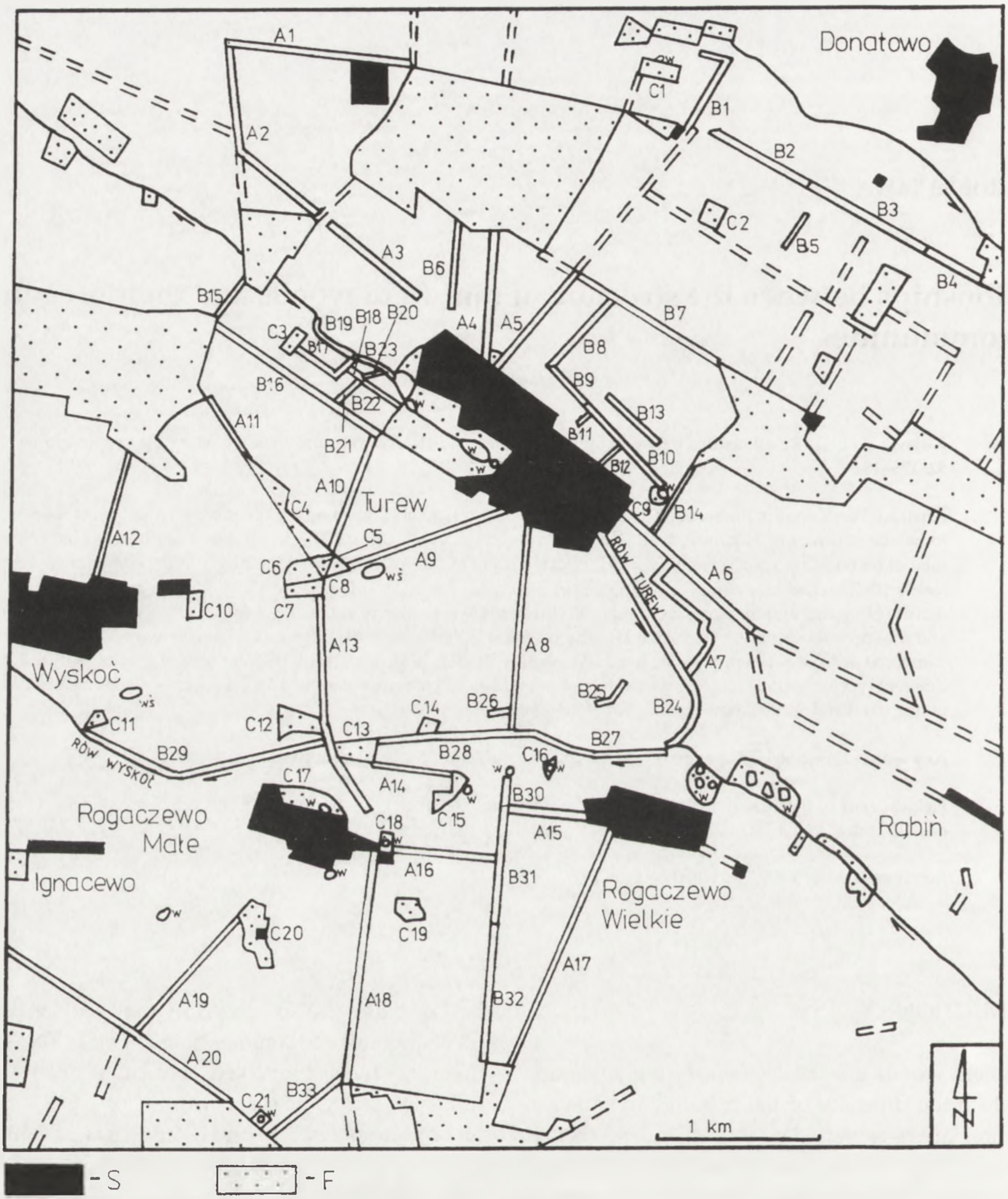


Fig. 1. Location of sampling plots. A1,...,A20 — avenues, B1,...,B33 — belts, C1,...,C21 — clumps, S — settlements, F — forests and clumps of trees, w — small bodies of water, wś — waste place.

[Ryc. 1. Położenie powierzchni badawczych. A1,...,A20 — aleje, B1,...,B33 — zadrzewienia pasowe, C1,...,C21 — zadrzewienia kępowe, S — osiedla ludzkie, F — lasy i kępy drzew, w — drobne zbiorniki wodne, wś — wysypisko śmieci.]

## STUDY AREA

The research was done in the central part of the General Dezydery Chłapowski Landscape Park, within a 5 km radius of Turew village and thus about 50 km to the south of Poznań. The Landscape Park is dominated by agricultural land (74% of the area, of which 9% is meadow and pasture), as well as by forests and woods covering 15%. The main crops grown are cereals (50% of the sown area), while large fields of several tens of

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hectares account for 2/3 of arable land. The Turew area is remarkable for the wealth of woods, and some of the woods (tree belts and avenues) were established as long ago as in the first half of the 19th century (Chłapowski 1843). Some of these woods remains today, permitting the maintenance — in an agricultural landscape that is used relatively intensively — of a diversity of animal life including insects (Ryszkowski & Karg 1991) and birds (Kujawa 1994, 1996). The current mean density of tree belts and avenues together is c. 2 km/km$^2$, and locally even up to 5 km/km$^2$. The dominant species in tree belts and clumps of trees is robinia *Robinia pseudacacia*, while the avenues mainly feature Norway maple *Acer platanoides*, small-leaved lime *Tilia cordata* and poplars *Populus* spp.

## METHODS

The 74 plots studied (Fig. 1, Tab. 1) were in woods taking the form of: 1) clumps — patches with similar length and breadth, 2) belts — with lengths many times greater than breadths, and multiple rows of trees; and 3) avenues — with one or two lines of trees, located along roads and with a very poor understorey. Each of the plots was described in relation to its vegetational structure and the numbers of species and densities of breeding birds.

### Methods of describing habitat structure

The areas of clumps were measured with the aid of a planimeter using 1:10 000 scale topographical maps, while those of avenues and tree belts were determined on the assumption that these took the form of rectangles. As in the study by Balat (1985), it was also assumed that the breadth of avenues and tree belts were the distances between the extreme edges of the land overgrown by permanent vegetation and not used agriculturally. It was usual for the breadth measured in this way to approximate the distance between external fragments of the crowns of trees. The degree of development of tree stand was in turn defined using indices of 0 to 4, where: 0 — no stand, 1 — 1 to 20 years old, 2 — 21 to 40 years, 3 — 41–60 years and 4 — over 60 years. The percentage covers of the tree, shrub and herb layers were defined approximately using the figures 0, 1, 5, 25, 50, 75 and 100%. The densities of trees were calculated by counting throughout an area or on the basis of counts in three square sampling areas selected at random and covering 400 m$^2$ each. The mean height of the herb layer was defined as the prevailing distance in a given area between the ground and the upper part of the continuous vegetation cover. The scale used in this had 1 for heights of 1–25 cm, 2 for 26–50 cm, 3 — for 51–75 cm and 4 for heights of more than 75 cm. The vegetation was described in June.

Table 1. Differences in the geometrical dimensions of the studied plots.

[Tabela 1. Różnice w wymiarach geometrycznych badanych powierzchni.]

| Type of afforestation (N - sample size) | Area [ha] | Length [m] | Breadth [m] |
|---|---|---|---|
| Avenues (N=20) | | | |
| Min.–max. | 0.57–3.58 | 400–1780 | 10.0–20.1 |
| Arithmetic mean | 1.33 | 930 | 14.2 |
| SD | 0.66 | 354 | 2.6 |
| Belts (N=33) | | | |
| Min.–max. | 0.06–3.98 | 100–2950 | 5.0–63.5 |
| Arithmetic mean | 0.95 | 569 | 18.0 |
| SD | 0.94 | 553 | 13.6 |
| Clumps (N=21) | | | |
| Min.–max. | 0.20–3.50 | – | – |
| Arithmetic mean | 1.49 | – | – |
| SD | 0.89 | – | – |

### Censuses of bird densities

These were done in the years 1991–1994 using the combined version of the cartographic method from Tomiałojć (1980). Censuses were made in two breeding seasons on most of the plots, in 3 seasons on 25 plots and 1 season on 2 plots. The subjects of further analyses were the arithmetic means of results obtained in the different years. There were between 7 and 9 (in a few cases 10) counts on the different plots, though only 6 on 1/3 of the plots in 1991. The counts were made in the early morning, beginning half an hour before sunrise and ending 4–5 hours later. For more accurate transferral of results to maps, a system of reference points was introduced in most of the plots. The mean rates of counting were 1–3 ha/h in clumps and 0.5–1 km/h along avenues and belts. The number of pairs of raptors and corvids were determined on the basis of nests found, and that of Mallards *Anas platyrhynchos* on the basis of nests and ducks with chicks.

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**Statistical analysis**

This followed the recommendations of Fowler and Cohen (1988), in that:

1. The choice of test was each time preceded by a goodness-of-fit comparison of the distribution of a given variable with a normal distribution using a chi-squared test or the Kolmogorov-Smirnov test if the number of degrees of freedom was insufficient.

2. The significance of differences between variables with a normal distribution was tested using a t-test, while cases in which a distribution was different from the normal were tested using the Mann-Whitney U-test for unpaired samples — a non-parametric test based on the comparison of medians.

3. The relationship between variables with normal distribution was measured with the aid of the correlation coefficient (r), or the Spearman rank correlation coefficient ($r_s$) in the case of non-normal distributions.

4. In multi-factor analysis, sets of variables impacting significantly upon a dependent variable were designated with the aid of stepwise multiple regression. Obtained in this way were mathematical equations explaining the linkage between parameters of the habitat and of communities of breeding birds. The significance of these equations was determined with the aid of the coefficient of determination ($r^2$).

5. In the case of a need to normalize distributions of variables differing from the normal, values were transformed using the *arcsin (x)* function — in the case of variables of the proportion type or *log (x)* — in the case of variables of other types.

The species composition similarities of two communities of birds were defined with the aid of Jaccard's index QS, where $QS = \frac{2c}{a+b} \cdot 100$, and where *a* is the number of species in one community, *b* — the number of species in the other community and *c* — the number of species common to both communities.

## CHARACTERISTICS OF THE HABITATS IN THE PLOTS STUDIED

The plots differed in terms of both their geometrical dimensions (Tab. 1) and the structure of their vegetation (Tab. 2). In most cases the distributions of the studied variables in particular plots differ from the normal, so the significance of the differences in variables were defined using the U-test. No differences were noted in the vegetational structure of belts and clumps, but avenues did differ significantly in regard to a significant proportion of the variables. Specifically, they differed significantly from belts in the percentage cover of the tree and shrub layers and the density of trees, and from clumps also in the percentage cover of herb layer and its height. On the basis of this analysis of vegetational structure, avenues may be considered the most distinct and at same time the poorest category of woods, while clumps and belts are seen to differ from each other in their geometrical features, with the vegetational structure being very similar.

Table 2. Vegetational structure of the three types of mid-field woods (arithmetic means for the features measured).

[Tabela 2. Struktura roślinności trzech typów zadrzewień śródpolnych (średnie arytmetyczne mierzonych zmiennych).]

| Feature | Avenues | Belts | Clumps |
|---|---|---|---|
| Developmental stage of tree stand | 2.7 | 2.6 | 2.7 |
| Density of trees/ha | 77 | 351 | 651 |
| Percentage cover of tree stand | 41 | 63 | 79 |
| Percentage cover of shrub layer | 7 | 49 | 43 |
| Percentage cover of herb layer | 67 | 74 | 81 |
| Percentage share of dicotyledons in herb layer | 29 | 30 | 43 |
| Height of herb layer [m] | 0.8 | 0.9 | 1.3 |
| Percentage cover of tree stand in relation to length of wood | 81 | 77 | – |
| Percentage cover of shrub layer in relation to length of wood | 11 | 72 | – |
| Density of trees per unit length (100 m) | 20 | 68 | – |

## CHARACTERISTICS OF BIRD COMMUNITIES

A total of 68 species were found to nest in the studied plots. The dominants (accounting for more than 5% of the total) were: *Fringilla coelebs, Emberiza citrinella, Passer montanus* and *Miliaria calandra* (Tab. 3). The number of breeding species on different plots varied form 1 to 31 (mean 14 ± 7) (Fig. 2) and the densities from 0.7 to 87.8 p/ha (mean 17.2 ± 12.8) (Fig. 3). The number of species was found to be greater where the area of plot was larger. Further analysis of the factors influencing bird density and the number of species are presented in the next

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Table 3. The community of breeding birds of the studied mid-field afforestations.

[Tabela 3. Zespół ptaków lęgowych zadrzewień śródpolnych.]

| Species | p/10 ha | % |
|---|---|---|
| *Fringilla coelebs* | 22.8 | 15.7 |
| *Emberiza citrinella* | 18.7 | 12.8 |
| *Passer montanus* | 10.8 | 7.4 |
| *Miliaria calandra* | 7.4 | 5.1 |
| *Carduelis carduelis* | 6.1 | 4.2 |
| *Hippolais icterina* | 6.0 | 4.1 |
| *Sturnus vulgaris* | 5.6 | 3.9 |
| *Sylvia communis* | 5.6 | 3.8 |
| *Parus caeruleus* | 5.2 | 3.6 |
| *Parus major* | 5.2 | 3.6 |
| *Emberiza citrinella* | 4.5 | 3.1 |
| *Carduelis chloris* | 3.5 | 2.4 |
| *Certhia brachydactyla* | 2.7 | 1.8 |
| *Anthus trivialis* | 2.6 | 1.8 |
| *Muscicapa striata* | 2.5 | 1.7 |
| *Acrocephalus palustris* | 2.5 | 1.7 |
| *Sylvia atricapilla* | 2.4 | 1.7 |
| *Turdus merula* | 2.3 | 1.6 |
| *Motacilla flava* | 2.1 | 1.5 |
| *Sylvia borin* | 2.0 | 1.4 |
| *Turdus philomelos* | 1.9 | 1.3 |
| *Lanius collurio* | 1.9 | 1.3 |
| *Luscinia megarhynchos* | 1.7 | 1.2 |
| *Motacilla alba* | 1.7 | 1.2 |
| *Carduelis cannabina* | 1.6 | 1.1 |
| *Phylloscopus collybita* | 1.6 | 1.1 |
| *Sylvia curruca* | 1.3 | 0.9 |
| *Columba palumbus* | 1.1 | 0.8 |
| *Emberiza schoeniclus* | 1.0 | 0.7 |
| *Serinus serinus* | 1.0 | 0.7 |
| *Saxicola rubetra* | 0.9 | 0.6 |
| *Oriolus oriolus* | 0.9 | 0.6 |
| *Streptopelia decaocto* | 0.8 | 0.5 |
| *Pica pica* | 0.6 | 0.4 |
| *Sitta europaea* | 0.5 | 0.4 |
| *Turdus pilaris* | 0.5 | 0.4 |
| *Corvus corone cornix* | 0.5 | 0.3 |
| *Dendrocopos major* | 0.5 | 0.3 |
| *Galerida cristata* | 0.4 | 0.3 |
| *Erithacus rubecula* | 0.4 | 0.3 |
| *Lanius excubitor* | 0.4 | 0.3 |
| *Passer domesticus* | 0.3 | 0.2 |
| *Buteo buteo* | 0.3 | 0.2 |
| *Phylloscopus trochilus* | 0.3 | 0.2 |
| *Coccothraustes coccothraustes* | 0.3 | 0.2 |
| *Anthus pratensis* | 0.3 | 0.2 |
| *Strix aluco* | 0.2 | 0.1 |
| *Luscinia luscinia* | 0.2 | 0.1 |
| *Sylvia nisoria* | 0.2 | 0.1 |
| *Acrocephalus scirpaceus* | 0.2 | 0.1 |
| *Certhia familiaris* | 0.2 | 0.1 |
| *Anas platyrhynchos* | 0.1 | 0.1 |
| *Oenanthe oenanthe* | 0.1 | 0.1 |
| *Phoenicurus ochruros* | 0.1 | 0.1 |
| *Parus montanus* | 0.1 | 0.1 |
| *Garrulus glandarius* | 0.1 | 0.1 |
| *Locustella fluviatilis* | 0.1 | 0.1 |
| *Jynx torquilla* | 0.1 | + |
| *Athene noctua* | 0.1 | + |
| *Phylloscopus sibilatrix* | 0.1 | + |
| *Streptopelia turtur* | 0.1 | + |
| *Gallinula chloropus* | 0.1 | + |
| *Parus palustris* | 0.1 | + |
| *Dendrocopos minor* | 0.1 | + |
| *Phoenicurus phoenicurus* | + | + |
| *Locustella naevia* | + | + |
| *Dryocopus martius* | + | + |
| *Perdix perdix* | + | + |
| Total 68 spp. | 146 | 100.0 |

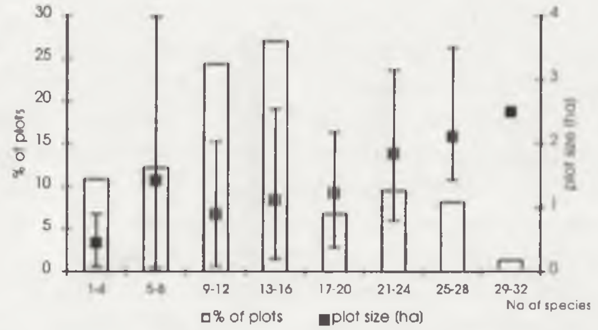


Fig.2. Distribution of species number in sampling plots and relationships between plot size and species number. Blocks — % of plots with the number of species, lines —plot size, (average, minimal and maximal numbers).

[Ryc. 2. Zróżnicowanie liczby gatunków na powierzchniach badawczych i zależność pomiędzy wielkością powierzchni, a ilością gatunków. Słupki — % powierzchni o danej liczbie gatunków, linie — wielkość powierzchni (średnia i zakres).]

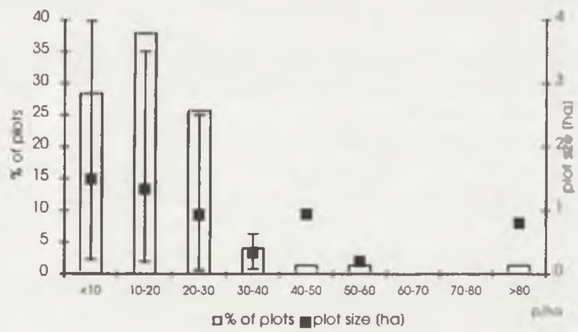


Fig.3. Distribution of bird density in sampling plots and relationships between plot size and density (average, max and min).

[Ryc. 3. Zróżnicowanie zagęszczenia par lęgowych na powierzchniach badawczych i zależność pomiędzy wielkością powierzchni, a zagęszczeniem (średnia, maksimum i minimum).]

section. The mean number of species was greatest in clumps and lowest in avenues (Tab. 4), although the latter did not differ significantly from the belts in this regard, while the clumps did have significantly more species than both avenues and belts (t-test, $P < 0.001$ and $P < 0.05$ respectively). The densities of birds in clumps and belts did not differ significantly from each

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other, but were both higher than those reported from the avenues — Tab. 4 (t-test, $P < 0.05$ and $P < 0.01$ respectively). The density of birds by length in belts was about 2.5 times greater than in avenues (Tab. 4), and this difference was significant at $P < 0.01$ (t-test).

So, avenues were poorest in terms of both the number of species and the density of birds, and the distinctiveness of this type of woods was also reflected in the analysis of the similarity of species compositions. The qualitative similarity as measured by the QS index was 79% when belts and clumps were compared, 70% for belts as compared with avenues and only 59% for clumps as compared with avenues. It should also be emphasised that no species was entirely confined to the avenues (with the exception of the extremely scarce *Athene noctua*). In contrast, there were even species nesting in abundance in belts and clumps that were not reported at all from avenues (*Sylvia borin*, *S. atricapilla*, *Phylloscopus collybita*, *Turdus philomelos*, *T. merula*, *Oriolus oriolus*, *Corvus corone cornix* and more than 20 less common species).

Table 4. Characteristics of the community of breeding birds in the different types of afforestations.

[Tabela 4. Charakterystyka zespołu ptaków lęgowych różnych typów zadrzewień.]

| Parameters | Clumps | Belts | Avenues |
|---|---|---|---|
| Total number of species | 60 | 51 | 32 |
| Mean number of species per plot | 21 | 16 | 10 |
| Density per unit area (p/ha) | 14.9 | 18.3 | 9.8 |
| Density per unit length (p/km) | – | 33.6 | 13.8 |

The research done in the Turew area thus points to considerable differences between avenues, tree belts and clumps of trees where their communities of birds are concerned. The greatest numbers of species nested in the clumps, while the highest densities were recorded in belts. The avenues were poorest as regards both variables. The same results (albeit based on fewer woods) was obtained in the same area in the 1960s (Gromadzki 1970).

In contrast to high number of species, however, the mean density of birds in the studied plots was lower than in other studies. For example, the ca. 15 p/ha noted for clumps of trees in the Turew area (Tab. 4) compares with the 28 p/ha recorded in the vicinity of Wrocław by Wuczyński (1995). In turn, according to Kurlavicius (1986), the range of bird densities for mid-field woods in Central Europe is 10–50 p/ha, while the figures given by Flade (1994) for central and northern Germany range from several to 37 p/ha. The relatively low densities of the communities of birds in most of the woods around Turew are probably a reflection of the prevalence of robinia in tree stands. Forest complexes formed from this species also have few nesting bird species and low densities of birds — an 11 ha study area near Sulechów was found to have 24 species and a density of 52 p/ha (Czwałga 1990), i.e. values lower than in leafy or coniferous forests (Jermaczek 1991, Tomiałojć & Profus 1977, Tomiałojć *et al.* 1984). It is usual for forests and woods of robinia to have very poorly developed shrub and herb layers, while the foliage of the species develops after many species of birds have started to breed. Many species (and especially those building open nests) prefer to locate nests in trees that are already in full leaf and thus better concealed. Similarly, Blackbirds and Song Thrushes more often choose to nest in coniferous trees at the beginning of the breeding season — when broad-leaved trees are still bare, than later — when foliage is developing (Wesolowski & Czapulak 1986). Working in Germany, Gassman & Glück (1993) noted that the breeding of species typical of woods (e.g. *Turdus merula*, *T. philomelos*, *Prunella modularis* and *Carduelis cannabina*) more often ended in success when nests were in very shaded places. For all these reasons, planted robinias would seem to form a habitat that is suboptimal for some species, and occupied in a particular season to a degree that depends on the size of the local population of a given species and on the degree of saturation of optimal habitats — as in the model from Fretwell & Lucas (1969).

## RELATIONSHIPS BETWEEN STRUCTURE OF WOODS AND BIRD COMMUNITIES

Where all the plots were taken together, the distributions of analyzed variables were found to differ significantly from the normal (thus not justifying regression analysis). In consequence, such analysis was

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performed for each type of wood separately. The application of stepwise multiple regression gave an equation of the general form:

$$y = A_1x_1 + A_2x_2 + \ldots + A_ix_i,$$

where: y was the dependent variable (number of species or density of birds), $x_i$ — the independent variable (describing structure of woods, their area, density of trees, etc.) and $A_i$ — the coefficient for a given independent variable. The following designations were introduced into the equations: AGE — the age of the tree stand (age class), AREA — the area of woods in ha, DIC — the proportion of dicotyledonous species cover in the herb layer (expressed in terms of values between 0 and 1), H_AREA (or T_AREA) — the proportion of cover of the herb (or tree) layer (0 to 1), T_DEN_AREA — the density of trees per ha, T_DEN_LEN — the density of trees per 100 m, T_LEN (or U_LEN) — the proportion of tree layer (or herb layer) cover in relation to length (0 to 1) and BREADTH — the breadth of the wood (belts or avenues) in m.

In the different cases, the equations took the following forms:

— for the number of bird species in avenues:
y = 2.83 (*AGE*) + 8.72·arcsin (*U_LEN*),
$r^2 = 0.91$

— for the number of bird species in belts:
y = 4.06 (*AREA*) + 5.18 arcsin(*T_LEN*) + 3.59 arcsin(*U_LEN*),
$r^2 = 0.91$

— for the number of bird species in clumps:
y = 3.44 (*AREA*) + 2.81 (*AGE*) + 12.97 arcsin(*DIC*),
$r^2 = 0.95$

— for the density of birds in avenues (p/ha):
y = 3.04·(*AGE*) + 0.15·arcsin(*T_AREA*) – 0.89 (*T_DEN_LEN*),
$r^2 = 0.91$

— for the density of birds in belts (p/ha):
y = 14.77·arcsin (*T_LEN*) + 4.18·arcsin(*H_AREA*) – 0.44·(*BREADTH*),
$r^2 = 0.74$

— for the density of birds in clumps (p/ha):
y = 4.13 (*AGE*) + 0.01 (*T_DEN_AREA*), $r^2 = 0.78$

— for the density of birds in avenues (p/km):
y = 4.35·(*AGE*) + 8.88 arcsin(*U_LEN*), $r^2 = 0.92$

— for the density of birds in belts (p/km):
y = 1.15 (*BREADTH*) + 11.27 arcsin(*T_LEN*), $r^2 = 0.84$

Noteworthy among these regression equations are the high values for the coefficient of determination ($r^2$) which defines the percentage of the variability in the analyzed parameter of the bird community that is explained with the aid the equation. The conclusions to be drawn from the analysis are as follow:

1. The number of species and density of birds in woods are dependent on a small number of fundamental structural features, namely area, breadth, tree stand age and the proportional cover of the shrub layer and tree stand. Sets of these features explain 91–95% of the variability in the number of species, and 74–92% of the variability in bird density.

2. Features of the tree layer, above all tree stand age and to a lesser extent cover, play the most important roles in most cases and are of greater significance than features of the shrub and herb layers.

Correlation coefficients were also used to determine the influence of geometrical features on numbers of species and densities, as opposed to variables concerning the structure of the vegetation. The coefficients for the relationships between these geometrical features and bird densities and number of species are given in Tab. 5. The values of the coefficients and the statistical significance level indicate no significant relationships where the avenues were concerned, but significant influences of breadth, length and area on the number of species occupying clumps and belts and, to a lesser extent, on the density of birds in these types of woods.

Multi-factor analysis showed that — among the geometrical dimensions of woods — it was area that was important in influencing the number of breeding species in belts and clumps. This findings is in line with those of many other studies which have reported greater numbers of species in larger forest plots (e.g. Bastian *et al.* 1989, Cieślak & Dombrowski 1993, Flade 1994, Gromadzki 1970). Unlike in belts and clumps, the total number of species in avenues was not linked significantly with any of the geometrical dimensions.

A similar result was obtained in this research on the basis of an analysis of the two variables — correlation coefficients for geometrical dimensions and the number of species (Tab. 5). The fact that the numbers of species were greater in larger woods was probably a result of the greater habitat diversity in the larger areas, and hence the greater probability that further species would

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breed (Cieślak & Dombrowski 1993). The greater number of species in broader tree belts may also be explained in this way, and similar findings were made by Gromadzki (1970) and da Prato (1985). As was emphasized above, this relationship does not apply to avenues — a phenomenon which may be explained by the nature of the vegetation cover. The vegetation of the avenues is generally very poor and monotonous (developing in a very unspontaneous way), and so does not undergo significant diversification with increasing length. Likewise, the breadth of avenues — largely dependent on road width ($r = 0.62$, $P < 0.01$ in the sample analyzed) — does not influence the diversity of the vegetation.

Table 5. Correlation coefficients for relationships between the dimensions of plots and the number of species and bird density. * — $P < 0.05$, ** — $P < 0.01$, *** — $P < 0.001$, NS — not significant.

[Tabela 5. Współczynniki korelacji pomiędzy wymiarami powierzchni a ilością gatunków i zagęszczeniem.]

| Type of wood<br>Parameters of community | Length | Breadth | Area |
|---|---|---|---|
| Avenues | | | |
| No. of species | 0.38$^{NS}$ | 0.003$^{NS}$ | 0.36$^{NS}$ |
| No of pairs/ha | 0.23$^{NS}$ | –0.20$^{NS}$ | 0.12$^{NS}$ |
| No. of pairs/km | 0.12$^{NS}$ | 0.18$^{NS}$ | 0.19$^{NS}$ |
| Belts | | | |
| No of species | 0.43$^{*}$ | 0.55$^{**}$ | 0.67$^{**}$ |
| No. of pairs/ha | 0.10$^{NS}$ | –0.36$^{*}$ | –0.15$^{NS}$ |
| No. of pairs/km | 0.03$^{NS}$ | 0.64$^{**}$ | 0.37$^{*}$ |
| Clumps | | | |
| No. of species | | | 0.74$^{**}$ |
| No. of pairs/ha | | | –0.63$^{**}$ |

The research also revealed a statistically significant negative correlation between the breadth of tree belts (or the area of clumps) and the density of birds (Tab. 5). This results is in line with those of other studies, e.g. Bastian *et al.* (1989), Cieślak & Dombrowski (1993) and Gromadzki (1970). The high densities of birds in very small clumps of trees (or narrow tree belts) are the results of the significant role played there by species associated with woodland edge habitat (Cieślak 1992, Kujawa 1992) and feeding beyond it. In reality, therefore, the territories of these species (like Yellowhammers *Emberiza citrinella*, Pigeons *Columba* spp., Starlings *Sturnus vulgaris* and Sparrows *Passer* spp.) also include neighbouring land. Because density calculations only take account of the woods, and not the total area within territories, there is an ever greater exaggeration effect with successively smaller real areas. A similar mechanism may occur in tree belts with the specific distribution of the breeding territories of birds nesting in them. The limited breadth of these areas enforces a one-dimensional, linear arrangement of territories.

The analysis of woods in the Turew area has pointed to the great significance of some features of vegetational structure in the shaping of bird communities. Of particular significance to both the number of species and the density of birds were tree stand age, as well as percentage cover of the tree stand and shrub layer. These findings accord with other published material. For example, the significance of the shrub layer was well illustrated by da Prato (1985), who amongst other things compared the number of species and density of birds in tree belts with or without a shrub layer, but of similar breadth and the same length. The areas with no shrub layer had 7 nesting species and an overall density of 9 p/km, while those with this kind of vegetation supported 14 species at a mean density of 29 p/km. The decisive significance of the development of the tree and/or shrub layers in raising the species richness and density of birds has also been demonstrated by, for example, Gromadzki (1970), Janda (1985), Osborne (1984) and Pfister & Naef-Daenzer (1987).

## CONCLUSIONS

1. Mid-field woods in the Turew area are characterised by the presence of a considerable number of breeding bird species (68), but by relatively low mean density (14.6 p/ha). This should be linked to the considerable representation of robinia in the tree stands studied.

2. Of the clumps of trees, tree belts and avenues studied, it was the last that had considerably lower numbers of species than the others, as well as lower density of birds. This findings was linked with the poorer vegetation structure in the avenues than in the other types of woods. In spite of this, in the face of the limited possibilities for establishing other types of woods, avenues may (as breeding sites for more than 30 bird species) contribute significantly to the protection of avifaunal biodiversity in an agricultural landscape.

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3. The variability in the number of bird species was found to depend:

a) in avenues — on the age of stands and the percentage cover of the shrub layer, to the extent of 91%;

b) in belts — on their area and the percentage cover in tree stand and shrub layer, to the extent of 91%;

c) in clumps — on their area, tree stand age and the proportion of dicotyledonous species in the herb layer, to the extent of 95%.

4. Variability in density depended:

a) in avenues — on the tree stand age, the percentage cover of the tree stand and the density of trees, to the extent of 91%;

b) in belts — on the percentage cover of the tree and herb layers and on breadth, to the extent of 74%;

c) in clumps — on the tree stand age and the density of trees, to the extent of 78%.

5. After excluding features of vegetational structure from the analysis, the geometrical dimensions of the planted areas emerged as having a significant influence on the number of species and the density of birds. The only exception were the avenues, for which no relationships occurred.

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## REFERENCES


Balat F. 1985. Birds of narrow belts of vegetation along water channels and ditches in the field landscape of southern Moravia. Folia zool. 34: 245–254.

Bastian O., Hummitzsch P., Schrack M. 1989. Beziehungen zwischen Landschaftsstruktur und Artenvielfalt der Avifauna in der Agrarlandschaft nordlich von Dresden. Zool. Abh. 45: 53–73.

Bezzel E. 1982. Vogel in der Kulturlandschaft. Ulmer Verl., Stuttgart.

Chlapowski D. 1843. O rolnictwie. Poznan.

Cieslak M. 1992. Breeding bird communities on forest edge and interior. Ekol. pol. 40: 461–475.

Cieslak M., Dombrowski A. 1993. The effect of forest size on breeding bird community. Acta orn. 27: 97–111.

Czwałga T. 1990. [Breeding avifauna of a *Robinia pseudacacia* forest near Sulechów]. Lub. Przegl. przyr. 1: 49–51.

Flade M. 1994. Die Brutvogelgemeinschaften Mittel- und Norddeutschlands. IHV-Verlag.

Fowler J. Cohen L. 1988. Statistics for ornithologists. BTO Guide No. 22, BTO.

Fretwell S. D., Lucas H. L.J r. 1969. On territorial behavior and other factors influencing habitat distribution in birds. Acta biotheoret. 19: 16–36.

Gassman H., Gluck E. 1993. Nistplatzwahl und Bruterfolg von Vogeln in Hecken. Vogelwelt 114: 136–147.

Gromadzki M. 1970. Breeding community of birds in midfield afforested areas. Ekol. pol. A, 18: 307–350.

Janda J. 1985. Relationship of the avifauna to the vegetation in an agricultural landscape. Ekologia (CSSR) 4: 387–398.

Jermaczek A. 1991. [Breeding bird communities of deciduous forests of Lubusian Land]. Lubuski Przegl. przyr. 2: 3–64.

Kujawa K. 1992. [Role of manorial parks for preservation of avifauna richness in agricultural landscape]. In: Bałazy S., Ryszkowski L. (eds.). Produkcja pierwotna, zasoby zwierząt i wymywanie materii organicznej w krajobrazie rolniczym. ZBSRiL PAN, Poznan, pp. 137–150.

Kujawa K. 1994. Awifauna lęgowa Agroekologicznego Parku Krajobrazowego im. gen. D. Chłapowskiego. Biul. Parków krajobr. 1: 37–49.

Kujawa K. 1996. Wpływ struktury krajobrazu rolniczego na awifaunę lęgową. Dr. thesis Uniwersytet Wrocławski.

Kurlavicius P. 1986. [Habitat distribution of birds in midfield woods]. Mosklas, Vilnius.

Lack P. C. 1988. Hedge intersections and breeding bird distribution in farmland. Bird Study 35: 133–136.

O'Connor R. J., Shrubb M. 1986. Farming and birds. Cambridge University Press.

Osborne P. 1984. Bird numbers and habitat characteristics in farmland hedgerows. J. appl. Ecol. 21: 63–82.

Pfister H., Naef-Danzer B. 1987. Der Neuntoter und andere Heckenbruter in der modernen Kulturlandschaft. Beih. Veroff. Naturschutz Landschaftspfl. Bad.-Wurtt. 48: 147–157.

da Prato S. R. D. 1985. The breeding birds of agricultural land in south-east Scotland. Scottish Birds 13: 203–216.

Ryszkowski L., Karg J. 1991. The effect of the structure of agricultural landscape on biomass of insects of the above-ground fauna. Ekol. pol. 39: 171–179.

Straka U. 1991. Brutzeitbeobachtungen in einer reich strukturierten Kulturlandschaft im südlichen Weinviertel. Vogelkundliche nachrichten aus Ostösterreich. 2,4: 1–4.

Tomiałojć L. 1980. The combined version of the mapping method. In: Oelke H. (ed.). Bird census work and nature conservation. Gottingen, pp. 92–106.

Tomialojc L., Profus P. 1977. Comparative analysis of breeding birds communities in two parks of Wrocław and in adjacent *Querco-Carpinetum* forest. Acta orn. 16: 117–177.

Tomiałojc L., Wesołowski W. Walankiewicz W. 1984 . Breeding bird community of a primeaval temperate forest (Białowieza National Park, Poland). Acta orn. 20: 241–310.

Wesołowski T., Czapulak A. 1986. [Breeding biology of Blackbird and Song Thrush in Poland — a preliminary analysis of nest cards]. Not. orn. 27: 1–2.

Wuczyński A. 1990. [An analysis of the breeding avifauna of the small mid-field woodlots in the Rownina Wrocławska plain]. Not orn. 36: 99–117.


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## STRESZCZENIE

**[Zależności pomiędzy strukturą zadrzewień śródpolnych i zgrupowaniami ptaków lęgowych]**

Celem badań była charakterystyka zgrupowań ptaków lęgowych zróżnicowanych zadrzewień śródpolnych i określenie parametrów środowiskowych warunkujących te zgrupowania. Badania przeprowadzono w latach 1991–1994 w urozmaiconym krajobrazie rolniczym koło wsi Turew (50 km na pd. od Poznania), gdzie wyznaczono 74 powierzchnie badawcze: 20 w alejach, 33 w zadrzewieniach pasowych i 21 w zadrzewieniach kępowych (ryc. 1, tab. 1). Zagęszczenie ptaków oceniono przy użyciu kombinowanej metody kartograficznej. Każdą z powierzchni scharakteryzowano w odniesieniu do: wielkości (dla alei i pasów także do długości i szerokości), wieku drzewostanu, stopnia pokrycia drzewostanem, podszytem i runem, zagęszczenia drzew, wysokości runa i udziału dwuliściennych w runie. Związki pomiędzy strukturą środowiska a zgrupowaniami ptaków badano przy pomocy krokowego doboru zmiennych w regresji wielorakiej oraz analizy współczynnika korelacji.

Na wszystkich powierzchniach łącznie stwierdzono 68 gatunków lęgowych ze średnim zagęszczeniem (średnia ważona) 14,6 par na ha. Liczba gatunków na poszczególnych powierzchniach wynosiła od 1 do 31 (ryc. 2), a zagęszczenie od 0,7 do 87,8 p/ha (ryc. 3). W zgrupowaniu dominowały: zięba, trznadel, mazurek i potrzeszcz (tab. 3). Średnia liczba gatunków w kępach była istotnie wyższa, niż w alejach i pasach ($P < 0{,}001$ i $P < 0{,}05$ w teście t) a najmniejsza — w alejach (tab. 4). Zagęszczenie ptaków w kępach i pasach (tab. 4), przy braku różnic między nimi, było wyższe, niż w alejach (odpowiednio $P < 0{,}05$ i $P < 0{,}01$ w teście t). Zagęszczenie ptaków w przeliczeniu na długość bylo w pasach 2,5-krotnie wyższe, niż w alejach (tab. 4) przy $P < 0{,}01$ w teście t. W alejach stwierdzono więc najuboższą awifaunę, zarówno pod względem liczby gatunków, jak i zagęszczenia. W kępach i pasach gniazdowało około 30 gatunków nie stwierdzonych w alejach, natomiast w alejach nie gniazdował żaden gatunek (z wyjątkiem skrajnie nielicznej pójdźki), którego nie stwierdzono w pozostałych typach zadrzewień. Pomimo to aleje, zasiedlane przez ponad 30 gatunków ptaków, mogą się istotnie przyczynić — przy braku możliwości zakładania kęp i pasów — do ochrony bogactwa awifauny w krajobrazie rolniczym.

Różnice w awifaunie pomiędzy zadrzewieniami były wyraźnie związane ze strukturą roślinności w analizowanych typach zadrzewień. Aleje w stosunku do pasów cechowały się mniejszym stopniem pokrycia drzewostanem i podszytem oraz mniejszym zagęszczeniem drzew, a również mniejszym stopniem pokrycia runem oraz jego mniejszą wysokością. Struktura roślinności w pasach i kępach była podobna (tab. 2).

Stwierdzono, że zmienność w liczbie gatunków ptaków zależała: w alejach — w 91% od wieku drzewostanu i stopnia pokrycia podszytem, w pasach — w 91% od ich powierzchni, stopnia pokrycia drzewostanem i podszytem, a w kępach — w 95% od ich powierzchni, wieku drzewostanu i udziału roślin dwuliściennych w runie. Zmienność w zagęszczeniu ptaków zależała: w alejach — w 91% od wieku drzewostanu, stopnia pokrycia drzewostanem i zagęszczenia drzew, w pasach — w 74% od stopnia pokrycia drzewostanem i runem oraz od szerokości, w kępach — w 78% od wieku drzewostanu i zagęszczenia drzew. Uwagę zwracają tu wysokie wartości współczynników determinacji, co świadczy o dużych możliwościach prognozowania stanu awifauny (liczby gatunków i zagęszczenia) i jej zmian na podstawie analizy struktury środowiska. Po wykluczeniu z analizy parametrów struktury roślinności, wymiary geometryczne zadrzewień okazały się mieć istotny wpływ na liczbę gatunków i zagęszczenie ptaków, z wyjątkiem alej, gdzie nie wystąpiły żadne zależności (tab. 5).



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