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Composition and dynamics of wintering bird communities in mid-field woods and woodbelts in Turew (western Poland)

Abstract. Studies carried out in an agricultural landscape between 1989 and 1992 revealed 32 wintering species of birds along 13.6 km of transects passing through three biotopes: woodland interior, woodland edge and belts of trees. 42 species were noted in the area as a whole. The variability in the densities and biomass of plant-eating species was found to be greater than that for insect-eaters, but no trends were noted for changes in density in the course of the winter. The variability in the density of plant-eating species was less differentiated in the different biotopes and greater than that observed for insect-eating species. 27 species fed in belts of trees (7.3 ind./ha), 24 at the woodland edge (2 ind./ha) and 22 in the woodland interior (3.9 ind./ha). Plant-eating species showed a significant preference for belts of trees over the other biotopes, while insect-eating species favoured belts of trees or the woodland interior where population density was concerned, and the woodland interior when it came to biomass. The proportion of insect-eating species was lowest in belts of trees (35% by population density and 10% by biomass) and highest in the woodland interior (86% and 71% respectively). Population density and biomass were correlated positively with the age of tree stand for insect-eating species but not for plant-eating species. The distribution of birds in woodbelts was modified by adjoining woods: population density (total or within trophic guilds) was higher near woodlands than in central parts of the belt of trees.

Key words: winter communities, trophic guilds, habitat selection, density of population, dynamics of community.

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INTRODUCTION

Over-winter mortality may have a significant influence on the densities of birds in the breeding season as well as on their reproduction (Desrochers *et al.* 1988, Ekman *et al.* 1981, Lack 1966). As a consequence, it is important to determine the factors influencing the species richness and density of communities of wintering birds. Europe and North America have witnessed a series of studies into communities of wintering birds. Such studies arose in the atlas work on the geographical distribution of wintering birds in different countries or regions – e.g. Great Britain (Shrubb & O'Connor 1986, Tucker 1989a) and the USA (Robbin & Bystrak 1974), as well as in the form of detailed quantitative research concerning, among other things, forests (Cink & Boyd 1988, Hammel *et al.* 1993, Meschini & Lambertini 1986) and also the environment provided by agricultural landscapes (Cink & Boyd 1988, Farina 1986, Tucker 1989b, Yahner 1981). Rather few studies of wintering terrestrial bird com-

munities have so far been done in Poland, and the ones that have been done have considered towns (Górska & Górski 1980, Luniak 1981), large forest complexes (Tomiałojć 1974, Wołk 1985) and also agricultural landscapes, mainly fields (Górski 1976, Jabłońska & Jabłoński 1971, Jabłoński 1972, Wiatr 1975a, Witkowski 1964). The aim of analysis in studies done in agricultural landscapes has always been first and foremost to study the influence of food resources and weather conditions on the density and species composition of communities of birds feeding on fields. No profound study has ever been done in Poland in relation to wintering communities of birds in mid-field wooded areas. Only Foksowicz and Sokołowski (1956) gave information from a single shelter-belt studied for one winter.

The aim of this work was therefore to characterize the communities of wintering birds in mid-field wooded areas (woods and belts of trees), as well as to determine the influence of the structure of these environments on species richness and abundance (density and biomass) of bird population.

STUDY AREA AND METHODS

The work was done in the years 1989-1992 in the area of the Agroecological Landscape Park in the area around Turew, (40 km to south of Poznań, western Poland). Forest cover in the Park amounts to 15%, with meadows and pastures covering 9%, and with 0.4 km of water course per km^2. The area in which the research was carried out (Tab. 1, Fig. 1) is characterized by the presence of numerous alleys with trees and shelter-belts with widths of 60-70m. Some of these have been in existence for 170 years. Linear structures of this kind constitute links between woods, as well as the majority of midfield clumps of trees. The density of these linear structures amounts here to about $5km/km^2$. The area is well known from the point of view of its breeding avifauna (Gromadzki 1970, Kujawa 1994, Ryszkowski et al. 1971), and

in fact has recorded the greatest species diversity and population density of breeding birds of any agricultural landscapes in Poland (Kujawa, in press).

Research was done by use of transect method. Birds were counted in the woodland interior and at the woodland edge in a belt with a width of about 50m (25m+25m). Woodbelts were censused in their entirety, as width ranged 10–50m (Tab. 1). The total length of transects I and II (Fig. 1) amounted to 13.6km and their area to about 50ha (Tab. 1). Densities of birds were evaluated on the basis of multiple counts on transects from which arithmetic means were calculated. All the counts were made between 9 Dec. and 18 Febr. 20 counts were made along transect I (7,8 and 5 in the successive winter seasons) and 9 along transect II (6,0 and 3). The dynamics of community was ana-

Table 1. Data on sectors of both transect belts studied.

[Tab. 1. Charakterystyka badanych transektów].

Sector	Localisation	Length [m]	Breadth [m]	Area [ha]	Tree stand	Understory
Transect I						
A	Tree belt along field road	250	10	0.25	Scarce oaks, 300 years	Dense hawthorns (170 years)
B	see A	600	10	0.60	See A, more scattered	See A
C	see A	250	10	0.25	See A, with rare maples	See A
D	Forest edge	1200	50	6.00	Mixed:pines (50-90 years) and oaks, maples, birches in different age)	Oaks in different density, elders, bird's cherries
E	Forest edge	275	50	1.37	Pines (90 years)	Scattered oaks and elders
F	Forest interior	625	50	3.12	50%: pines (90-100 years), 50%: oaks, pines with rare birches and larches (40-60 years)	Dense elders and bird's cherries
G	Forest interior	550	50	2.75	Dense pines with rare oaks and birches (10-20 years)	Absent
H	Forest interior	300	50	1.50	Pines and oaks (25-40 years) with rare birches and larches	Scattered *Frangula alnus* and spindele trees
I	Wedge-shaped tree belt	750	50	3.87	Accacia (50 years)	Almost absent
Transect II						
A	Alley along midfield road	750	16.5	1.24	100-years limes, maples and ashes with single poplars and maples on both sides of road	Single elders and roses
B	Tree belt along midfield road	1050	47.0	4.97	Many rows of accacia with single oaks, small parts with 10-15 years red oaks, ashes, accacia, maples and poplars	Almost absent
C	Tree belt along asphalt road	400	47.0	1.88	50-years accacia on one side and dense 10-20 years accacia on second side	Scattered single elders and bird's trees
D	Forest edge	1325	50.0	6.62	50-years accacia with small parts of 20-40 years poplar or birches or pines or larches	Clumps of elders and bird's trees
E	Forest edge	875	50.0	4.37	In 80%: accacia, 20%: 90-years oaks	Well developed, elder
F	Forest interior	600	50.0	3.00	Mainly oaks and pines (35 and 90 years), small parts of 50 years), birches or 30 years larches	Well developed, mainly elders
G	Forest interior	825	50.0	4.12	Mosaic of pieces of 25-75 years accacia, pines, oaks, larches and poplars	Well developed,elder, bird's trees
H	Forest interior	500	50.0	2.50	In 80%: pines with rare birches, 20%; larches, 50 years	As above
I	Forest edge	200	50.0	1.00	50-years accacia-pine with rare oaks	Single elders
J	Alley along midfield road	750	14.5	1.09	100-years limes on both sides of road	Young stems of limes

lysed on the basis of data from transect I (with a longer series of counts). Data from the two transects formed the basis on which to calculate the mean densities and biomasses of the bird populations in the biotopes distinguished. Birds were counted between 10.00 and 13.00 on calm days with light winds, and all days were
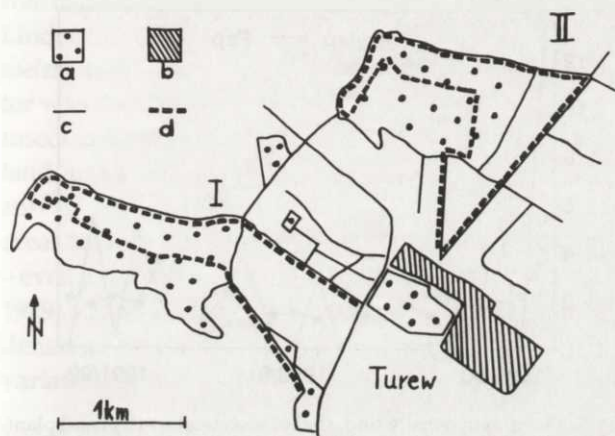

Fig. 1. Study area and transects. a – forests, b – built up areas, c – belts of trees, d – transects (I,II).

[Ryc. 1. Teren badań i usytuowanie transektów. a – lasy, b – obszar zabudowany, c – zadrzewienia pasowe, d – transekty (I,II).]

without heavy falls of snow. The mean speed of walk along the transect was around 2km/h. Birds were noted with the use of a dictaphone. Quantitative analysis took in birds that were present along the identified transects, but birds occuring beyond it were also noted in order that a complete list of all species of birds wintering in the landscape might be obtained. Used to calculate the biomasses of birds were mean body weights per individual of a given species taken from the work by Busse (1990). In the case of Treecreepers (*Certhia* spp.) no attempt was made to establish which sightings referred to which species, and the analysis simply treated the two together. Species were divided into two trophic groups. It was assumed that species from the families *Paridae, Picidae, Certhiidae, Sittidae, Aegithalidae* and *Sylviidae* were amongst the species surviving on animal food and termed „insect-eaters", while other species were assumed to eat plant food and were termed „plant-eaters". This division cannot be regarded as absolute, because some plant-eaters may exist in certain areas on animal food, and vice versa (e.g. in the case of *Dendrocopos major*, which eats the seeds of coniferous trees). All types of belt-like areas with trees were termed „belts of trees", and the

significance of differences between biotopes in density and biomass were studied using a test for paired samples. The significance of differences in variances was determined using the F test (Fowler & Cohen 1985).

RESULTS AND DISCUSSION

Work done on the transects in the winters 1989/90, 1990/91 and 1991/92 saw a total of 2909 individuals of 32 species recorded. Of these the most abundant were *Parus caeruleus, Turdus pilaris* and *Parus major* (Tab. 2). The following 10 species were observed beyond the transects: *Buteo buteo, B. lagopus, Accipiter nisus, A. gentilis, Corvus corax, C. c. cornix, C. monedula, Alauda arvensis, Passer domesticus* and *P. montanus*. A total of 42 species of birds were therefore wintering in the study area.

Table 2. Birds recorded (N) within the census transects. I – insect eaters, P – plant-eaters.

[Tabela. 2. Ptaki stwierdzone podczas liczeń na transektach. I – gatunki owadożerne, P – gatunki roślinożerne.]

Species and trophy		N
Parus caeruleus	I	761
Turdus pilaris	P	446
Parus major	I	289
Dendrocopos major	I	165
Emberiza citrinella	P	147
Certhia sp.	I	129
Sitta europaea	I	128
Regulus regulus	I	114
Turdus merula	P	83
Aegitalos caudatus	I	72
Pyrrhula pyrrhula	P	71
Parus montanus	I	66
Acanthis flammea	P	54
Garrulus glandarius	P	44
Parus ater	I	42
Passer montanus	P	42
Fringilla montifringilla	P	35
Parus palustris	I	34
Emberiza calandra	P	30
Bombycilla garrulus	P	30
Fringilla coelebs	P	27
C. coccothraustes	P	23
Carduelis chloris	P	19
Carduelis carduelis	P	14
Parus cristatus	I	11
Dryocopus martius	I	10
Carduelis spinus	P	7
Dendrocopos medius	I	6
Dendrocopos minor	I	5
Galerida cristata	P	2
Turdus viscivorus	P	2
Erithacus rubecula	I	1
Total 32 spp.		2909

Seasonal variability of density and biomass

Significant variations in density and biomass were noted in successive count periods (Fig. 2). At the beginning of winter 1989/90, such variations were related to flocks of up to 150 individuals of *Turdus pilaris* flying in and out irregularly. The presence of this species declined considerably as the winter continued. A similar course of changes in the abundance of fructivorous species was also described by Tucker (1989a).
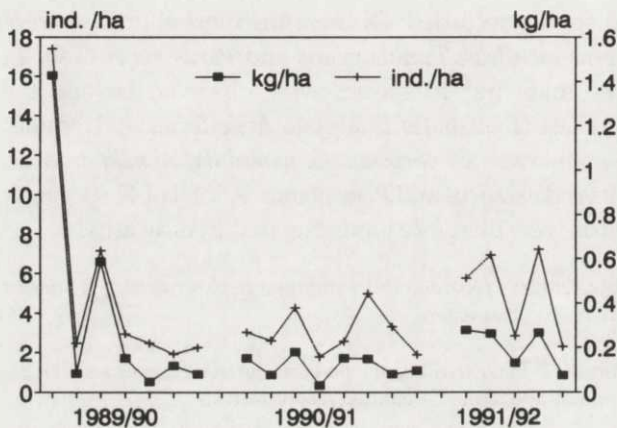

Fig. 2. Changes in the total density (ind./ha) and biomass (kg/ha) of bird population recorded in particular censuses (transect I).

[Ryc. 2. Zmiany ogólnego zagęszczenia (ind./ha) i biomasy (kg/ha) zgrupowań ptaków w kolejnych liczeniach (transekt I).]

The variance in density and biomass was considerably greater (F test, P<0.01) for the guild of plant-eaters (with or without *Turdus pilaris*) than for that of insect-eaters (Fig. 3, 4). At the same time, changes in density and biomass between the two guilds were not synchronous (the correlations for biomass and density were not significant). Total density and biomass for all birds combined did not show either rising or falling trends in the course of the winter. This was the case for both insect-eaters and plant-eaters (when *Turdus pilaris* was excluded).

The picture of variance in the densities of bird communities in belts of trees and woods differed significantly in the two trophic groups. The co-efficient of variability (the mean/standard deviation) for the guild of plant-eaters in the woodland interior, woodland edge and belts of trees was similar and amounted to 1.99, 2.29 and 1.98, respectively. On the other hand, in the guild of insect-eaters, the respective figures were 0.70, 0.63 and 1.22. The fact that the variance in density

was also twice as great for insect-eaters in belts of trees as for those in the woodland interior or at the woodland edge was a testament to the probability that belts of trees are used by insect-eaters as places in which to
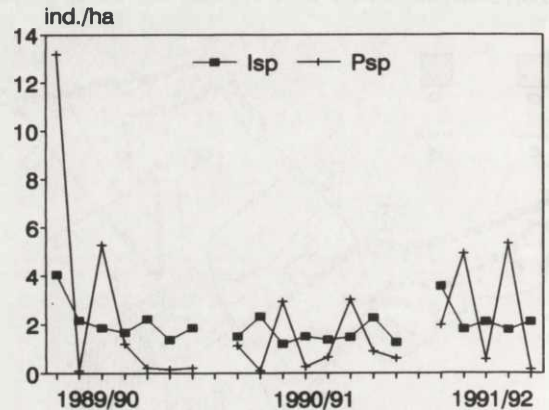

Fig. 3. Changes in density (ind./ha) of insect-eaters (Isp) and plant-eaters (Psp) - transect I.

[Ryc. 3. Zmiany zagęszczenia (ind./ha) ptaków owadożernych (Isp) i odżywiających się pokarmem roślinnym (Psp) - transekt I.]

forage during displacement from one wood to another. This leads to great variations in the number of birds occurring in the belts. The clearly greater variance of density and biomass in plant-eaters as opposed to insect-eaters, is a manifestation of the different wintering strategies of these two trophic groups. Plant-eaters in search of source of food with clumped
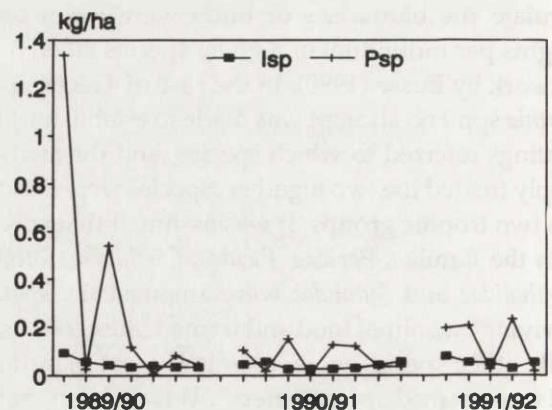

Fig. 4. Changes in biomass (kg/ha) of insect-eaters (Isp) and plant-eaters (Psp) species - transect I.

[Ryc. 4. Zmiany biomasy (kg/ha) ptaków owadożernych (Isp) i odżywiających się pokarmem roślinnym (Psp) - transekt I.]

distribution (e.g. clumps or belts of bushes with fruits) form roving, very mobile flocks of sometimes great size. It is the presence or absence of these flocks on transects which give the great variations in density and biomass which were observed. Although some authors (Buchanan *et al.* 1988, Kus 1986) emphasize the role of predators in the forming of flocks, the study by Lindström (1989) of the formation of flocks of *Fringilla coelebs* and *F. montifringilla* showed that the main factor was the clumped distribution of food. In contrast, insect-eaters can make use of virtually all of the woodland areas and belts of trees. They are more thinly-spread and more strongly associated with a given area. Some – e.g. *Sitta europaea* and *Dendrocopos major* – even establish winter territories (Lőhrl 1967, Rychlik 1979, Sikora 1980). It is as a result of these factors that densities and biomasses were subject to much lesser variation in the case of this group of birds (Fig. 3, 4).

Table 3. Species composition, density (ind./ha) and biomass(g/ha) of bird community in midfield belts of tree.

[Tabela 3. Zagęszczenie (ind./ha) i biomasa (g/ha) populacji ptaków w śródpolnych zadrzewieniach pasowych.]

Species	ind./ha	g/ha
Parus caeruleus	2.8	31
Turdus pilaris	1.5	149
Emberiza citrinella	0.7	20
Parus major	0.5	10
P. pyrrhula	0.2	7
Sitta europaea	0.2	4
Turdus merula	0.2	19
Certhia sp.	0.2	2
Passer montanus	0.2	3
Fringilla montifringilla	0.1	3
Fringilla coelebs	0.1	2
Bombycilla garrulus	0.1	6
Miliaria calandra	0.1	5
Carduelis chloris	0.1	2
Garrulus glandarius	0.1	10
Parus palustris	0.1	1
Parus montanus	0.1	1
Aegithalos caudatus	0.1	+
Dendrocopos major	+	3
C. coccothraustes	+	2
C. carduelis	+	+
Galerida cristata	+	1
Dendrocopos minor	+	+
Carduelis spinus	+	+
Dendrocopos medius	+	1
Dryocopus martius	+	2
Erithacus rubecula	+	+

Number of species, their density and biomass

Found foraging in belts of trees were a total of 27 species, while woodland edges had 24 and woodland interiors – 22 (Tab. 3, 4 and 5). At 15, 10 and 8 respectively, the number of plant-eating species in these biotopes was more variable than the number of insect-eating species (at 12, 14 and 14 respectively). Mean densities and biomasses were highest in belts of trees, with 7.3 individuals or 283g per ha. The woodland interior had 3.9 individuals and 113g per ha and the woodland edge 2 individuals and 60g per ha (Tab. 3, 4 and 5). Differences in density and biomass between these biotopes were statistically significant $(0.05>P>0.0001)$, besides differences in biomass between the woodland interior and the belts of trees (where $P>0.1$).

Table 4. Species composition, density (ind./ha) and biomass (g/ha) of bird community at the woodland edge.

[Tabela 4. Zagęszczenie (ind./ha) i biomasa (g/ha) populacji ptaków na skraju lasu.]

Species	ind./ha	g/ha
Parus major	0.5	10
Parus caeruleus	0.3	4
Dendrocopos major	0.1	12
Certhia sp.	0.1	1
Sitta europaea	0.1	3
Emberiza citrinella	0.1	4
Turdus merula	0.1	9
Aegithalos caudatus	0.1	1
R. regulus	0.1	+
Passer montanus	0.1	1
Turdus pilaris	+	5
C. carduelis	+	1
C. coccothraustes	+	2
Acanthis flammea	+	+
Parus ater	+	+
P. pyrrhula	+	1
Garrulus glandarius	+	3
Fringilla coelebs	+	+
Parus palustris	+	+
Parus cristatus	+	+
Carduelis spinus	+	+
Dryocopus martius	+	2
Turdus viscivorus	+	+
Dendrocopos medius	+	+

Differences were also noted in the environmental preferences of plant- and insect-eaters. The guild of plant-eaters preferred belts of trees (Fig. 5), with a low

Table 5. Species composition, density (ind./ha) and biomass (g/ha) of bird community in woodland interior.

[Tabela 5. Zagęszczenie (ind./ha) i biomasa (g/ha) populacji ptaków we wnętrzu lasu.]

Species	ind./ha	g/ha
Parus caeruleus	1.0	11
Dendrocopos major	0.5	44
Parus major	0.4	9
R. regulus	0.4	2
Certhia sp.	0.3	3
Sitta europaea	0.2	5
Parus montanus	0.2	2
Parus ater	0.1	1
Acanthis flammea	0.1	2
Aegithalos caudatus	0.1	1
Parus palustris	0.1	1
Garrulus glandarius	0.1	12
C. coccothraustes	0.1	3
Turdus merula	+	5
Emberiza citrinella	+	1
Dryocopus martius	+	8
Dendrocopos medius	+	2
Parus cristatus	+	+
Dendrocopos minor	+	+
P. pyrrhula	+	1
Carduelis spinus	+	+
Turdus viscivorus	+	+

significance for differences between belts of trees and the other biotopes (P<0.05 for density and P<0.1 for biomass). On the other hand, the guild of insect-eaters demonstrated higher density in belts of trees and in woodla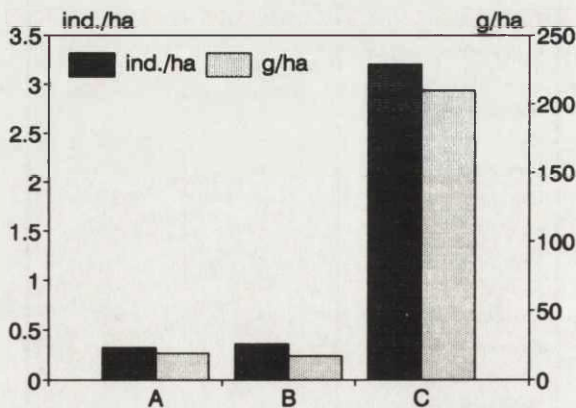nd interior, with differences between these and the woodland edge being significant at P<0.01 and P<0.001 respectively. Where biomass was concerned (Fig. 6), the differences with the woodland interior were significant at P<0.01, where the belts of trees were concerned and P<0.0001 when it came to the woodland edge. The proportions of insect-eaters in the total density and biomass amounted to 35% and 10% respectively in the case of belts of trees, 79% and 57% in the case of the woodland edge and 86% and 71% in the case of the woodland interior.
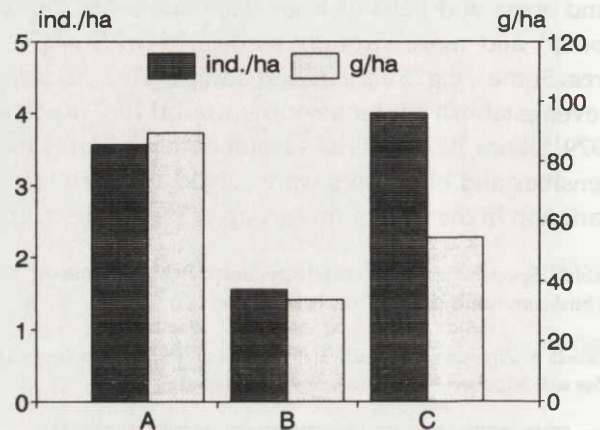

Fig. 6. Average density (ind./ha) and biomass (g/ha) of insect-eaters in interior of forest (A), edge of forest (B) and tree belts (C).

[Ryc. 6. Średnie zagęszczenie (ind./ha) i biomasa (g/ha) ptaków owadożernych we wnętrzu lasu (A), na skraju lasu (B) i zadrzewieniach pasowych (C).]

The assurance of feeding areas for insect-eaters is the main element in the significance of woods and mid-field belts of trees for birds wintering in an agricultural landscape. Plant-eaters mainly feed in extensive open fields (e.g. Górski 1976, Jabłoński 1972, Wiatr 1975a, 1975b, Witkowski 1964), although they can also make use of forest biotopes, and particularly belts of trees (Tab. 3, 4 and 5). In contrast, insect-eaters are considerably more dependent on forest biotopes (mid-field wooded areas and woods) and are virtually absent as feeders from open areas of agricultural landscape. It was shown, for example by Górski (1976), that the most numerous insect-eating species – *Parus caeruleus* and *P. major* – made up less than 0.1% of the birds recorded in open fields.

The densities of wintering birds in mid-field woods around Turew are within the ranges recorded in other studies carried out in woods (Tomiałojć 1974). These

Fig. 5. Average density (ind./ha) and biomass (g/ha) of plant-eaters in interior of forest (A), edge of forest (B) and tree belts (C).

[Ryc. 5. Średnie zagęszczenie (ind./ha) i biomasa (g/ha) ptaków roślinożernych we wnętrzu lasu (A), na skraju lasu (B) i zadrzewieniach pasowych (C).]

were in general higher than in open fields (Górski 1976, Jabłońska & Jabłoński 1971, Jabłoński 1972, Witkowski 1964, Wiatr 1975a) and much lower than in town parks (Górska & Górski 1980, Luniak 1981). Belts of trees are characterized by higher densities of birds than woods and cultivated areas, and densities that are lower than in town parks and built-up areas (Górska & Górski 1980), where the densities were highest.

Influence of vegetational structure

With a view to defining the influence of stand age on the distribution of birds feeding in woodland, comparisons were made between the results of counts in three sections (F, G and H) of transect I running through the woodland interior (Tab. 1). The species composition of the stands on these sections was very similar, in spite of the fact that the ages differed. A similar number of species (14–16) were wintering on all three sections. Differences in biomass and density between the youngest and older tree stands (Fig. 7) were statistically significant (P<0.05 and P<0.01). No link between density and biomass and the age of tree stands was noted for the guild of plant-eaters, and none of the differences were statistically significant.
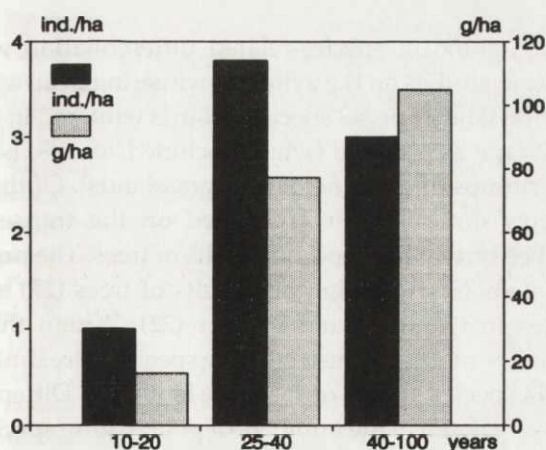

Fig. 7. Average density (ind./ha) and biomass (g/ha) of insect-eating birds in relation to age of tree stand.

[Ryc. 7. Średnie zagęszczenie (ind./ha) i biomasa (g/ha) ptaków owadożernych w zależności od wieku drzewostanu.]

The establishment of a link between the density and biomass of birds wintering and the vegetational structure of belts of trees on the basis of their quality as feeding areas is made difficult by the fact that these

areas are in great measure used by birds (at least by insect-eaters) as routes by which to move about the countryside, and not merely as feeding areas. It would also seem that the distribution of birds in belts of trees is modified by the proximity of woods to them (see next section). It was for this reason that comparisons were made between the results from sections A and B of transect II (Tab. 1), which differed distinctly in their vegetational structure and were at the same time situated in a similar way with respect to the nearest wood. No significant differences were noted for the guild of insect-eaters: the mean densities in section A and B amounted to 4.8 and 4.6 individuals/ha and the mean biomasses 58.1 and 63.2g/ha. On the other hand, several-fold differences did occur for the guild of plant-eaters, with densities of 2.7 and 0.3 ind./ha and biomasses of 89.8 and 9.5g/ha. These differences were caused mainly by the frequent feeding of *P. pyrrhula*
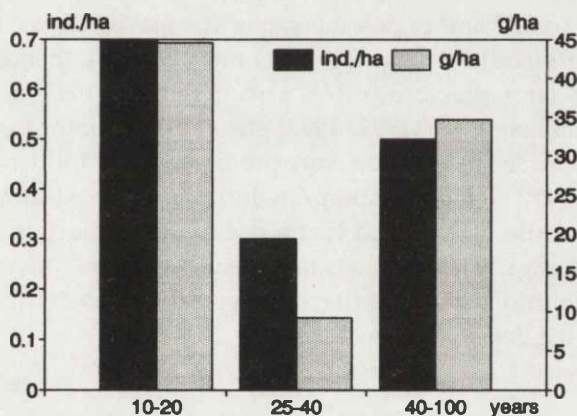

Fig. 8. Average density (ind./ha) and biomass (g/ha) of plant-eating birds in relation to age of tree stand.

[Ryc. 8. Średnie zagęszczenie (ind./ha) i biomasa (g/ha) ptaków owadożernych w zależności od wieku drzewostanu.]

on old ashes and maples growing along section A.

A clear influence on communities of birds wintering in the open agricultural landscape was demonstrated for food resources especially. The significance of these for birds wintering in cultivated areas was studied: for plant-eaters by Górski (1976), Jabłoński (1972) and Wiatr (1975a,b,c) and for species eating invertebrates – by Tucker (1992). Parks in Warsaw (Luniak 1981) and Poznań (Górska & Górski 1980) were found to have many times greater densities and biomasses of birds in the places, where food was con-

tinually augmented by feeding and easy access to wastes. More controversial in its nature is the issue of links between the birds wintering in woods and the structure of those woods. For example, studies on the influence of the size of woods on the species richness and density of wintering birds have given positive associations (Blake 1987, Tilghman 1987) or no obvious links (Hammel *et al.* 1993, Robbins *et al.* 1987, Yahner 1985). Studies in the Turew area did not involve woods of different sizes, but a significantly lower density of insect-eaters was noted at the woodland edge (Tab. 4, 5). The high level of statistical significance of this difference (P<0.001) attests to the existence of a real cause of this phenomenon. This may be the decline in the insect resources wintering at the woodland edge in relation to the interior – perhaps associated with the less favourable microclimatic conditions in the former (the greater variations in temperatures and the vulnerability to strong frosty winds). Another possible factor for the avoidance of the woodland edge by birds may be the enhanced predator pressure in this area. Suhonen (1993) and Suhonen *et al.* (1992, 1993) showed that both, food resource distribution and predation risk, influence density of tit population. On the basis of these factors, it would be expected that a rise in the proportion of the edge zone of woods (as a result of the fragmentation or diminution of woods) would lead to declines in the density of insect-eaters.
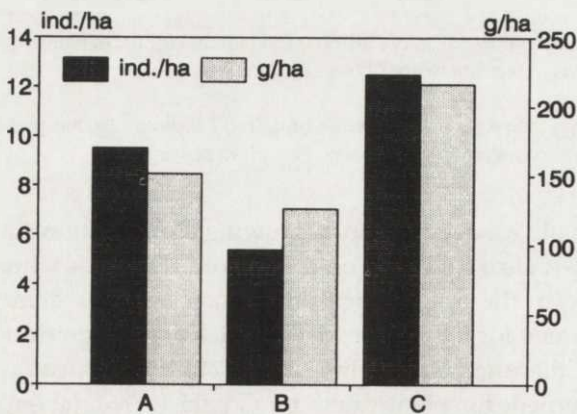

Fig. 9. Impact of the neighbourhood of forest on the distribution of birds in tree belts. A and C – verge sectors of tree belt, adjacent to forests, B – central sector of tree belt.

[Ryc. 8. Wpływ sąsiedztwa lasu na rozmieszczenie ptaków w zadrzewieniu pasowym. A i C – odcinki skrajne zadrzewienia, sąsiadujące z lasem, B – odcinek środkowy zadrzewienia.]

Influence of neighbouring woods

The influence of woods on the distribution of the birds wintering in belts of trees was defined on the basis of a fragment of transect I (Tab. 1, sections A,B,C) – a belt of trees linking a wood of 80ha with a park of a natural character covering 20ha. As Fig. 9 shows, both density and biomass were higher in extreme section of belt (A and C) than in the central section (B). Though clear, these differences were not statistically significant (0.12>P>0.47). It is probable that this results from the great variability of the parameters measured. Correlation analysis of changes in density and biomass between the extreme sections of belt and its central section indicated that the larger complex of woodland adjacent to the belt of trees modified the distribution of birds. The complete lack of any correlation indicates that density and biomass in the extreme sections of the belt of trees and its interior varied in an independent way. The factor behind the phenomenon is probably the penetration of the edges of belt of trees by birds from the neighbouring woods.

CONCLUSIONS

1. Significant species-related differentiation was noted in studies on the avifauna wintering in an agricultural landscape. 42 species of birds wintered in the landscape as a whole (which included forests, belts and clumps of trees, fields and grasslands). Of these species some 32 were recorded on the transects marked out in the woods and belts of trees. The number of species was highest in belts of trees (27) and lowest in the woodland interior (22). Within these totals, the number of insect-eating species were similar (12-14 species in each of the three biotopes). Differences were noted in the numbers of plant-eating species.

2. Characteristic of the communities of wintering birds was a great variability in the density and biomass over time. This variation was significantly greater for the guild of plant-eaters than for insect-eaters.

3. The belt areas were significant for insect-eaters moving through the landscape.

4. Significant differences were noted between belts of trees, the woodland edge and the woodland interior, in terms of the densities and biomasses of birds. The greatest values were noted in belts of trees and the

lowest at the woodland edge. The preferences of the trophic groups were variable. Species eating plant food had a clear preference for belts of trees, while insect-eaters preferred belts of trees and the woodland interior.

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STRESZCZENIE

[Skład i dynamika zgrupowań ptaków zimujących w
śródpolnych lasach i zadrzewieniach okolic Turwi.]

Celem badań było określenie wpływu struktury
środowiska na bogactwo gatunkowe oraz liczebność
(zagęszczenie i biomasę) ptaków zimujących w za-
drzewieniach (pasach wiatrochronnych i alejach) i la-
sach śródpolnych. Badania prowadzono w obrębie
Agroekologicznego Parku Krajobrazowego koło wsi
Turew (woj. leszczyńskie). W okolicy tej znajdowały
się liczne aleje i pasy wiatrochronne w wieku do 170
lat. Ich łączne zagęszczenie wynosiło średnio 2, a lo-
kalnie do 5km/km^2. Ptaki liczono na dwóch transek-
tach (ryc. 1) o łącznej długości 13.6km przez trzy
kolejne zimy w latach 1989-1992. Liczenia powtarzano
kilkakrotnie w ciągu każdej zimy (łącznie 28 liczeń na
obu transektach). Transekty obejmowały trzy wyróż-
nione biotopy: wnętrze lasu, skraj lasu i zadrzewie-
nia liniowe (ryc. 1). Ich łączna powierzchnia wynosiła
około 50ha (tab. 1). Biomasę ptaków obliczono na pod-
stawie danych w opracowaniu Bussego (1990).

Zagęszczenie i biomasa badanych zgrupowań pta-
ków zmieniały się znacznie w kolejnych terminach
liczeń (ryc. 2), przy czym zagęszczenie i biomasa ga-
tunków owadożernych (ryc. 3) były w porównaniu do
roślinożernych (ryc. 4) znacznie mniej zmienne
(P<0.01 w teście F). W dodatku zmiany zagęszczenia i
biomasy były pomiędzy gatunkami owadożernymi i
roślinożernymi niezsynchronizowane (P>0.3).
Zmienność zagęszczenia gatunków roślinożer-
nych była mniej zróżnicowana w trzech wyróżnio-
nych biotopach (dla wnętrza lasu, jego skraju i
zadrzewień pasowych c.v. wynosił 1.99, 2.29, 1.98) i
wyższa niż owadożernych (c.v.= 0.7, 0.63, 1.22).

Wyższa zmienność zagęszczenia gatunków owa-
dożernych w zadrzewieniach świadczy prawdopo-
dobnie o tym, że są one wykorzystywane jako drogi
przemieszczania się ptaków pomiędzy lasami.

W zadrzewieniach pasowych zimowało 27 gatun-
ków (tab. 3), na skraju lasu – 24 (tab. 4), a we wnętrzu
lasu – 22 (tab. 5). Różnice w zagęszczeniu i biomasie
pomiędzy biotopami (z wyjątkiem jednej) były istotne
(0.05>P>0.0001). Gatunki roślinożerne preferowały
zadrzewienia pasowe (ryc. 5), natomiast gatunki owa-
dożerne pod względem zagęszczenia – zadrzewienia
i wnętrze lasu, a pod względem biomasy – wnętrze
lasu (ryc. 6). Udział gatunków roślinożernych w cał-
kowitym zagęszczeniu i biomasie wynosił: w zadrze-
wieniach – odpowiednio 35% i 10%, na skraju lasu –
79% i 57%, a we wnętrzu lasu – 86% i 71%.

We wnętrzu lasu zagęszczenie i biomasa gatun-
ków owadożernych (ryc. 7) były istotnie niższe
(P<0.05) w drzewostanie najmłodszym (10–20 lat), niż
w starszych (25–40 oraz 90–100 lat). Natomiast za-
gęszczenie i biomasa gatunków roślinożernych oraz
łączna liczba gatunków nie były związane z wiekiem
drzewostanu (ryc. 8). Stwierdzono wyraźny wpływ
składu gatunkowego drzewostanu w zadrzewieniach
pasowych na zagęszczenie i biomasę gatunków rośli-
nożernych – na odcinku z jesionami i klonami wyno-
siły one odpowiednio 2.7os./ha i 89.8g/ha, a na
odcinku z robiniami – 0.3os./ha i 9.5g/ha. Natomiast
zagęszczenie i biomasa gatunków owadożernych na
tych odcinkach były bardzo podobne.

Rozmieszczenie ptaków w zadrzewieniu pa-
sowym było modyfikowane przez sąsiadujące z nim
lasy. Zarówno zagęszczenie, jak i biomasa na skrajach
zadrzewienia w pobliżu lasów były wyższe, niż w
środkowej części zadrzewienia (ryc. 9). Dotyczyło to
zarówno całości zgrupowania ptaków, jak i grup tro-
ficznych.

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