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Birds inhabiting organic and conventional farms in Central Poland

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Abstract. A study conducted in Central Poland showed that organic farming is more beneficial to birds of the agricultural landscape when compared to conventional farming. The abundance of breeding pairs and species richness were higher on organic farms. Bird communities on organic farms were more diverse and balanced as far as the contribution of habitat specialists and generalists is concerned. The study also indicated that organic farms provided better conditions for representatives of nesting, foraging and habitat groups of birds as opposed to conventional farms. The observed differences were mainly due to the more heterogeneous landscape of organic farms. The number of breeding species was positively correlated with the relative density of edge zones of ecosystems. The following species: Ortolan Bunting *Emberiza hortulana*, Great Tit *Parus major*, Whitethroat *Sylvia communis* and Starling *Sturnus vulgaris* were among those which particularly benefited from organic farming.

Key words: Bird communities, breeding season, species richness, organic farming, agricultural landscape.

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I. INTRODUCTION

Intensive farming practices are considered to be one of the main reasons of population declines observed for many bird species in Europe (JENNY 1990; ROBERTSON & BERG 1992; CRICK et al. 1998; SIRIVARDENA et al. 1998; TRYJANOWSKI 1999; WEGLER & WIDMER 2000; HOLE et al. 2005). Contrary to the conventional system, organic farming is not only regarded as one of the basic tools of sustainable development of agricultural areas, but also as supportive to farmland wildlife (HOLE et al. 2005). Organic farming significantly contributes to the limitation of the use of chemicals (artificial fertilisers, pesticides) and supports landscape heterogeneity, e.g. by mixed farming, traditional rotations resulting in greater diversity of land use; maintenance of hedgerows, bushes, trees and field margins within the farmland resulting in higher densities of small biotopes (LEVIN 2007). One of the general principles of organic production refers to enhancement of agricultural ecosystems and conservation of biodiversity (IFOAM 2006). Organic farmers are encouraged to support wildlife by conserving ecologically relevant habitats such as extensive grasslands, meadows, wetlands and various landscape elements like hedges, hedgerows, groups of trees, bushes, as well as rich field margins. More diverse ecosystems show a higher level of self-regulatory processes, and consequently can function in terms of limited human help. Many groups of organisms benefit from organic agriculture. Hole et al. (2005) summarized available data concerning the impact of this type of farming system on biodiversity and showed that the majority of analysed taxa find better habitats on organic farms as compared to conventional ones.

Birds, being subject to intensive studies, are among those animals that are positively influenced by organic farming. Several studies reported greater bird abundance and species richness on organic farms in comparison to conventional farms (Brae et al. 1988; Berg & Pärt 1994; Christensen et al. 1996; Fuller 1997; Lokemoen & Beiser 1997; Wilson et al. 1997; Chamberlain et al. 1999; Freemark & Kirk 2001; Beecher et al. 2002; Kragten et al. 2008). Most species were more abundant on organic farms, with a relatively low number showing an opposite trend. Compared with conventional agriculture, organic farming significantly increases the likelihood of higher bird densities (Flade et al. 2008).

However, in Poland, where conventional agriculture is relatively extensive, such comparisons have not been performed to date. One could expect differences compared to the situation in countries that are characterized by more intensive agriculture. The aim of this paper was to compare breeding bird communities on Polish farms differing in agricultural system (organic vs. conventional). We selected species for which organic farming could increase their abundance to the highest degree.

II. STUDY AREA AND METHODS

The study was conducted in the western part of the Mazovian province (Central Poland), ca. 80 km from Warsaw. The study area was located on lowlands characterized by low relative altitudes and mild slopes. Land use was typical for the rural landscape of this part of Poland (mosaic of cultivated land, meadows and pastures). The most frequently cultivated plants were cereals. Five pairs of farms, organic and conventional, bordering each other, were selected. The chosen farms were similar with regard to cultivation structure. The study plots varied from 10 to 12 ha in size. Different heterogeneous elements of landscape influencing local biocenoses, such as groups of trees, tree lines, bushes, hedges, ponds and melioration ditches were identified in both groups of study plots (Table I). In the case of three pairs of farms under study, the length of borders (edge zones) between different ecosystems, e.g. water bodies, crop fields, orchards, wooded areas or tree lines, built-up areas (the density of edge zones) was determined as a measure of landscape heterogeneity.

Table I

Presence of elements influencing landscape heterogeneity on organic and conventional farms

Landscape elements	Organic Farms					Conventional Farms				
	OF 1	OF 2	OF 3	OF 4	OF 5	CF 1	CF 2	CF 3	CF 4	CF 5
Group of trees	+	+		+						
Bushes	+	+	+	+	+	+		+		+
Tree line	+	+	+	+	+	+	+	+	+	+
Stream; Watercourse	+		+	+						
Pond			+	+						
Hedge		+		+						
Orchard	+	+	+	+	+	+	+	+	+	+

A mapping method was used in order to determine the number of breeding pairs. During the study period (April 15-June 27, 2004) at least 5 counts were performed on each study plot – farm (on some study plots up to 8 counts were conducted, in order to verify previously made assumptions – preliminary observations). Birds were observed in the morning hours, therefore no information was obtained on the presence of species whose flying activity occurs mainly at night.

For territorial species the results of all counts were combined on a single map, i.e. clusters of records indicated individual territories. The presence of a breeding pair was confirmed by at least a three-time record of a singing male. A pair was counted as 0.5 if the territory of a breeding pair was not entirely located within the boundaries of a given study plot. For colonial nesters, such as e.g. House Sparrow *Passer domesticus*, Starling *Sturnus vulgaris*, Swallow *Hirundo rustica*, the number of breeding pairs was determined on the basis of inhabited nests (or sites with nests) at the beginning of the breeding season (April, May).

The occurrence of birds within the study plots was shown separately for two areas within a farm, differing in use and character. The first area, comprised of dwellings and farm buildings as well as adjacent gardens, was called the housing zone; the second, comprised of crop fields, meadows and orchards, was labeled as the cultivation zone.

Within the identified bird communities, the contribution of different bird species in relation to nest location, foraging and habitat requirements (the so called preference fulfillment structure of bird communities) was evaluated. Nesting, foraging and habitat groups of birds were distinguished (TOMIAŁOJĆ 1970; WUCZYŃSKI 1995) and compiled in order to present their contribution to the bird communities of organic and conventional farms (Table II).

Table II

Comparison of median values of densities (pairs/10 ha) of different nesting, foraging and habitat groups of birds identified within bird communities of organic and conventional farms, N = 5 (statistically significant differences in bold)

Ecological group*	Organic farms	Conventional farms	Z	Significance (P)
H	8.2	1.6	**2.61**	**0.01**
T	6.9	1.7	**2.48**	**0.01**
S	5.1	2.1	**2.63**	**0.01**
GR	10.0	6.7	1.16	0.25
B	8.9	6.5	1.26	0.21
I	17.8	7.4	**2.61**	**0.01**
G	10.3	4.7	**2.20**	**0.03**
IG	10.0	6.5	1.78	0.08
O	0.8	0.0	1.93	0.05
C	0.2	0.0	1.0	0.32
F	4.5	0.2	**2.48**	**0.01**
FM	8.1	3.3	**2.51**	**0.01**
HD	10.0	6.5	1.36	0.18
OA	9.1	6.9	0.52	0.60

* H – nesting in hollows, T – nesting on trees, S – nesting in shrubs (bushes, hedges), GR – nesting on the ground, B – nesting on buildings, I – insectivorous, G – granivorous, IG – feeding on insects and grains, O – omnivorous, C – carnivorous, F – forest related, FM – forest margin related, HD – human dwelling zone related, OA – open areas related.

Taking into account the relation to the agricultural landscape and the level of habitat tolerance, two groups of birds (specialists and generalists) were identified (TOMIAŁOJĆ 1970; DOMBROWSKI & GOŁAWSKI 2002).

Breeding species relation to the housing and cultivation zones was evaluated basing on the dependence index, which was calculated according to the following equation:

$$D_i = (p_z \times 100)/\Sigma p_t$$

where p_z is the number of pairs of a given species breeding in a certain zone and p_t is the total number of breeding pairs of a given species.

The domination of certain species was evaluated within the bird communities. Species was considered as dominant when the number of its breeding pairs attained at least 5% of the total number of breeding pairs of the given bird community.

The Mann-Whitney U test was used to compare avian characteristics between organic and conventional farms. The SPEARMAN rank correlation coefficient (r_s) was calculated to estimate the relationship between the measure of landscape heterogeneity and bird density or species richness. The adopted significance level was $P = 0.05$.

III. RESULTS

In the study area 39 bird species were recorded as breeding within the monitored plots. Among all identified species as many as 17 were noted only on the organic farms. Both overall density and number of breeding pairs were significantly higher on the organic farms under study. The differences in the number of bird species showed a similar pattern, both when considering the farm space as a whole and when comparing the separate study plots' areas: the housing and cultivation zone, in which considerable differences between the number of breeding species were noted in favour of the organic farms. The median value of the number of breeding species as well as the overall density were over two times higher on the organically managed farms (Table III). Species considered as dominant in the analysed communities of birds on both types of farms are as follows: House Sparrow, Skylark *Alauda arvensis*, Swallow, Corn Bunting *Emberiza calandra* and to a lesser extent

Table III

Comparison of median values of selected avian characteristics between organic and conventional farms, N = 5 (statistically significant differences in bold)

Avian characteristic	Organic farms	Conventional farms	Z	Significance (P)
Overall density*	39.2	18.6	**2.61**	**0.01**
Number of species	22.4	11.0	**2.62**	**0.01**
Number of species (housing zone)	13.4	6.0	**2.62**	**0.01**
Number of species (cultivation zone)	13.2	5.0	**2.62**	**0.01**
Specialists (number of species)	10.0	6.4	2.01	0.05
Generalists (number of species)	12.4	4.6	**2.53**	**0.01**
Density of specialists*	16.4	11.0	1.78	0.08
Density of generalists*	22.8	7.8	**2.64**	**0.01**

* pairs/10 ha

Tree Sparrow *Passer montanus*, Yellow Wagtail *Motacilla flava* and Chaffinch *Fringilla coelebs*. On the organic farms, additionally the following species were included into the group of dominants: Whitethroat *Sylvia communis*, Great Tit *Parus major*, Blue Tit *Cyanistes caeruleus* and Starling.

The differences in the median density and the number of species with a wider habitat toleration range (generalists), were statistically significant in favour of organic farms. Habitat specialists showed a similar trend, although this was not statistically supported (Table III).

As for the nesting and habitat demands of breeding species, the preference fulfillment structure of bird communities was more diverse, complex and balanced on the organic plots contrary to the conventional ones, where the contribution of different nesting or habitat groups of birds was minor (Table II). Significantly higher densities, in favour of organic farms, were recorded in the case of birds nesting in hollows, shrubs and on trees. A greater abundance of ground nesting birds (dominating in the communities of the studied plots), was not statistically relevant.

The contribution of different foraging groups of birds was relatively similar on the compared plots, however, their representatives were much more numerous on the organic farms. Insectivorous and granivorous birds were more abundant on the organic farms, where their median density was at least two times higher in comparison to the conventional farms. Contrary to the conventional plots, representatives of omnivorous and carnivorous birds were detected on the organic farms. As for species habitat preferences, higher levels of densities on the organic farms were confirmed for the forest related species as opposed to the conventional farms. While on the organic farms the bird communities were relatively equally represented by birds with different habitat preferences, the conventional farms were inhabited mainly by two dominating groups: open area and human dwelling zone related birds.

Four species among those confirmed in the analysed bird communities were positively influenced by organic agricultural practices in general. Median densities of these species were significantly higher on the organically managed plots, with the strongest indication for Great Tit (Table IV). Densities of other species identified within the conventional and organic farms (with the exception of Skylark) showed noticeable differences in favour of the organic plots, however, they were not statistically supported.

Table IV

Comparison of median values of density (pairs/10 ha) of the selected species on organic and conventional farms, N = 5 (statistically significant differences in bold)

Species	Organic farms	Conventional farms	Z	Significance (P)
House Sparrow *Passer domesticus*	5.7	2.9	1.59	0.11
Skylark *Alauda arvensis*	3.3	3.4	0.32	0.75
Whitethroat *Sylvia communis*	2.7	0.9	**2.22**	**0.03**
Chaffinch *Fringilla coelebs*	2.4	0.9	1.80	0.07
Great Tit *Parus major*	2.2	0.2	**2.48**	**0.01**
Corn Bunting *Emberiza calandra*	1.8	0.9	1.27	0.21
Starling *Sturnus vulgaris*	1.6	0	**2.22**	**0.03**
Whinchat *Saxicola rubetra*	0.9	0	1.93	0.05
Ortolan Bunting *Emberiza hortulana*	0.8	0.1	**2.02**	**0.04**
Yellowhammer *Emberiza citrinella*	0.6	0	**1.18**	**0.24**

Species exclusively noted on organic farms included among others: Whinchat *Saxicola rubetra*, Starling, Lesser Whitethroat *Sylvia curruca*, Blackcap *Sylvia atricapilla*, Greenfinch *Carduelis chloris*, Blue Tit and Short-toed Treecreeper *Certhia brachydactyla*. Only results for the Starling appeared to be statistically important. In the case of Whinchat the results were relatively close to the significance level.

The breeding of certain species was connected with either the housing and cultivation zones. Because housing and cultivation zones provided different habitat and foraging conditions, the structures of their bird communities varied, regardless of whether it was on an organic or a conventional farm. The results showed that some species bred exclusively within either housing or cultivation zone, being solely dependent on one zone (Table V).

Table V

Chosen species most frequently breeding in housing and cultivation zones of farms under study, with dependence index (D_i) reflecting their connection to one of the zones

Species	Total number of pairs	D_i [%]	
		Housing zone	Cultivation zone
House Sparrow *Passer domesticus*	45	100.0	0
Swallow *Hirundo rustica*	22	100.0	0
Black Redstart *Phoenicurus ochruros*	7	100.0	0
White Wagtail *Motacilla alba*	5	100.0	0
Fieldfare *Turdus pilaris*	5	100.0	0
Greenfinch *Carduelis chloris*	4	100.0	0
Icterine Warbler *Hippolais icterina*	7.5	91.3	8.7
Chaffinch *Fringilla coelebs*	18	82.6	17.4
Goldfinch *Carduelis carduelis*	4	80.0	20.0
Starling *Sturnus vulgaris*	9	73.3	26.7
Woodpigeon *Columba palumbus*	6	62.5	37.5
Great Tit *Parus major*	13	62.5	37.5
Lesser Whitethroat *Sylvia curruca*	5	57.1	42.9
Tree Sparrow *Passer montanus*	17	54.2	45.8
Whitethroat *Sylvia communis*	21	51.9	48.1
Blue Tit *Cyanistes caeruleus*	10	45.5	54.5
Yellowhammer *Emberiza citrinella*	4.5	40.0	60.0
Skylark *Alauda arvensis*	35.5	0	100.0
Corn Bunting *Emberiza calandra*	15	0	100.0
Yellow Wagtail *Motacilla flava*	13	0	100.0
Ortolan Bunting *Emberiza hortulana*	5.5	0	100.0
Whinchat *Saxicola rubetra*	5	0	100.0
Partridge *Perdix perdix*	5	0	100.0

The comparison made for the three pairs of farms in order to assess the correlation between landscape heterogeneity measured by the relative density of edge zones within the farm and the number of species as well as the overall density showed that farms (especially organically managed) with a diverse landscape (having more biocenosis enhancing elements) had a considerably higher number of breeding species and their densities (Table VI). The relationship between the number of species (1) or the overall density (2) and the relative density of edge zones (3), calculated for the three pairs of organic and conventional farms was significant in the case of (1) vs. (3): $r_s = 0.89$, $P = 0.02$, $N = 6$, and not significant in the case of (2) vs. (3): $r_s = 0.66$, $P = 0.16$, $N = 6$.

Table VI

The influence of the relative density of edge zones on the species richness and the overall density within organic and conventional farms, N = 6

Study plot*	Density of edge zones [km/100 ha]	Number of species	Overall density [pairs/10 ha]
OF 1	46.9	23	46.0
OF 2	51.1	26	34.6
OF 3	56.2	24	44.5
CF 1	47.3	15	23.0
CF 2	32.7	7	15.0
CF 3	34.7	8	17.0

* OF – organic farm; CF – conventional farm.

IV. DISCUSSION

The results of this study support the hypothesis that the organic agricultural system positively influences breeding bird communities (BRAE et al. 1988; CHRISTENSEN et al. 1996; LOKEMOEN & BEISER 1997; CHAMBERLAIN et al. 1999; FREEMARK & KIRK 2001; BEECHER et al. 2002). Differences in the overall abundance and species richness between organic and conventional farms found in this study attained a similar level (more than double) as reported by BEECHER et al. (2002). The diversity within different nesting, foraging and habitat groups resulted in higher values of overall density and number of breeding species. Significantly more diverse bird preference fulfillment structure identified within the bird communities of organic farms, may be, among others, the result of higher densities of small biotopes recorded on organic farms.

Landscape heterogeneity is one of the main factors responsible for the differences in avian characteristics between organic and conventional farms. The presence of landscape elements such as water bodies, trees, shrubs and hedges improves breeding conditions of farmland habitats and attracts birds. This is justified by the results showing that species that benefited the most were those connected with trees and shrubs (Great Tit, Starling and to a lesser extent Ortolan Bunting *Emberiza hortulana* and Whitethroat).

The comparison of the three pairs of farms, taking into consideration the relationship between species abundance and densities of edge zones, showed that the landscape complexity factor could be responsible for the obtained differences. The farms (especially organically managed) having a more diverse landscape and greater contribution of different biocenosis enhancing elements (as indicated in Table I), as well as higher values of edge zone densities, showed larger numbers of breeding species (Table VI).

Landscape diversity of organic farms has been mentioned as an important factor for some bird species (e.g. Yellowhammer *Emberiza citrinella*, Linnet *Carduelis cannabina*, Tree Sparrow) providing better foraging, shelter and nesting grounds (CHAMBERLAIN et al. 1999; FREEMARK & KIRK 2001). In this study the generalists were the group of species which greatly benefited from organic farms and their diverse landscape. The statistically significant advantage in the number of species and abundance of generalists shows that organic farms support species originally connected with forest margins in agricultural areas.

The attractiveness and value of a given habitat can also be measured by the presence of a sufficient and complex foraging background. One of the concepts of organic agricultural systems is banning synthetic pesticides and fertilisers (IFOAM 2006). The exclusion of chemicals is particularly supportive to farmland biodiversity and has a beneficial influence on the flora and fauna of cultivated areas and edge biotopes (HOLE at al. 2005, PETERSEN et al. 2006, LEVIN 2007). The absence of pesticide and artificial fertiliser inputs can result in a relatively rich bird foraging background (environment) consisting of nutritional resources of both plant and animal origin, making organic farms more suitable bird habitats.

Several studies showed that greater abundance and diversity of potential bird food (invertebrates and plants), resulting from organic management, was the main reason for the obtained differences in avian characteristics (CHRISTENSEN et al. 1996; FREEMARK & KIRK 2001). CHAMBERLAIN and WILSON (2000) confirmed that the lack of pesticides may result in higher density levels of insectivorous birds, due to a more abundant food base – invertebrates (WILSON et al. 1997). As this study shows, densities of insectivorous birds were remarkably higher on the farms managed in an organic way, however, not enough data on this issue was collected and the indication could also result from other factors.

Many studies have indicated that organic farms are more supportive for ground-nesting, cultivated crop field species. According to WILSON et al. (1997) Skylark had a greater breeding success and density on organic farms situated in English agricultural areas. KRAGTEN et al. (2008) noted a similar trend for this species while conducting research in the Netherlands, where Skylark nest density was seven times higher on organic farms in comparison to conventional farms. The authors found reason for this situation in the diversity of cultivated cereals. Differences in crop types between organic and conventional farms were also identified as the factor responsible for higher densities of Skylark on organically managed plots in the Netherlands (KRAGTEN & DE SNOO 2008).

This study showed that the representative of the ground-nesting, cultivated crop field species, the Skylark, was not influenced by the type of farming system in Central Poland. A similar trend should be also observed for Corn Bunting, a species with similar habitat requirements. Its density was higher on the organic farms, however, this was not statistically supported. The lack of differences in densities of this species on the organic and conventional farms in Central Poland could be the outcome of extensive farming predominating in this region, in which farms are characterised by similarity of crops and rather diverse cultivation. The difference between organic and conventional farms in Central Poland is not as strongly defined as it is e.g. in England or in the Netherlands where widespread monocultures are present. The plots under study were characterised by similar cultivated crops and land use, which could be the key reason for this outcome.

Considering the decline of bird populations in agricultural landscapes observed e.g. in Germany, organic farming as well as extensive pastoral agriculture have been suggested as key factors in the strategy that would halt the decline of biological diversity on agricultural land (FLADE et al. 2008). According to HOLE et al. (2005) the data collected so far shows that organic farming could play a significant role in increasing biodiversity across lowland farms in Europe. The results of this study, showing that organically managed plots have greater bird abundance and species richness, are in line with the aforementioned thesis. They are also in accordance with the conclusion of FREEMARK and KIRK (2001) that both habitat and agricultural practices are important in explaining bird species composition and abundance and should be taken into account while establishing conservation strategies.

Organic production in Poland is still under considerable development (GIJHARS 2008). According to the Agricultural and Food Quality Inspection (2008) the overall number of organic producers in Poland increased from 3760 in 2004 up to 15158 in 2008. In the Mazovian province, where the study plots were located, the number of organically managing producers increased from 849 in 2005 to 1200 in 2007. This dynamic growth may in consequence contribute to the improvement of habitat conditions for birds of the agricultural landscape and biodiversity as such, however, it is probably to early to state that results of this study are applicable to future comparisons of organic and conventional farms in Poland. Further studies are needed to investigate the impact of organic agriculture on bird communities in Poland (not only for the breeding season), as the results presented in this paper are the first and should thus be considered preliminary.

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