ACTA ORNITHOLOGICA
Vol. 33 (1998) No. 3–4

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Bird communities of intensively cultivated fields in North-eastern Slovenia

Vogrin M., Vogrin N. 1998. Bird communities of intensively cultivated fields in North-eastern Slovenia. Acta orn. 33: 173–179.

Abstract. Species richness and density of bird communities on intensively cultivated acres in relation to habitat characteristics were studied on the basis of counts in 15 fields (5–69 ha) situated on Dravsko Polje (46°25'N, 15°45'E), North-eastern Slovenia. There were three groups of fields: those covered with wheat, sugar-beet and maize. On average, ten bird species bred on intensive cultivated areas. Six of these occurred in all three field groups. The density of bird population ranged from 0 to 11.6 pairs/10 ha, averaging 2.93 pairs/10 ha. Only two species (*Alauda arvensis* and *Saxicola torquata*) were amongst the dominants in all three kinds of fields. The highest densities were on wheat fields but the differences among field categories were not significant (Kruskal-Wallis test). The number of species and bird population density did not dependent on the area of a particular field or nor relative edge length.

Key words: bird communities, cultivated fields, Skylark *Alauda arvensis*, Stonechat *Saxicola torquata*, Slovenia

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Received — Nov. 1997, accepted — July 1998

INTRODUCTION

Birds living in agricultural habitats are especially affected by human activity. Over the last hundred years there have been considerable changes in farming practice, and many bird species that formerly accepted extensive agriculture, nowadays seem to be adversely affected by modern intensive methods (e.g. Bezzel 1982, Gates *et al.* 1994). Many ecological studies have concerned bird communities of intensively cultivated fields (e.g. Pain & Pienkowski 1997 and references therein); however, most of them refer to north and western Europe.

About 32% of the Slovenia land area is cultivated, however, bird assemblages of fields in this country are poorly known so far.

The present study demonstrates the species composition, species richness, bird population density, and the impact of some habitat factors in various kinds of fields studied.

STUDY AREA

The study fields were situated on Dravsko Polje — Drava field (46°25'N, 15°45'E) in North-eastern Slovenia between the Drava river and Mt. Pohorje at an altitude from 238 m to 270 m. Dravsko Polje belongs to the sub-Pannonic phytogeographical area (Marinček 1987). The climate is modified continental with mean annual rainfall 1000 mm; mean temperature: 8C° (Furlan 1990).

Regulation of Polskava stream and its tributaries and drainage of marshy and flood areas (about thirty years ago) of Dravsko Polje have caused decline of many natural habitats. Dravsko Polje is today one of the most intensively managed agricultural areas in Slovenia. In this part of Slovenia very few wetlands have been preserved (Vogrin 1996, 1997).

On the studied part of Dravsko Polje the modernisation of farming has led to a homogeneous landscape of large fields with drainage channels, lacking hedges and other kinds of edge vegetation. Farmers grow here

mainly corn, cereals, potatoes and sugar-beets. Artificial fertilisers and pesticides have been used in enormous quantity (author's data).

Altogether, 15 fields, ranging from 5 to 69 ha, with a total area of 303.9 ha were surveyed (Tab. 1): 145 ha (7 fields) with wheat, 87.4 ha (4 fields) with maize and 71.5 ha (4 fields) with sugar-beets. The field types (i.e. crops) are representative of the agriculture in the region. Plots studied were selected without prior knowledge of bird communities.

Table 1. Characteristics of fields studied on Dravsko Polje.

[Tabela 1. Charakterystyka badanych pól.]

No.	ha	Characteristics of field
1	18	Wheat, field surrounded with ditches with some *Typha* sp. and some bushes of *Salix* sp., without clearings between wheat
2	35.8	Wheat, field surrounded with ditches with some *Typha* sp. and some bushes of *Salix* sp., small clearings between wheat, *Cirsium arvense* and *Rumex* sp. between wheat
3	8	Wheat, without ditches and clearings
4	38.5	Wheat, field surrounded with ditches with some *Typha* sp., small clearings between wheat, *Cirsium arvense* between wheat
5	20.7	Wheat, field surrounded with ditches, *Cirsium arvense* between wheat
6	12	Wheat, field surrounded with ditches
7	12	Wheat, small clearings
8	15	Sugar-beet, field surrounded with ditches with some *Typha* sp. and some bushes of *Salix* sp., small clearings between sugar-beet
9	24.5	Sugar-beet, field surrounded with ditches without *Typha* sp. and bushes, small clearings between sugar-beet
10	26	Sugar-beet, field surrounded with ditches with some *Typha* sp. and some bushes of *Salix* sp., small clearings between sugar-beet
11	6	Sugar-beet, field surrounded with, small clearings between sugar-beet
12	5	Maize, field surrounded with other fields with sugar-beet and wheat
13	7.4	Maize, field surrounded with ditches with some *Typha* sp., small clearings between maize
14	69	Maize, field surrounded with ditches with some *Typha* sp., small clearings between maize
15	6	Maize, small clearings between maize

METHODS

The density and composition of fifteen bird communities in the fields were estimated by using the territory mapping method (Bibby *et al.*1992), during the breeding period (mid April – mid June) 1997. All birds encountered and their activity were recorded on a map of the field. Each field was visited four times between dawn and 10 a.m., avoiding days with rain or strong winds. Searching for nests was used as a routine part of the census procedure. Several fields (2–4) were censused during the same morning in random sequence to avoid effects of time and temperature on the conspicuousness of the birds. The territory mapping method is less suitable for birds breeding in colonies or semi-colonial ones. Such species, i.e. Lapwing *Vanellus vanellus*, was censused separately (Vogrin 1998). With only four visits, the breeding population was likely to have been underestimated (e.g. Bellamy *et al.* 1996, Hinsley *et al.* 1996).

Bird visitors (e.g. Grey Heron *Ardea cinerea*, Common Buzzard *Buteo buteo*, Hooded Crow *Corvus corone cornix*, Starling *Sturnus vulgaris*) were disregarded. For species that breed in ditches (e.g. Marsh Warbler *Acrocephalus palustris*) only half of their territory was taken into consideration. The Black-headed Wagtail *Motacilla feldegg* was considered as an independent species according to Gantlett *et al.* (1996).

Fields were divided into three groups: wheat fields, sugar-beets and maize, and then into two further groups: fields surrounded with ditches and fields without ditches.

The following designations and indications were used:

1) Index of diversity, according to Shannon-Wiener's formula (Heyek 1994) was calculated: $H' = -\Sigma P_i \times \ln P_i$, $P_i = n_i/N$, where H' denotes the size of information expressed in bits per individual in the set of

species examined, n is the number of individuals of each species in the set examined, N is the total number of individuals of all species in a community.

2) The structure of species domination within a community (evenness or equitability) — Je was determined by Pielou (1966) formula: Je = H'/ln S, where H' is Shannon-Wiener's index, S is the number of species.

3) For quantitative comparisons of bird communities, the Soerensen index (QS) was applied: QS = 2c/(a + b) x 100 (Tomiałojć *et al.* 1984), where c is the common part of the sets, a is the size of the first set, and b is the size of the second set. The value of QS exceeding 80% indicates a great similarity of the communities (Biaduń 1994).

4) The Renkonen index (Re), is calculated from the formula $Re = \Sigma d_{i\,min}$, where $d_{i\,min}$ is the smallest value of the dominance of a particular species in two communities under comparison. The value of Re exceeding 70% indicates a great similarity of the communities (Tomiałojć *et al.* 1984, Biaduń 1994).

5) A measure of niche breadth using Hurlbert's (1978) standardised formula was calculated for all breeding species: $B_A = (nB - 1) (n - 1)$, where B represents Levin's measure of niche breadth and n represents the number of possible resource states. Values of this index range from 0 to 1, with greater values indicating a broader niche.

6) For studying the relation between density and edge length, relative edge length (supposing that fields are squares) was calculated according to Suhonen & Jokimäki (1988): $REL = 400 \times \sqrt{A}/A$ (m/ha), where A is the field area in hectares.

7) Statistical analyses were performed with non-parametric tests (Kruskal-Wallis and Mann-Whitney U tests), since data were not normally distributed (Sokal & Rohlf 1995). Spearman rank correlation was used. All statistical tests were performed with the SPSS 6.0 statistical package. A p-value < 0.05 was considered significant.

RESULTS AND DISCUSSION

A total of 10 nesting species was found on 14 agricultural fields, one wheat field was without birds (Tab. 2). Six of these species (i.e. Quail *Coturnix coturnix*, Skylark *Alauda arvensis*, Blue-headed Wagtail *Motacilla flava*, Stonechat *Saxicola torquata*, Marsh Warbler and Common Whitethroat *Sylvia communis*) occurred in all three kinds of fields. The density of birds on the fields studied ranged from 0 to 11.6 pairs/10 ha, averaging 2.9 pairs/10 ha.

Eight of the breeding species were recorded as dominants on particular fields, but only two — Skylark and Stonechat — were amongst the dominants in all three kinds of fields.

The bird densities were highest on the wheat fields; however, the differences among fields were not significant (Kruskal-Wallis test = 1.37, df = 2, p > 0.05). The bird densities were highest on the fields without

Table 2. Breeding population density and dominance (%) in fields studied.

[Tabela 2. Zagęszczenia par lęgowych i dominacja (%) na badanych polach.]

Species	Wheat (145 ha)		Sugar-beet (71.5 ha)		Maize (87.4 ha)	
	p/10 ha	%	p/10 ha	%	p/10 ha	%
Coturnix coturnix	0.2	5	+	2	+	3
Vanellus vanellus	–	–	1.9	58	0.5	24
Charadrius dubius	–	–	–	–	0.1	6
Alauda arvensis	0.2	5	0.6	17	0.4	24
Motacilla flava flava	+	2	–	–	–	–
Motacilla f. cinereocapilla	0.9	27	0.1	4	0.1	6
Motacilla feldegg	0.3	8	0.1	4	–	–
Saxicola torquata	1.1	33	0.2	6	0.4	21
Acrocephalus palustris	0.6	17	0.1	4	0.2	12
Sylvia communis	+	1	0.1	4	+	3
Emberiza citrinella	+	2	–	–	–	–
Pairs/10 ha	3.7		3.4		1.9	
No. of species	8		8		8	
Diversity (H')	1.71		1.13		1.81	
Evenness (J')	0.82		0.54		0.87	

ditches, but differences were not significant (Mann-Whitney U test = 18.0, $p > 0.5$). The species diversities were highest on the maize fields; however, the differences among fields were not significant (Kruskal-Wallis test = 2.36, df = 2, $p > 0.05$). The differences were also not significant between fields surrounded with ditches as against fields without ditches (Mann-Whitney U test = 11.5, $p > 0.05$).

The highest densities of breeding species were noted for Stonechat and Lapwing on wheat fields and sugar-beets respectively. The dominant species of the total data set, Skylark and Stonechat, together comprised more than a third of the total number of pairs.

The most abundant species were Stonechat and Skylark. The differences between densities of Quail, Skylark, Blue-headed Wagtail, Stonechat and Marsh Warbler on wheat fields, sugar-beets and maize were not significant (Kruskal-Wallis test).

The density of breeding birds on fields on Dravsko Polje was low compared with densities in some other agricultural areas in Central Europe (e.g. Jermaczek & Tryjanowski 1990, Kujawa 1994, Tryjanowski 1996). However, we must take into account that most authors also censused birds that breed in various hedges (e.g. Berg & Pärt 1994, Kujawa 1994), which have well known positive affects on the abundance of breeding birds (e.g. Solonen 1985, Robertson & Berg 1992, Kujawa 1994).

Haila *et al.* (1980), censused arable fields in SW Finland, Jermaczek & Tryjanowski (1990) and Tryjanowski (1996) in western Poland. They obtained a total density of 12.8, between 2.0 and 22.7 and 6.3 pairs/10 ha respectively. Their data, because of the method applied, includes species that certainly do not breed on the fields (e.g. Spotted Flycatcher *Muscicapa striata*, Chaffinch *Fringilla coelebs*, Black Redstart *Phoenicurus ochruros*, Starling, Tree Sparrow *Passer montanus*, Blackbird *Turdus merula*). If these species are excluded from the comparison, the results are fairly similar.

The problem is so low number of breeding species and average bird density on the fields studied. Pesticides, which are used in enormous quantities on intensively cultivated fields, could reduce the supply of invertebrate food for the youngs of such birds as the Grey Partridge *Perdix perdix* (e.g. Blank *et al.* 1967) and probably also most of the above mentioned insectivorous species which were found to breed on the intensive fields. Use of herbicides can also reduce the quality of remaining habitats (e.g. hedges, herbaceous strips; author's data) which are important as nesting places, singing posts and foraging places for many birds, e.g. Yellowhammer *Emberiza citrinella* (Biber 1993), Skylark (Schläpfer 1988).

When comparing the densities of particular species, e.g. Stonechat, Blue-headed Wagtail, and Skylark with densities in some other open areas in Slovenia and abroad, e.g. in wet meadows (Chmielewski *et al.* 1993, Trontelj & Vogrin 1993, Trontelj 1994, Vogrin 1996 and references therein), we can ascertain that densities of these species are in Dravsko Polje, surprisingly, the same or even higher. On set-aside fields near Aberdeen (Watson & Rae 1997), densities of several species were on average much higher than on Dravsko Polje. However, the densities of Lapwing on particular fields, i.e. maize and sugar-beets fields were almost identical (Vogrin 1998).

Among the breeding species, seven species were migratory, and two of them are only short distance migrants, occasionally wintering in Slovenia. Six species belong to the insectivorous thropic group and four species are omnivorous.

Measures of niche breadth (Hurlbert 1978; Tab. 3, Fig. 1) showed that the Skylark and Common Whitethroat had the broadest niches, while the Little Ringed Plover *Charadrius dubius*, Yellowhammer and Blue-headed Wagtail had the narrowest. Skylark and Stonechat were typical species of cultivated fields (Schläpfer 1988, Jenny 1990, author's data). The Skylark was a species typical of all kinds of fields in some clearings (Fig. 1), while Stonechat preferred relatively open fields with scattered bushes in ditches and *Cirsium arvense* between cereals. The Blue-headed Wagtail preferred wheat fields, whereas the Lapwing and Little Ringed Plover occur only on fields with low vegetation. The vegetation, if present, for both species must not be high enough to impede walking or block the view. Common Whitethroat was not so dependent on the kind of fields but on bushes around the fields — even one is enough (author's data). Frequency (%) of occurrence of breeding species in types of fields is presented in Fig. 1. All species, which were found to breed in the fields, nested on the ground or in the lower parts of shrubs.

There was identical species composition on wheat and sugar-beets fields versus sugar-beets and maize

fields. Comparison between wheat fields and maize fields showed clear similarity (QS 60 — 80%). The Renkonen index revealed clear similarity (Re > 50%) in comparison between maize fields and sugar-beets fields however, breeding communities were markedly different (Re < 50%) between fields with wheat and sugar-beets and between wheat and maize.

Table 3. Standardised niche breadth — (B_A) of breeding species.

[Tabela 3. Ujednolicona pojemność nisz — (B_A) gatunków.]

Species	B_A
Alauda arvensis	0.94
Sylvia communis	0.84
Coturnix coturnix	0.41
Acrocephalus palustris	0.38
Saxicola torquata	0.32
Vanellus vanellus	0.27
Motacilla feldegg	0.24
Motacilla flava cinereocapilla	0.16
Charadrius dubius	0
Motacilla flava flava	0
Emberiza citrinella	0

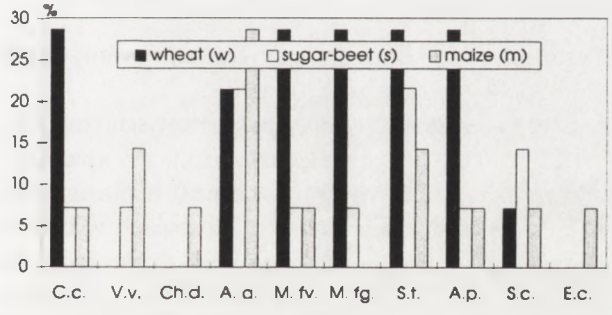

Fig. 1. Frequency (%) of occurrence of breeding species in types of fields studied. C.c. — *Coturnix coturnix*, V.v. — *Vanellus vanellus*, Ch.d. — *Charadrius dubius*, A.a. — *Alauda arvensis*, M.fv. — *Motacilla flava*, M.fg. — *Motacilla feldegg*, S.t. — *Saxicola torquata*, A.p. — *Acrocephalus palustris*, S.c. — *Sylvia communis*, E.c. — *Emberiza citrinella*.

[Ryc. 1. Częstość występowania (%) gatunków lęgowych w różnych typach badanych pól.]

In spite of the great similarity in species composition and the structure of dominance between the communities of birds inhabiting the three kinds of fields, the changes were noticeable. They affected both the species composition, although the numbers of breeding species were the same, and the number of individuals in particular species, e.g. Lapwing, Blue-headed Wagtail, Stonechat.

Surprisingly, the number of species was not dependent on the area of a particular field ($r_s = 0.42$, $p > 0.05$) or on the relative edge length ($r_s = -0.42$, $p > 0.05$) as was ascertained for forest areas (e.g. Haila *et al.*1983, Martin 1983, Suhonen & Jokimaki 1988, Cieślak & Dombrowski 1993, Solonen 1996). Moreover, a negative correlation between bird density and field area exists, although the correlation was not significant ($r_s = -0.18$, $p > 0.05$). Density was positively correlated with relative edge length but correlation was not significant ($r_s = 0.18$, $p > 0.05$); this is in contradiction with a previous study (e.g. Solonen 1985).

ACKNOWLEDGEMENTS

We thank Dr R. J. Fuller and reviewer for constructive comments on earlier versions of the manuscript. We greatly appreciate the help of Dr V. Kennedy, who made the necessary corrections to the English grammar.

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STRESZCZENIE

[Zgrupowania ptaków intensywnie uprawianych pól w północno-wschodniej Słowenii]

Łącznie w Dravsko Polje (północno-wschodnia Słowenia) zbadano awifaunę lęgową 15 intensywnie użytkowanych pól uprawnych (agrocenoz) o powierzchni od 5 do 69 ha. Na terenach tych stosowano w bardzo dużych dawkach sztuczne nawożenie i pestycydy. Na siedmiu powierzchniach (łącznie 145 ha) uprawiano pszenicę, na czterech (87,4 ha) kukurydzę i na czterech (71,5 ha) buraki cukrowe. Badane tereny były reprezentatywne dla agrocenoz omawianego regionu (tab. 1).

Zastosowano metodę kartograficzną liczeń według Bibby *et al.* (1992). Każde pole było kontrolowane czterokrotnie — od połowy kwietnia do połowy czerwca w 1997r.

Na jednym polu nie stwierdzono gniazdowania ptaków. Na pozostałych 14 wykryto łącznie 10 gatunków lęgowych. Zagęszczenia par lęgowych wynosiły od 0 do 11,6 par/10 ha, średnio 2,93 pary/10 ha. Zagęszczenie to było niskie w porównaniu z analogicznymi danymi, znanymi z agrocenoz środkowej Europy (np. Jermaczek & Tryjanowski 1990, Kujawa 1994). Przy porównaniu tym należy jednak pamiętać, że wymienieni autorzy uwzględniali w swoich wynikach także

ptaki, które nie gniazdowały na polach (np. gatunki gniazdujące w żywopłotach).

Sześć gatunków (przepiórka, skowronek, pliszka żółta, kląskawka, łozówka i cierniówka) występowało we wszystkich trzech rodzajach upraw. Wśród nich tylko skowronek i kląskawka należały do dominantów (> 5% udziału) we wszystkich typach upraw (tab. 2). Zagęszczenie par lęgowych było najwyższe w uprawach pszenicy, jednakże różnice pomiędzy uprawami nie były istotne statystycznie (Kruskal-Wallis test = 1,37, df = 2, p > 0,05). Zagęszczenia par były także najwyższe na połach bez rowów melioracyjnych, różnice także nie były istotne statystycznie (Mann-Whitney U test = 18,0, p > 0,5). Najwyższą różnorodność gatunkową stwierdzono w uprawach kukurydzy, różnice między rodzajami upraw również nie były istotne statystycznie — Kruskal-Wallis test = 2,36, df = 2, p > 0,05. Różnorodność gatunkowa nie różniła się także statystycznie na terenach otoczonych rowami i na terenach bez tych rowów (Mann-Whitney U test = 11,5, p > 0,05).

Według wskaźnika Soerensena (Tomiałojć *et al.* 1984), wysokie podobieństwa składów gatunkowych stwierdzono w porównaniach upraw pszenicy i buraków cukrowych oraz buraków cukrowych i kukurydzy. Pojemność niszy (Hurlbert 1978) gniazdujących gatunków na badanych powierzchniach wynosiła od 0 do 0,94. Najszerszą niszę miał skworonek (tab. 3).