ABSTRACT: Studies on the habitat preferences of Reed Bunting Emberiza schoeniclus L. conducted on an intensively farmed (93% arable land) area (54 km²) of Wroclaw Plain (Lower Silesia Province, SW Poland, 17°03'E, 51°02'N) have shown that during the breeding season this species was found mainly in abandoned crop fields profusely overgrown with Tanacetum vulgare, Artemisia vulgaris and Solidago sp. Wintering birds remained in strongly weeded crops (arable habitats). The presence of breeding pairs (n = 37) was recorded within 24 (36%) out of the 67 long-term fallows (total area = 336.88 ha, average area = 5.03 (± 10.52 SD) ha, range = 0.19 to 83.53 ha). The field size was the best predictor of the Reed Bunting abundance among the seven landscape variables describing the environmental diversity of a fallow (apart from the field size, these were the lengths of: treebelts, hedges, railway embankments, roads, ditches and borders with adjacent crop fields). In the model of multiple regression after stepwise forward selection this variable explained as much as 86% of the variance in Reed Bunting abundance in that biotope. Wintering birds (total of 367 specimens) were discovered in 43 (37%) out of the 117 studied fields, comprising seven arable habitats – cereal stubbles, young and old fallows, root crop stubbles, fruit and vegetable crops, bare tilled and winter cereals (average area = 2.81 (± 2.31), range = 0.23 to 12.72 ha). The highest density and frequency (i.e. percentage of one field type where at least one Reed Bunting was recorded) were found in strongly weeded fruit and vegetable crops and in root crop stubbles (with abundant Amaranthus retroflexus, frequency respectively 89 and 64%), in young fallows (with a series of annual weed species, including the abundant Chenopodium album; 77% frequency) and in cereal stubbles (with Chenopodium album and Setaria viridis; 50% frequency). In winter season birds were recorded only in 20% of old fallows. No wintering birds were found in winter cereals, nor in ploughed fields. The large area of root crops in Poland and the related spreading of weeds, such as Amaranthus and Chenopodium, coupled with long-term set-aside may compensate many granivorous birds, wintering in Europe on farmland, for the considerable reduction in their winter food resources, caused by the massive introduction of winter cereals.

KEY WORDS: granivorous birds, land use, arable habitats, set-aside, land abandonment, crop management, weeds

1. INTRODUCTION

Reed Bunting Emberiza schoeniclus L. belongs to a group of birds which populations were drastically reduced in the agricultural areas of western Europe (Siriwardena et al. 1998, Peach et al. 1999). One of the reasons of the species’ decline, like in other
granivorous birds, was the substantial decrease in its winter food resources caused by the disappearance of stubble fields resulting from the introduction of highly productive, winter varieties of cereals (Chamberlain et al. 2000, Moorcroft et al. 2002). Equally essential factors were the massive use of herbicides with concomitant elimination of weeds, and the simplification of crop rotation and structure (Moreby and Southway 1999, Peach et al. 1999, reviewed in Marshall et al. 2003). According to Peach et al. (1999), the critical factor in limiting the Reed Bunting population in farmland was the low survival rate in winter, caused by the lack of feeding grounds (stubble fields in particular).

In Central Europe the diet of Reed Bunting depends on the season. In the autumn-winter season the main food consists of common weeds (review in Prýs-Jones 1984, Cramp 1998, Trnka and Matoušek 1999, Matessi et al. 2002). In spring and summer Reed Bunting feeds exclusively on insects (various systematic groups – review in Prýs-Jones 1984, Cramp 1998). This yearly food diversity makes the Reed Bunting abundance dependent on availability of habitats that insure suitable breeding (abundant in insects) and wintering grounds (rich in weed seeds).

In Europe the main breeding biotope of Reed Bunting within farmed landscapes are small reedbeds, herbaceous vegetation growing along ditches and small watercourses (e.g. Kosiński and Tryjanowski 2000, Brickle and Peach 2004, Surmacki 2004), and in the last few decades – also crop fields (Cramp 1998, Gregory and Bailie 1998). Currently, in Britain as much as 27.2% of the total population breeds in crop fields (Gregory and Bailie 1998), and recently nesting has also been reported from set-aside fields (e.g. Watson and Rae 1999). In Poland the occurrence of Reed Bunting on arable land is a relatively new and poorly recognized phenomenon (Surmacki 2001, Tomiałojć and Stawarczyk 2003). Recent studies have shown that in abandoned fields of south-west Poland the Reed Bunting belonged to the group of dominants, constituting 5.9% of the whole breeding community (Orłowski, in press).

In Poland, like in western Europe, Reed Bunting winters mainly in strongly weeded fields and cereal stubbles (Górski 1976, Wilson et al. 1996, Moorcroft et al. 2002), avoiding other kinds of habitats and crops (e.g. set-aside, winter cereals, root crops, meadows, ploughed fields) (Wilson et al. 1996, Buckingham et al. 1999, Perkins et al. 2000). Wintering of the Reed Bunting in crop fields of western Poland has been noticed quite recently, the first specific information about the used biotopes originate from 1960’s (Witkowki 1964, Górski 1976).

Changes in arable land use, which in Poland include mostly land abandonment (in late 1990s the area of abandoned arable land amounted to about two million hectares, i.e. ca. 11% of total farmland – Marks and Nowicki 2002) and introduction of winter cereals, undoubtedly also influence the state of populations of many bird species associated with farmed landscapes.

The aim of the work is to determine the effect of arable land use forms on the size and distribution of breeding and wintering Reed Bunting population in the farmland of Lower Silesia (SW Poland). The paper presents: 1) large-scale analysis of arable habitats used by birds, and 2) principle relationships between the structure of abandoned crop fields and breeding of that species. The study provides detailed information about the size and frequency of occurrence of Reed Bunting population in various types of crops characteristic for agricultural areas of Lower Silesia. The obtained results can be applied in the practical conservation of this, and other endangered and declining bird species in agricultural regions all over Europe.

2. METHODS

2.1. Study sites

The research was conducted on an area of 54 km² of Wroclaw Plain (Lower Silesia, SW Poland; 17°03'E, 51°02'N; Fig. 1). The dominant form of land use was arable that occupied about 93% of the total. In the year 2000 the main crops were wheat (50%), rape
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(25%), root crops (10%) and maize (8%). Forests and woodlots cover barely 1.5%, the rest (5.5%) belonging to built-up areas and transportation routes.

The breeding period study was conducted in spring of 2002 in 67 abandoned arable fields (permanent fallows), selected from the 94 localized in 2001, when a detailed mapping of these habitats was done (Orłowski 2004). The selected fallows were characterized by similar structure of herbaceous plants, dominated by permanent communities of alien perennial species (*Artemisio-Tanacetetum vulgaris* and *Rudbeckio-Solidaginetum* associations). In order to characterize the effect of habitat elements, present in the studied fallows, on the Reed Bunting abundance, seven continuous landscape variables were specified (Table 1).

The winter study covered 117 fields, both utilized and abandoned (n = 58) with the total area of 329.287 ha (Fig. 1, Table 2). The choice of the fields reflected share of the main crops in the study area. In the group of utilized fields were: ploughed fields (bare till), winter cereals (wheat and barley), oil-seed rape and cereals (maize, wheat and barley) stubbles, weeded root crop (sugar and fodder beet, potatoes) stubbles, as well as vegetable and fruit crops (cucumbers, strawberries, onions, celeries, red beetroot, chokeberries) (Table 2). Due to the small number of particular crops, vegetable and fruit cultivations were merged into one group. The abandoned fields were divided into young (not used for 1–3 years) and old fallows (at least 3–5 years old). Winter counts were conducted on 45 of the 67 old fallows, studied in the breeding

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Fig. 1. Distribution of surveyed fields in farmland in the vicinity of Wrocław city (Lower Silesia, SW Poland). Symbols refer to different types of fields: (○) abandoned (permanent fallow), (●) young fallow, (Δ) root crop stubble, (□) cereal and oil-seed rape stubble, (▲) vegetable and fruit crops, (●) bare till (ploughed fields), (+)
Table 1. Characteristic of environmental variables specified to describe the habitat differentiation of the 67 abandoned fields. Data on fields size are given in Table 2.

<table>
<thead>
<tr>
<th>Variable (unit)</th>
<th>Number of fields with given variable</th>
<th>Mean ± SD (m)</th>
<th>Range (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of treebelt (m)</td>
<td>45</td>
<td>119.2 ± 184.5</td>
<td>0 – 950</td>
</tr>
<tr>
<td>Length of hedges (m)</td>
<td>56</td>
<td>120.6 ± 196.2</td>
<td>0 – 1180</td>
</tr>
<tr>
<td>Length of railway embankment (m)</td>
<td>11</td>
<td>24.6 ± 63.7</td>
<td>0 – 300</td>
</tr>
<tr>
<td>Length of road (m)</td>
<td>57</td>
<td>169.0 ± 148.6</td>
<td>0 – 550</td>
</tr>
<tr>
<td>Length of ditch (m)</td>
<td>34</td>
<td>143.6 ± 345.6</td>
<td>0 – 2500</td>
</tr>
<tr>
<td>Length of border with adjacent crop field (m)</td>
<td>56</td>
<td>227.6 ± 205.8</td>
<td>0 – 1150</td>
</tr>
</tbody>
</table>

Table 2. Characteristics of the studied arable habitats. Differences between average sizes of particular types of studied fields in winter are statistically significant (Kruskal-Wallis test, $H_g = 14.53$, $P = 0.024$, $n = 117$).

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Number of fields</th>
<th>Total area (ha)</th>
<th>Mean area ± SD (ha)</th>
<th>Range (ha)</th>
<th>Dominant weed species</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREEDING PERIOD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent fallow (&gt;3–&gt;5 years)</td>
<td>67</td>
<td>336.88</td>
<td>5.03 ± 10.52</td>
<td>0.19 – 83.53</td>
<td>Tanacetum vulgare Arte-misia vulgaris Solidago sp.</td>
</tr>
<tr>
<td>WINTER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent fallow (&gt;3–&gt;5 years)</td>
<td>45</td>
<td>135.87</td>
<td>3.02 ± 2.83</td>
<td>0.30 – 12.72</td>
<td>As above</td>
</tr>
<tr>
<td>Cereal and oil-seed rape stubble</td>
<td>18</td>
<td>62.08</td>
<td>3.45 ± 2.00</td>
<td>0.69 – 7.22</td>
<td>Chenopodium album</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Setaria viridis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Chenopodium album</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Achillea millefolium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Senecio jacobaea</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Erigeron canadensis</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cirsium arvense</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Marticaria perforata</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Atriplex sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Capsella bursa pastoris</td>
</tr>
<tr>
<td>Young fallow (&lt;3 years)</td>
<td>13</td>
<td>45.43</td>
<td>3.49 ± 2.87</td>
<td>0.23 – 10.93</td>
<td>Chenopodium retroflexus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Galinsoga sp.</td>
</tr>
<tr>
<td>Root crop stubble</td>
<td>11</td>
<td>20.42</td>
<td>1.86 ± 1.94</td>
<td>0.25 – 6.00</td>
<td>Amaranthus retroflexus</td>
</tr>
<tr>
<td>Fruit and vegetable crops</td>
<td>9</td>
<td>12.18</td>
<td>1.35 ± 0.94</td>
<td>0.40 – 3.20</td>
<td>Chenopodium album</td>
</tr>
<tr>
<td>Bare till</td>
<td>10</td>
<td>21.57</td>
<td>2.16 ± 0.90</td>
<td>0.84 – 3.50</td>
<td>–</td>
</tr>
<tr>
<td>Winter cereals</td>
<td>11</td>
<td>31.74</td>
<td>2.88 ± 0.44</td>
<td>2.43 – 3.50</td>
<td>–</td>
</tr>
<tr>
<td>Total*</td>
<td>117</td>
<td>275.98</td>
<td>2.81 ± 2.31</td>
<td>0.23 – 12.72</td>
<td>–</td>
</tr>
</tbody>
</table>

* Excluding of 67 fallows surveyed in breeding season
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season. Typical weed communities, characteristic for particular crops, appeared on the fields. In the case of maize, barley and rape it was mainly Chenopodium album and Setaria viridis. Root crops, fruit and vegetable fields were dominated by Amaranthus retroflexus, which locally formed compact, single-species patches (up to 1 m high). Young fallows were floristically the richest, characterized by compact plant cover formed by many annual weed species (Table 2). Weather conditions during the censuses varied remarkably, both with regard to temperature (from –20 to 10°C) and snow cover (from 0 to 30 cm).

Field sizes and characteristics of landscape variables within the abandoned fields were determined on the basis of cadastral maps and data (1: 5000 and 1: 2500), ordnance survey maps (1: 25000 and 1: 10000) and direct field measurements.

2.2. Bird counts

The Reed Bunting breeding population censuses were conducted with the use of the mapping method (Bibby et al. 1992). The fieldwork was done between 20 April and the beginning of July 2002. Each abandoned field was visited eight times in the morning. The controls started at dawn and lasted until about 10 am. Duration of the visit depended on the field size. In case of the smallest fields (less than 3 ha) it lasted 20 to 45 minutes, while in the largest ones it took about six hours. Small fields were controlled along a centrally located axis, while larger ones – along parallel lines 100 m apart. The observation results were marked on maps (1: 5000). A territory was considered as occupied if a singing male was recorded at least twice in 14 days intervals.

Winter bird numbers were determined on the base of 2–3 counts, conducted within each field from the second half of December 2002 to the middle of February 2003. Smaller fields were controlled along the central axis, larger ones along parallel lines 50 m apart. All birds flushed by the approaching observer were recorded, and to avoid double counting of the same individuals special attention was paid to their movements. The maximum number of birds recorded in a single control of each field was included in the analysis.

2.3. Statistical analysis

Due to the lack of normal distribution, the relationship and differences between field size and abundance and density of wintering birds, were determined by using non-parameter statistical methods (Kruskal-Wallis test, \( \chi^2 \) test, sign test, Mann-Whitney test, Spearman’s rank correlation coefficient). As a significance level the probability \( P \leq 0.05 \) was accepted. The relation between the structure of abandoned fields and the number of Reed Bunting pairs was determined by using multiple regression analysis after stepwise forward selection of predictor variables. The probability of occurrence of breeding (for 67 fields) and wintering (for 45 fields) Reed Bunting in relation to the field size, was calculated on the basis of the logistic regression method. The presence (1) or absence (0) of birds (or pairs in the breeding season) was assumed as the dependent variable. The independent variable was the field area (expressed in ha). Statistical analysis of the collected material was carried out with the use of Statistica 5 software and Excel 2000.

3. RESULTS

3.1. Breeding period – usage of abandoned crop fields

The presence of breeding pairs (n = 37) was detected in 24 (36%) out of the 67 old fallows. One to eleven pairs bred in a single field (mean ± SD = 0.55 ± 1.43 pair). The smallest occupied field had an area of 0.75 ha, while in the largest one (83.53 ha) 11 pairs were localized.

In spite of the fact that three variables were included in the final solution, the main predictor of Reed Bunting abundance within the studied fallows was field size. This variable determined as much as 86% of variance in numbers of Reed Bunting (on introduction of only this variable to the model, the regression solution was: \( F_{1,65} = 391.52, P < 0.0001, r = 0.93, R^2 = 0.86\% \)). Also the three variables applied in the final regression model (of the seven variables introduced simultaneously into the model – Table 3) determined 87%
of the variance in number of that species (Table 3). Additional stimulating factor (apart from the field size) was the length of border with a crop field, while a negative effect was found in the case of treebelts (Table 3).

The probability of Reed Bunting occurrence in a fallow was closely related to its size. It reached 50% for the area of 8 ha and 100% for the fields over 30 ha (Fig. 2).

### 3.2. Wintering

Wintering birds \( (n = 367) \) were recorded in 43 (37%) of the 117 studied fields (Table 4). No wintering Reed Buntings were spotted on ploughed fields or winter cereals. The lowest share of fields with at least one Reed Bunting was characteristic for old fallows (9%), while the highest – for fruit and vegetable crops (89% – Table 4). Statistically significant differences were found in the occupied-to-empty fields ratio in the group of five compared habitats \( (\chi^2 = 118.0, \text{df} = 9, P < 0.0001 – \text{Table 4}) \).

The highest number of wintering Reed Buntings (130 individuals) was found in young fallows; these habitats also had the highest mean number of birds per one controlled field (Table 4). Statistically significant differences were found in the mean number of birds per one controlled field (taking into account five types of habitats, where wintering birds were recorded, see Table 4 – Kruskal-Wallis test, \( H = 30.65, P = 0.000 \)).

<table>
<thead>
<tr>
<th>Variable</th>
<th>( \beta )</th>
<th>( B )</th>
<th>( P )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>0.973</td>
<td>0.132</td>
<td>0.000</td>
</tr>
<tr>
<td>Length of treebelt</td>
<td>–0.101</td>
<td>–0.001</td>
<td>0.062</td>
</tr>
<tr>
<td>Length of border with adjacent crop field</td>
<td>0.077</td>
<td>0.001</td>
<td>0.107</td>
</tr>
<tr>
<td>Constant</td>
<td>–0.140</td>
<td>0.177</td>
<td></td>
</tr>
</tbody>
</table>

\( F_{3,63} = 138.13, P < 0.0001, r = 0.93, R^2 = 0.87\% \)

**Fig. 2.** Probability of Reed Bunting occurrence within abandoned fields in relation to field size; solid line – for 67 fallows surveyed in breeding period (logistic regression model, \( \chi^2 = 5.68, \text{df} = 1, P = 0.017 \)), dashed line – for 45 fallows surveyed in winter (\( \chi^2 = 4.57, \text{df} = 1, P = 0.032 \)).
share of the total number of birds in the five investigated habitats was not proportional to their total area ($\chi^2 = 83.54$, df = 9, $P < 0.0001$).

The size of bird concentrations in a field (excluding ploughed fields and winter cereals, where no Reed Buntings were found) ranged from 1 to 53 birds (mean of five types of habitats, where wintering birds were seen, total of 96 fields – average $\pm$ SD = $3.82 \pm 8.96$ individuals). The mean size of flock ($n = 43$) was $8.5 \pm 11.8$ individuals. Single birds were recorded in 15 (13%) fields. In sixteen (14%) fields 2 to 10 birds were found. Flocks of over 10 birds were recorded in 12 (10%) fields (Fig. 3).

The average density of wintering Reed Buntings was lowest in old fallows, and highest in fruit and vegetable crops (Table 4). Statistically significant differences were found between mean densities in particular habitats (for five types of habitats where wintering birds were recorded – Kruskal-Wallis test, $H_4 = 36.06$, $P = 0.000$ – Table 4).

The field size was not correlated with the number of wintering Reed Buntings, both in the case of all studied fields (for five types of habitats where wintering birds were found, total of 96 fields: $r_s = 0.11$, $P = 0.287$) and the respective five types of habitats (range of $r_s = 0.09 – 0.32$, n.s.), with the exception of old fallows ($r_s = 0.37$, $P = 0.012$, $n = 45$).

Table 4. Reed Bunting occurrence in the studied arable habitats (for $n = 96$) during winter. The table does not include ploughed fields and winter cereals where no wintering Reed Buntings were found.

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Number of fields with wintering birds</th>
<th>Share of fields with at least one recorded individual (%)</th>
<th>Total number of recorded individuals</th>
<th>Maximal recorded flock (number of individuals)</th>
<th>Average number of individuals per 1 field $\pm$ SD (individuals)</th>
<th>Average density $\pm$ SD $(\pm$ SD) 10 ha$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent fallow &gt;3–&gt;5 years</td>
<td>9</td>
<td>20.0</td>
<td>14</td>
<td>4</td>
<td>$0.31 \pm 0.11$</td>
<td>$0.93 \pm 2.41$</td>
</tr>
<tr>
<td>Cereal stubble</td>
<td>9</td>
<td>50.0</td>
<td>44</td>
<td>14</td>
<td>$2.44 \pm 4.11$</td>
<td>$9.10 \pm 16.33$</td>
</tr>
<tr>
<td>Young fallows (&lt;3 years)</td>
<td>10</td>
<td>76.9</td>
<td>130</td>
<td>53</td>
<td>$10.00 \pm 4.70$</td>
<td>$29.50 \pm 42.02$</td>
</tr>
<tr>
<td>Root crop stubble</td>
<td>7</td>
<td>63.6</td>
<td>106</td>
<td>30</td>
<td>$9.64 \pm 12.35$</td>
<td>$73.33 \pm 101.73$</td>
</tr>
<tr>
<td>Fruit and vegetable crops</td>
<td>8</td>
<td>88.9</td>
<td>73</td>
<td>25</td>
<td>$8.11 \pm 9.41$</td>
<td>$96.21 \pm 160.03$</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>44.8</td>
<td>367</td>
<td>53</td>
<td>$3.82 \pm 8.95$</td>
<td>$23.56 \pm 67.77$</td>
</tr>
</tbody>
</table>

Fig. 3. Distribution of winter flock sizes ($n = 43$) of Reed Buntings in 96 controlled fields (275.98 ha) in farmland of Lower Silesia (SW Poland).
Also, no statistically significant differences were found in mean field sizes (again, apart from old fallows), where Reed Buntings were found / not found (Table 5).

Wintering Reed Buntings were found in 9 out of the 45 fallows studied in both periods of the year (Table 4). The presence of wintering birds was confirmed only in four out of 11 fallows occupied during breeding season. No statistically significant difference appeared in the ratio of fallows occupied in breeding and winter seasons (sign test, \( Z = 0.28, P = 0.77 \)). Like in the breeding season, the probability of Reed Bunting occurrence within abandoned fields depended on their size, and amounted to 100% at 30 ha area (logistic regression model, \( \chi^2 = 4.57, df = 1, P = 0.03 \) – Fig. 2).

4. DISCUSSION

The results of the present study indicate that nowadays in agricultural areas of Lower Silesia (SW Poland) Reed Bunting exhibits quite different habitat preferences in breeding and winter seasons. The breeding population inhabits mainly the abandoned fields, with a well-developed layer of perennial plants. In the study area, 8 breeding pairs were also found in reedbelts along drainage ditches, outside fallows (G. Orłowski – unpublished data). Wintering birds, however, clearly avoided these habitats (as well as bare tilled fields and winter crops), concentrating mainly in strongly weeded stubbles. Although wintering of Reed Bunting on stubbles is a common phenomenon in Europe (Pr̆ys-Jones 1984, Wilson et al. 1996, Peach et al. 1999), its nesting in fallows seems to be a new adaptation, connected with emergence of that biotope in Central Europe in the last decades (where substantial areas of farmland have been abandoned as a result of recent social and economic transformations). So far in agricultural areas of Poland the Reed Bunting breed mainly in marshland biotopes (Kosiński and Tryjanowski 2000, Surmacki 2001, 2004, Tomiałojć and Stawarczyk 2003).

The undoubtedly different habitat preferences in breeding and winter season result from differentiated diet of Reed Bunting in those periods. The distinct differences in abundance and occurrence of wintering Reed Buntings within the studied habitats are most probably closely related with occurrence of some weed species, and to a lesser degree with the field size. Studies conducted in central England on granivorous birds wintering in three types of cereal stubbles (intensive barley, intensive and organic wheat) showed that Reed Bunting occurred mainly in strongly weeded fields (with density of weed over 250 seeds m\(^{-2}\)); and, like in this study, no significant influence of

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Average area of fields (ha)</th>
<th>Results of the Mann-Whitney test on the differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>without Reed Bunting</td>
<td>with at least one Reed Bunting</td>
</tr>
<tr>
<td>Permanent fallows</td>
<td>2.54</td>
<td>4.94</td>
</tr>
<tr>
<td>Cereal stubble</td>
<td>3.05</td>
<td>3.85</td>
</tr>
<tr>
<td>Young fallows</td>
<td>3.26</td>
<td>3.56</td>
</tr>
<tr>
<td>Root crop stubble</td>
<td>2.04</td>
<td>1.75</td>
</tr>
<tr>
<td>Fruit and vegetable crops(^1)</td>
<td>1.50</td>
<td>1.36</td>
</tr>
<tr>
<td>All habitats</td>
<td>2.61</td>
<td>3.20</td>
</tr>
</tbody>
</table>

\(^1\) Data are not suitable for calculating differences in Mann-Whitney test.
seed-eaters (including Reed Bunting) in win-
cies achieved the highest frequency and den-
length of border with crop fields was posi-
ber of breeding pairs, while the effect of the
ence of trees negatively affected the num-
in breeding season indicate that the pres-
patches were seen.

abundantly also in Wrocław Plain) –
field size on occupancy of this species was
recorded (Mo orcroft et al. 2002). Also in
Wrocław Plain (the present study) this spe-
cies achieved the highest frequency and den-
sity in fields with a clearly developed weed
layer (young fallows, root crop stubbles and
fruit and vegetable crops), which constitute
the staple food of Reed Bunting in winter.
For instance, in Slovakia, in 126 Reed Bun-
ting stomachs three taxa of weeds (occurring
abundantly also in Wrocław Plain) – Setaria
spp., Chenopodium spp. and Amaranthus
retroflexus – were found, constituting 74.2% of
their content (Trnka and Matoušek 1999).

The high density of Reed Bunting in root
crop stubbles and fruit-vegetable crops in Low-
er Silesia is connected with the occurrence of
tall (ca. 1 m), dense patches of Amaranthus
retroflexus, that were often the only plants
sticking out of the thick snow cover. It should
also be remembered that Reed Bunting may
be less adapted to staying in bushes and trees,
compared to other seed-eaters wintering in
farmland. Dense herbaceous vegetation may
constitute one of the few places offering rela-
tive protection against predators, though
a number of times body remnants were
found and attacks by Sparrowhawk Accipiter
nisus on Reed Buntings sitting in Amaran-
thus patches were seen.

The environmental parameters of fallows
in breeding season indicate that the pres-
ence of trees negatively affected the num-
er of breeding pairs, while the effect of the
length of border with crop fields was posi-
tive (Table 3). Trees seem to constitute a kind
of obstacle for free roaming of birds, which
during breeding season often use crop fields
as feeding grounds (Surmacki 2001, 2004,
Brickle and Peach 2004).

According to Mo orcroft et al. (2002),
seed-eaters (including Reed Bunting) in win-
ter prefer a looser vegetation growing on bare
ground, that allows more effective feeding, as
dense patches of vegetation may hamper bird
movements. It seems, however, that Reed
Buntings wintering in Lower Silesia clearly
prefer high and dense vegetation, and the re-
results obtained in Great Britain may suggest
otherwise because of the lack of similar weed
communities there. The big weed infestation
of fields in Poland may be due to both lower
farming standards and greater abundance
of some weed species in this part of Europe.
According to Wilson and others (1999),
the abundant occurrence of Amaranthus, is
characteristic for central Europe (Toth et al.
1997), while in Great Britain these species are
rare in crops, have not been proved to spread
and are thought irrelevant as a component of
the bird diet (Wilson et al. 1999, Marshall
et al. 2003). In contemporary Poland and
the Czech Republic Amaranthus retroflexus
and Chenopodium album belong to the most
abundant and rapidly spreading weed species
in root (Amaranthus) and cereal crops (Che-
opodium), and are being intensively stud-
ied (Rola et al. 2002). These weeds, owing
to many easily crossing forms, exhibit high
resistance to modern herbicides (Mikulka
of Chenopodium and Amaranthus retroflexus
may constitute an essential component of the
diet of many granivorous birds. For instance,
as early in 1960’s it was found that strongly
weeded crop fields may produce up to 177 kg
ha⁻¹ of the first and up to 142 kg ha⁻¹ seeds
of the other species, of which nearly 60% were
eaten by Tree Sparrows Passer montanus (Pi-
nowski and Wójcik 1968).

Cereal stubbles were characterized by
markedly lower frequency and abundance of
wintering birds, which could also be associ-
ated with smaller density and different struc-
ture of weed communities there (mainly Che-
opodium album and Setaria viridis occurred
in these fields), which contrary to the tall
Amaranthus reached barely ca. 20 cm height
(high snow cover may make their seeds
unavailable for feeding birds). In central
England, in three types of set-aside stubble
fields (intensive barley, intensive and organic
wheat), Reed Bunting occurred in 10 to 40%
of controlled fields (Mo orcroft et al. 2002),
which is close to the frequency recorded for
cereal stubbles (50%), and markedly lower
than for the strongly weeded (Amaranthus)
root crop fields (64 and 89%) in the Lower
Silesia region (present work).

Owing to the method of bird counting
used in the present study, the obtained data
may not reflect the changes in Reed Bunting
abundance within individual fields throughout winter. The data collected by Witkowski (1964) in the beginning of 1960’s on the same area showed that during the presence of thick snow cover a remarkable concentration of Reed Buntings occurred in one strongly weeded field (*Chenopodium* sp.). In the period from the beginning of November to early March, the overall number of Reed Buntings in the area of ca. 20 km$^2$ ranged from 3 to 230 birds (average ± SD = 83.8 ± 82.6, for 17 counts), whereas at the appearance of high snow cover the birds formed one large concentration (230 individuals), moving there from neighbouring fields (Witkowski 1964).

The Reed Buntings wintering in the fields of Wrocław Plain were not distinctively gregarious, most often forming small, loose feeding flocks (Fig. 3). This is in line with the very general information contained in Cramp’s review (1998) about formation of small flocks with other seed-eaters in that period. Substantially larger flocks of wintering Reed Buntings (over 1000 birds) were recorded in marshland biotopes (communities of: *Phragmites communis*, *Carex* sp., *Glyceria* sp., *Spartina anglica*, *Juncus* sp. – e.g. Fennell and Stone 1976, Blümel 1982, Kalejta-Summers 1997).

4.1. Conservation implications

Recently published data from Western Europe indicate that both in breeding and wintering period Reed Buntings does not usually occur in crop fields that have been left fallow as a part of set-aside schemes (Wilson *et al.* 1996, Buckingham *et al.* 1999, Henderson *et al.* 2000 a,b). The results of the present study seem to contradict that, as fields with spontaneous development of vegetation (abandoned fields) constitute both a good place for breeding (old fallows) and wintering (young fallows) of this species. The differences in utilization of young and old fallows, result undoubtedly from different composition of the vegetation in these habitats, as well as from different food preferences of Reed Bunting in both seasons (see Discussion). Most probably, these are also the reasons for the differences in utilization by birds of set-aside fields in West Europe and abandoned fields in Poland. Another species that occupies abandoned fields in Lower Silesia, but not the set-aside fields elsewhere, is Whinchat *Saxicola rubetra* L. In the case of Reed Bunting and Whinchat an essential factor influencing the occurrence of breeding pairs is availability of dry, compact last year’s vegetation cover formed by perennial plants – *Tanacetum vulgare, Artemisia vulgaris, Solidago* sp. (Orłowski 2004).

In the light of the obtained results it seems more desirable to allow spontaneous development of vegetation in fallowed fields in order to protect bird fauna in agricultural areas of Europe. That would require, however, the introduction of some changes both in the set-aside methods and in the current EU agricultural policy (Orłowski, in press).

The obtained results emphasize the need to preserve a differentiated structure of farmland as a factor allowing the Reed Bunting to breed in agricultural areas. This makes it necessary both to preserve some abandoned land (as breeding places) and leave unploughed stubbles throughout winter. It seems that the large area of root crops in Poland (in 2000, potato, sugar and fodder beet, and vegetables occupied 1 882 000 ha, i.e. nearly 17% of total crop area; Central Statistical Office 2001), and the resulting spreading of such weed species as *Amaranthus* and *Chenopodium* (Rola *et al.* 2002), will favour Reed Bunting and many other granivorous species wintering in farmland of central Europe. It should be noted that the considerable decrease in winter food resources for that group of birds, caused by disappearance of weed-rich stubbles due to introduction of winter cereals (e.g. Peach *et al.* 1999, Robinson and Sutherland 2000, Moorcroft *et al.* 2002), can be “ecologically compensated” by the large area of root crops (beet, potatoes, root vegetables).

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