POLISH JOURNAL OF ECOLOGY (Pol. J. Ecol.)	53	1	135–142	2005

Short research contribution

Grzegorz ORŁOWSKI[1], Marcin SĘK[2]

[1] Department of Agricultural Bases for Environmental Management, Agricultural University of Wrocław, pl. Grunwaldzki 24, 50-363 Wrocław, Poland, e-mail: orlog@poczta.onet.pl
[2] Becka 8/3, 51-672 Wrocław, Poland, e-mail: marsek03@yahoo.co.uk

SEMI-NATURAL REEDBEDS AS BREEDING HABITAT OF BLUETHROAT (*LUSCINIA SVECICA* L.) ON SEWAGE FARM IN WROCŁAW CITY (SOUTH-WESTERN POLAND)

ABSTRACT: In the breeding season of 2004 in sewage sedimentation basins overgrown with semi-natural reedbeds (n = 63, total area = 113.3 ha, mean area = 1.80 (± 3.90) ha, range: 0.018 do 26.54 ha) on a sewage farm (total study area 14.22 km^2) in the northern part of Wrocław city (640 000 inhabitants, SW Poland) 45 territories of Bluethroat *Luscinia svecica cyanecula* were found. Territorial birds were detected in 38% of all controlled reedbeds. Up to eight territories were localized in a single reedbed. In at least ten territories (22% of all) the presence of breeding pairs was also recorded. The smallest reedbed occupied by a single male had 0.081 ha and by a pair – 0.204 ha. A high statistically significant correlation was found between the reedbed area, the length of its border and the number of territories it contained. The probability of Bluethroat occurrence in a reedbed was closely related to its size. Even in small reedbeds (<2 ha) it amounted to *ca.* 35% and it reached 100% at 10 ha. Within particular occupied reedbeds (n = 24) the densities ranged from 1.5 to 49.5 (exceptionally 123.4) territories 10 ha^{-1}. The average density (± SD) for all reedbeds (n = 63) was 7.6 (± 19.2) territories 10 ha^{-1}, while within the occupied reedbeds (n = 24) it amounted to 20.0 (± 27.1) territories 10 ha^{-1}. The Wrocław population of Bluethroat is one of the biggest known breeding concentration of this species not only in western Poland, but probably also in large part of central Europe. So far reports of marked increases of Bluethroat abundance in anthropogenic habitats (after a dramatic decline observed since the end of XIX century) have come mainly from western Europe.

KEY WORDS: Bluethroat, *Luscinia svecica cyanecula*, breeding population, breeding habitats, reedbeds, Wrocław, Poland

In south-western Poland, as in many other parts of the country the Bluethroat *Luscinia svecica cyanecula* (Meisn., 1804) has been considered as a nearly extinct species (J. Bednorz – unpubl. data after Glutz von Blotzheim and Bauer 1988, Dyrcz *et al.* 1991, Bednorz 2001, Tomiałojć and Stawarczyk 2003). This situation reflects a dramatic decline in its abundance observed since the end of XIX century in most of the central and western Europe (Cramp 1988, Glutz von Blotzheim and Bauer 1988). In Poland, as in some other countries, Bluethroat was placed on the red list of endangered species (review in: Cramp 1988, Glutz von Blotzheim and Bauer 1988, Osieck and Hustings 1994, Bednorz 2001). Its original habitat in central Europe were associations of osier-beds in big river valleys (Glutz von Blotzheim and Bauer 1988, Cramp 1988). Deterioration

of these habitats due to drainage operations is seen as the main reason of the species disappearance (Glutz von Blotzheim and Bauer 1988, Cramp 1988). For this reason its main Polish strongholds have remained almost exclusively in relatively natural river valleys (Bednorz 2000, 2001, Tomiałojć and Stawarczyk 2003).

In 1980s and 1990s a marked increase of Bluethroat abundance occurred in western Europe. It came together with the colonisation of previously avoided anthropogenic habitats, which currently hold most of the species breeding population (Glutz von Blotzheim and Bauer 1988, Hustings *et al.* 1995, Cornulier *et al.* 1997, Geslin *et al.* 2002). In Holland in the years 1970–1990 an 8-fold increase of abundance (from 800 to 6500 pairs in the given period) was recorded (Hustings *et al.* 1995). In southern Germany (Bayern) Bluethroat occurs in small willow hedges growing along drainage ditches (Kujawa 1998), while in France and Holland it inhabits crop fields such as oilseed rape and young orchards (Hustings *et al.* 1995, Cornulier *et al.* 1997). It can colonize even completely dry habitats, e.g. permanent fallows, in Bayern, where it occurs together with Whinchat *Saxicola rubetra* and Stonechat *S. torquata* (Theiss 1993), sand and gravel pits, and in Spain also rocky slopes overgrown with broom *Sarothamnus* sp. (Glutz von Blotzheim and Bauer 1988, Hustings *et al.* 1995, Snow and Perrins 1998).

Breeding of Bluethroat in reedbeds of central Europe is known mainly from Hungary, where it inhabits in large numbers reed islands on big shallow lakes (Balaton, Velence) (Baldi and Kisbenedek 1999). Similarly in Holland it breeds in reedbeds growing on artificial polders (Hustings *et al.* 1995). The highest Bluethroat densities are recorded within big reedbeds. It is therefore considered as a species associated with reedbed interior (Baldi and Kisbenedek 1999). In Poland its breeding in reedbeds has been proved so far on lakes in northern part of the country, fish ponds (Dyrcz *et al.* 1991, review in: Tomiałojć and Stawarczyk 2003) and on a sewage farm situated on the outskirts of Wrocław city (Słychan 1996). On the last site the first nesting of single pairs was recorded in 1995 (Słychan 1996), although several spring observations suggesting breeding were made as early as in 1970s (Lontkowski 1989). Since the first breeding record of Bluethroat in Wrocław no detailed surveys of its abundance trends or habitat preferences in this area have been made.

The aim of this study was the characteristic of the Bluethroat population inhabiting an extensively managed sewage farm located on the outskirts of Wrocław by the means of determination of: 1) the number of territories, 2) inhabited biotopes and 3) formulation of the main relations between habitat structure (area and length of reedbed borders) and the number of species territories.

The research was conducted on a sewage farm located in northern, peripheral part of the Wrocław city (640 000 inhabitants, 17°02'E, 51°07'N). The surveyed area (1422.5 ha) was shaped entirely by the human activity in the second half of the XIX century, as a natural sewage treatment facility (Fig. 1), by levelling of the remaining parts of natural river-beds of Odra and Widawa (J. Paluch – unpubl. manuscript). The research was focused on extensively used (partly disused) sedimentation basins and reserve fields overgrown with reed *Phragmites australis*. In places with high water level reedmace *Typha platyphyllos* and sweet flag *Acorus calamus* were also present. The reedbeds were located in open terrain, surrounded by meadows (that covered *ca*. 90% of the total study area), only around some of them small clumps of trees occurred (Fig. 1). Larger suburban woods border the area in the north, west and south (Fig. 1). The area is uninhabited, some small settlements lie outside, close to its eastern edge. Apart from two minor cobbled roads no communication routes cross the sewage farm, although a busy railway line runs along its eastern border. In recent years a gradual drying up of many reedbeds is taking place, due to the opening of a new sewage treatment plant in another location that cut by more than half the amount of sewage delivered to the area (150 000 m^3 per day^{-1} in the 1980s, 50–70 000 m^3 day^{-1} now) (J. Paluch – pers. inf.).

Overall 63 reedbeds were selected, situated both within small walled, regular-shaped

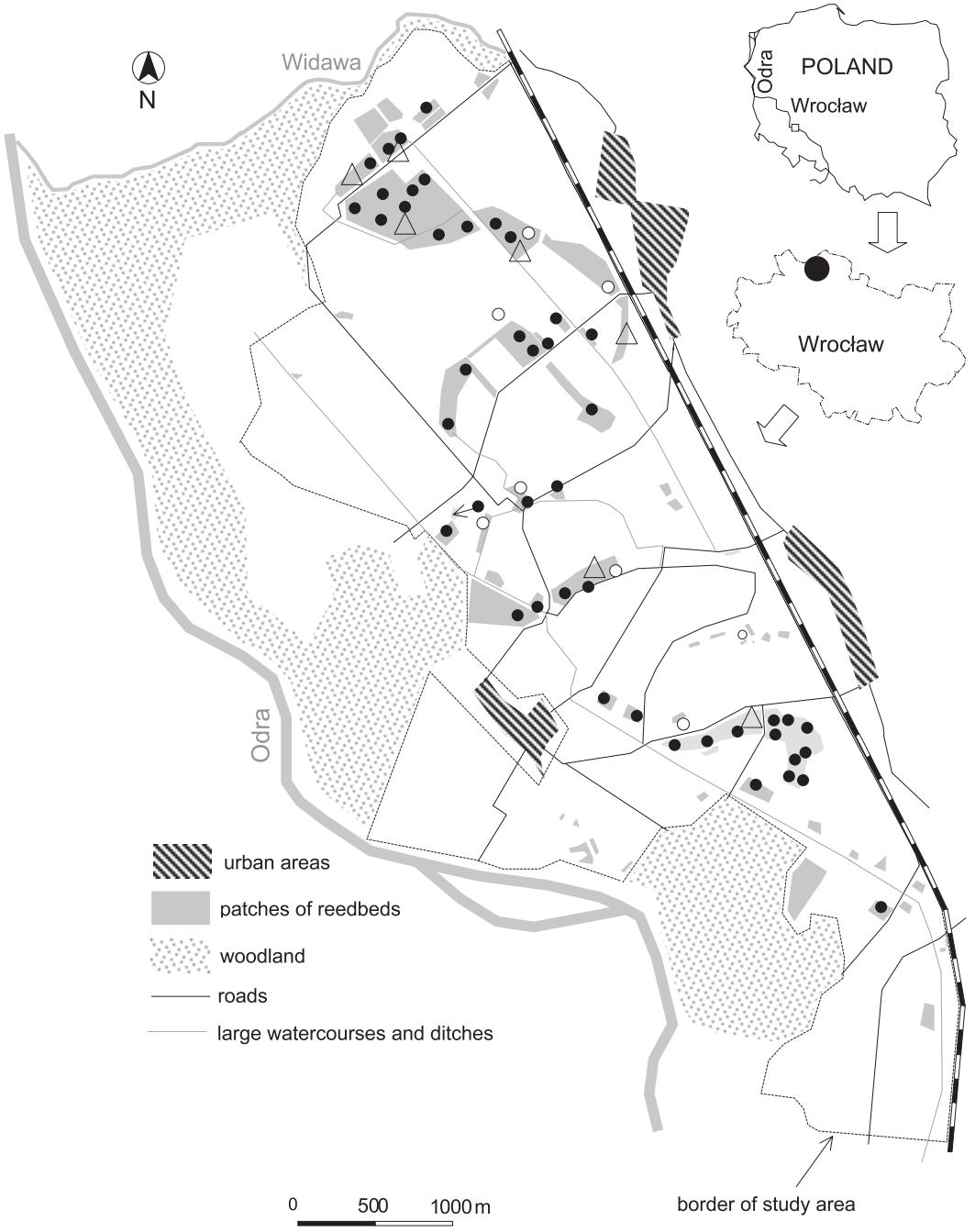

Fig. 1. Distribution of Bluethroat *Luscinia svecica* territories (black circles, N = 45) on Wrocław sewage farm in spring 2004. White circles (n = 8) – places of single records of singing males, localized outside the main concentration of territories. Triangles – reedbeds burnt in more than 50%.

sedimentation basins (n = 54) and in some semi-natural depressions, partly filled with water, with an irregular and varied shoreline (n = 9). The total area of reedbeds was 113.3 ha. They covered 8% of the entire study area. Sizes of particular reedbeds ranged from 0.018 to 26.54 ha (average = 1.80 (± 3.90) ha). Fifty five of them (87%) did not exceed 5 ha. Seven reedbeds (11%) were between 5 and 15 ha. Overall length of the borders of all reedbeds amounted to 29152.8 m (average = 462.7 (± 501.3), range = 54–2389 m). A high positive statistically significant correlation was found between the area and the length of the border within all studied reedbeds (after logarithmic transformation: r = 0.97, $P = 0.000$ for all 63 patches). The average distance between the two neighbouring reedbeds was 103.0 m (SD = ± 137.6 m, range = 10–722 m).

In the end of April 2004, at the time of a prominent vocal activity of Bluethroat males, large fragments of some reedbeds (up to 100% of the area in some cases, Fig. 1) were destroyed after being deliberately set on fire. Data concerning the area of reedbeds were obtained on the base of ordnance survey maps (1:25 000 and 1:50 000) and by direct field measurements.

Fieldwork on the distribution and abundance of territories was carried out from the beginning of April until the second half of June 2004. The first singing male was seen in a breeding territory as early as on March 20th, the last specimens still heard in the first days of July. All potential breeding sites were visited 5 times. In places with especially high concentration of territories the number of counts was higher (7–8). The censuses were made during the species highest activity, i.e. in early evening and around dusk (from about 6 pm until *ca.* 1–2 hours after the sunset) on calm, dry days. The time spent on a visit depended on the reedbed size. In the case of the smallest reedbeds (<1 ha) it took 20–30 minutes, while in the biggest ones it lasted about 2–3 hours. In addition, during some visits the audio-stimulation was used and in May–June birds were also attracted with the "strangled nestling" call imitated by the observer. The research results from Finland showed that the song playback caused the reaction of mainly single, unpaired males (Sorjonen and Merila 2000). The census results were put down on the 1:12 500 maps. In order to determine the subspecies of males and to detect the presence of females, spotting scope (22–62 × 102 mm) was used.

When carrying out the censuses, the special attention was paid to the simultaneous records of singing males and to their movements during (or immediately after) display flights. Considering a peculiar breeding biology with a very low proportion of females in the population (e.g. less than 30% in some populations of the Scandinavian subspecies *L. s. svecica*), as well as a high incidence of extra-pair copulations (64–76% of broods can contain offspring of other males) (Questiau *et al.* 1999, Sorjonen and Merila 2000, Johnsen and Lifjeld 2003) and regular visiting by females of neighbouring territories belonging to unpaired males (Smiseth and Amundsen 1995), efforts were made to detect territories occupied by pairs, and particularly to register the presence of females. The localization of a territorial pair, especially a female, can be very important when determining the number and range of the territories of unpaired males.

A territory was regarded as occupied by a solitary male, when a singing bird was recorded at least twice within 14-days interval. When classifying a territory as taken by a pair, other signs of breeding (birds carrying food, distress calls of parents, presence of fledglings) observed later in the season were decisive. An efficient way of determining the status of a territory was the imitation of the "strangled nestling" call, to which both birds of the pair responded by uttering loud distress calls (*eeet eeet eeet*) and flying towards the observer (feeding birds and fledglings also behaved in this way).

The statistical analysis of the collected material was carried out with the help of Statistica 5 software and Excel 2000. Due to the lack of the normal spread of the variable "the number of territories" (both before and after logarithmic transformation in Kolmogorov-Smirnov test, $P < 0.01$), the relations and differences between this variable and the area and length of the reedbed borders were determined with the use of non-parametric statistical methods (Sperman's rank correlation coefficient, Mann-Whitney and χ^2 test). As a significance level the probability $P \leq 0.05$

was accepted. The probability of Bluethroat occurrence in a reedbed in relation to its size was calculated on the base of logistic regression method. As a dependent variable the presence (1) or absence (0) of a territory was assumed.

A total of 45 occupied territories were recorded, all of them in reedbeds (Fig. 1). In at least 10 territories (22% of all) the presence of pairs was detected. In addition, in eight other places single observations of singing males were made. Territorial birds were present in 24 (38%) out of 63 surveyed reedbeds. The lowest proportion of occupied reedbeds was typical for small patches (<1 ha) (Table 1). In the reedbeds of this size class five territories of solitary males and five of pairs were localized (no differences in average area, U = 12.0, Z = 0.10, P = 0.92). Within the specified size classes (Table 1) the difference between the proportion of occupied and unoccupied reedbeds was statistically significant (χ^2 test = 101.61, df = 5, P <0.0001). The area of the smallest reedbed taken by an unpaired male was 0.081 ha, and by a pair – 0.204 ha.

The average density calculated for the whole study area amounted to 0.32 territories 10 ha^{-1}, and for the area of reedbeds it reached 3.97 territories 10 ha^{-1}. Up to eight territories were localized in a single reedbed. In 22 (35%) reedbeds their number ranged from 1 to 3 (Fig. 2). The highest number was recorded in two biggest reedbeds (26.54 and 10.49 ha – 8 territories in each).

A high statistically significant relationship was found between the reedbed area and the number of Bluethroat territories occurring in it (Fig. 3A). After excluding all unoccupied reedbeds the correlation coefficient remained similar (for n = 24, r_s = 0.67, P <0.001). A similar result was obtained when analysing the relation between the length of the reedbed border and the number of territories (Fig. 3B). After rejecting the unoccupied reedbeds this value also remained similar (for n = 24, r_s = 0.68, P <0.001).

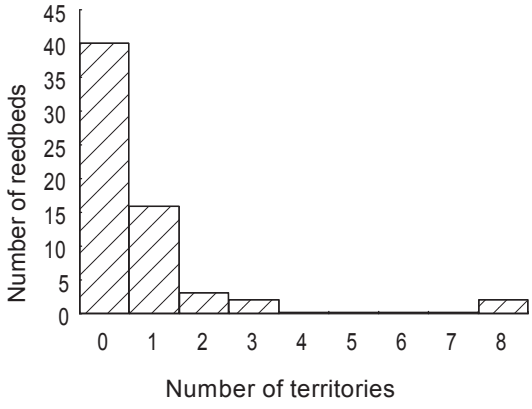

Fig. 2. Distribution of the number of Bluethroat territories (N = 45) in the studied reedbeds (n = 63)

The probability of Bluethroat occurrence in a reedbed was closely related to its size. Even for the small reedbeds (<2 ha) it reached about 35% and increased to 100% for reedbeds of about 10 ha (Fig. 4).

The average area of reedbeds occupied by at least one territory was over six times higher than that of unoccupied ones (mean ± SD = 3.77 ± 5.62 ha for occupied *vs.* 0.58 ± 1.30 ha for unoccupied). This difference was statistically significant (Mann-Whitney test, U = 145, Z = –4.57, P <0.0001). Similar results were obtained from the analysis of the length of reedbed borders. The average length of borders was three times higher

Table 1. The number of Bluethroat territories in reedbeds in relation to their size.

Size class	Number of reedbeds	Area (ha)	Reedbeds occupied by at least 1 territory		Total number of territories
			n	%[a]	
>5 ha	8	74.056	7	88	25
1–5 ha	10	28.567	7	70	10
<1 ha	45	10.681	9	20	10
Total	63	113.304	24	38	45

[a] as a proportion of reedbeds in a given class size

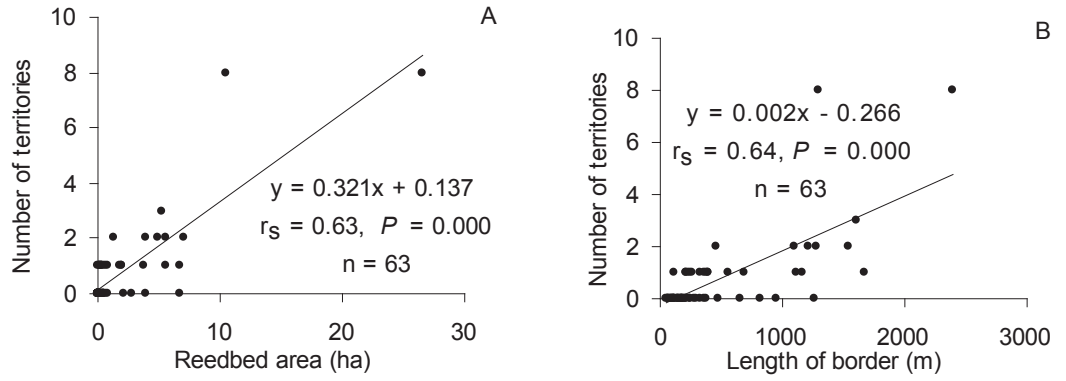

Fig. 3. The relationship between the number of Bluethroat territories and: A) reedbed area, B) the length of the reedbed border.

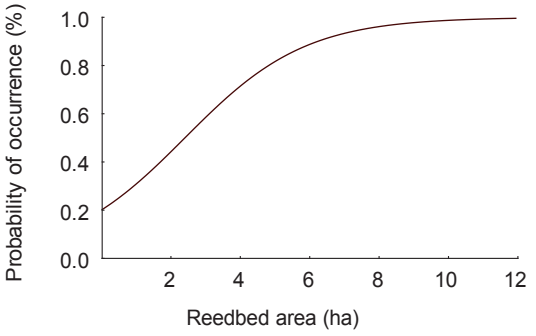

Fig. 4. The probability of Bluethroat occurrence in a reedbed in relation to its size (for N = 63). Obtained logistic regression model: χ^2 = 16.62, df = 1, *P* = 0.00004; and equation: Bluethroat presence = exp [–1.257 + (0.545 × Reedbed area) / (1 + exp(–1.257 + (0.545 × Reedbed area)]

for the occupied reedbeds (mean = 800.3 (± 613.2) m for occupied *vs.* 255.0 (± 257.3) m for unoccupied). These differences were also significant (Mann-Whitney test, *U* = 134.5, Z = –4.72, *P* <0.0001).

Within particular occupied reedbeds (n = 24) the densities ranged from 1.5 to 49.5 (exceptionally 123.4 for the smallest occupied reedbed) territories 10 ha^{-1}. The average density (± SD) for all reedbeds (n = 63) was 7.6 (± 19.2) territories 10 ha^{-1}, and for the occupied reedbeds (n = 24) it amounted to 20.0 (± 27.1) territories 10 ha^{-1}. A negative statistically significant relationship was found between the reedbed area and Bluethroat density (for all 63 reedbeds: r*s* = –0.45, *P* <0.001). Within the occupied reedbeds the correlation coefficient was over two times higher (r*s* = –0.89, *P* = 0.000, n = 24).

The average distance between the nearest reedbeds was clearly smaller in the case of occupied ones (67.7 m – occupied reedbeds *vs.* 124.7 – unoccupied reedbeds). These differences, however, were statistically insignificant (Mann-Whitney test, *U* = 363, Z = 1.48, *P* = 0.14).

In the course of the study the Bluethroat did not withdraw completely from the reedbeds destroyed by the fire (up to 80–90% of the area, Fig. 1). In such reedbeds both singing males and nesting pairs were recorded in small (several m^2) patches of old reed.

The population of Bluethroat on Wrocław sewage farm is currently one of the biggest known breeding concentrations of this species in western Poland and probably also in large part of central Europe (Czech Republic, Slovakia, southern part of east Germany), that developed in an anthropogenic habitat outside natural river valleys (Glutz von Blotzheim and Bauer 1988, Tomiałojć and Stawarczyk 2003). A clear growth of this population (from 1–2 pairs in 1995 to 45 in 2004) (Słychan 1996, this study) can herald further expansion of this species in western Poland. In recent years breeding of Bluethroat in similar wet anthropogenic habitats was found e.g. in salt-pans of western France (Geslin *et al.* 2002) and artificially flooded polders in Holland (Hustings *et al.* 1995).

The positive relationship between the reedbed size and the number of territories shown in this study confirms the results

from Hungary, where a clear preference for nesting inside the reedbeds was proved, the densities there being 3.5 times higher than on the edges (Baldi and Kisbenedek 1999). This regularity has been mentioned many times in literature as the "islands theory" (MacArthur and Wilson 1967), also for bird fauna of reedbed islands (Baldi and Kisbenedek 2000).

The calculated Bluethroat densities appear to be very high, but taking into account local habitat conditions – close neighbourhood of reedbeds with territories of different status (solitary males / pairs) – and specific breeding biology (visiting by females of adjacent territories of single males) (Smiseth and Amundsen 1995), the obtained values seem to be reasonable. In optimal habitat conditions in Europe (mainly in reedbeds) the size of the Bluethroat territory ranges from 0.13 to 1.5 ha, at the densities from 0.7 to 11.9 territories 10 ha^{-1} (review in: Glutz von Blotzheim and Bauer 1988). In Hungary inside the reedbeds they reached 8.7, while on the edges 2.5 pairs 10 ha^{-1} (Baldi and Kisbenedek 1999). The density calculated for all reedbeds in this paper (3.97 territories 10 ha^{-1}) seems to be similar.

It must be stressed that although the counting method applied in this study gives a reliable picture of the abundance and distribution of all Bluethroat territories in the area, it may not reflect fully the actual number of breeding pairs, the establishing of which would require an even higher number of censuses and detailed observations. The obtained data seem however to be in line with the results of a detailed study of Scandinavian population, where the proportion of territories occupied by pairs was equally low (in Finland about 23%) (Sorjonen and Merila 2000).

In contrary to the findings of Hungarian researchers (Baldi and Moskat 1995) the Bluethroat did not abandon completely the burned reedbeds. It may be a proof of its wider ecological spectrum and perhaps an increasing flexibility in the habitat choice, similar to that observed recently in many western European populations. The Bluethroat was, apart from the Reed Bunting *Emberiza schoeniclus*, the only species that remained in some almost completely destroyed reedbeds. However, for the sake of the protection of other bird species that disappeared completely from the devastated areas (Great Reed Warbler *Acrocephalus arundinaceus*, Reed Warbler *A. scirpaceus*, Sedge Warbler *A. schoenobaenus*, Savi's Warbler *Locustella luscinioides*, Marsh Harrier *Circus aeruginosus* and rare Bearded Tit *Panurus biarmicus*), the burning of reedbeds must be condemned as a harmful practice. Sadly it is still rife in spite of its illegality.

Currently in Europe the Bluethroat is a recovering species, with many populations increasing in new anthropogenic habitats. It is therefore important to monitor the abundance trend as well as maintain the extensive land-use in the inhabited places (e.g. Geslin *et al.* 2002). In the light of presented results and bearing in mind the large number of reedbeds in many parts of the country, steps should be taken to recognize the full picture of the species abundance and distribution in Poland.

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(Received after revising August 2004)