POLISH JOURNAL OF ECOLOGY (Pol. J. Ecol.)	56	3	527–534	2008

Short research contribution

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POPULATION DECLINE OF THE LITTLE OWL (*ATHENE NOCTUA* SCOP.) IN THE CZECH REPUBLIC

ABSTRACT: A change of land use is often cited as a causal factor in the decline of many species of farmland birds. Populations of the Little Owl (*Athene noctua* Scop., 1769) have notably decreased throughout Europe in the last 60 years, including the Czech Republic. The aims of this study were to estimate the recent population trend of the Little Owl and to analyze the importance of altitude and grassland habitat within Little Owl territories. The population trend of the Little Owl in the Czech Republic has still decreasing tendency. The population density dropped from 0.33 breeding pairs (bps) 10 km^{-2} to 0.12 bps 10 km^{-2} in the first (1993–1995) and second (1998–1999) monitoring program, respectively. The decline is apparent also from results from last Little Owl monitoring program which were carried out in 2005–2006 on 35 study plots (4607 km^2). The average population density was estimated at 0.1 bps 10 km^{-2}. A distinct feature of these recent populations is that they occur in the places with relatively high local density (core areas) in comparison to the surroundings, which are unoccupied. At present, the Little Owl rarely breeds in natural tree cavities, but rather the majority of nesting sites are situated in human artifacts, especially within agricultural objects. Areas in which the Little Owl occurs have a significantly larger proportion of grasslands and are situated at lower altitudes. We suggest that the changes in agricultural landscape associated with disappearance of traditional farming management of grassland habitats, forceful pasturage and regular mowing were the main factors in this long-term population decline. The recent decrease of Little Owls could be also the consequence of the existence of small isolated populations in which mortality is not balanced by immigration from surrounding areas.

KEY WORDS: Little Owl, *Athene noctua*, population decline, altitude, grassland, farming management, Czech Republic

Large-scale landscape changes and agricultural intensification, especially during the last 60 years, has notably affected a wide range of biota which inhabits farmland (Fuller *et al.* 1995, Donald 1998, Vickery *et al.* 2001). Most remarkable have been changes in landscape structure, accompanied by the removal of hedgerows and vegetative patches, land drainage, and extinction of old trees, as well as changes in agricultural management, including an increase in soil fertilization and a switch from spring to autumn sowing. In central Europe, a drastic reduction in pastures has occurred, with a majority of grasslands drained and overloaded with nitrogen inputs, as well as sown with competitive nitrogen-responsive grass species. All these changes have led to a rapid decrease

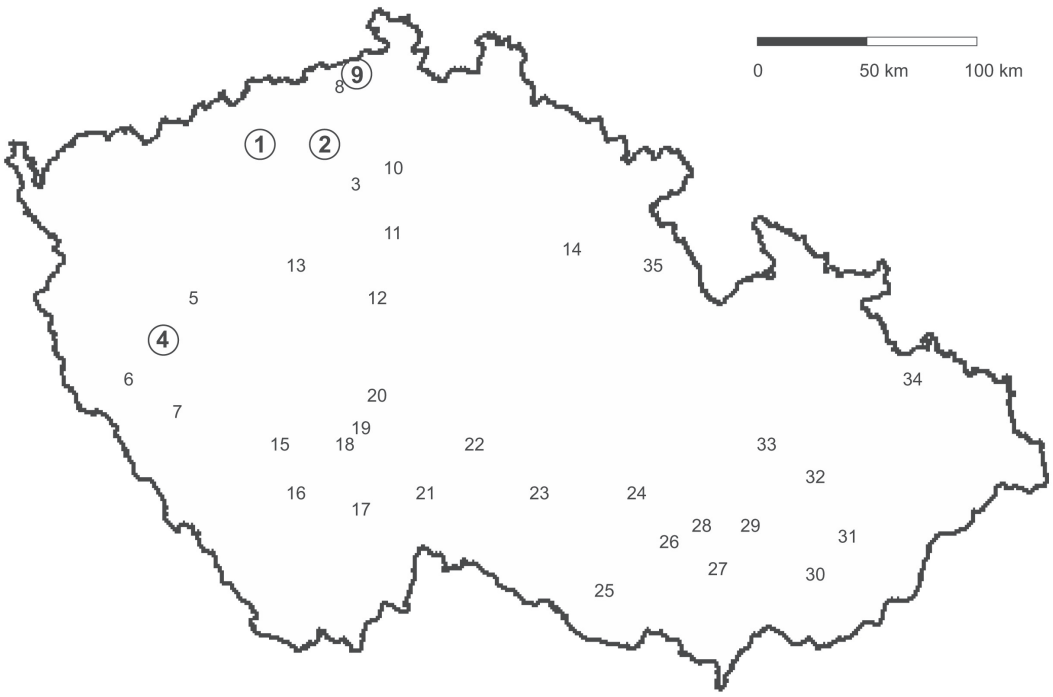

Fig. 1. The location of study areas (1–35) for Little Owl (*Athene noctua* Scop., 1769) monitoring in the Czech Republic in 2005–06. (Study plots with population density exceeding 0.5 bps 10 km^{-2} – Core areas are in circles)

in species diversity and numbers of farmland biota (e.g. Fuller *et al.* 1995). This trend has been also documented for many species of farmland birds (Tucker and Heath 1994, Krebs *et al.* 1999, Donald *et al.* 2001, Evans 2004, Newton 2004).

The Little Owl (*Athene noctua*), a small owl species nesting in agricultural landscapes, has declined in most European countries. As a result, its distribution has become fragmented and isolated in many areas (Cramp 1985, Schönn *et al.* 1991, Exo 1992, Tucker and Heath 1994). The abudance and distribution of the Little Owl was monitored on the territory of the Czech Republic in 1993–1995 and 1998–1999. In these study plots, the Little Owl population declined by more than half compared to previous surveys (Schröpfer 1996, 2000).

The main objective of this study was to estimate the recent population trend in selected localities and in the context of whole country, as well as to analyze factors that may be pivotal in the population decline of this species. To achieve these aims, comparisons were made with published data from previous monitoring programs (Schröpfer 1996, 2000). In addition, altitude and changes in the proportion of grassland habitat, as a key habitat for the Little Owl, were examined, to analyze how these factors affect occurrence in the particular localities.

The population density of the Little Owl was monitored between 2005 and 2006, using similar methods as in the monitoring programs performed in 1993–95 and 1998–99 (Schröpfer 1996, 2000). The investigation was based on a tape-recorded stimulation of the territorial voice of the Little Owl male, which is the most widespread method used for the recognition of Little Owl presence (e.g. Génot 1996/1997, Schönn *et al.* 1991, Żmihorski *et al.* 2006). The population density was estimated in 35 study plots and their area size varies from 10 to 1300 km^2 (Fig. 1). The monitoring program was carried out at each locality within the selected study area. The territorial voice recording was usually played in places where owls were expected to occur, particularly in agricultural buildings, tree-lined avenues, and at the edges of inhabited areas. Fieldwork was performed

from February to the end of April, although in some cases the survey was extended to the middle of May. This period overlaps the peak of Little Owl calling activity (Exo 1989, Finck 1990). Playback experiments were carried out during favorable meteorological conditions, from sunset until midnight, and sometimes extended into the morning hours. Most of the studied villages were checked repeatedly at intervals of several days. The presence of a calling male was considered to represent the occurrence of an owl pair within that breeding place (bps 10 km^{-2}). Core areas were classified as areas where the population density exceeded 0.5 bps 10 km^{-2} (study plots no. 1, 2, 4 and 9 – see Fig. 1). Furthermore, we analyzed expected nesting places in all 35 study areas and compared them with results from previous monitoring programs (1993–95, 1998–99). Expected nesting places were considered as places in owl territories where a nest was found or where breeding behavior was repeatedly recorded.

Grasslands are the most important habitat of the Little Owl territories in central and western Europe (Exo 1983, Loske 1986, Bauer and Berthold 1996, Dalbeck *et al.* 1999, Šálek and Berec 2001). Therefore, we compared the total proportion of grassland area within localities with and without the Little Owl's presence. As territory sizes can vary from 1.5 to 107 hectares (Finck 1990, Génot and Wilhelm 1993, Šálek 2004), which does not allow an accurate estimate of territory boundaries, we decided to analyze the proportion of grassland in an 800 meter circle around the center of human settlements. This circle size is in accordance with the study of Šálek and Berec (2001), who found a strong relationship between the Little Owl's occurrence and the proportion of grassland within this radius. We compared localities both occupied and unoccupied by the Little Owl, and also distinguished localities in core areas (areas with a high population density of Little Owl, see Fig. 1) from others chosen randomly with the presence of the Little Owl outside core areas (study plots no. 8, 10, 12, 17, 19, 21, 29, 31; Fig. 1). All together, we evaluated data from 150 localities (100 unoccupied and 50 occupied). The estimation of grassland area was carried out from updated aerial maps (scale 1:10 000, www.mapy.cz/). Similarly we examined the average altitude of localities within these selected study plots.

The differences in changes of expected breeding sites were compared using the Chi square test (STATISTICA Software, Statsoft, Inc. 1996), with Bonferroni correction. For comparisons, the difference in proportion of meadow habitat and altitude at particular localities was analyzed by the t-test using STATISTICA Software (Statsoft, Inc. 1996).

The negative population trend of the Little Owl was observed in the monitoring programs which were performed in the years 1993–1995 and 1998–1999 (Schröpfer 1996, 2000), and continued by this study in 2005–2006. The average breeding density dropped from 0.33 bps 10 km^{-2} in the first monitoring program (1993–95) to 0.12 bps 10 km^{-2} in the second (1998–1999), respectively. The negative trend did not stop and result in the next population decline. The average population density of the Little Owl in 2005–2006 in these 35 study plots was estimated at 0.1 bps 10 km^{-2}.

Due to the two previous monitoring programs (1993–95, 1998–99) it was possible to compare population changes in some areas separately (Table 1). None of the studied plots showed an increase in population, and in two study plots (plots no. 6 and 22) no changes occurred. These two study plots already lacked an owl population in previous surveys, and in this study the absence of this owl was confirmed. Population decreases were recorded in the rest of the study plots; however, this trend can be characterized as a strong decrease in only three localities (study plots no. 4, 9, 15 – Fig. 1).

A comparison of localities with and without Little Owls showed significant differences in the proportion of grassland habitats within the 800 m radius from the center of settlement ($n = 150$; $t = 2.012$; $P = 0.05$, Fig. 2). Places where the Little Owl was observed had a higher proportion of grasslands (21 *versus* 16%). Moreover, unoccupied localities in core areas (see Methods) had a higher proportion of meadows than in other study areas ($n = 100$; $t = 2.203$; $P = 0.03$). Analysis of the occupied localities within core and other study areas showed no differences in the proportion of grasslands ($n = 50$; $t = 1.459$;

Table 1. Population trend (bps 10 km^{-2}) for the Little Owl in selected areas in the Czech Republic in 1993-95, 1998-99, and this study ([a] – see Fig. 1)

Study area[a]	1993–95	1998–99	2005–06	Trend
4	1.00	1.45	0.55	↓
6	0.40	0.00	0.00	↓
7	0.20	0.10	0.00	↓
9	No data	4.00	2.00	↓
15	No data	0.33	0.00	↓
22	No data	0.00	0.00	↔
27	0.17	0.09	0.05	↓

Table 2. Differences of expected number of breeding places of the Little Owl on the territory of the Czech Republic in 1993–95, 1998–99 and 2005–06 (Schröpfer 1996*, 2000**, this study). Data from 35 study areas (see Fig. 1). Significant and marginally significant *P* values are in bold. Numbers in brackets show proportions (%) of particular breeding place categories in each period. Chi square test, critical *P* value after Bonferroni correction was set at 0.0125.

Expected breeding places	1993-95*	1998-99**	2005-06	d.f.	χ2	P
Agricultural objects	90 (78%)	46 (77%)	29 (53%)	2	5.88	**0.053**
Lanes, parks	13 (11%)	2 (3%)	1 (2%)	2	8.94	**0.011**
Churches, castles	6 (5%)	3 (5%)	3 (6%)	2	0.02	0.990
Other buildings	5 (4%)	9 (15%)	21 (38%)	2	33.07	**0.001**
Industrial buildings	1 (1%)	0 (0%)	1 (2%)	2	1.86	0.395

P = 0.151). As well, these differences were not found when comparing altitude of occupied and unoccupied localities (n = 150; t = 1.835; *P* = 0.07), but occupied localities we found at slightly lower average altitude.

The analysis of expected breeding places sites of the Little Owl throughout the 35 study areas in the Czech Republic confirmed a strong preference for human artifacts over their original breeding sites in tree cavities (Table 2). Compared to previous studies, it was found that the preference for natural places significantly decreased (χ2 = 8.94, (df = 2, *P* = 0.011) in contrast to the rapid increase of residential buildings (χ2 = 33.07, df = 2, *P* = 0.001). Nesting in tree cavities was recorded only at a single locality (study plot no. 8) and it seems that there is no breeding population in any open farming landscape outside of human settlements, except for a nest-box population in Southern Moravia (study plot no. 27). Pooled data from all three monitoring programs showed that agricultural buildings are the most important breeding places (72%; n = 165), followed by residential buildings (15%; n = 35).

At the beginning of 20th century the Little Owl (*Athene noctua*) was widely distributed and was most numerous owl species in the Czech Republic (Jirsík 1944). Especially since the 1950s, a rapid decline in numbers of Little Owls was recorded throughout its whole range. Between 1973–1977 and 1985–1989, a 30% decrease in occupancy of census squares was recorded in two editions of an Atlas of breeding birds in the Czech Republic (Šťastný *et al.* 1987, Šťastný *et al.* 1997). Unfortunately, the trend continued, and in 2001–03 the presence of the Little Owl was recorded in only 168 census squares, which indicates a further 60% decrease in occupancy from previous mapping action (Šťastný *et al.* 2006). Our data from all three programs also confirm negative population trend throughout whole range of the Czech Republic. The Little Owl vanished from

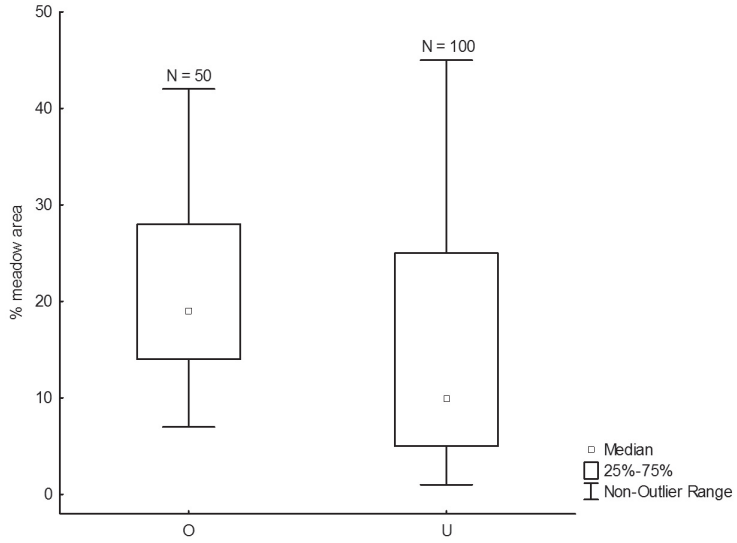

Fig. 2. Proportions of grassland within perimeters of an 800 m radius from the center of villages in unoccupied (U) and occupied localities (O) within selected study areas (n = 150; t = 2.012; $P = 0.05$).

most settlements and its distribution is concentrated to few areas with a relatively high local population density (core areas), compared to wider surroundings that are unoccupied. These high-level population areas are known from previous surveys in the Czech Republic (Schröpfer 1996, 2000), France (Génot 1996/97), and also from many other species with sporadic distributions within a fragmented landscape (Hanski and Ovaskainen 2000). The relative isolation of particular local centers is influenced by the minimal immigration of individuals from surrounding areas. Taking into account the migration behavior of the Little Owl (dispersion of offspring up to 10 km from the nesting place, the high fidelity of adult individuals), only a very low percentage of birds are able to disperse out of these areas into neighboring populations to support their numbers (Gassman and Bäumer 1993, Génot 1995, Šálek 2004). This factor augments the isolation of these populations, thereby making them more vulnerable.

Agricultural intensification and radical changes in the management of arable landscapes between 1950 and 1990 could be the main factors in the sharp population decrease of the Little Owl (Cramp 1985, Schönn *et al.* 1991, Schröpfer 1996, 2000, Šálek and Berec 2001). Even if the land-use changes over this period were not fundamentally different from what had taken place historically, the scale of the changes over time and space, and their impact, was much greater than before. Land collectivization in the 1950´s was accompanied by an increase in the scale of agriculture (small private plots were joined into large collective ones), drainage of exploited soils, disappearing of the traditional landscape structure or reduction of scattered vegetation patches and patches of non-agricultural land (Lipský 2000, Boucníková and Kučera 2005). Changes in the exploitation of agricultural land was reflected in the composition of grasslands, which significantly decreased from 1950–1990 (23 *versus* 19% of agricultural land) and was accompained by an increase in the proportion of arable land (Czech Statistical Office 2006, http://www.czso.cz/).

Different types of grasslands, with a high availability of small mammals and invertebrates, are the most important feeding habitat of the Little Owl in the central European agriculture landscape. Results of our study confirm the importance of grassland habitats within Little Owl territories. Recently occupied localities and all localities within core areas contain a distinctly higher proportion of meadows, as was also observed in a previous study in Southern Bohemia (Šálek and Berec 2001). However, the importance of locality does not only depend on

the overall area of grasslands, but also on the size of particular grassland plots. The Little Owl prefers localities with a higher number of small grassland plots over those joined into large area of grassland (Dalbeck *et al.* 1999). Trees, walls, hedges, poles and fences are important as elevated hunting perches for this owl species (Loske 1986, Dalbeck *et al.* 1999, Šálek 2004).

The importance of short grass swards for catching prey is crucial not only for the Little Owl (Finck 1990, Exo 1991, Dalbeck *et al.* 1999), but also for many species of farmland birds (e.g. Atkinson *et al.* 2004, Devereux *et al.* 2004, Wuczynski 2005). Short swards improve foraging rates by increasing food accessibility, reducing predation risk, and lowering hunting costs for birds foraging in these habitats (Devereux *et al.* 2004). High and dense plant cover in late spring hampers the Little Owl from seeing prey and hunting, and is linked with high feeding effort. This period thus results in high mortality of adult individuals (Exo 1988, Šálek 2004). Little Owl populations could suffer under intensification management, i.e. increasing fertilization of grassland habitats and reseeding with competitive species (e.g. *Lolium* sp.) or conversion of permanent or temporal pastures into arable land. For instance, Loske (1980) observed a rapid decrease in the Little Owl after the plowing of pastures. Also, extensive farming of grassland habitats leads to shaggy long-stalk herb communities, which are also unsuitable for prey catching. The amount of uncultivated agriculture land has rapidly increased, especially since the nineties of last century (Boucníková and Kučera 2005). In areas with a high proportion of uncultivated agriculture land, or in the late spring before the first mowing, owls feed on alternative hunting grounds such as lawns, concrete slabs or roads (Šálek 2004). Suitable breeding territories throughout the year occur in city environments, where owls nest in slab blocks and hunt in mown or tramped-down lawns (Salvati *et al.* 2002, Kitowski 2003). A second peak in mortality occurs in the winter months, especially those with long-standing snow cover (Cramp 1985, Schönn *et al.* 1991, Bauer and Berthold 1996).

Other factors that may contribute to the decline in the Little Owl density are the following: application of rodentocides (Bauer and Berthold 1996), mortality on roads and railways (Bauer and Berthold 1996), deaths in water reservoirs, air shafts and chimneys (Génot 1995, Bauer and Berthold 1996), contamination by biocides (van den Bring *et al.* 2003, Zaccaroni *et al.* 2003) or direct human interference (Schönn *et al.* 1991). However, I suppose that these factors were not responsible for the observed widespread decline. Predation pressure by stone martens (*Martes foina* Erxleben, 1777), whose population dramatically increased (Mitchell-Jones *et al.* 1999), may be another negative factor. The number of safe nest sites is a limiting factor for breeding success in many populations (Schönn *et al.* 1991).

The majority of Little Owl nesting places is no longer in natural tree cavities, and nesting in man-made artifacts has replaced these sites. Tree cavities, especially in pollard willows, formed 83% of nesting resources until the 1980s (Hudec 1983). Since that time, the proportion of natural nesting places has dramatically decreased. In 1993–95, natural habitats provided 11%, in 1998–99 3%, and in 2005–06 only 2% of breeding places. This trend is clearly caused by the strong reduction of old pollard trees within most areas during last 60 years. On the contrary, man-made habitats were the most widely used breeding territories of the Little Owl in the Czech Republic from 1993–2006. Nesting places situated in man-made objects have often been described in other studies (Schönn *et al.* 1991, Kasprzykowski and Goławski 2006). The decline of breeding sites in agricultural objects in contrast to the increasing number of territories in residential buildings was exemplified by the residential nesting sites found in study plot (study plot no. 1). Extensive farming, abandoned agricultural objects and overgrown patches with high and dense vegetation in their surroundings could also contribute to this trend.

We suppose that the long-term decline of the Little Owl in agricultural landscapes in central Europe was principally caused by habitat degradation. The recent decrease in highly fragmented Little Owl populations is also result of fluctuations due to severe winters and consequence of a very small number of the birds, where mortality is

not balanced by migrations from neighboring areas. Population numbers up to tens of pairs could be also strongly affected by accidental factors (e.g. mortality in smokestacks, open water basins, poisoning), which would not drastically affect larger populations. Nowadays, the absence of Little Owls in many localities could be the result of not only unsuitable habitat, but also could be attributed to the accidental dying out of these fragile subpopulations.

ACKNOWLEDGEMENTS: We are very grateful to T. Diviš, J. Prach, D. Lacina, O. Volf, J. Procházka, A. Kadouch, Z. Vermouzek, J. Hruška, D. Melichar, V.Štovíček, L. Blaho, P. Stochlová, T. Pigula, P. Molitor, Z. Pangrácová, M. Kubelík, J. Vajner, M. Pešata, P. Benda, Z. Jabůrek, P. Lumpe, P. Marek, D. Stejskal, J. Vítovský, D. Fuka, R. Všetečka, M. Chaloupka, T. Had, Z. Konečný, O. Pěnkava, I. Hertl, J. Hartl, V. Křivan, V. Škorpíková, M. Valášek, B. Lansdsfeld, L. Opuštil, F. Krause, P. Berka without their help in the field this study could not arise. We thank A. Hillbricht-Ilkowska and F. Sedláček for their comments to manuscript and J. Riegert for statistic improvement. This study was supported by the grant MSMT6007665801 of the Czech Ministry of Education and by the research aim of the Institute of Systems Biology and Ecology AV0Z60870520.

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Received after revising February 2008