Habitat preferences of a declining population of the little owl, *Athene noctua* in Central Poland

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A b s t r a c t . The number of little owls, *Athene noctua* is decreasing in many European countries. In order to evaluate causes of the decline in Poland, habitat preferences of this species were analysed. Using GIS methods, 25 settled territories of the little owl, recorded during field surveys between 2000 and 2005, were compared with 50 unsettled locations. It was found that the proportion of built-up areas was higher in the occupied territories than in the random locations. No differences in grassland, forest and field proportion, habitat diversity and edge length were recorded between the occupied, and the random locations. The amount of forest and the proportion of built up areas appeared to be the best predictor of the occurrence of the little owl. Next, habitat use at 7 additional territories, which were occupied by little owls in 1980–90s and later abandoned, was analysed. In 2006, as compared to the period 1980–90, numbers of pollard willows decreased, whereas the number of buildings increased in these territories. The overall results lead to a conclusion that the little owl shows a high degree of habitat plasticity. The decrease of the area of grasslands and numbers of pollard willows is not likely to explain the population decline of the species.

Key words: grasslands, pastures, GIS, agriculture, farmland, conservation

Introduction

The size of European populations of many bird species associated with agriculture has changed significantly during the last decades (D o n a l d et al. 2006, Ž í d k o v á et al. 2007). In Poland, many birds inhabiting farmland have been observed to be on the decline, e.g. the lapwing *Vanellus vanellus* (Linnaeus, 1758), the kestrel *Falco tinnunculus* (Linnaeus, 1758), the hooded crow *Corvus corone* (Linnaeus, 1758), the linnet *Carduelis cannabina* (Linnaeus, 1758), the goldfinch *C.carduelis* (Linnaeus, 1758) and the tree sparrow *Passer montanus* (Linnaeus, 1758) (C h y l a r e c k i & J a w i ń s k a 2007). In spite of the clear negative trends the knowledge about the importance of many potential factors that are at work remains incomplete. Therefore, a detailed analysis of factors affecting the decline of the farmland populations of birds is necessary. The most important one confirmed in western Europe appears to be habitat change. Agriculture intensification, mechanisation, large-scale monocultures and many other transformations have negative impact on parameters such as nest site availability, breeding success or foraging efficiency (e.g. N e w t o n 2004). Since agricultural landscape has changed significantly in many European countries, determination of habitat preferences of declining bird species is especially important for predicting change in their populations and formulating a strategy of biodiversity conservation in farmland.

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The little owl is one of the many farmland species that have declined during the last two decades in Europe (BirdLife International 2004, Martínez & Zuberogoitia 2004a, Salek & Shröpfer 2008), including Poland (Stańko & Żegliński 2000, Żmihorski et al. 2005, 2006, Grzywaczewski 2006, but see also Ławicki & Rubacha 2008). In order to propose effective protection methods, more data concerning factors shaping the distribution and abundance of populations are needed. The aim of this paper is to evaluate habitat preferences of the little owl in an extensively managed agricultural landscape, including assessment of habitat changes in recently abandonment little owl territories. Since the little owl seems to favour grassland as a hunting habitat (e.g. Grzywaczewski 2006, van Nieuwenhuyse et al. 2008), the hypothesis is put forward that the observed decline is associated with low availability of this habitat in the study area.

Methods

The research was conducted in the Mazowsze Lowland, Central Poland. Average ambient temperatures in this region are 7–8 ºC, and the amount of precipitation is less than 550 mm. Summer lasts on average 90 days, winter 90–100 days and the growing season is 220 days long (Stopa-Boryczka & Boryczka 2005). The study was conducted in an agricultural landscape situated within 50 km from Warsaw, however no clear border of the study area can be provided because of sampling design (see below). The study area is a mosaic of arable and abandoned fields, grasslands, and built-up land. Fields predominated on the study area and contribution of remaining habitats was lower. Roads that intersected the landscape were lined with pollard willow *Salix* spp. trees which provided little owls with nesting and roosting sites.

Habitat preferences of the little owl were investigated by comparing the occupied territories (inhabited by owls) and random unsettled locations (RUL; no owls recorded). Data on occupied territories were collected by means of voice stimulation carried out with playbacks by authors and observations provided by birdwatchers and foresters. In total, 413 playback calls were performed in spring (March–June), in the years 2002–2005. The calls were played from dusk to dawn, during good weather conditions (no strong wind and rain). In each playback point the territorial voice of the little owl was played for ca. 3 minutes, followed by a 5-minute listen-out (Zuberogoitia & Campos 1998). Each playback point was visited once and the presence or absence of the little owl was noted. All playback points were evenly distributed, 300 m to 1 km away from one another. This sampling design is commonly used for investigation of habitat preferences in birds (e.g. Müller et al. 2009) however, it does not allow density assessment. Although the nests of the recorded owls were not located, it was assumed that the birds were territorial, since all the playbacks and observations provided by birdwatchers were made in spring.

The centre of each occupied territory was determined by the location of the vocalising bird, immediately after the playback, before the owl managed to get closer. Additional information about the centre of a territory was recorded by visual observation. The birdwatchers who saw little owls in the study area between 2000–2005 marked the localisation of known territories, as precisely as possible, on topographic maps in the scale 1:10 000 or 1:25 000.

The centres of the RULs were established in a different way. Out of the 400 playback points at which the little owl was not detected, 50 were randomly chosen for further analysis. In order to select a RUL, a random azimuth (0–360°) and a range of distance (0–150m, 151–300m, 301–450m or 451–600m) from the playback point was chosen for each of the 50 points. The probability of choosing a given distance range was weighted by the percentage of occupied territories in this distance range, calculated on the basis of their distribution: 25% for the range 0–150m; 33% for 151–300m; 0% for 301–450m; and 42% for 451–600m.

The 25 occupied and the 50 RULs were analysed with GIS techniques. The localisation of all territories was marked on topographical maps (scale 1:10000 or 1:25000), which were then digitised (one pixel size corresponded to 70 cm or 200 cm in the two scales, respectively) and analysed in the ArcView 3.3 program (ESRI 2000). Around each centre of the occupied territory or RUL a 300 m radius buffer was marked which corresponds to an average little owl territory in the breeding season (Finck 1990). For each buffer, the proportion of four main habitats was computed: grassland (mainly pastures and meadows), fields (both arable and abandoned), afforested areas (forest, woodlots, orchards) and built-up areas. Moreover, for each buffer habitat diversity index was computed according to Levin's (1968) formula: $1/\Sigma p_i^2$, where p_i denotes contribution of a given habitat to the buffer. The index values range from one (the least diverse habitat) to four (the most diverse habitat). Also, for each buffer the total length of habitat edge (i.e. the border between two adjacent habitats, which is a potential little owl foraging habitat) was computed (van Nieuwenhuyse et al. 2008).

Habitat changes which took place in the seven territories inhabited by the little owl in the years 1981–1995 (Romanowski 1988, Bacia 1997) and abandoned recently (Żmihorski et al. 2006) were described. The territories were situated in the "Łomianki" plot, near Warsaw (Dombrowski et al. 1991). This plot was selected because the highest farmland density of the little owl in Poland was recorded on the plot in 1986 (6.7 territories/10 km^2; Dombrowski et al. 1991) while none of the 7 territories were used by owls in 2003 (Żmihorski et al. 2006). Field observations and simplified descriptions of each territory (in the radius of 300 m from the former nest) were conducted in 2006 and compared with available data collected in the 1980s and 1990s.

Percentages of four habitat types, habitat diversity index and edge length in occupied territories and RULs were compared with the Mann-Whitney test. The Principal Components Analysis (PCA) with varimax rotation was used to reduce the four habitat variables. The components extracted were used as predictors in a logistic regression, in which the response variable was probability of the little owl occurrence. The best model of the logistic regression was chosen on the basis of the Akaike Information Criterion (AIC, Johnson & Omland 2004). The number of willows in the years 1981–1995 and 2006 within 7 abandonment territories was compared with the Wilcoxon Signed Rank Test. SPSS 13.0 was used for the statistical analysis (SPSS 2004).

Results

In total, 13 territories of the little owl were located by playbacks and 12 other were detected by birdwatchers and foresters. The proportion of built-up areas was higher in the occupied territories (14.9%) as compared to the RULs (7.4%) and the difference was significant (Fig. 1). The proportion of three remaining habitat types as well as habitat diversity index and edge length did not differ between occupied territories and the RULs (Fig. 1).

The percentages of the four main habitat types were negatively correlated. Significant correlations were recorded between the percentage of built-up area and forest ($r = -0.24$, $p = 0.036$), grassland and field ($r = -0.66$, $p < 0.001$) and forest and field ($r = -0.54$, $p < 0.001$). The PCA was applied and two components with eigenvalues greater than 1.0 were extracted.

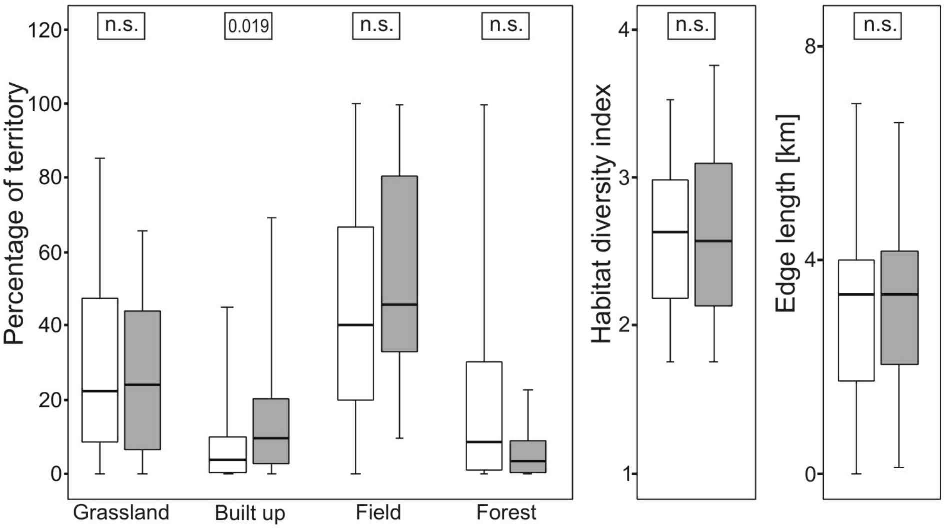

Fig. 1. Box-whisker plot of the proportion of four main landscape components, habitat diversity index and habitat edge length in 50 unsettled territories (empty boxes) and 25 occupied territories (shaded boxes) of the little owl *Athene noctua* in an agricultural landscape in Central Poland. The boxes represent inter-quartile range, whiskers - range, central line – medians. P-values of the nonparametric Mann-Whitney test are given above each pair. See methods for the habitat diversity index explanations.

The first component explained 45.3% of the overall habitat variance and was positively correlated with grasslands proportion (r = 0.81) and negatively with fields proportion (r = –0.97). The second component explained 30.2% of the variance and was positively correlated with built-up areas proportion (r = 0.73) and negatively with forests proportion (r = –0.83).

The two components were used as explanatory variables in the logistic regression. The first component was not significant but the second component significantly affected the little owl presence (Table 1). The model with the two components was significant. The AIC values computed for the models 2 and 3 were much lower as compared to model containing intercept only. In contrast, the AIC value computed for model 1 was similar to the AIC value obtained for intercept only model, indicating that component 1 was not useful for explaining the little owl presence in the analysed locations. The second model was the most parsimonious as assessed with AIC (Table 1). The model predicts that the probability of the little owl occurrence is greater than 0.5 for the locations without forest and when the percentage of built-up areas exceeds 20% (Fig. 2).

In the seven territories that were used by the little owl in the 1980s and 1990s some habitat transformations were observed in 2006. The number of pollard willows decreased although the change was on the verge of significance (Wilcoxon Signed Rank Test, Z = 1.83, p = 0.068).

Table 1. Models of the logistic regression explaining occurrence of the little owl *Athene noctua* in playback points in Central Poland. For each model the pseudo R^2 (Cox and Snell), p-value of the final model, and AIC value are given. The model with the lowest AIC value is marked in bold.

Variables in the model	Pseudo R^2	p-value	AIC
Component 1	0.6%	0.508	99.04
Component 2	**12.4%**	**0.002**	**89.54**
Component 1 + 2	13.5%	0.004	90.58
Intercept only	–	–	97.48

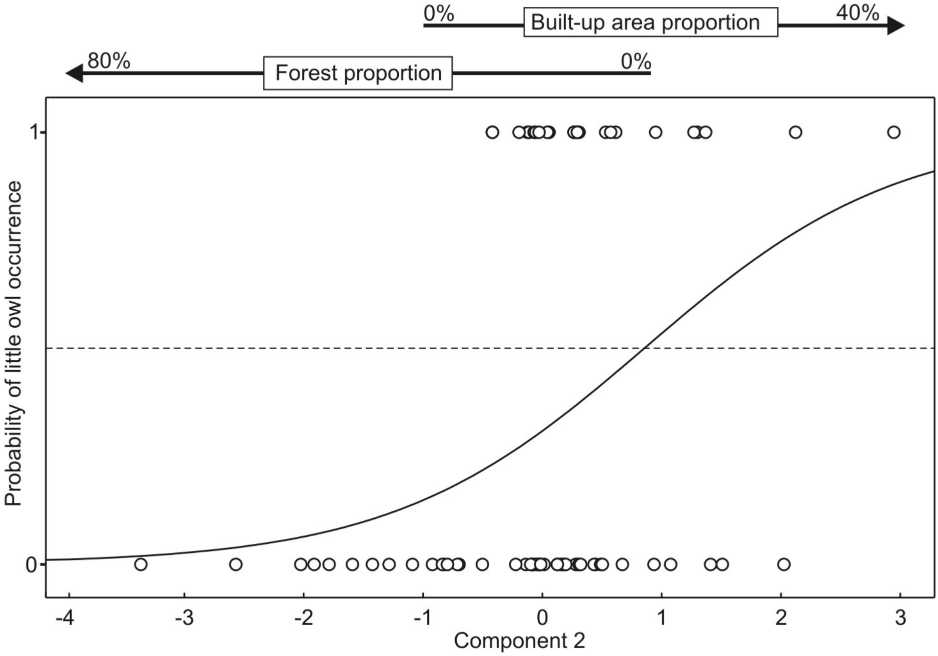

Fig. 2. Model of the logistic regression presenting probability of the little owl *Athene noctua* occurrence in relation to the values of the component 2. The model was selected as the best on the basis of AIC values presented in table 1. The component 2 represents contrast between high proportion of forest and built-up areas. Each dot represents one territory, horizontal line represents probability = 0.5.

No signs of recent trimming of remaining willows were found, however approximately 30% of the willows contained hollows suitable for the little owl (diameter ≥ 60 mm). In some of the analysed territories the number of buildings increased (Table 2). The territories were composed predominantly of abandoned land and arable fields, and no grazed pastures were recorded in 2006.

Table 2. Habitat composition (as recorded in 2006) in the radius of 300 m from the nest in seven *Athene noctua* territories used in the 1980s and 1990s and abandoned since 2003.

Features / territory no.	1	2	3	4	5	6	7	Mean
All willows (n)	10	32	40	41	3	85	22	33
Willows with hollows (n)	-	7	3	27	2	34	8	14
N of willows that disappeared since the 1980s	-	20	5	0	0	15	4	7
N of new buildings since the 1980s	5	2	2	0	0	0	0	1
Grasslands (%)	0	10	30	13	50	25	0	18
Fields – abandoned (%)	65	30	50	75	10	20	50	43
Fields – arable (%)	10	50	15	13	40	55	50	33

Discussion

Habitat preferences

The percentages of the four habitat types in the real territories and random locations were quite similar, with the exception of built-up areas: proportion of buildings was higher in occupied territories. However, the most parsimonious model of the logistic regression explaining the occurrence of the little owl points to the gradient between forested areas and built-up grounds as the most important habitat variable affecting the owl. The forest avoidance by territorial little owls recorded in this study was expected, since similar habitat avoidance was reported earlier (van Nieuwenhuyse et al. 2008). The highest proportion of forested areas in an occupied territory in the study area reached 22% (Fig. 1). The proportion of forest in the RULs was much higher, including some locations that were totally covered by forest. Avoidance of this habitat by the little owl may be caused by lack of appropriate hunting grounds in afforested areas. In Central Poland the little owls hunt mainly voles and epigeic invertebrates (Romanowski 1988, Romanowski & Żmihorski 2006), which may be less abundant or even unavailable in forests. This avoidance may be also linked to the common occurrence in forests of two predators: the tawny owl *Strix aluco* and the pine marten *Martes martes* that prey on the little owl (Herrera & Heraldo 1976, Mikkola 1976, Knötzsch 1978, Lunder & Stange 2001).

The preference of the little owl for built-up areas indicates that the species is strongly associated with human settlements and confirms earlier results obtained in Spain (Martínez & Zuberogoitia 2004c). This supports the observed tendency of the little owl to withdraw from farmland and colonise more urbanised areas (Martínez & Zuberogoitia 2004a, Grzywaczewski 2006). Recently, its nests have been found in man-made structures (e.g. buildings) more frequently than in natural tree holes (see Grzywaczewski 2006 for a review). The shift may be related with the loss of preferred little owl's habitats in typical farmland (Martínez & Zuberogoitia 2004a).

Habitat diversity and total length of edges were similar in the occupied and unoccupied locations, and seem to be unimportant for the owl occurrence. This result is unexpected since both habitat diversity and the length of edges were reported to be important habitat features for the little owl (van Nieuwenhuyse et al. 2008). Grassland is regarded as a key foraging habitat for the little owl (and other raptors, Butet & Leroux 2001, Aschwanden et al. 2005), since low vegetation positively affects prey availability (van Nieuwenhuyse et al. 2008). The decrease in suitable hunting habitats is considered a threat for the little owl's population in Poland and Czech Republic (e.g. Grzywaczewski 2006, Salek & Shröpfer 2008). This importance of grassland for the distribution of little owl territories is not corroborated by our results. Moreover, the growing number of the little owl in urban habitats (Grzywaczewski 2006), where the proportion of grassland is very low, confirms the conclusion that the importance of grassland for the species' occurrence is not always high. It appears that the habitat category called "grassland" is composed of several vegetation and land use types, which have different value for the little owl, and therefore cannot be a reliable indicator of habitat suitability in this species. In the study area part of the meadows are rarely mown in recent years, what leads to an increase in vegetation height and a decrease in prey availability for the owl. Therefore, even if the amount of grasslands in the area remains stable, ratio of grazed pastures to rarely mown meadows can change significantly, which in turn can affect the little owl and many other species associated with low vegetation (e.g. the starling *Sturnus vulgaris*, hoopoe *Upupa epops* – Romanowski & Żmihorski 2008).

Habitat transformation and the little owl extinction

Considerable habitat transformations were recorded in the seven territories formerly inhabited by the little owls. The number of willows, which were earlier the main nesting place for the owls (Romanowski 1988, Bacia 1997, Romanowski unpubl. data) has decreased, and the remaining willows are no longer pollard. In contrast, the number of buildings has increased. However, it may be hypothesized that despite the habitat transformation this changes are not responsible for the little owl's decline. Although the number of willows has fallen, the trees are still much more abundant at the Łomianki plot than in the Warsaw suburban zone, where the little owl is still present (Żmihorski 2004). Moreover, a considerable proportion of the willows within abandonment territories still contain appropriate holes. In the light of these observations, the low availability of nesting places should not be responsible for the population's decline. This holds also in the case of the increase in built-up areas in the territories because, as it was shown, the species prefers the vicinity of buildings. Instead, it may be suggested that changes in vegetation type, in particular disappearance of grazed pastures and increase in the proportion of abandoned land, undergoing plant succession, reduce the availability of optimal little owl hunting habitats and are more important for the abundance of this species.

Implications for conservation

In general, it was recorded that the little owl is not a habitat specialist and can occur in a wide range of agricultural and suburban habitats, with the exception of highly afforested areas. It may inhabit areas with high percentage of both grassland and fields. Most interestingly, it was observed that some of the little owl territories are characterised by a very low amount of grassland, which leads to a conclusion that grasslands are not necessary for the species' occurrence. However, a more precise analysis of habitat use by the little owl is needed to evaluate the importance of particular habitat types for its distribution and abundance.

Most importantly, lack of the expected preference for grasslands suggests that the decline of the little owl in Central Poland (Żmihorski et al. 2005, 2006, Grzywaczewski 2006) is not explained by decrease in the amount of grassland in agricultural landscape. It is also unlikely that the decrease in the number of pollard willows and the increase in the number of buildings are responsible for the owl's extinction in the Łomianki plot. More credible factors that may drive the observed decline of the little owl and of other birds inhabiting farmland appear to be negative changes in habitat quality, such as road mortality or decrease in grazing/mowing frequency (e.g. Butet & Leroux 2001, Martínez & Zuberogoitia 2004a, Romanowski & Żmihorski 2008). In the light of the observations presented in this paper, installing nest boxes in a typical agriculture landscape may be useless (see also Martínez & Zuberogoitia 2004b). Monitoring of the little owl population and further investigations of its habitat requirements and preferences are necessary.

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LITERATURE

Aschwanden J., Birrer S. & Jenni L. 2005: Are ecological compensation areas attractive hunting sites for common kestrel (*Falco tinnunculus*) and long-eared owls (*Asio otus*)? *J. Ornithol. 146: 279–286.*

Bacia D. 1997: Pokarm i preferencje środowiskowe pójdźki (*Athene noctua* Scop.) na terenach rolniczych [Food and habitat preferences of little owl (*Athene noctua* Scop.) in an agricultural area]. *Master Thesis, Warsaw University. (in Polish)*

BirdLife International 2004: Birds in the European Union: a status assessment. *Wageningen, The Netherlands, BirdLife International.*

Butet A. & Leroux A.B.A. 2001: Effects of agriculture development on vole dynamics and conservation of Montagu's harrier in western French wetlands. *Biol. Conserv. 100: 289–295.*

Chylarecki P. & Jawińska D. 2007: Common breeding bird monitoring in Poland: Annual report 2005–2006. *Polish Society for the Protection of Birds, Warszawa. (in Polish with English summary)*

Dombrowski A., Fronczak J., Kowalski M. & Lippoman T. 1991: Population density and habitat preferences of owls Strigiformes on agricultural areas of Mazowsze Lowland (Central Poland). *Acta Ornithol. 26: 39–53. (in Polish with English summary)*

Donald P.F., Sanderson F.J., Burfield I.J. & van Bommel F.P.J. 2006: Further evidence of continent-wide impacts of agriculture intensification on European farmland birds, 1990–2000. *Agric. Ecosyst. Environ. 116: 189–196.*

ESRI 2000: ArcView 3.2. *Environmental Systems Research Institute, Redlands, California.*

Finck P. 1990: Seasonal variation of territory size with the little owl (*Athene noctua*). *Oecologia 83: 68–75.*

Grzywaczewski G. 2006: State of the population of the little owl *Athene noctua* in Poland. *Not. Ornitol. 47: 147–158. (in Polish with English summary)*

Herrera C.M. & Hiraldo F. 1976: Food-niche and trophic relationships among European owls. *Ornis Scand. 7: 29–41.*

Johnson J.B. & Omland K.S. 2004: Model selection in ecology and evolution. *Trends Ecol. Evol. 19: 101–108.*

Knötzsch G. 1978: Colonization experiments and notes on the biology of the little owl. *Vogelwelt 99: 41–54.*

Levins R. 1968: Evolution in changing environments. *Princeton Univ. Press, Princeton.*

Luder R. & Stange C. 2001: Evolution of a population of little owls *Athene noctua* near Basel 1978–1993. *Der Orn. Beob. 98: 237–248.*

Ławicki Ł. & Rubacha S. 2008: Fluctuations in the little owl *Athene noctua* abundance in the Warta and Noteć River valleys in the Województwo Lubuskie province. *Not. Ornitol. 49: 169–174. (in Polish with English summary)*

Martínez J.A. & Zuberogoitia I. 2004a: Effects of habitat loss on perceived and actual abundance of the little owl *Athene noctua* in eastern Spain. *Ardeola 51: 215–219.*

Martínez J.A. & Zuberogoitia I. 2004b: Habitat preferences and causes of population decline for barn owl *Tyto alba*: a multi-scale approach. *Ardeola 51: 303–317.*

Martínez J.A. & Zuberogoitia I. 2004c: Habitat preferences for long-eared owls *Asio otus* and little owls *Athene noctua* in semi-arid environments at three spatial scales. *Bird Study 51: 163–169.*

Mikkola H. 1976: Owls killing and killed by other owls and raptors in Europe. *Brit. Birds 60: 144–154.*

Müller J., Pöllath J., Moshammer R. & Schröder B. 2009: Predicting the occurrence of middle spotted woodpecker *Dendrocopos medius* on a regional scale, using forest inventory data. *Forest Ecol. Manage. 257: 502–509.*

Newton I. 2004: The recent declines of farmland bird populations in Britain: an appraisal of causal factors and conservation actions. *Ibis 146: 579–600.*

Romanowski J. 1988: Trophic ecology of *Asio otus* (L.) and *Athene noctua* (Scop.) in the suburbs of Warsaw. *Pol. Ecol. Stud. 14: 223–234.*

Romanowski J. & Żmihorski M. 2006: The little owl *Athene noctua* diet in Central Poland. *Not. Ornitol. 47: 203–206. (in Polish with English summary)*

Romanowski J. & Żmihorski M. 2008: Selection of foraging habitat by grassland birds: effect of prey abundance or availability? *Pol. J. Ecol. 56: 365–370.*

Salek M. & Schröpfer L. 2008: Population decline of the little owl (*Athene noctua* Scop.) in the Czech Republic. *Pol. J. Ecol. 56: 527–534.*

SPSS 2004: SPSS 13.0 for Windows. *SPSS, Chicago, Illinois, USA.*

Stańko R. & Żagliński G. 2000: The number of little owl *Athene noctua* in the River Warta valley near Głuchowo, Lubusian Land. *Przegl. Przyr. 11: 100–102. (in Polish with English summary)*

Stopa-Boryczka M. & Boryczka J. 2005: Klimat [Climate]. In: Richling A. & Ostaszewska K. (eds) Geografia fizyczna Polski [Physical geography of Poland]. *PWN, Warszawa: 84–127. (in Polish)*

Van Nieuwenhuyse D., Génot J.C. & Johnson D.H. 2008: The little owl. Conservation, ecology and behavior of *Athene noctua*. *Cambridge Univ. Press, New York*.
Zuberogoitia I. & Campos L.F. 1998: Censusing owls in large areas: a comparison between methods. *Ardeola 45: 47–53*.
Žídková L., Marková V. & Adamík P. 2007: Lapwing, *Vanellus vanellus* chick ringing data indicate a region-wide population decline in the Czech Republic. *Folia Zool. 56: 301–306*.
Żmihorski M. 2004: Number of little owl *Athene noctua* in Warsaw suburban zone (Central Poland). *Kulon 9: 203–205. (in Polish with English summary)*
Żmihorski M., Krupiński D., Osojca G. & Jarzombkowski F. 2005: Owls of Kampinoski National Park (Central Poland). *Kulon 10: 43–46. (in Polish with English summary)*
Żmihorski M., Altenburg D., Romanowski J., Kowalski M. & Osojca G. 2006: Long term decline of the little owl (*Athene noctua* Scop., 1769) in Central Poland. *Pol. J. Ecol. 54: 321–324*.