

LAND-USE CHANGES AT NEST SITES OF THE LITTLE OWL (*ATHENE NOCTUA*) IN THE SOUTH-MORAVIAN REGION OF THE CZECH REPUBLIC

KAREL POPRACH¹, LIBOR OPLUŠTIL², FRANTIŠEK KRAUSE³
AND IVO MACHAR^{4*}

^{1, 4} *Department of Development and Environmental Studies, Faculty of Science, Palacky University, Olomouc, tř. 17. listopadu 12, 771 40 Olomouc; e-mail: karel.poprach@tyto.cz*

² *Podolí 286, 664 03 Podolí u Brna; e-mail: libor.oplustil@email.cz*

³ *Břetislavova 8, 690 02 Břeclav; email: bretislavovafk@seznam.cz*

* *Corresponding author e-mail: ivo.machar@upol.cz*

Received: 5th April 2017, **Accepted:** 15th June 2017

ABSTRACT

The Little Owl is currently endangered bird species of agricultural lowland areas in Central Europe. Nesting sites of the Little Owl are often old trees as well as buildings and quarries with suitable nesting cavities. The Little Owl has severely declined in a major part of Europe during the past decades. Information on habitat requirements of the Little Owl and data related to land-use changes at nest sites (covering both the breeding and foraging habitats) are needed for conservation programmes aimed at this bird species. Land-use changes in farmland rank among frequently discussed negative factors causing the population decline of the Little Owl. The aim of this study is to analyse land-use changes at nest sites of the Little Owl in the South-Moravian region (Czech Republic) between the years 1976/1977 and 2014. In both studied periods (1976/1977 and 2014), the most important land-use type within 500 m from the nest sites of the Little Owl was arable land (66.94 % - 62.25 %), followed by built-up areas (19.97 % - 22.41 %), while the other land-use types made up less than 5 %. The proportion of the particular land-use type did not change significantly between the years 1976/1977 and 2014. The most important change in comparison with the period 1976/1977 was the decrease in the area of arable land by 4.69 % and that of orchards and gardens by 1.99 %, while the surface of built-up areas increased slightly by 2.45 % and that of meadows and pastures by 1.5 %. The analysis shows that at the known nest sites of the Little Owl in the South-Moravian region (Czech Republic), there were no significant changes in the proportion of the particular land-use types within 500 m from the nests between the years 1976/1977 and 2014. Based on these results, we can conclude that in comparison with the availability of nest sites, which seems to be the important limiting factor for the occurrence and population density of the Little Owl, land-use changes in study area were not very important factor influencing decline of the Little Owl.

Keywords: Agricultural land, birds, GIS analyse, land-cover, nest site.

INTRODUCTION

The Little Owl (*Athene noctua*) is a Turcmenic-Mediterranean faunal element (Vogus, 1962) which uses open habitats such as meadows, grasslands and fields as hunting grounds. Nesting takes place in tree cavities which are also important as raised stands (Framis *et al.*,

2011). In Central Europe, open agricultural land is a typical hunting habitat of the Little Owl (Scherzinger, 1981). Nesting sites are often old trees as well as buildings and quarries with suitable cavities (Mebs & Scherzinger, 2000). The Little Owl has severely declined in a major part of Europe during the past decades (Šálek & Schröpfer, 2008; Zmihorski *et al.*, 2009). This population trend of the Little Owl is similar as population trends of other owls breeding in agricultural landscapes in Europe. Artificial nest boxes seem to be a simple and effective conservation measure supporting the population restoration of the Little Owl. However, further information on habitat requirements of the Little Owl and data related to land-use changes at nest sites (covering both the breeding and foraging habitats) are needed for conservation programmes aimed at this endangered bird species.

Several decades ago, the Little Owl was one of the most common breeding owl species in the Czech Republic. It was widespread in lowland areas of the country, breeding in almost every settlement there, and its population comprised several thousands of breeding pairs. Since the 1960s the species started to decline gradually (Hudec, 1983) and the decrease became more pronounced in the late 20th century (Hudec & Šťastný, 2005). The breeding population of the Little Owl in the Czech Republic in the year 1990 was estimated at 600–700 pairs (Danko *et al.*, 1994). On the other hand, Schröpfer (1996) mentioned 1,000–2,100 pairs for the period 1993–1995, and the same author (Schröpfer, 2000) noted 500–1,000 pairs for the period 1998–1999. According to the results of monitoring of the Little Owl in the Czech Republic, the breeding population did not exceed 100 pairs in the year 2015 and it was approximately 130 pairs in 2016 (Opluštil, 2016).

The causes of the dramatic decline in numbers of the Little Owl in the Czech Republic are not quite clear. Some authors (Hudec *et al.*, 2005) suggest climatic factors to influence the Little Owl population (severe winter rich in snow). However, in lowland areas of Central Europe, such winters have been rather exceptional in recent decades. Other potential important causes of the population decrease of the Little Owl mentioned in the literature include road and railway casualties (Hernandez, 1988; Bauer & Berthold, 1996) and mortality due to technical dangers, such as concrete electric poles with a vertical inner cavity where the Little Owls hide but are not able to leave, or molasses tanks in agricultural farms where the Little Owls get drowned (Machar & Poprach, 2012).

The main causes of the dramatic decline in numbers of the Little Owl mentioned in the literature include intensification of agriculture (use of chemicals and rodenticides), increased predation pressure due to high abundance of small carnivores, loss of breeding opportunities related to the elimination of scattered vegetation in the landscape, or climatic factors (Šťastný *et al.*, 1987; Martiško, 1994).

Land-use changes in farmland rank are one of important factors among frequently discussed negative factors causing the population decline of the Little Owl (e.g. Cramp, 1985; Génot *et al.*, 1997; Šálek & Berec, 2001; Machar, 2012). As pointed out by Kitowski & Stasiak (2013), different types of grassland with high availability of potential prey are the most important feeding habitat within the Little Owl territories in the Central European farmland. The reduction of the area covered by grasslands is recognized as an important factor in the disappearance of the occurrence sites of the Little Owl (Loske, 1986; Finck, 1990). The study by Kitowski & Pawlega (2009) revealed that insects associated with pastures as well as with stored grain is a significant component of the Little Owl diet. Decreasing numbers of cattle in the farms result in deterioration of the conditions of pastures as hunting areas for the Little Owl. This deterioration refers to factors such as the increase of grass length, due to lower pressure in the form of grazing, which may limit the access to potential prey, or to the lack of dung pats, which attract various species of insects (Denholm-Young, 1978).

Presented study deals with land-use changes in the South-Moravian region (Czech Republic) in the context of changes in abundance of breeding population of the Little Owl. This region has been chosen as the typical landscape with convenient environmental conditions for the Little Owl in Europe based on current knowledge of this species. In the South-Moravian region (the area of the current South-Moravian region together with the districts of Jihlava, Kroměříž, Prostějov, Třebíč, Uherské Hradiště, Zlín and Žďár nad Sázavou), the Little Owl was a regularly and commonly breeding species in the first half of the 20th century, mainly at the altitudes below 450 m a.s.l. At higher elevations (up to 550 m a.s.l.) it was rare or absent. Already after the year 1940, a decline in numbers was recorded, this became more pronounced after 1957. The aim of this study is to analyse land-use changes at nest sites of the Little Owl in the South-Moravian region between the years 1976/1977 and 2014.

MATERIAL AND METHODS

We analysed the available data on breeding of the Little Owl in the South-Moravian region (1620 km²) from the period 1998–2014. These data are related to altogether 35 nest sites of the Little Owl (Fig. 1). The nest site is defined as a concrete nesting place of the Little Owl; there may be more than one nest site in a settlement (nesting of two pairs). Primary data were processed using the TYTO database application (Poprach, 2011). Within 500 m from each nest site (flying range of the Little Owl during foraging, usually less than 200–300 m from the nest), individual land-use types were recorded from the orthophotomaps coming from the years 1976/1977 and 2014. For each site and aerial image, the following land-use types were distinguished: 1) woodland; 2) meadows and pastures; 3) arable land; 4) hedgerows, windbreaks and parks; 5) orchards and gardens; 6) vineyards; 7) water bodies; 8) built-up area. The area of the individual land-use type was measured using GIS application of Esri products (Arc-Info v.9) and the results for the particular nest site and aerial images from the years 1976/1977 and 2014 were compared.

Fig. 1: Distribution of the studied breeding sites of the Little Owl (*Athene noctua*) in the South-Moravian region (Czech Republic) in the period 1998–2014



RESULTS

In the period 1998–2014, we localised altogether 35 nest sites of the Little Owl in the South-Moravian region. Of them, 33 were situated in farms, 1 in an attic of a castle and 1 in a dwelling house. Altogether 15 nest sites were „natural“ (Little Owls used the existing nesting opportunities) and 20 sites were in nest boxes (designed for the Little Owl or the Barn Owl, respectively) installed in farming facilities. In the study period, we recorded altogether 69 nesting attempts at the 35 nest sites. At most of the sites, breeding occurred for 1–3 years, however, continuous nesting of the Little Owl at the same site for six years was recorded at two nest sites in the Břeclav district. In a large part of the nest sites (51 %, $n = 18$), we registered nesting in one year only. In the recent period 2012–2014, nesting of the Little Owl was recorded at 8 nest sites (23 % of the 35 nest sites). The decline in the nesting sites has been caused by reduced density in mostly the same area (Fig. 1.).

In both studied periods (1976/1977 and 2014), the most abundant land-use type found within 500 m from the nest sites of the Little Owl was arable land (66.94 % – 62.25 %), followed by built-up areas (19.97–22.41 %), while the other land-use types made up less than 5 %. The proportion of the particular land-use type did not change significantly between the years 1976/1977 and 2014 (Tables 1–2). The most important change in comparison with the period 1976/1977 is the decrease in the area of arable land by 4.69 % and that of orchards and gardens by 1.99 %, while the surface of built-up areas increased slightly by 2.45 % and that of meadows and pastures by 1.5 %.

DISCUSSION AND CONCLUSION

During the mapping of breeding distribution of birds in the Czech Republic in the period 1973–1977, the occurrence of the Little Owl in the breeding season was recorded in 72 % of the mapping squares ($n = 607$) and breeding of the species was confirmed in 39 % of the squares ($n = 331$) (Šťastný *et al.*, 1987). During the subsequent mapping in the period 1985–1989, the occurrence of the Little Owl in the breeding season was reported from 68 % of the squares ($n = 428$) and confirmed breeding from 30 % of the squares ($n = 189$) (Šťastný *et al.*, 1996). The breeding distribution of the Little Owl thus did not change much between the two atlas mapping periods. A sharp decline in numbers of the Little Owl in the Czech Republic is apparent first from the results of bird mapping in the period 2001–2003, when the occurrence of the species in the breeding season was recorded in 27 % of the squares only ($n = 168$) and confirmed breeding in 6 % of the squares (Šťastný *et al.*, 2006). This population decline has continued until today (Šálek, 2014). The question arises whether there indeed was a 50 % decline of the Little Owl population between the periods 1993–1995 and 1998–1999 (e.g. due to the severe winter of 1995/1996) or whether the data on numbers for the period 1993–1995 were overestimated. The estimate of the number of pairs was based on mean population densities of the Little Owl: 0.33 and 0.17 pairs/10 km², respectively, in the years 1993–1995, and 0.12 pairs/10 km² in the period 1998–1999. The values of mean densities were extrapolated to the whole area of the Czech Republic (78,870 km²), i.e. including areas not inhabited by, and unsuitable for, the Little Owl, such as mountainous areas and forest complexes. As a certain compensation of the estimate and possible overestimation, the in the period 1998–1999 the monitoring methods were not observed strictly in some areas and the local populations of the Little Owl thus could have been underestimated.

During the first mapping of birds of the Czech Republic in 1973–1977, the breeding distribution of the Little Owl in the South-Moravian region was still more or less the same,

but a marked decline in numbers was apparent. In the early 1980s, the Little Owl was still quite abundant in some areas, e.g. in the Břeclav district (mapping square no. 7267) there were 6–7 breeding pairs. After the year 1985, a further population decrease and disappearance of the species from a number of sites, regularly occupied as late as in the early 1980s, was recorded. In the early 1990s, the breeding population in the region was estimated at less than 50 pairs (Martiško, 1994). Danko *et al.* (1994) estimated the population size in the then South-Moravian region at 30 breeding pairs by the year 1990, which was probably an undervalued estimate.

The Little Owl prefers sheltered roost sites such as tree cavities with multiple entrances. This important habitat is often negatively affected by human activities in the landscape (Bock *et al.*, 2013). In some areas, where Little Owls nest in tree holes, a factor reducing their population could be felling of old trees (Génot *et al.*, 1997). However, in Central Europe, this factor plays a rather insignificant role due to the decreasing importance of tree holes as nesting sites, both in agricultural landscape and in towns (Kitowski & Grzywaczewski, 2010).

In eastern Poland, Kitowski & Stasiak (2013) showed that the disappearance of nest sites of the Little Owl is caused by factors connected with the changes in farming practices, especially demolitions of buildings motivated by tax burdens, abandonment of pig and cattle production, including pasturing in the vicinity of farm buildings and increase in the area of rapeseed fields in farms.

Habel *et al.* (2015) analysed the effects of land-use changes on the Little Owl in 2001–2010 across Western Luxembourg. They found out a large-scale transformation of pastures with single trees into arable land during the past 10 years. Despite this agricultural intensification, the presence of the Little Owl increased, most likely as a result of the installation of nest boxes. Their results indicate that land-use parameters such as the presence of arable land, forests, pastures and pastures with trees had only a negligible impact on the occurrence of the Little Owl.

The results of our study indicate a similar interpretation. The analysis shows that at the known nest sites of the Little Owl in the South-Moravian region (Czech Republic), there were no significant changes in the proportion of the particular land-use types within 500 m from the nests between the years 1976/1977 and 2014. We believe the composition of the land-uses within 500 m of the total landscape is sufficiently representative based on the knowledge of maximum size of foraging range of the Little Owl. However, the proportion of the particular land-use types is not directly connected with the farming practices applied at these sites. Even though the proportion of crops is similar in both studied periods, the Little Owl may react e.g. on the way and frequency of mowing of meadows and pastures, loss of food due to the use of chemicals in agriculture, increased predation pressure as well as the other above mentioned negative factors.

We can conclude that in comparison with the availability of nest sites, which seems to be the limiting factor for the occurrence and population density of the Little Owl, land-use parameters play a rather negligible role. This conclusion is in line with other studies focussing on the habitat requirements of the Little Owl, indicating a positive correlation with open land (Dalbeck *et al.*, 1999; Kasprzykowski & Golawski, 2006; Loske, 2007) and the presence of pastures (Mebs & Scherzinger, 2000). The high relevance of open land might be connected with the hunting behaviour of the Little Owl – the bird typically feeds where crops have been recently harvested or replanted or where meadows have been cut (Tomé *et al.*, 2011). These conditions simplify visual recognition of prey and hunting (Schönn *et al.*, 1991). In contrast to meadows and pastures, arable land is only suitable as long as the crop is still short, but becomes unsuitable if high standing crops make visual recognition of prey

difficult (van Nieuwenhuyse *et al.*, 2008). This explanation is further supported by the negative correlation between the increase of arable land and the population density of the Little Owl recorded in some areas in Europe.

ACKNOWLEDGEMENTS

We thank anonymous reviewers for valuable comments on the manuscript. We are also grateful to V. Škorpíková, A. Reiter & Z. Tunka for providing us with data on three nest sites of the Little Owl in the South-Moravian region. The analyses of land-use changes were financially supported by the Department of Environment of the South-Moravian Regional Authority. Publication of the results of the analysis was supported by the grant „Cultural landscape of the Olomouc Arcidiocese – research, presentation and management“ within the NAKI II programme financed from the state budget of the Czech Republic. We thank Eva Cepáková for translation into English.

REFERENCES

- Bauer, H. G. & Berthold, P. (1996). *Die Brutvögel Mitteleuropas*. Bestand und Gefährdung. Wiesbaden: AULA Verlag.
- Bock, A., Naef-Daenzer, B., Keil, H., Korner-Nievergelt, F., Perrig, M. & Gruebler, M. U., (2013). Roost site selection by Little Owl *Athene noctua* in relation to environmental conditions and life-history stages. *Ibis* 155: 847–856.
- Cramp, S., (1985). *Handbook of the Birds of Europe, the Middle East and North Africa*. Volume IV – Terns to Woodpeckers. Oxford University Press, Oxford, New York.
- Dalbeck, L., Bergerhausen, W. & Hachtel, M., (1999). Habitatpräferenzen des Steinkauzes (*Athene noctua*) im ortsnahen Grünland. *Eulen-Rundblick* 48 (49): 3–15.
- Danko, Š., Diviš, T., Dvorská, J., Dvorský, M., Chavko, J., Karaska, D., Kloubec, B., Kurka, P., Matušik, H., Peške, L., Schröpfer, L. & Vacík, R., (1994). Stav poznatkov o početnosti hniezdných populácií dravcov (Falconiformes) a sov (Strigiformes) v Českej a Slovenskej republike k roku 1990 a ich populačný trend v rokoch 1970–1990. *Buteo* 6: 1–89.
- Denholm-Young, P. A., (1978). *Studies of decomposing cattle dung and its associated fauna*. Ph.D. Thesis. University of Oxford.
- Finck, P., (1990). Seasonal variation of territory size with Little Owl *Athene noctua*. *Oecologia* 83 (1): 68–75.
- Framis, H., Holroyd, G. L. & Manosa, S., (2011). Home range and habitat use of the Little Owl *Athene noctua* in an agricultural landscape in coastal Catalonia. *Animal Biodiversity Conservation* 34: 369–378.
- Génot, J. C., Juillard, M. & van Nieuwenhuyse, D., (1997). Little Owl *Athene noctua*. In: Hagemeyer E.J.M., Blair M.J. (eds.): *The EBCC Atlas of European Breeding Birds: Their Distribution and Abundance* (pp. 408–409). T. & A. D. Poyser, London.
- Habel, J. C., Braun, J., Fischer, Ch., Weisser, W. W. & Gossner, M. M., (2015). Population restoration of the nocturnal bird *Athene noctua* in Western Europe: an example of evidence based species conservation. *Biodiversity Conservation* 24: 1743–1753.
- Hernandez, M., (1988). Road mortality of the Little Owl *Athene noctua* in Spain. *Journal of Raptor Research* 22 (3): 81–84.

- Hudec, K., (1983). *Fauna ČSSR. Ptáci 3/I*. Academia, Praha.
- Hudec, K. & Šťastný, K., eds., (2005). *Fauna ČR. Ptáci 2/II*. Academia, Praha.
- Kasprzykowski, Z. & Golawski, A., (2006). Habitat use of the Barn Owl *Tyto alba* and Little Owl *Athene noctua* in Central-Eastern Poland. *Biology Letters* 43: 33–39.
- Kitowski, I. & Grzywaczewski, G., (2010). Occurrence of the Little Owl *Athene noctua* in town and cities of Poland. In: Barančoková, M., Krajčí, J., Kollár, J., Belčáková, I. (eds): *Landscape ecology – Methods, applications and interdisciplinary approach* (pp. 791–801). Bratislava, ILE, Slovak Academy of Science.
- Kitowski, I. & Pawlega, K., (2010). Food Composition of the Little Owl *Athene noctua* in Farmalld Areas of South East Poland. *Belgian Journal of Zoology* 140 (2): 203–211.
- Kitowski, I. & Stasiak, K., (2013). The disappearance of barn Owl *Tyto alba* and Little Owl *Athene noctua* occurrence sites in farmland in East Poland. *Ekológia* (Bratislava) 32 (4): 361–368.
- Loske, K. H., (1986). Zum Habitat des Steinkauzes (*Athene noctua*) in der Bundesrepublik Deutschland. *Vogelwelt* 107 (3): 91–101.
- Loske, K. H., (2007). Erfassung des Steinkauzes (*Athene noctua*) in Krefeld: Ein Beispiel für die Berücksichtigung geschützter Arten in der Bauleitplanung. *Natur in NRW* 3: 2–8.
- Machar, I., (2012). Changes in Ecological Stability and Biodiversity in a Floodplain Landscape. In: *Applying landscape ecology in conservation and management of the floodplain forests (Czech Republic)* (pp. 73–87). Olomouc: Palacky University. ISBN 978-80-244-2997-7.
- Machar, I. & Poprach, K., (2012). Tanks and Cisterns for Fodder Molasses on Farms as Ecological Traps. *Listy cukrovarnické a řepářské* 128 (11): 347–349.
- Martiško, J., ed., (1994). *Hnízdní rozšíření ptáků – Jihomoravský region. Část I. Nepěvci*. Moravské zemské muzeum & ČSOP ZO Pálava, Brno.
- Mebs, T. & Scherzinger, W., (2000). *Die Eulen Europas: Biologie, Kennzeichen. Bestände*. Franckh-Kosmos Verlags-GmbH & Co., Stuttgart.
- Opluštil, L., (2016). Sýček obecný (*Athene noctua*). *Zpravodaj SOVDS* 16: 34–35.
- Opluštil, L., (2017). Sýček obecný (*Athene noctua*). *Zpravodaj SOVDS* 17: 33–34.
- Poprach, K., (2011). Prezentace databáze občanského sdružení TYTO. In: Sedláček, O., Hošková, L., Škorpilová, J. (eds.) 2011: "*Ornitologie věda pro každého*", celostátní konference České společnosti ornitologické (pp. 1-20), Mikulov. Sborník z abstraktů z konference 7. až 9. října 2011. ČSO, Praha.
- Poprach, K. (2015). *Monitoring stavu před realizací projektu „Ochrana a podpora hnízdní populace sýčka obecného a sovy pálené v Ústeckém kraji s lokální působností projektu v jiných regionech České republiky“*. TYTO, z. s., Nenakonice.
- Scherzinger, W. (1981). Vorkommen und Gefährdung der vier kleinen Eulenarten in Mitteleuropa. *Ökologie der Vögel* 3: 283–292.
- Schönn, S., Scherzinger, W., Exo, K. M. & Ille, R., (1991). *Der Steinkauz*. Urania Verlagsgesellschaft mbH, Leipzig.
- Schröpfer, L., (1996). Sýček obecný (*Athene noctua*) v České republice – početnost a rozšíření v letech 1993–1995. *Buteo* 8: 23–38.
- Schröpfer, L., (2000). Sýček obecný (*Athene noctua*) v České republice – početnost a rozšíření v letech 1998–1999. *Buteo* 11: 161–174.

- Šálek, M., (2014). Dlouhodobý pokles početnosti sýčka obecného (*Athene noctua*) v jádrové oblasti jeho rozšíření v Čechách. *Sylvia* 50: 2–11.
- Šálek, M. & Berec, M., (2001). Rozšíření a biotopové preference sýčka obecného (*Athene noctua*) ve vybraných oblastech jižních Čech. *Buteo* 12: 127–134.
- Šálek, M. & Schröpfer, L., (2008). Population decline of the Little Owl *Athene noctua* in the Czech Republic. *Polish Journal of Ecology* 56 (3): 527–534.
- Šťastný, K., Bejček, V. & Hudec, K., (1996). *Atlas hnízdního rozšíření ptáků v České republice 1985–1989*. Nakladatelství a vydavatelství H & H, Jinočany.
- Šťastný, K., Bejček, V. & Hudec, K., (2006). *Atlas hnízdního rozšíření ptáků v České republice*. Aventinum, Praha.
- Šťastný, K., Randík, A. & Hudec, K. (1987). *Atlas hnízdního rozšíření ptáků v ČSSR 1973/77*. Academia, Praha.
- Tomé, R., Dias, M. P., Chumbinho, A. C. & Bloise, C. (2011). Influence of perch height and vegetation structure on the foraging behaviour of Little Owl *Athene noctua*: How to achieve the same success in two distinct habitats. *Ardea* 99: 17–26.
- Van Nieuwenhuyse, D., Génot, J. C. & Johnson, D. H. (2008). *The Little Owl – Conservation, ecology and behaviour of Athene noctua*. Cambridge: Cambridge University Press.
- Vogus, K. H., (1962). *Die Vogelwelt Europas und ihre Verbreitung*. Hamburg, Berlin.
- Zmihorski, M., Romanowski, J. & Osojaca, G. (2009). Habitat preferences of a declining population of the Little Owl *Athene noctua* in Central Poland. *Folia Zoologica* 58: 207–215.

APPENDIX

Table 1: Absolute area of the particular land-use types within 500 m from the nest sites of the Little Owl (*Athene noctua*) in the South-Moravian region, Czech Republic, in the years 1976/1977 and 2014 (n = 35)

Number of the nest in TYTO database	Land-use type	Orthophoto 1976/1977 (m ²)	Orthophoto 2014 (m ²)	Land-use changes between 1976/1977 and 2014 (m ²)
582	meadows and pastures	0	34328,8	-34328,8
	arable land	651278,1	620556,6	30721,5
	hedgerows, windbreaks and parks	4794,889	10330,23	-5535,341
	built-up areas	129325,6	120182,5	9143,1
	Σ	785398,589	785398,13	0,459
253	meadows and pastures	6236,776	21334,95	-15098,174
	arable land	609397,2	587828,1	21569,1
	hedgerows, windbreaks and parks	9232,36	26123,32	-16890,96
	orchards and gardens	18340,99	11285,01	7055,98
	built-up areas	142190,8	138826,9	3363,9
	Σ	785398,126	785398,28	-0,154
583	meadows and pastures	20839,52	18723,92	2115,6
	arable land	616279,4	582018	34261,4
	hedgerows, windbreaks and parks	14036,87	17503,58	-3466,71
	orchards and gardens	32270,95	13466,33	18804,62
	built-up areas	101971,5	153686,3	-51714,8
	Σ	785398,24	785398,13	0,11
584	arable land	582484,6	697969,2	-115484,6
	hedgerows, windbreaks and parks	21054,32	23154,53	-2100,21
	orchards and gardens	146659,2	25464,07	121195,13
	built-up areas	35200,05	38810,26	-3610,21
	Σ	785398,17	785398,06	0,11
585	meadows and pastures	0	2848,659	-2848,659
	arable land	666945,7	668378,5	-1432,8
	hedgerows, windbreaks and parks	42058,18	12691,59	29366,59

	orchards and gardens	0	31592,26	-31592,26
	water bodies	3853,707	6259,45	-2405,743
	built-up areas	72540,61	63627,96	8912,65
	Σ	785398,197	785398,419	-0,222
574	woodland	59372,02	78636,58	-19264,56
	meadows and pastures	20009,8	31426,53	-11416,73
	arable land	578353,6	347723,6	230630
	vineyards	4352,655	161974,4	-157621,745
	built-up areas	123310	165637	-42327
	Σ	785398,075	785398,11	-0,035
575	woodland	105798,9	109682,2	-3883,3
	meadows and pastures	9979,992	79749,69	-69769,698
	arable land	572904,1	417436,3	155467,8
	hedgerows, windbreaks and parks	2283,955	116178,5	-113894,545
	vineyards	41119,6	0	41119,6
	built-up areas	53311,51	62426,38	-9114,87
	Σ	785398,057	785473,07	-75,013
576	woodland	14095,54	14221,46	-125,92
	arable land	700100,2	709581,2	-9481
	hedgerows, windbreaks and parks	1444,507	1572,802	-128,295
	built-up areas	69758,21	60023,06	9735,15
	Σ	785398,457	785398,522	-0,065
573	meadows and pastures	21146,68	10109,36	11037,32
	arable land	621696,1	630639,6	-8943,5
	hedgerows, windbreaks and parks	0	1571,404	-1571,404
	orchards and gardens	8233,189	0	8233,189
	vineyards	0	15646,57	-15646,57
	built-up areas	134322,2	127431,1	6891,1
	Σ	785398,169	785398,034	0,135
77	meadows and pastures	0	8460,033	-8460,033
	arable land	311016,1	288605,2	22410,9

	hedgerows, windbreaks and parks	0	20654,93	-20654,93
	orchards and gardens	123516,5	124041	-524,5
	built-up areas	350865,1	343636,8	7228,3
	Σ	785397,7	785397,963	-0,263
923	meadows and pastures	0	3200,654	-3200,654
	arable land	706568,5	700804,9	5763,6
	hedgerows, windbreaks and parks	19675,8	26145,38	-6469,58
	orchards and gardens	12309,81	0	12309,81
	built-up areas	46843,92	55247,24	-8403,32
	Σ	785398,03	785398,174	-0,144
316	meadows and pastures	6392,9	60826,37	-54433,47
	arable land	487805,5	479348,9	8456,6
	hedgerows, windbreaks and parks	0	28278,83	-28278,83
	orchards and gardens	153968,8	84442,76	69526,04
	built-up areas	137230,7	132501,2	4729,5
	Σ	785397,9	785398,06	-0,16
254	meadows and pastures	0	3465,435	-3465,435
	arable land	626345,3	613748,5	12596,8
	hedgerows, windbreaks and parks	0	9925,352	-9925,352
	built-up areas	159052,8	158259	793,8
	Σ	785398,1	785398,287	-0,187
315	meadows and pastures	0	36685,85	-36685,85
	arable land	669828,2	564397,6	105430,6
	hedgerows, windbreaks and parks	19196,33	63955,9	-44759,57
	orchards and gardens	1190,424	0	1190,424
	water bodies	8135,585	5004,11	3131,475
	built-up areas	87047,7	115354,8	-28307,1
	Σ	785398,239	785398,26	-0,021
149	woodland	122882	128846,8	-5964,8
	meadows and pastures	86046,82	102014,6	-15967,78
	arable land	434669,6	415131,1	19538,5

	hedgerows, windbreaks and parks	3618,978	5535,885	-1916,907
	built-up areas	138180,7	133869,8	4310,9
	Σ	785398,098	785398,185	-0,087
249	meadows and pastures	778,1456	4928,67	-4150,5244
	arable land	574050,3	563514,7	10535,6
	hedgerows, windbreaks and parks	50345,64	73655,95	-23310,31
	vineyards	6883,973	0	6883,973
	built-up areas	153340,1	143299	10041,1
	Σ	785398,1586	785398,32	-0,1614
142	woodland	78973,41	84437,87	-5464,46
	meadows and pastures	5201,198	47114,22	-41913,022
	arable land	483145	411600,1	71544,9
	hedgerows, windbreaks and parks	12669,39	28374,57	-15705,18
	orchards and gardens	55028,06	14263,1	40764,96
	built-up areas	150380,6	199608,3	-49227,7
	Σ	785397,658	785398,16	-0,502
4247	meadows and pastures	0	15979,62	-15979,62
	arable land	518631,9	483764	34867,9
	hedgerows, windbreaks and parks	11721,22	15298,61	-3577,39
	built-up areas	255045	270356	-15311
	Σ	785398,12	785398,23	-0,11
161	meadows and pastures	0	15979,62	-15979,62
	arable land	519464,2	484380,1	35084,1
	hedgerows, windbreaks and parks	11242,78	14858,49	-3615,71
	built-up areas	254691,2	270179,9	-15488,7
	Σ	785398,18	785398,11	0,07
183	woodland	0	18217	-18217
	meadows and pastures	7881,945	20713,13	-12831,185
	arable land	548511,4	486187	62324,4
	hedgerows, windbreaks and parks	0	1016,626	-1016,626
	orchards and gardens	51236,66	33968,34	17268,32

	built-up areas	177768,1	225296,2	-47528,1
	Σ	785398,105	785398,296	-0,191
4214	meadows and pastures	12263,52	25962,12	-13698,6
	arable land	599458,5	567240,7	32217,8
	hedgerows, windbreaks and parks	4287,967	6044,855	-1756,888
	built-up areas	169388,1	186150,5	-16762,4
	Σ	785398,087	785398,175	-0,088
180	meadows and pastures	12210,05	24655,9	-12445,85
	arable land	602078,6	570846,7	31231,9
	hedgerows, windbreaks and parks	4211,31	5972,716	-1761,406
	built-up areas	166898,2	183923	-17024,8
	Σ	785398,16	785398,316	-0,156
579	woodland	102145	128280,2	-26135,2
	meadows and pastures	49565,95	36543,71	13022,24
	arable land	75641,37	57149,76	18491,61
	hedgerows, windbreaks and parks	7599,428	11624,72	-4025,292
	orchards and gardens	33071,84	0	33071,84
	vineyards	23512,05	21208,09	2303,96
	water bodies	94999,63	97278,92	-2279,29
	built-up areas	398862,9	433312,8	-34449,9
	Σ	785398,168	785398,2	-0,032
577	woodland	223703,9	243431,5	-19727,6
	meadows and pastures	18355,77	15607,02	2748,75
	arable land	367427,7	315214,9	52212,8
	hedgerows, windbreaks and parks	2134,736	2661,987	-527,251
	orchards and gardens	62831,69	0	62831,69
	vineyards	57389,85	134244	-76854,15
	built-up areas	53554,57	74239	-20684,43
	Σ	785398,216	785398,407	-0,191
4284	meadows and pastures	3335,005	36305,07	-32970,065
	arable land	377241,7	402341	-25099,3

	hedgerows, windbreaks and parks	6297,001	15926,27	-9629,269
	orchards and gardens	69504,39	72133,93	-2629,54
	vineyards	95324,53	0	95324,53
	built-up areas	233695,5	258692	-24996,5
	Σ	785398,126	785398,27	-0,144
205	meadows and pastures	0	24658,14	-24658,14
	arable land	540361	540801,7	-440,7
	hedgerows, windbreaks and parks	0	2379,115	-2379,115
	orchards and gardens	20070,2	10686,42	9383,78
	built-up areas	224965,4	206877,2	18088,2
	Σ	785396,6	785402,575	-5,975
157	arable land	402455,1	327147,3	75307,8
	hedgerows, windbreaks and parks	7278,842	34587,78	-27308,938
	orchards and gardens	10424,32	0	10424,32
	built-up areas	365239,8	423663	-58423,2
	Σ	785398,062	785398,08	-0,018
251	arable land	538662,5	481642,2	57020,3
	hedgerows, windbreaks and parks	11546,78	38223,47	-26676,69
	orchards and gardens	10424,32	0	10424,32
	built-up areas	224764,5	265532,4	-40767,9
	Σ	785398,1	785398,07	0,03
167	meadows and pastures	35241,22	34314,02	927,2
	arable land	554925,6	478909,8	76015,8
	hedgerows, windbreaks and parks	23241,32	19037,24	4204,08
	orchards and gardens	6816,622	1897,017	4919,605
	water bodies	4425,313	13442,67	-9017,357
	built-up areas	160748	237797,4	-77049,4
	Σ	785398,075	785398,147	-0,072
169	meadows and pastures	10306,31	4716,516	5589,794
	arable land	658191,5	597700,9	60490,6
	hedgerows, windbreaks and parks	0	2417,782	-2417,782

	orchards and gardens	6485,241	0	6485,241
	built-up areas	110415,1	180563	-70147,9
	Σ	785398,151	785398,198	-0,047
4217	woodland	39273	41798,48	-2525,48
	meadows and pastures	17557,39	0	17557,39
	arable land	373818,8	443590,6	-69771,8
	hedgerows, windbreaks and parks	2284,629	4901,668	-2617,039
	orchards and gardens	99720,27	0	99720,27
	vineyards	8199,142	0	8199,142
	built-up areas	244544,1	295133,3	-50589,2
	Σ	785397,331	785424,048	-26,717
252	woodland	80151,2	89364,03	-9212,83
	meadows and pastures	23331,1	23885,84	-554,74
	arable land	297599,4	293904,3	3695,1
	hedgerows, windbreaks and parks	5924,124	20685,11	-14760,986
	orchards and gardens	54145,29	0	54145,29
	vineyards	266673,5	288272,7	-21599,2
	built-up areas	57572,97	69285,71	-11712,74
	Σ	785397,584	785397,69	-0,106
215	meadows and pastures	3120,558	11285,18	-8164,622
	arable land	624526,7	590300	34226,7
	hedgerows, windbreaks and parks	0	4400,489	-4400,489
	orchards and gardens	2157,589	0	2157,589
	built-up areas	155593,3	179412,4	-23819,1
	Σ	785398,147	785398,069	0,078
581	woodland	2879,407	6556,433	-3677,026
	meadows and pastures	27605,51	17186,4	10419,11
	arable land	349180,5	384815,8	-35635,3
	hedgerows, windbreaks and parks	7976,901	41390,02	-33413,119
	vineyards	297890,8	194855,2	103035,6
	built-up areas	99865,07	140594,1	-40729,03
	Σ	785398,188	785397,953	0,235

580	woodland	0	6137,046	-6137,046
	meadows and pastures	7601,349	43187,85	-35586,501
	arable land	559958,3	307539,2	252419,1
	hedgerows, windbreaks and parks	8967,741	20871,77	-11904,029
	orchards and gardens	52721,27	60109,34	-7388,07
	vineyards	106366,6	300491,7	-194125,1
	built-up areas	49782,84	47061,28	2721,56
	Σ	785398,1	785398,186	-0,086

Table 2: Land-use within 500 m from the nest sites of the Little Owl (*Athene noctua*) in the South-Moravian region, Czech Republic, in the years 1976/1977 and 2014 (n = 35)

Land-use type	1976/1977		2014		Differences in land-use between 1976/1977 and 2014
	n (m2)	%	n (m2)	%	
woodland	829274,377	3,02%	949609,599	3,45%	0,44%
meadows and pastures	405007,509	1,47%	816197,877	2,97%	1,50%
arable land	18401002,3	66,94%	17112758,06	62,25%	-4,69%
hedgerows, windbreaks and parks	315125,998	1,15%	727951,471	2,23%	1,08%
orchards and gardens	1031127,63	3,75%	483349,577	1,76%	-1,99%
vineyards	907712,7	3,30%	1116692,66	4,48%	1,18%
water bodies	111414,235	0,41%	121985,15	0,44%	0,04%
built-up areas	5488266,75	19,97%	6160496,79	22,41%	2,45%
Total	27488931,5	100,00%	27489041,18	100,00%	