

Population trend, distribution and habitat requirements of the Montagu's Harrier (*Circus pygargus*) in central Moravia (Czech Republic)

Populační trend, rozšíření a hnízdní nároky motáka lužního (*Circus pygargus*) na střední Moravě

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Monitoring of the Montagu's Harrier (*Circus pygargus*) was carried out in the intensively used farmland of central Moravia in 1974–2013. In the years 1974–1985, irregular breeding of altogether 10 pairs was recorded. In the period 1991–2013, the species nested in the study area annually with the total number of 270 pairs. Breeding density was assessed for two areas: in the wider monitored area (299.26 km²) it ranged between 0.67 pairs/100 km² in 1991 and 8.69 pairs/100 km² in 2010, while in the core nesting area (203.1 km²) it ranged between 0.98 pairs/100 km² in 1991 and 12.8 pairs/100 km² in 2010. However, due to semicolonial breeding, the Montagu's Harrier can locally reach much higher densities. Breeding of all 280 pairs in the years 1974–2013 was recorded in fields, which poses a considerable threat to the birds during harvest. Breeding pairs were found in the following crops: winter wheat – 202 pairs (78%), winter barley – 16 pairs (6.2%), alfalfa – 16 pairs (6.2%), rape – 10 pairs (3.9%), spring barley – 5 pairs (1.9%), ryegrass – 4 pairs (1.5%), rye – 3 pairs (1.2%), spring wheat – 2 pairs (0.8%), legume-cereal melange – 1 pair (0.4%). Out of 222 breeding pairs, 34.3% nested individually and 65.7% semicolonially. Semicolonies of 2 pairs were most frequent, followed by semicolonies of up to 5 pairs. Semicolonies of 6, 10 and 12 pairs were recorded only once. The mean distance from the nearest nest in the semicolony was 221.4 m, altogether 57 nests (54.3%) were situated less than 150 m from the nearest nest. At the time of fledging of the young, the vegetation surrounding the nest was usually 60 to 100 cm high. The nests were situated on field blocks ranging from 6.1 to 97.54 ha in size (mean 30.98 ha), usually rather close to margins of the field blocks. In the years 1997–2012, altogether 103 nests (67.8%) were found less than 100 m from the margin and 49 nests (32.2%) were situated 101–305 m from the margin. The nearest margin of the land block with a nest was represented by a field road (98 cases), tarmac road (42), watercourse (6), bulk (3), wood (2) and ditch (1). Over a half of the nests (83 nests, 55.3%) were found less than 500 m from the nearest built-up area of a settlement, 64% of the nests (96 nests) less than 600 m and 76.7% of the nests (115 nests) less than 700 m from a settlement. In the wider surroundings of the monitored area, the Montagu's Harrier was quite rare, altogether 18 breeding pairs were recorded there in the period 1997–2013.

Monitoring motáka lužního (Circus pygargus) probíhal v intenzivně zemědělsky využívané oblasti střední Moravy v období let 1974–2013. V letech 1974–1985 bylo zaznamenáno nepravdělné hnízdění celkem 10 párů, v letech 1991–2013 hnízdil moták lužní v oblasti každoročně, v celkovém počtu 270 párů. Densita byla vymezena pro dvě oblasti: pro širší monitorovanou oblast (299,26 km²) – min. 0,67 párů/100 km² v roce 1991 a max. 8,69 párů v roce 2010, a pro hnízdní oblast (203,1 km²) – min. 0,98 párů/100 km² v roce 1991 a max. 12,8 párů v roce 2010. Díky semikoloniálnímu hnízdění může moták lužní dosahovat lokálně i mnohem vyšších densit. Hnízdění všech 280 párů v letech 1974–2013 bylo zjištěno v polích, což představuje pro motáky značné riziko v období žní. Hnízdící páry byly zaznamenány v kulturách: pšenice ozimá – 202 párů (78 %), ječmen ozimý – 16 párů (6,2 %), vojtěška – 16 párů (6,2 %), řepka – 10 párů (3,9 %), ječmen jarní – 5 párů (1,9 %), jilek – 4 páry (1,5 %), žito – 3 páry (1,2 %), pšenice jarní – 2 páry (0,8 %), směska – 1 pár (0,4 %). Z 222 hnízdicích párů hnízdilo 34,3 % jednotlivě a 65,7 % semikoloniálně. Nejvíce byly zastoupeny semikolonie po 2 párech, semikolonie do 5 párů byly méně časté a semikolonie v počtu 6, 10 a 12 párů byly zaznamenány pouze jednou. Vzdálenost k nejbližšímu hnízdu v semikolonii byla průměrně 221,4 m, do 150 m bylo v semikoloniích situováno 57 hnízd (54,3 %). V období dospívání mláďat výška porostu v okolí hnízd dosahovala většinou 60 až 100 cm. Hnízda byla umístěná na půdních dílech o velikosti od 6,1 do 97,54 ha (průměr 30,98 ha) a spíše k okrajům půdních dílů. V letech 1997–2012 bylo od okraje pozemku situováno do 100 m 103 hnízd (67,8 %) a ve vzdálenosti 101–305 m 49 hnízd (32,2 %). Nejbližší okraj pozemku s hnízdem byl tvořen polní cestou (98×), asfaltovou silnicí (42×), vodotečí (6×), mezí (3×), lesem (2×) a příkopem (1×). Do 500 m od nejbližší zastavěné části sídla se nacházelo 55,3 % hnízd (n=83), do 600 m od zástavby bylo situováno 64 % hnízd (n=96) a do 700 m 76,7 % hnízd (n=115). V širším okolí monitorované oblasti byl moták lužní vzácně hnízdící dravec, hnízdění bylo zjištěno v letech 1997–2013 v celkovém počtu 18 párů.

Keywords: central Moravia, Czech Republic, distribution, habitat requirements, Montagu's Harrier, population trend

INTRODUCTION

In the Czech Republic, the Montagu's Harrier (*Circus pygargus*) ranks among rarely breeding raptor species. However, an increase in the number of breeding pairs has been recorded in some regions of the country in recent years, including areas where the species had not bred before (Hlásek & Hlásek 1974, Holínek 1975, Čech 1978, Korba 1979, Čech 1981, Diviš 1988, Veselý & Krameš 1990, Prášek & Čutka 1993, Martiško 1994, Kunstmüller 1996, Hruška 1997, Závalský 1998, Bošek et al. 1999, Mrlík et al. 2002, Petera 2002, Kunstmüller 2003, Vlček & Strolený 2003, Kunstmüller 2004, Vlček & Strolený 2004, Volf 2004, Kunstmüller 2005, Kunstmüller & Kodet 2005, Poprach 2006, Stolarczyk 2006, Urbánek & Polák 2006, Poprach 2011).

Already in the second half of the 18th century, the Montagu's Harrier was rather uncommonly observed in the populated areas of the Liberec region (Richter 1786). In the 19th century, the species occurred relatively frequently in Bohemia and it also nested there (Frič 1872). In the first half of the 19th century, it was much more common in the Czech lands than the Hen Harrier (*Circus cyaneus*) (Amerling 1852). Šír (1890) reported several non-documented breeding attempts from Bohemia from the middle of the 19th century. In the Pardubice region in the first half of the 20th century, Musílek (1946) did not record breeding of the species but mentioned regular occurrence of mostly juvenile birds during autumn migration (in the 1930s he found altogether 9 juvenile birds, hunted in late August and early September, in taxider-

mists in the Pardubice town). In Moravia, occasional breeding was known in its southern part in the 19th century (Talský 1889). Since the year 1943, the Montagu's Harrier started to breed regularly in clearings of floodplain forests in southern Moravia (Balát 1946). The south-Moravian population was estimated at 20 breeding pairs around the year 1950 (Kux et al. 1955).

Hudec & Černý (1977) characterised occurrence of the Montagu's Harrier in the country as „irregularly breeding and uncommonly passing during migration“. During the mapping of breeding distribution of birds in the years 1973–1977, 3% of the mapping squares were occupied by the species, and its occurrence was mostly concentrated into three regions: the Třeboň basin, Polabí (lowland region along the Elbe river in central Bohemia) and the central Morava river basin; every year 5–20 pairs bred in the country (Šťastný et al. 1987). In the years 1985–1989, 7% of the mapping squares were occupied, mainly in southern Bohemia, Polabí and central Moravia, and population numbers were estimated at 20–30 pairs (Šťastný et al. 1996). In the years 2001–2003, the occupancy increased to 17% of the squares and population numbers to 80–120 pairs, with centres of occurrence mainly in the Znojmo region, Českomoravská vrchovina Highlands, central Moravia and Silesia (Šťastný et al. 2006). Danko et al. (1994) reported 20–40 breeding pairs in the Czech Republic in the year 1990, Mrlík et al. (2002) mentioned 80–120 pairs for the period 2001–2003. The current Czech breeding population can be estimated at 170–200 pairs (Poprach, Kunstmüller & Veselý unpubl.). The region of central Moravia (mainly the Uničov area) ranks among traditional breeding areas of the Montagu's Harrier and, at the same time,

among the longest monitored areas in the Czech Republic. The paper brings a summary of results of a long-term monitoring of the local population of the Montagu's Harrier in central Moravia over 39 years (1974–2013).

MATERIAL AND METHODS

Study area

The study area is situated in the northern part of the Hornomoravský úval mesoregion (Upper Morava Lowland) in the Olomouc region, in the territory of two former districts – Olomouc (a larger part) and Šumperk (a small part), among the towns of Olomouc, Šternberk, Libina, Mohelnice and Uničov (fig. 1). It is an intensively used farmland with land blocks of 10–100 ha in size, situated at the altitude of 230–300 m a.s.l., with the occurrence of several rather small groves (mostly 0.5–9 ha, single groves up to 18 ha) and rather small settlements. A larger agglomeration is represented by the Uničov town. In the north and east, the monitored area is bordered by hills of the Nízký Jeseník Mts., in the west by the floodplain of the central Morava river (Litovelské Pomoraví Protected Landscape Area). The size of particular fields with nests of the Montagu's Harrier were taken from the Czech LPIS (Land Parcel Identification System). The basic reference unit of the Czech LPIS is a „farmer's block“ – a continuous area of agricultural land with one type of crop, cultivated by one user in one farming mode. A farmer's block is either a land block portion or a single-piece land block (<http://www.lpis.cz>).

Data analysis

In the years 1974–2013, breeding of 280 pairs of the Montagu's Harrier was confirmed in the monitored area by the following authors: Vladimír

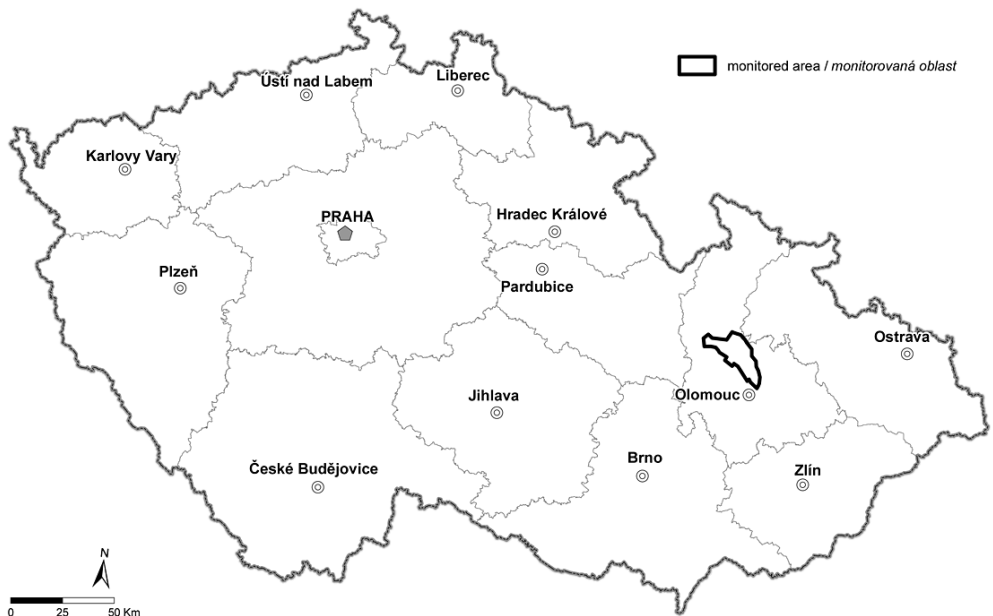


Fig. 1. Map of the Czech Republic showing boundaries of the monitored area of the Montagu's Harrier.

Obr. 1. Přehledová mapa Česka s vymezením hranic monitorované oblasti motáka lužního.

Gahura – 5 nests (2004, 2010), Bořivoj Holínek – 4 nests (1974–1979), Karel Maton – 2 nests (2003), Karel Poprach – 194 nests (1995, 1998, 2000–2013), Oldřich Suchý – 75 nests (1978–2002). Confirmed breeding was defined as a finding of a nest with eggs or young, or observation of parental behaviour documenting presence of the nest (delivery of food by a male to a female at the nest site, or with subsequent landing of the female on the nest, feeding of the young, presence of hatched young). The nests were searched for in the period of feeding of the young, mostly since mid June. Altogether 222 nests with eggs or young were found, breeding of other 58 pairs was confirmed based on the above described epigamic behaviour. Most of these breeding attempts were later unsuccessful (due to predation or nest abandonment). Non-breeding birds (males in their second

calendar year, subadult or adult individuals with no bond to a potential nest site) were not included in the number of breeding pairs. Field work was carried out by Karel Poprach; Ivo Machar and Jana Vrbková were involved in data analysis and discussion.

Localisation of nests found in the period 1974–1998 was reconstructed based on the available literature sources (Holínek 1975, Hudec & Šťastný 2005, Suchý 1990, 2003), field notes taken by Oldřich Suchý (dep. Karel Poprach) and transformed to the WGS-84 system. The nests localised in the period 1999–2007 were recorded on a map and later transformed to WGS-84. Exact position of the nests found in the years 2008–2011 was recorded using a GPS device.

For assessment and presentation of the data, two categories were differentiated within the study area – the “monitored area” and the “nesting area”. Values

of abundance and population density were determined for each of the two categories separately. Population density was assessed for the period from 1991, when the species started breeding regularly in the area.

1) Monitored area - 299.26 km² in size. It is the area where monitoring of the breeding population of the Montagu's Harrier was carried out regularly and systematically in the years 1995–2011. The first half of the monitoring in the years 1978–2002 was performed by Suchý (1990, 1994, 1998, 1999, 2003), who monitored the birds first in the area of Zlaté návrší near Uničov (9 km²) in 1978–1986 (Suchý 1990) and later in the years 1987–2000 in a wider area of the Uničov plateau (about 70 km²) (Suchý 2003). Poprach carried out monitoring of the Montagu's Harrier irregularly till 1995 and regularly since 1998, first in the southern part of the monitored area and after the death of Oldřich Suchý (in 2002) in the whole monitored area. The monitored area includes also the Úsov area, where Holínek found 4 nests in the years 1974–1979 (Holínek 1975, Hudec & Šťastný 2005).

2) Nesting area - 203.10 km² in size. Its boundaries are delimited by Montagu's Harrier nests found in the years 1974–2013, situated on the periphery of the area. The delimited area was further enlarged by 1 km, which is, based on own observations, the maximum flight range of a female from the nest (Poprach unpubl.).

Less intensive monitoring of the Montagu's Harrier was also carried out in the wider surroundings of the monitored area (Olomouc, Šumperk and Prostějov regions), where the species was recorded as a rare breeder in the years 1997–2013 in the total number of 18 pairs.

The following parameters were re-

corded in the nests (some of them are missing in the historical nests): distance of the nest to the nearest built-up area of a settlement (n = 151), size of the land block with the nest (n = 203), distance of the nest from the land block margin including identification of the margin habitat (n = 153), crop species (n = 259). In the years 2008–2013, vegetation height was measured at the time of presence of grown-up juveniles at the nest (second half of July) in the following crops: spring wheat (n = 4), winter wheat (n = 75), rye (n = 1). Moreover, individual or semicolonial breeding of the pairs was recorded (n = 222). Semicolonially breeding pairs were defined as those in which the distance to the nearest other nest was lower than 1,000 m and the females from two neighbouring nests could communicate with each other (fly together, drive off predators together etc.) (Poprach unpubl.). For the assessment of hypsometric characteristics of the localised nests, the altitude interval of 20 m a.s.l. was chosen, since the classification into 10 classes (according to the Sturges' rule) with the interval of 10 m a.s.l. showed to be too fine. Results from the year 2013 are given in figs. 2, 8 and 9 and in table 1, but they are not included in arithmetic and statistical outputs. Primary data were processed in the TYTO database (Poprach 2011b), statistical analysis of the data was carried out using the R software. Representation of land blocks with Montagu's Harrier nests was assessed using the Pearson's chi-square test for even distribution of frequencies within the classes of 20 ha (from 0 to 100 ha). The same test was used for the assessment of distance of the nests to the margins of land blocks; classes in the range from 0 to 310 m, 50 m wide (except for the last class 60 m wide) were evaluated.

RESULTS

The first breeding of the Montagu's Harrier in the monitored area was documented in the Úsov area in 1974 by Holínek (1975), who recorded 4 breeding attempts there in the years 1974–1979 (Hudec & Štastný 2005). In the Uničov area, Suchý (1990) observed a Montagu's Harrier pair bringing food in 1978, and in 1983 he found a nest with one juvenile and at the same time he observed epigamic behaviour of another pair. The Montagu's Harrier has been breeding in the area regularly since 1991 (fig. 2), with the maximum number of 26 pairs in 2010. Montagu's Harrier nests were situated at the altitudes ranging between 224 and 318 m a.s.l. ($n=262$), which corresponds to hypsometric characteristics of the area. Altogether 223 nests (85 %) were situated at the altitude of 224–

270 m (fig. 10). Fig. 10 showing the distribution of frequencies of the particular altitude classes indicates that the values between 240 and 260 m a.s.l. are most frequent, while the frequency of altitudes over 280 m a.s.l. is very low.

In the monitored area, the Montagu's Harrier reaches very high population densities, especially in recent years (table 1). Semicolonally breeding pairs reach even higher densities. In the northern part of the monitored area, altogether 28 pairs of the Montagu's Harrier nested on several land blocks with the total area of 110 ha in the years 2010–2012 (2010 – 12 pairs, 2011 – 6 pairs, 2012 – 10 pairs). The highest concentration of nests was recorded on two neighbouring land blocks with the area of 14.53 ha and 13.38 ha, respectively, which are a part of the above mentioned 110 ha. Altogether 7 pairs nested there

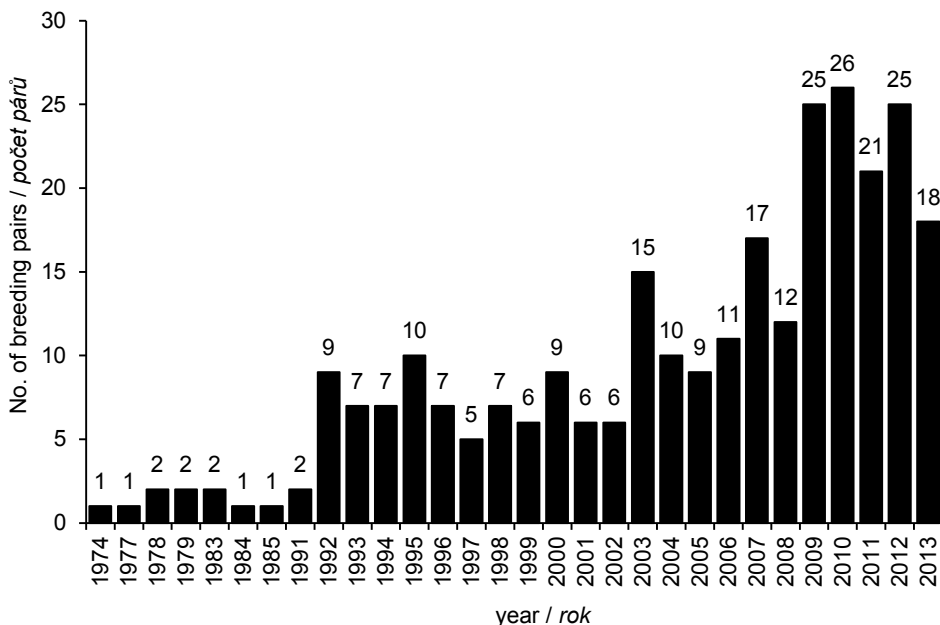


Fig. 2. Population trend of the Montagu's Harrier in central Moravia in the years 1974–2013 ($n = 280$).

Obr. 2. Populační trend motáka lužního na střední Moravě v letech 1974–2013 ($n = 280$).

Table 1. Breeding density of the Montagu's Harrier (number of pairs/100 km²) in the years 1991–2013, shown separately for the wider monitored area and the smaller nesting area.

Tab. 1. Densita motáka lužního (počet párů/100 km²) v období let 1991–2013 vymezená pro širší monitorovanou a menší hnízdní oblast.

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Monitored area	0,67	3,01	2,34	2,34	3,34	2,34	1,67	2,34	2,00	3,01	2,00	2,00
Nesting area	0,98	4,43	3,45	3,45	4,92	3,45	2,46	3,45	2,95	4,43	2,95	2,95

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Monitored area	5,01	3,34	3,01	3,68	5,68	4,01	8,35	8,69	7,02	8,35	6,01
Nesting area	7,39	4,92	4,43	5,42	8,37	5,91	12,31	12,80	10,34	12,31	8,86

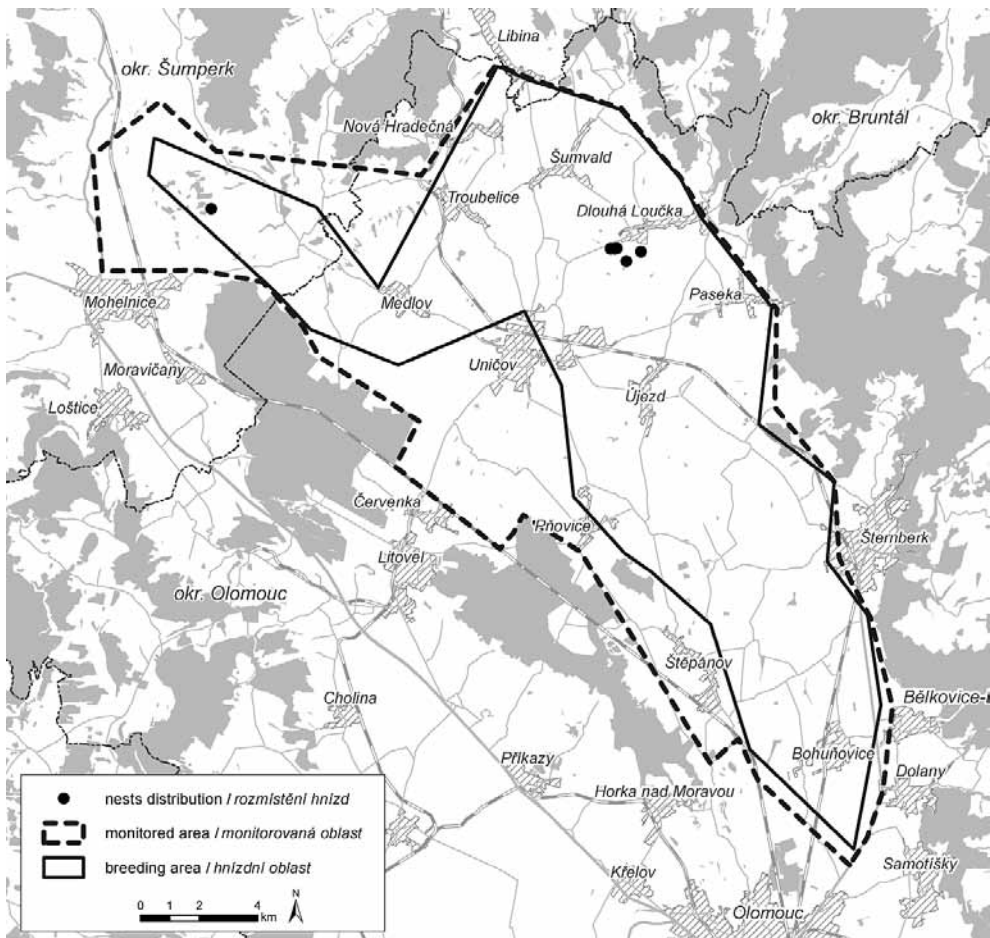


Fig. 3. Distribution of nests of the Montagu's Harrier in the years 1974–1985 (n = 9).

Obr. 3. Rozmístění hnízd motáka lužního v letech 1974–1985 (n = 9).

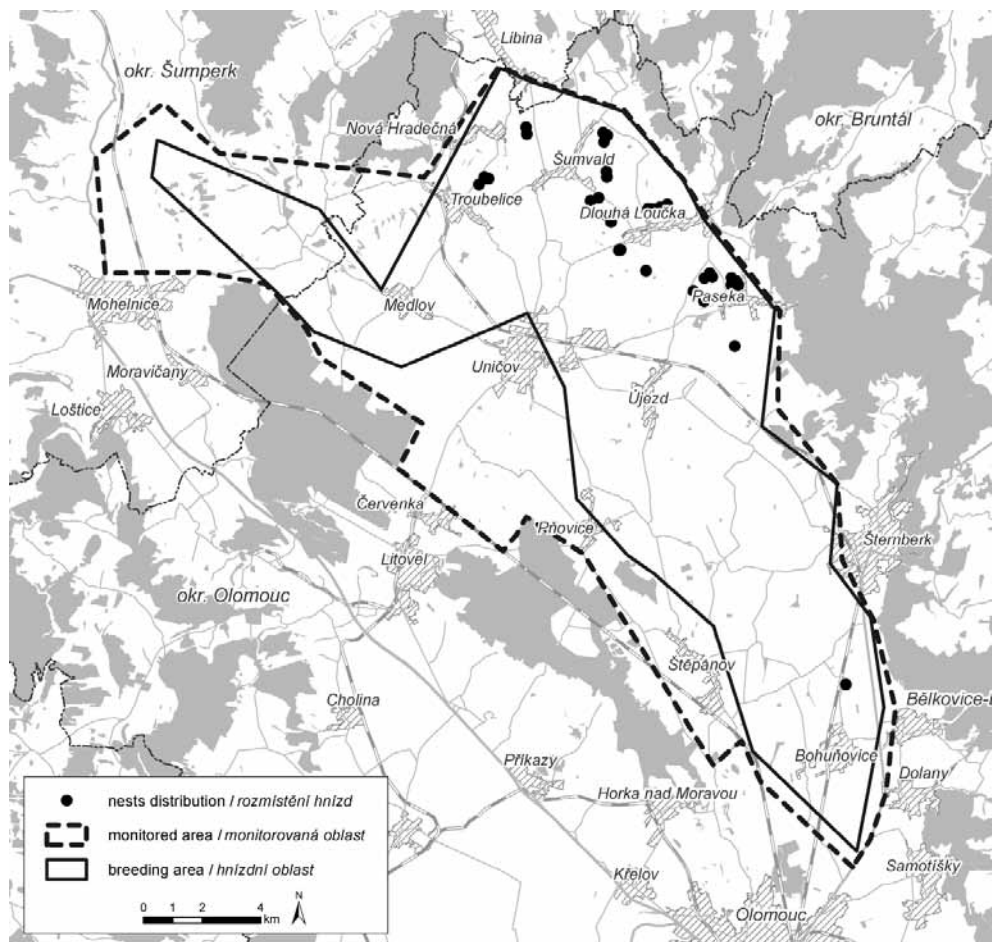


Fig. 4. Distribution of nests of the Montagu's Harrier in the years 1991–1995 (n = 35).

Obr. 4. Rozmístění hnízd motáka lužního v letech 1991–1995 (n = 35).

in 2010, 4 pairs in 2011 and 10 pairs in 2012. Interestingly enough, the total of 24 Montagu's Harrier nests was found on these two land blocks in the years 2007, 2010–2012, i.e. 21.3% of all nests recorded in the area in the given years. Larger semicolonies composed of 5 pairs were found at the following localities (all of them in winter wheat): near Bohuňovice in 2001 – land block 16.24 ha in size, near Hnojice in 2006 – land block 29.47 ha in size, near Dlouhá Loučka in 2009 – land block 14.96 ha in size (here including one nest of the Western Marsh-harrier),

and near Medlov in 2009 – land block 69.23 ha in size.

Out of 222 breeding pairs in which the number of pairs at the locality could be determined, 76 pairs (34.3%) nested individually and 146 pairs (65.7%) semicolonially. Semicolonies of 2 pairs were most frequent, followed by semicolonies of up to 5 pairs. Semicolonies of 6, 10 and 12 pairs were recorded only once (fig. 11). The distance to the nearest other nest in a semicolony is shown in fig. 12; it ranged between 20 and 1,000 m (mean = 221.4 m, median = 138.3, n = 105).

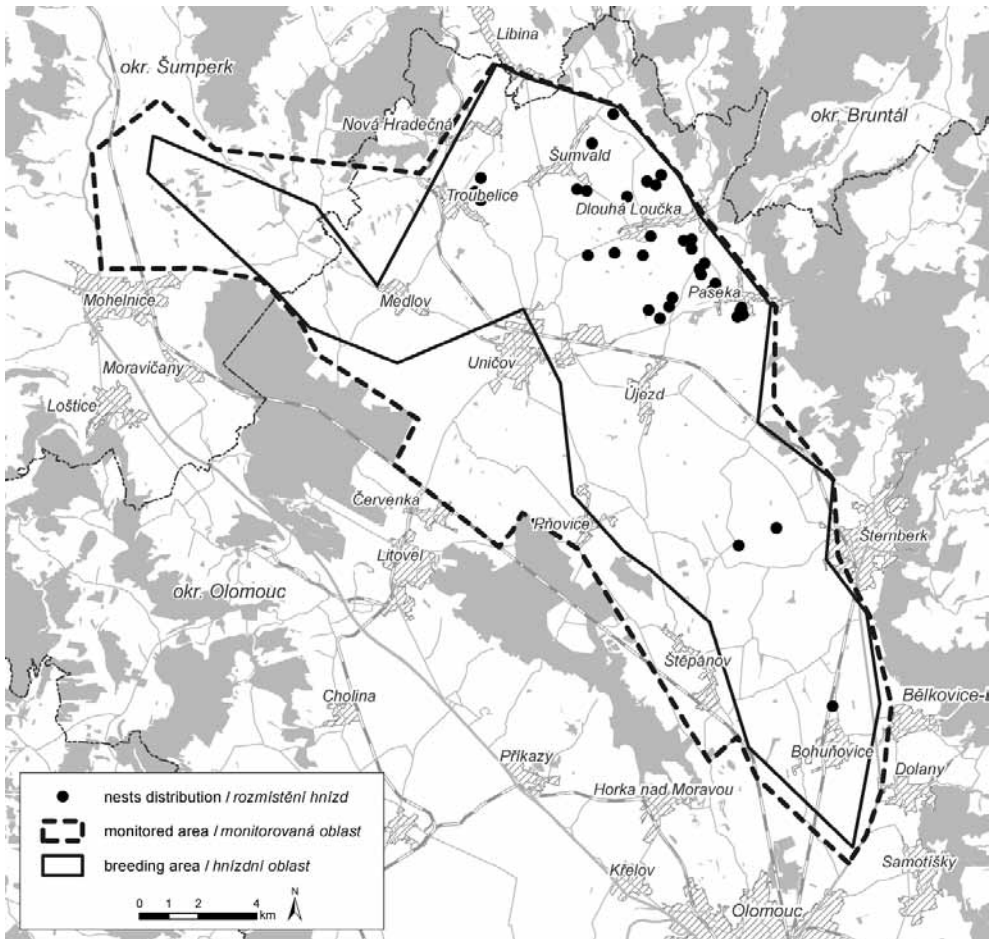


Fig. 5. Distribution of nests of the Montagu's Harrier in the years 1996–2000 ($n = 34$).

Obr. 5. Rozmístění hnízd motáka lužního v letech 1996–2000 ($n = 34$).

Altogether 57 nests (54.3%) were situated at the distance lower than 150 m. The distance to the nearest nest differed significantly among semicolonies with a different number of pairs (Kruskal-Wallis test, $KW = 26.8868$, $p < 0.001$). The following combinations of the number of pairs in semicolonies showed statistically significant differences in nest distance: 2 vs. 4, 2 vs. 5, 2 vs. 10, 3 vs. 4, 3 vs. 5, 3 vs. 10 (multiple comparison for unbalanced design after the K.-W. test was performed, see Anděl 2007, level of significance 5%). When the colonies

were classified into smaller (2–3 pairs) and larger semicolonies (4–12 pairs), the distances between nests (minimum/median/maximum) were 53/219/1000 m for 2–3 pairs and 20/109/941.5 m for 4–12 pairs. It is obvious that the distance to the nearest nest is generally smaller in larger semicolonies (fig. 13; Wilcoxon two-sample test, $W = 1972$, $P < 0.001$).

All 280 Montagu's Harrier pairs breeding in the years 1974–2013 nested in fields. Breeding pairs were recorded in the following crops: winter wheat – 202 pairs (78%), winter barley – 16 pairs

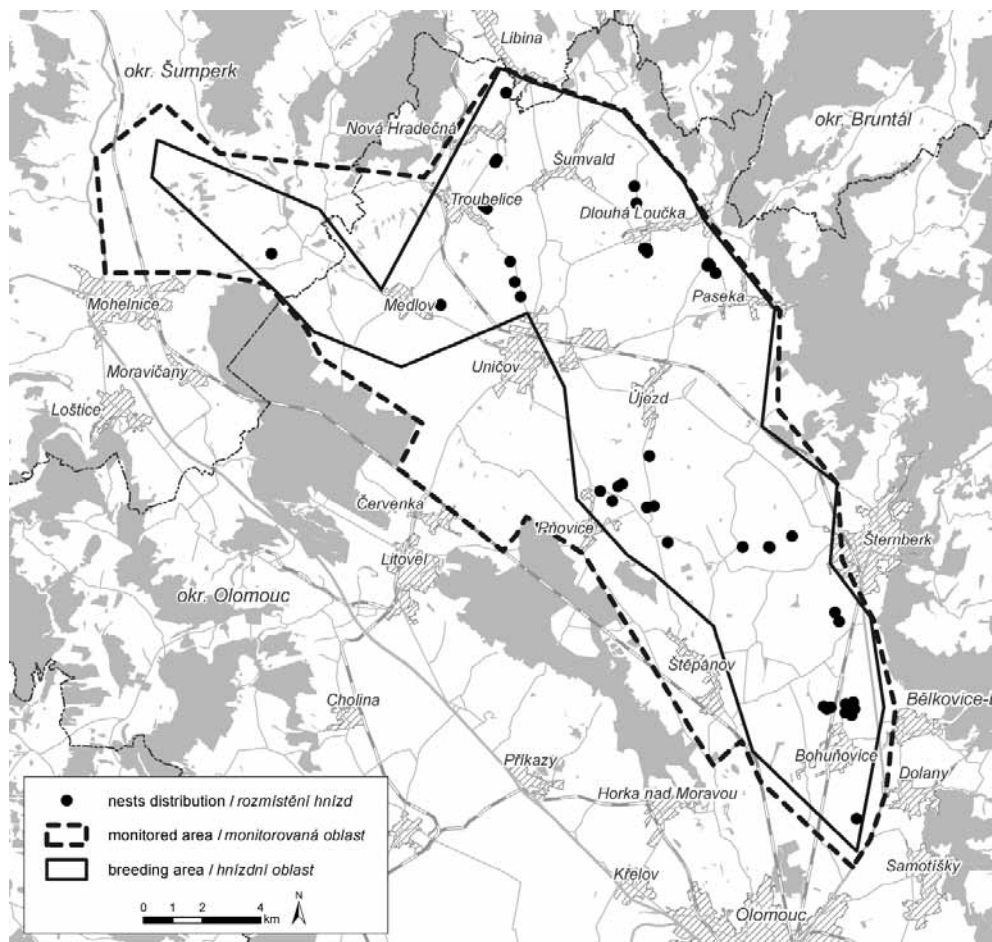


Fig. 6. Distribution of nests of the Montagu's Harrier in the years 2001–2005 (n = 46).
Obr. 6. Rozmístění hnízd motáka lužního v letech 2001–2005 (n = 46).

(6.2%), alfalfa - 16 pairs (6.2%), rape - 10 pairs (3.9%), spring barley - 5 pairs (1.9%), ryegrass - 4 pairs (1.5%), rye - 3 pairs (1.2%), spring wheat - 2 pairs (0.8%), legume-cereal melange - 1 pair (0.4%). Vegetation height was recorded in the following crops: spring barley (min. 48 cm, max. 86 cm, mean = 69 cm), winter wheat (min. 70 cm, max. 115 cm, mean = 86 cm), rye (95 cm, n = 1). In the fledging period, vegetation surrounding the Montagu's Harrier nests was 60–100 cm high (76 of 80 observations, i.e. 95%).

Although in the study area, the

Montagu's Harrier used land blocks of 6.1 to 97.54 ha in size (mean = 30.98 ha) for breeding, distribution of the nests in relation to the size of land blocks was not homogeneous ($\chi^2 = 117.2709$, $df = 4$, $P < 0.001$, land blocks of 0–100 ha were classified into five classes 20 ha wide). Montagu's Harrier nests were most frequently situated on smaller land blocks (see fig. 14). Similar results were obtained also for the distance of the nest to the margin of the land block ($\chi^2 = 120.7632$, $df = 5$, $P < 0.001$, distance to land block margin from 0 to 310 m was

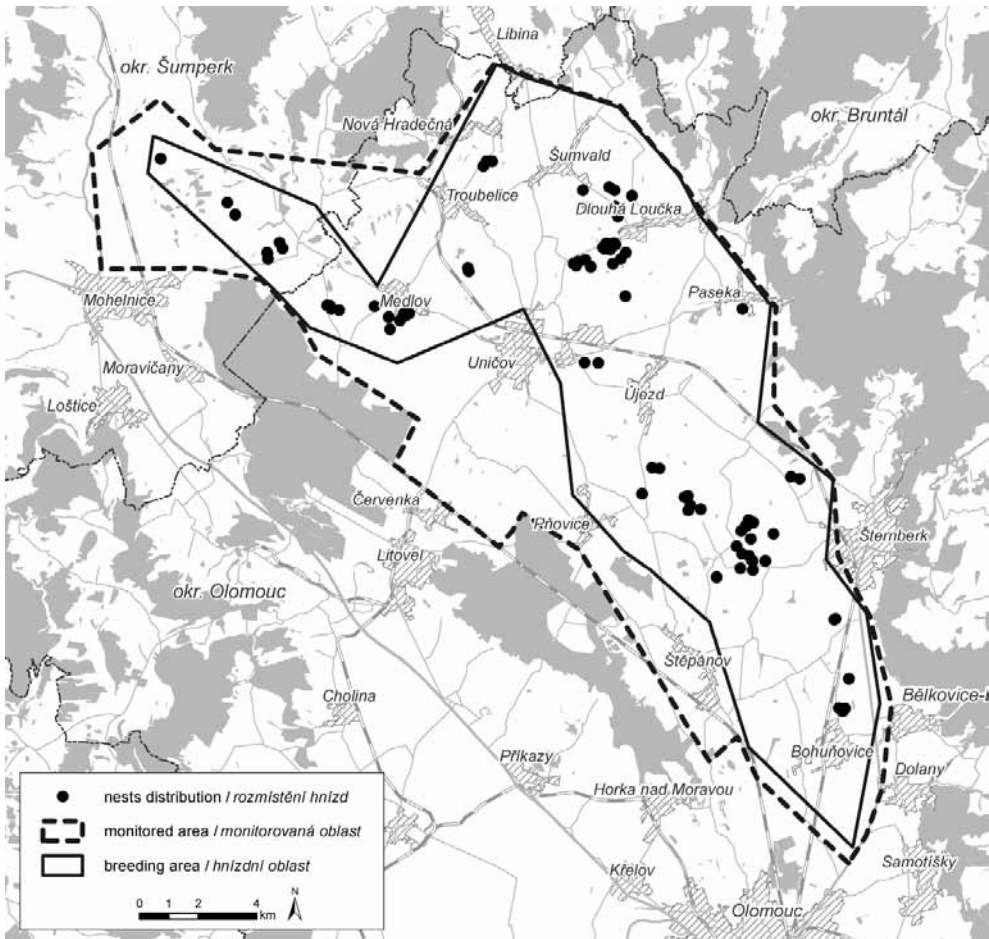


Fig. 7. Distribution of nests of the Montagu's Harrier in the years 2006–2010 ($n = 91$).

Obr. 7. Rozmístění hnízd motáka lužního v letech 2006–2010 ($n = 91$).

classified into 6 intervals 50 m wide, except for the last one which was 60 m wide). The nests tended to be situated towards land block margins (fig. 15). In the years 1997–2012, altogether 103 nests (67.8%) were situated less than 100 m from the land block margin and the remaining 49 nests (32.2%) at the distance of 101–305 m from the land block margin (min. 11.8 m, max. 305 m, mean = 97 m, $n = 152$). The nearest margin of the land block with a nest was represented by a field road (98 cases), tarmac road (42), watercourse (6), bulk (3), wood (2)

and ditch (1). Over a half of the nests (83 nests, 55.3%) were found less than 500 m from the nearest built-up area of a settlement, 64 % of the nests (96 nests) less than 600 m and 76.7% of the nests (115 nests) less than 700 m from the settlement (min. 69.5 m, max. 1391 m, mean = 512 m, $n = 150$), see fig. 16.

DISCUSSION

In the last 10–15 years, increased attention has been paid to monitoring and conservation of regional popula-

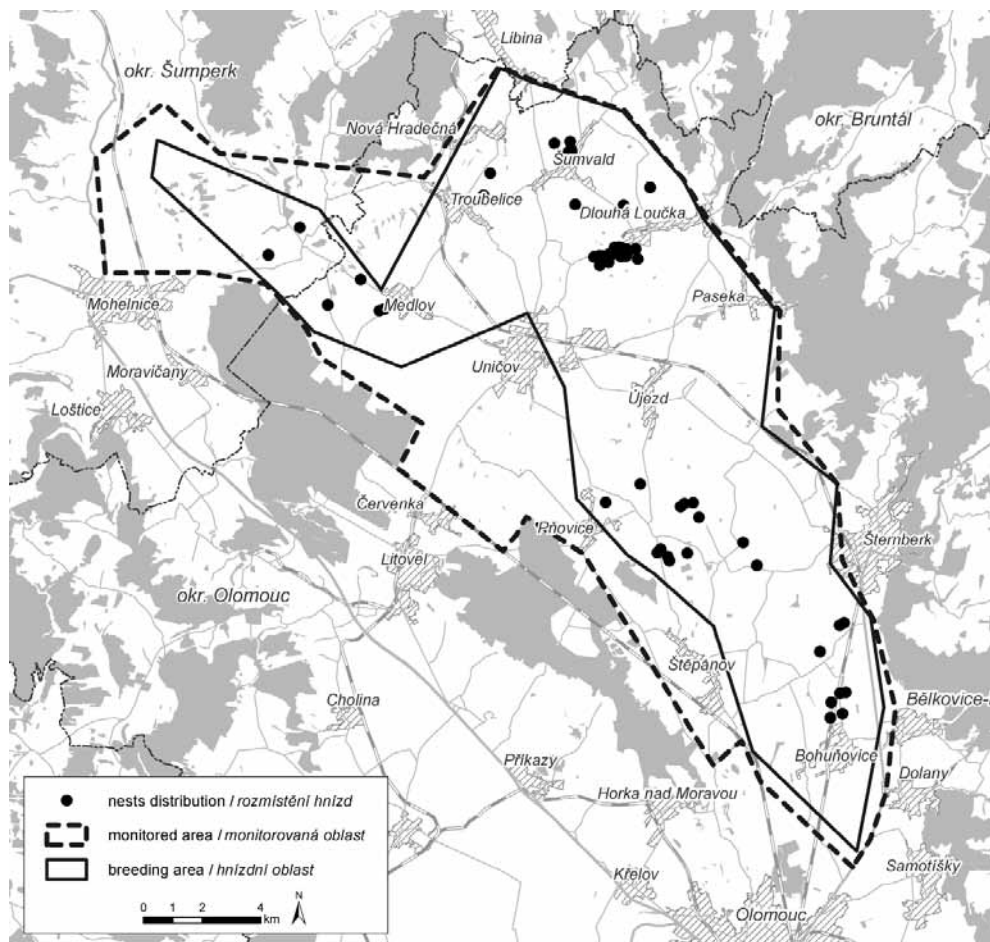


Fig. 8. Distribution of nests of the Montagu's Harrier in the years 2011–2013 (n = 64).

Obr. 8. Rozmístění hnízd motáka lužního v letech 2011–2013 (n = 64).

tions of the Montagu's Harrier in the Czech Republic (e.g. Beran 2005, Hora et al. 2010). In the present paper, we assess population trend and distribution of the Montagu's Harrier in the longest-monitored local population in the Czech Republic in central Moravia over 39 years. The first breeding was documented in 1974 (Holínek 1975), since 1991 the species has been breeding there every year (Suchý 2003). Until 2000, Montagu's Harriers nested almost exclusively in the Uničov area (78 km²) (Suchý 2003), however, since that they started to

use a wider area of the Olomouc region or central Moravia, respectively (Hora et al. 2010, Mrlík et al. 2013).

The most abundant regional breeding population of the Montagu's Harrier in the Czech Republic was recorded in the Českomoravská vrchovina highlands, where the species started to appear in the years 1987–1988 (Kunstmüller & Kodet 2005), the first breeding was documented there in 1994 (Kunstmüller 1996). Regular occurrence and nesting of individual pairs has been reported since 1997; since 2000 the breed-

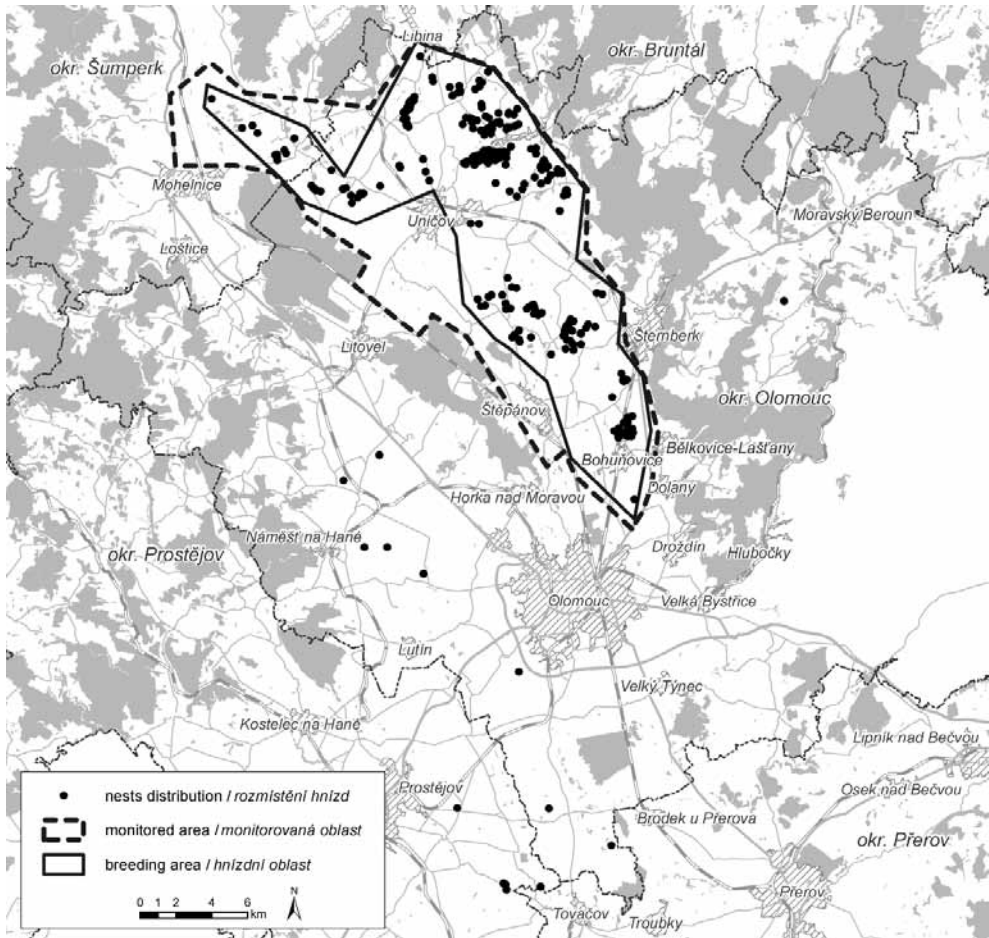


Fig. 9. Distribution of nests of the Montagu's Harrier in the monitored area, including its wider surroundings, in the years 1974–2013 ($n = 298$).

Obr. 9. Rozmístění hnízd motáka lužního v monitorované oblasti, včetně širšího okolí této oblasti, v letech 1974–2013 ($n = 298$).

ing population started to increase very quickly from 8 up to 74 pairs in 2007 (Kunstmüller 2003, 2004, Kunstmüller et al. 2007, Kunstmüller & Kodet 2008, Kunstmüller in litt.). In the years 2009–2012 there was a slight decline, 28–41 pairs were recorded (Kunstmüller in litt.). Another quite numerous breeding population in the Czech Republic is found in the Znojmo region. The first breeding was documented there in 1970, the species nested sporadical-

ly in the years 1979–1981, 1987–1988 and 1992 (Klejduš 1980, Martiško 1994, Prášek & Čutka 1993). Since 1999 it has been breeding there regularly (Poprach 2006), in the years 2009–2012 altogether 17–25 pairs nested in the region every year (Poprach unpubl.). In the Opava region, 17 breeding pairs were recorded in 2006 (Stolarczyk et al. 2006). A relatively numerous population (10–15 pairs) was reported from the eastern part of the Jindřichův Hradec area from 2012

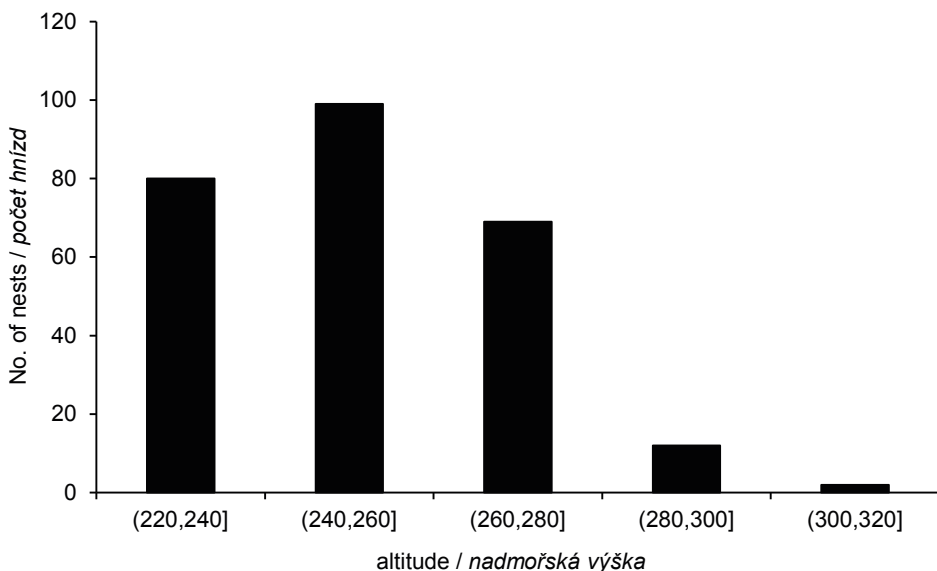


Fig. 10. Hypsometric characteristics of nests of the Montagu's Harrier in central Moravia in the years 1974–2012 (n = 262). Interval of 20 m.

Obr. 10. *Hypsometrické charakteristiky hnízd motáka lužního na střední Moravě v letech 1974–2012 (n = 262). Interval 20 m.*

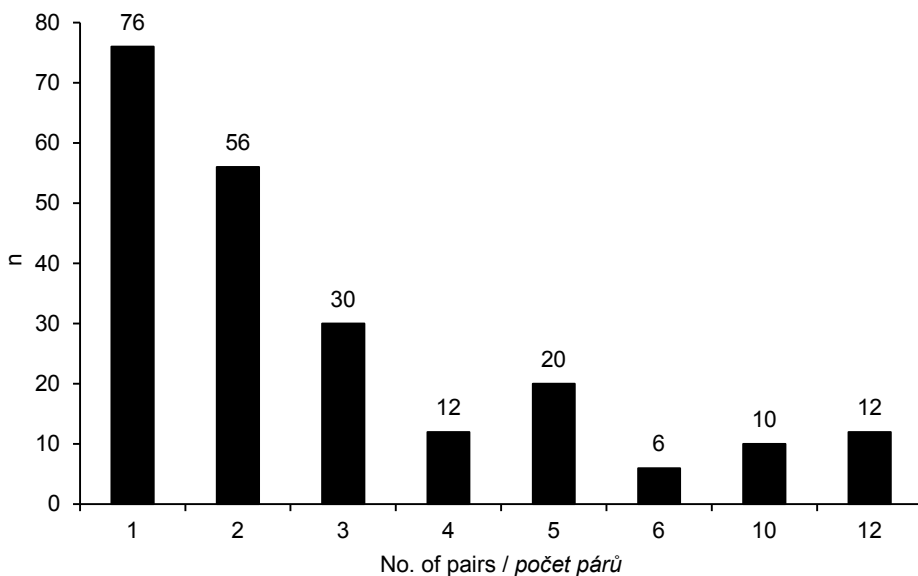


Fig. 11. Overview of individually and semicolonally nesting pairs of the Montagu's Harrier in central Moravia in the years 1974–2012 (n = 222).

Obr. 11. *Přehled individuálně a semikoloniálně hnízdících párů motáka lužního na střední Moravě v letech 1974–2012 (n = 222).*

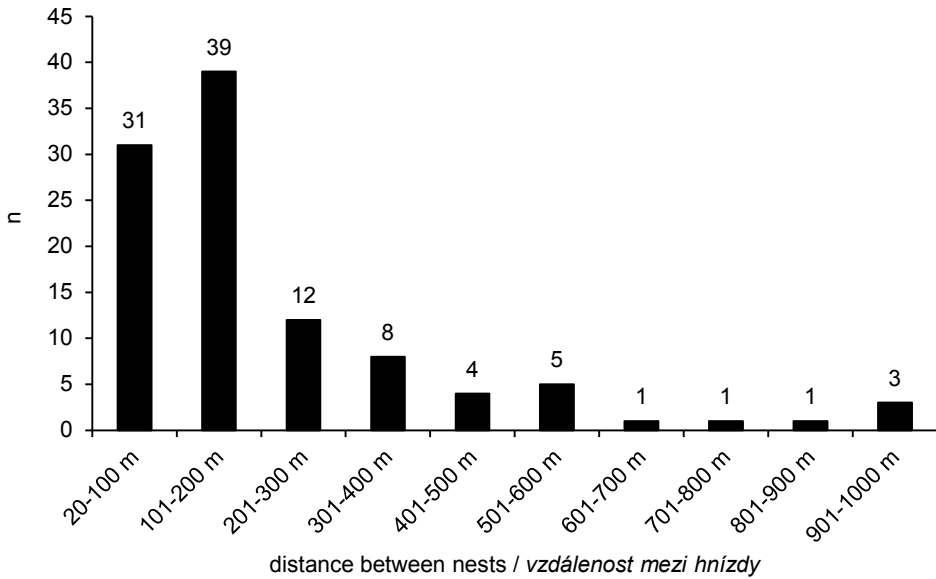


Fig. 12. Distribution of distances between the nests in semicolonially breeding pairs of the Montagu's Harrier in central Moravia in the years 1997–2012 ($n = 105$).

Obr. 12. Rozložení vzdáleností mezi hnízdy u semikoloniálně hnízdících párů motáka lužního na střední Moravě v letech 1997–2012 ($n = 105$).

(Veselý in litt.). Other local, relatively less numerous populations of the Montagu's Harrier in the Czech Republic are described by Hora et al. (2010).

Danko et al. (1994) reported 20–40 pairs of the Montagu's Harrier breeding in the Czech Republic in the year 1990, Mrlík et al. (2002) mentioned already 80–120 pairs for the period 2001–2003. The current breeding population in the Czech Republic can be estimated at 170–200 pairs (Poprach, Kunstmüller & Veselý unpubl.). This population increase corresponds with the growing numbers of the Montagu's Harrier in the EU countries in the years 1970–1990 and 1990–2000. Around the year 2000, altogether 9,400–21,000 pairs nested in the EU, i.e. about 30% of the European population of the species (BirdLife International 2004a,b).

The question arises which factors contribute to the long-term increase in

numbers of the Montagu's Harrier in the studied region, Czech Republic as well as in Europe. In the Českomoravská vrchovina Highlands (Czech Republic), the increase in numbers of breeding Montagu's Harriers correlated with population gradation of the Common Vole (*Microtus arvalis*) in the years 2001, 2002, 2005 and 2007 (Kunstmüller et al. 2007, Kunstmüller & Kodet 2008). The dramatic growth in numbers of Montagu's Harrier pairs breeding in farmland in the Netherlands in the 1990s was also explained by increased numbers of the vole population (Koks et al. 2007). Higher food availability in the given area increased breeding success of the Montagu's Harrier as well as the numbers of its local population in Spain (Arroyo & Garcia 2006). In France, an increase in the numbers of breeding Montagu's Harriers is supposed to be related to the growth of the overwintering

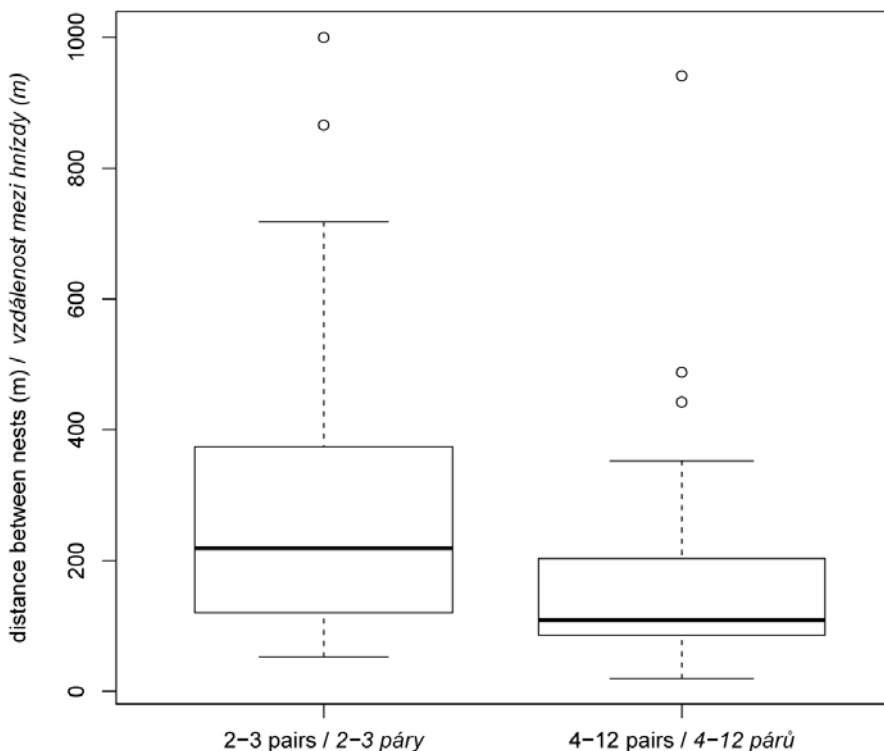


Fig. 13. Box and whisker plot of the distance to the nearest nest for birds breeding in smaller (2-3 pairs) and larger (4-12 pairs) semicolonies.

Obr. 13. Krabicový graf vzdálenosti k nejbližšímu hnízdu pro ptáky hnízdící v méně početných (2-3 páry) a více početných (4-12 párů) semikoloniích.

vole population (Millon & Bretagnolle 2008). Kunstmüller (2012) recorded a high number of breeding pairs of the Western Marsh-harrier (*Circus aeruginosus*) with a significantly high percentage of productive nests in gradation phases of the Common Vole during the period 1996-2008. On the other hand, in the latent phase of the vole population, a markedly lower number of pairs nested with a significantly lower percentage of productive nests.

It is apparent that sufficient food availability along with successful reproduction are the main factors limiting the numbers of the Montagu's Harrier. It should also be taken into consideration that food-niche differentiation can

be important for birds of prey breeding in farmland. Garcia & Arroyo (2005) compared diet composition of the Hen Harrier and the Montagu's Harrier in central Spain, where both species breed sympatrically in a farmland. In qualitative characteristics, the diet of both species was similar. However, the Hen Harrier hunted larger individuals of the same prey species more frequently than the Montagu's Harrier. This was recorded in the mean size of the prevailing prey (Lagomorpha) as well as in the mean size of alternative prey (small birds and insects). Other differences between the two species were recorded in the frequency of feeding of the young at the nest - the frequency increased during

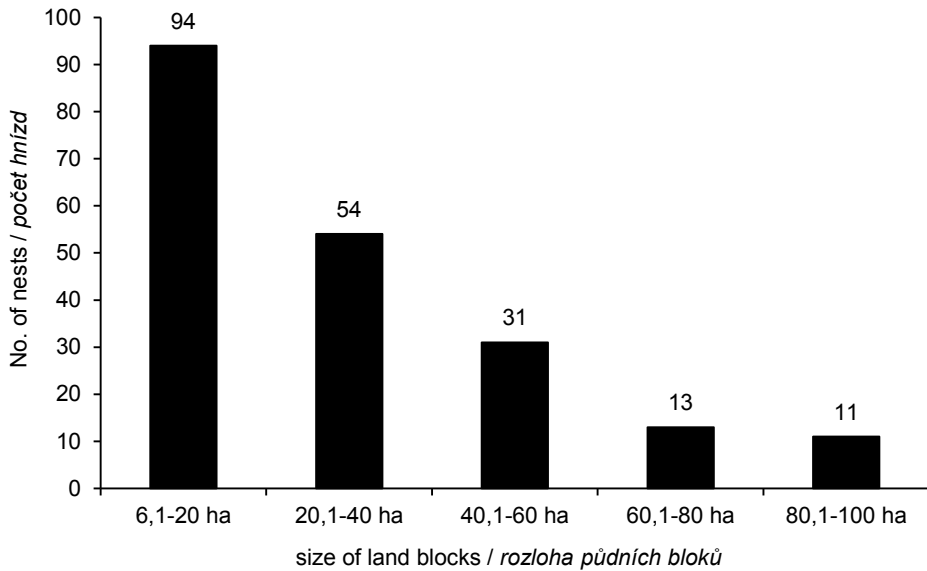


Fig. 14. Size of land blocks with nests of the Montagu's Harrier in central Moravia in the years 1974-2012 (n = 203).

Obr. 14. Rozloha půdních dílů (bloků) s hnízdy motáka lužního na střední Moravě v letech 1974-2012 (n = 203).

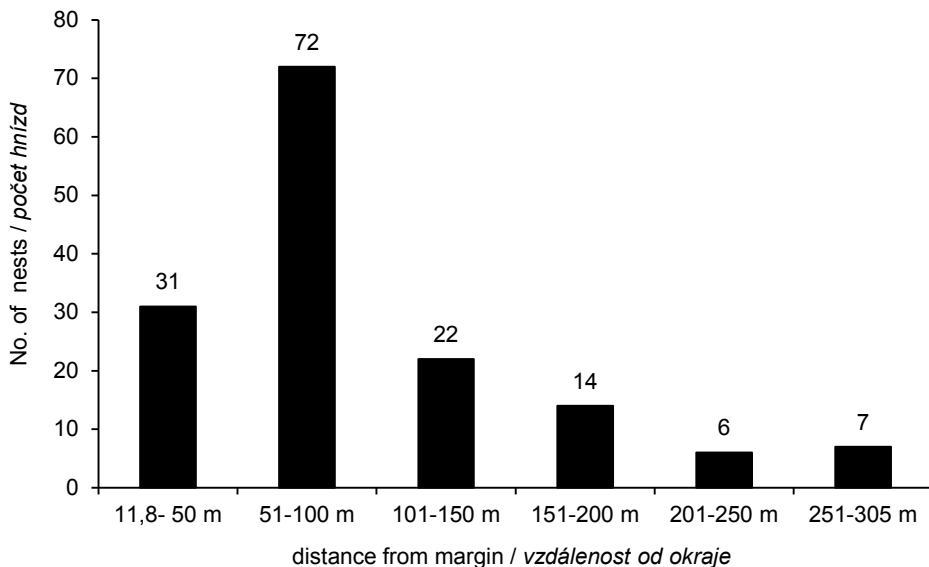


Fig. 15. Distance of nests of the Montagu's Harrier from land block margin in central Moravia in the years 1997-2012 (n = 152).

Obr. 15. Vzdálenosti hnízd motáka lužního od okraje pozemku na střední Moravě v letech 1997-2012 (n = 152).

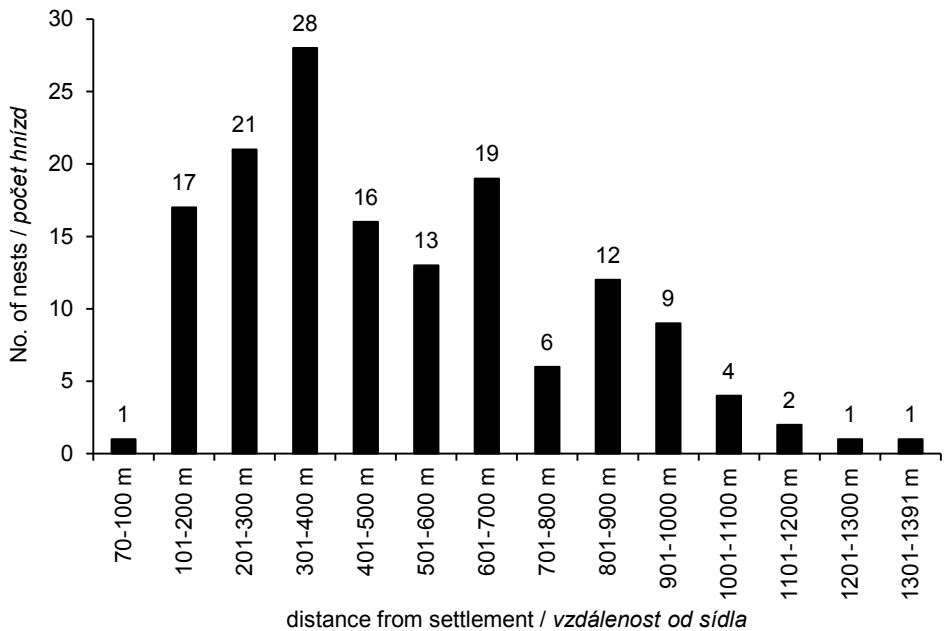


Fig. 16. Distance of nests of the Montagu's Harrier from the nearest built-up area of a settlement in central Moravia in the years 1997-2012 (n = 150).

Obr. 16. Vzdálenosti hnízd motáka lužního od nejbližší zastavěné části sídla na střední Moravě v letech 1997-2012 (n = 150).

the breeding season in the Montagu's Harrier, while in the Hen Harrier it did not. Adult Hen Harriers spent more time searching for food for the young in the vicinity of their nest than adult Montagu's Harriers, which looked for the food at a rather larger distances from the nest.

In the studied area of central Moravia, population of the Common Vole fluctuates in 3-5 year periodical cycles (Zapletal et al. 2000, Poprach 2008). Male Montagu's Harriers compensate for the lack of food by searching for prey at larger distances from the nest. In the study area, an exact distance between the nest and the place of prey catching was recorded in two males, reaching 5570 m and 5650 m, respectively (Poprach unpubl.). The breeding population of the Montagu's Harrier in the studied lowland area may benefit

from the possibility to hunt food in the neighbouring hills of the Nížký Jeseník Mts., situated 3-6 km from the breeding grounds, with a dominant proportion of grazed grasslands and thus perhaps more stable food availability.

Nests of the Montagu's Harrier in central Moravia were most often recorded at the altitudes of 240 to 260 m a.s.l. The analysis of altitudinal data for 113 breeding pairs of the Montagu's Harrier in the Czech Republic in 2012 showed 3 peaks for the values 501-550 m and 551-600 m a.s.l. (nests in the Českomoravská vrchovina Highlands) and 251-300 m a.s.l. (nests in central Moravia and the Znojmo region) (Kunstmüller et al. 2013).

The results suggest that the Montagu's Harrier uses land blocks of smaller size for breeding and it tends to place its nests towards their margins. In the Znojmo region, altogether 30 nests (88%) were

situated less than 100 m from the land block margin in 1999–2006 (Poprach 2006). The reason for selection of smaller land blocks and placing the nests to their margins rather than to their interiors seems to be an uncluttered view which is important for orientation of the birds at the nest site. Large land blocks with monocultures of field crops are not occupied by the Montagu's Harrier, or only exceptionally. Over 50% of the nests were situated less than 500 m from the nearest built-up area of a settlement. Similar results were obtained by Krupiński et al. (2012) in eastern Poland, where 66% of the nests were placed less than 300 m and 80% less than 400 m from a settlement.

All 280 breeding pairs of the Montagu's Harrier recorded in the years 1974–2013 nested in fields. Such high number of breeding pairs in field habitats corresponds with the intensive agricultural use of the studied area of central Moravia and, at the same time, indicates an important threat to the Montagu's Harrier during harvest. Protection of the nests from mowing is thus highly needed. In the study area, the Montagu's Harrier used winter wheat for nesting most frequently. Among other crops, rape reaches the largest height at the time of courtship, however, Montagu's Harriers used it only rarely for nesting. This was probably due to its relatively sparse cover and compact connection in a later vegetation period, making the arrival and departure from the nest more difficult. When flushed, the female needs more time to leave the nest in rape, she arrives and leaves the nest through a „tunnel“ in connected vegetation. In 2012, we found a predated nest with eggs and a dead female which probably did not manage to escape from the dense rape vegetation (Poprach unpubl.). On the other hand, rape was used more often

in the Podlasie region in eastern Poland: 18% of the pairs nested there, however, 52 % of the nests were found in winter cereals, mostly in triticale (41%, Krupiński et al. 2012). In the years 1926–1970, 96% of all recorded Montagu's Harrier pairs in Czechia nested in natural or close-to-nature habitats (wetlands, reedbeds, wet meadows, clearings). Changes in selection of breeding habitats by the Montagu's Harrier could be observed in 1975–1980, when the species started to nest in field crops more frequently. In the years 1971–1980, 67% of the nests were placed there, and in 1991–2001, already 88% of the nests (Mrlík et al. 2002). Habitat preference varies among particular regions of the country, depending on landscape type. For instance in the Českomoravská vrchovina highlands, a half of the total of 140 pairs nested in wetland and rural habitats, while the other half nested in field crops in the years 2000–2006 (Kunstmüller et al. 2007). However, in the neighbouring Znojmo region, 174 (87.9%) out of 198 nests were situated in field crops in 1999–2013 (Poprach 2006, Poprach unpubl.). Preference for winter cereals as a breeding habitat of the Montagu's Harrier was recorded in an eight-year study of breeding population of the species in northeastern France (Millon et al. 2002).

Density and height of the vegetation in the period of courtship seem to be the most important factors affecting the selection of a particular field crop. At the time of fledging of the young, vegetation surrounding the Montagu's Harrier nests in central Moravia was 60 to 100 cm high (69 cm in spring barley, 86 cm in winter wheat). Similar results are known also from natural habitats of the Montagu's Harrier. In eastern Poland, preference for higher and denser vegetation was recorded during nest site selection in

a wetland habitat, where the Montagu's Harrier nested mainly in the Saw Sedge (*Cladium mariscus*) (Wiaczek 2009). In Catalonia, where the Montagu's Harrier nested in extensive bushy vegetation dominated by the Kermes Oak (*Quercus coccifera*), Gorse (*Ulex parviflorus*) and Rosemary (*Rosmarinus officinalis*), the mean height of vegetation at the nest was 83.5 cm. The vegetation 1 m from the nest was higher, with the mean value of 109 cm (Limiñana et al. 2006).

Nesting of the Montagu's Harrier on the ground and the use of field crops for breeding results in relatively high nest losses, caused mainly by predation and mowing during harvest (Poprach unpubl.). Land use affecting population dynamics of birds of prey in farmland may be indirectly shown by the occurrence of toxic chemicals in food chain (Macedo-Sousa et al. 2009). Another key factor affecting the numbers of local populations of the Montagu's Harrier is active protection of the nests from destruction by agricultural machinery during harvest (Corbacho et al. 1999). The presented results of a long-term monitoring of a local population of the Montagu's Harrier confirm these findings. Active protection of the nests in central Moravia has been carried out since 1991.

In central Moravia and the Znojmo region, installing a fence around the nest using contiguous stakes and a wire mesh (net eye diameter 13 mm, 2x2 m in top view) proved to be an effective conservation measure. The fence protects the young from mowing during harvest, from abandoning the nest site during harvest before fledging, and also from predation. In recent years, there have been three cases when the young were killed by man in the fence, which is visible in the field. A way how to prevent this criminal activities at the particular localities is to use a fence not exceeding

the height of the crop as well as to raise public awareness of the needs of conservation of the Montagu's Harrier among hunters and farmers (Poprach unpubl.).

The continuous increase in numbers of the studied local population of the Montagu's Harrier in central Moravia is likely to be affected also by demographic changes in the population. For instance, it has been shown that breeding of older female Montagu's Harriers is more successful and that older females have larger clutches as well as a higher number of fledged young than younger females (Arroyo et al. 2007). In the studied local population of the Montagu's Harrier over the period of 39 years, a trend of gradual increase in the number of breeding pairs is apparent. This population trend might have been triggered by the beginning of active protection of the nests in the early 1990s. In the course of time, this probably led to higher nest success and to the tendency to aggregate the nests into semicolonies. Out of 222 breeding pairs, 34.3% nested individually and 65.7% semicolonally. The mean distance from the nearest nest in the semicolony was 221.4 m, altogether 54.3% were situated less than 150 m from the nearest nest. In eastern Poland, where the limit for a semicolony was set to 600 m, 59% of the pairs nested individually, 31% of the pairs formed smaller semicolonies of 2-3 pairs, semicolonies of more than 4 pairs made up 9% and the largest semicolony of 14 pairs was recorded in rape in 2009 (Krupiński et al. 2012). Aggregation of nests into colonies is generally known in this species (Arroyo et al. 2001) and is explained by the need to reduce energy expenditure for protection of the nests from predators. Although the females stay at the nest site, they usually fly within 500 m from the nest. In several cases, an even larger flight range was recorded of up

to around 1 km (e.g. in 2011 in a nesting female, caught using an eagle owl decoy, the distance was 1040 m). Semicolonally breeding pairs may thus benefit from mutual communication and protection of the nests from predators at the distance of up to 1 km (Poprach unpubl.). An interesting comparison between two species of bird predators showing nest aggregation was presented by Cornulier & Bretagnolle (2006). Using the method of assessment of the environment non-homogeneity, they found that nest aggregation in the Little Owl corresponds with heterogeneity of the environment; in areas with sufficient habitat availability, the Little Owl does not create nest aggregations. On the other hand, tendency to semicolonial breeding in the Montagu's Harrier persists even in areas with abundance of suitable habitats.

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