

Trend in an isolated population of the red-footed falcon (*Falco vespertinus*) at the edge of its breeding range (south-western Slovakia)

Trend izolovanej populácie sokola kobcovitého (*Falco vespertinus*) na okraji jeho hniezdneho rozšírenia (juhozápadné Slovensko)

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Abstract: The population of the red-footed falcon in Slovakia inhabits the north-western edge of the species' breeding range. This breeding population is relatively small and came near to extinction during the population decline of this species in central Europe in recent decades. Thanks to increasing numbers of breeding pairs in Hungary, the Slovak population began to grow again. Moreover, some differences in breeding biology associated with breeding in nest boxes were found. Here we describe the dependence of the small isolated breeding population in Slovakia on the core population in the more eastern parts of the Carpathian Basin, and the impact of supporting activities (nest boxes) on this raptor species in Slovakia.

Abstrakt: Populácia sokola kobcovitého sa na Slovensku nachádza na severozápadnom okraji jeho hniezdneho areálu. Je relatívne malá a bola v reálnom ohrození zániku počas výrazného poklesu početnosti tohto druhu v strednej Európe počas predchádzajúcich desaťročí. Začala rásť až vďaka zvýšeniu početnosti hniezdiacich párov v Maďarsku. Zároveň je od tohto momentu možné pozorovať aj niekoľko zmien v biológii hniezdenia tohto druhu v súvislosti s hniezdením v búdkach. V tomto príspevku opisujeme závislosť malej izolovanej hniezdnej populácie na Slovensku od jadrovej populácie vo východnejších častiach Karpatskej kotliny a vplyv podporných ochranných aktivít (hniezdnych búdok) na tento druh dravca na Slovensku.

Key words: breeding population, population trend, artificial nests, nest height, nest success

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Breeding populations in any species' breeding range are often under threat due to several factors, especially if they are isolated and small in number (Ebenhard 1991). The risk of extinction is relatively high (Harrison 1991) and their survival depends on migration from the core population (Serrano & Tella 2003). The number of breeding pairs is thus highly affected by the number of breeding pairs in the nearest strong population.

The breeding range of the red-footed falcon (*Falco vespertinus*) extends from central and eastern Europe through northern Central Asia to Lake Baikal. The southern limit of the breeding range passes through Serbia, Bulgaria, Ukraine, southern Russia and northern

Kazakhstan (Cramp 1980, Purger 2008). Altogether 300,000 to 800,000 birds tend to live within this range (Ferguson-Lees & Christie 2001). Irregularly breeding birds can be found northward to Belarus (Dombrovski & Ivanovski 2005), in western Russia as far north as Moscow, in central Russia up to Novosibirsk and Krasnoyarsk, and in the Khantia-Mansia region. The core of the EU population breeds in the Carpathian (Pannonian) Basin (eastern Austria, Hungary, western Romania, and northern Serbia), which forms the western border of the range. A small but stable number of red-footed falcons breeds in northern Italy (Tinarelli 1997, Sponza et al. 2001). In the past red-footed falcons have

occasionally bred in small numbers in France (Pilard & Roy 1994, de Sousa 1994) and Finland.

The local breeding population in Slovakia can be characterised as an isolated population due to the relatively long distance to the nearest breeding colonies in Hungary containing several hundred pairs (Fig. 1). Only a few breeding pairs (1–14) persist today in Austria at Parndorfer Platte and Heideboden and near Neusiedlersee lake (Dvorak et al. 2016). A small and irregular colony is/was also located in the north-western part of Hungary near the Slovakian border (Fig. 1). The Slovak breeding population is likewise small. It has never reached more than one hundred breeding pairs

(Danko & Chavko 2002). The only recent regular breeding locality is the Sysľovské polia SPA in south-western Slovakia (Fig. 1).

Red-footed falcons are facultative colonial breeders (i.e. they breed equally in colonies or in solitary pairs). They do not build a nest; naturally falcon colonies breed in rook (*Corvus frugilegus*) nests in their colonies (rookeries) (Horváth 1964, Purger & Tepavcevic 1999) or in abandoned nests of magpies (*Pica pica*) or hooded crowns (*Corvus cornix*) (Végyvári et al. 2001).

Due to the significant decline in rook colonies in agricultural landscape and their particular movement to other rural and urban habitats during the last few dec-

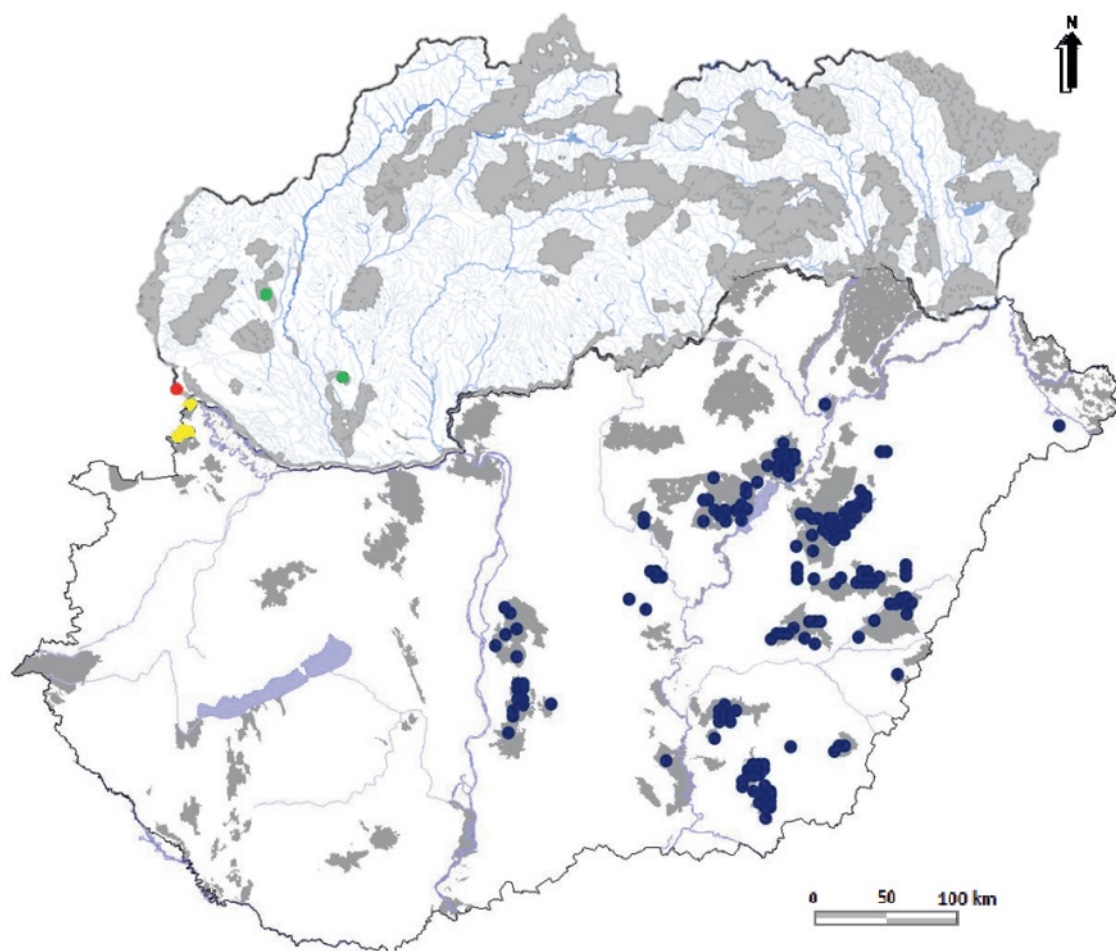


Fig. 1. Localization of the breeding sites of the red-footed falcon in Slovakia and Hungary. Studied population at the Sysľovské polia locality (red), occasional breeding sites in Slovakia (green) and north-western Hungary (yellow), and the core population in the central and eastern parts of Hungary (blue).

Obr. 1. Lokalizácia hniezdných lokalít sokola kobcovitého na Slovensku a v Maďarsku. Študovaná populácia na Sysľovských poliach (červená), náhodné hniezdne lokality na Slovensku (zelená) a v severozápadnom Maďarsku (žltá) a jadrová populácia v centrálnych a východných častiach Maďarska (modrá).

ades, the number of breeding red-footed falcons has suffered a dramatic decline in the entire Carpathian Basin (Tucker & Heath 1994, Puzović et al. 2003, Purger 2008, Fehérvári et al. 2009, Palatitz et al. 2009, 2015). The number of breeding pairs in Hungary continuously decreased from the 1940s to the end of the 20th century. The lowest estimated number of breeding pairs occurred in 2006, when only 558 occupied nests were identified. This represents a decline of more than 70% (Palatitz et al. 2015). A similar situation was registered in the region of Vojvodina (northern Serbia), where the number of breeding red-footed falcon pairs decreased almost to one half of the initial figure during the period 1988–2003 (Puzović et al. 2003, Purger 2008).

Over the next few years the Hungarian population produced a fluctuating increase. By 2014 the estimated breeding population was 1,200 breeding pairs (Palatitz et al. 2015), and a positive change in population size was also registered in Voivodina (Barna 2015). This pattern is ascribed to several activities within the species management program implemented in Hungary. Due to recent conservation actions aiming to compensate for the lack of nesting sites in suitable habitats, the species started to breed in colonies of artificial nest boxes (Fehérvári et al. 2009).

The aims of this study are (i) to describe the development of the population size of the red-footed falcon in Slovakia depending on changes in the number of breeding pairs in the Hungarian population, and (ii) to discuss the impact of supporting activities (nest boxes) on this raptor species in Slovakia.

The data on breeding of the red-footed falcon in Slovakia were obtained from several field zoologists working in south-western Slovakia and by analysing the literature. Altogether, 88 breeding territories with occupied nests were identified between 2004–2017. This dataset provides usable information for the description of population fluctuation and for characterising some aspects of the species' breeding ecology in Slovakia. Data on breeding biology were compared using χ^2 test and t-test in the Statistica 7 (StatSoft, USA) programme.

Estimated numbers of breeding red-footed falcons before 2004 are partly inaccurate. There are no specific data on breeding of this raptor species in south-western Slovakia in the report on species abundance in Slovakia between 1970–1990 (Danko 1994). The first information on documented breeding of this species in this area dates from 1993 (Danko et al. 1995a). More data were

collected in 1994, when the breeding in artificial nests was also documented (Danko et al. 1995b). The overall estimate of the species' abundance in south-western Slovakia was at least 43 breeding pairs (Danko & Chavko 2002). In the second half of the 1990s 15–20 breeding red-footed falcon pairs were monitored in the breeding colony at Sysľovské polia. At the turn of the century however, only 4–6 breeding pairs were registered at this locality (Maderič 2007).

As a steppe bird species the red-footed falcon prefers open habitats and it is secondarily adapted to agricultural landscape. This is why its distribution in Slovakia has never been large. Only 5.6% of the area of Slovakia has ever been inhabited by this species, concentrated in the south-western and south-eastern parts of the country with relatively small populations (Danko & Chavko 2002). The small number of breeding pairs can be also linked to the decreasing numbers of rook colonies in agricultural areas. The rook is a species with negative population trends in this area (Mošanský & Trnka 2002) and rookeries are now rare (for more information on the status of the rook and on red-footed falcon-rook relations, see Slobodník et al. 2017). Although this negative population trend has appeared since the 1970s (Danko 1990, 1994, Danko & Chavko 2002), the dramatic decline in the population dates from the end of the 20th and the first decade of the 21th century. The number of breeding birds decreased to its minimum in 2012, when only one pair was found, but no nest (Tab. 1). The Sysľovské polia SPA in the tri-point border area of Slovakia, Hungary and Austria is today the only known breeding locality in Slovakia, and there are only a few records of this species being sighted during breeding seasons in other parts of the country (e.g. Katona 2006, Kern & Nešták 2007, Danko et al. 2017, own unpublished data). In the last few years (from 2014) the Slovakian population of the red-footed falcon has shown a slight increase. The number of birds has grown to 16 breeding pairs in 2017 (Tab. 1).

This increase in the Slovakian population can be ascribed to the stabilizing of the species' numbers in the Carpathian Basin, and mainly to the increase in the number of breeding birds in the Hungarian population, which started showing a rising trend from 2010 (Palatitz et al. 2015). Birds in stronger populations tend to migrate to the edge of their range when their population is increasing (Serrano & Tella 2003). This can be confirmed by the observation of seven red-footed falcons in Slovakia which hatched in Hungary.

Tab. 1. Number of breeding territories, incubated clutches, failed nests and minimum number of fledged nestlings of the red-footed falcon (*Falco vespertinus*) in the Sysľovské polia Special Protection Area between 2004–2017.

Tab. 1. Počet hniezdnych teritórií, inkubovaných znášok, neúspešných hniezd a minimálny počet vyvedených mláďat sokola kobcovitého (*Falco vespertinus*) v chránenom vtáčom území Sysľovské polia v rokoch 2004 – 2017.

year / rok	breeding territories / hniezdne teritória	nests with clutches / hniezda so znáškami	unsuccessful nests / neúspešné hniezda	fledged nestlings / vyvedené mlá tá
2004	9	6	3	7
2005	14	11	3	19
2006	6	2	1	3
2007	8	7	3	11
2008	6	6	1	10
2009	5	2	0	6
2010	3	3	2	2
2011	3	2	1	3
2012	1	0	0	0
2013	1	1	0	4
2014	4	3	0	11
2015	5	2	1	4
2016	5	5	0	19
2017	16	16	1	41
	86	66	31	115

Most of the nests of the red-footed falcon in Slovakia were found in abandoned nests of magpies (47%) and in the nests of rooks (28%). More than one half of all monitored nests were situated in black locust trees (*Robinia pseudoacacia*) and nearly one fourth of them in cultivated poplars (*Populus × euroamericana*). The average nest height was 8.6 m (4.5–15 m; n = 73). The mean clutch size was 3.2 eggs per nest (n = 45), with hatching success of 2.9 nestlings per nest (n = 53). Fledgling success was 2.8 nestlings per successful nest (n = 71) and 1.8 nestlings for all monitored nests (n = 108).

There are significant differences in some aspects of the breeding biology of this species between two time periods: before 2013 and after 2013 (during population decline and during population growth). Higher numbers of pairs have begun breeding in nest boxes in the study population in Slovakia. Only 8.9% of all monitored nests in 2004–2013 were established in nest boxes, but 62.9% of them were in nest boxes in 2013–2017 ($\chi^2 = 14.3$; $P = 0.002$; n = 83; Fig. 2). This trend is similar to that in the Hungarian population, where provided nest boxes have been one of the most successful activities supporting the breeding of the red-footed falcon (Palatitz et al. 2015). The Slovakian nest boxes programme was very similar to the one in Hungary. Similar types of nest boxes were used, and they were placed in similar habitats and in similar places. Likewise in Hungary, groups of nest boxes were installed at selected locations

to enable the formation of breeding colonies (Kotymán et al. 2015). The typical nest height was lower due to the nest boxes preference. The mean nest height before 2013 was 8.9 m above the ground, but decreased after nest box occupancy developed to 7.3 m above the ground ($t = 3.17$; $P = 0.002$; n = 70; Fig. 3). Approximately one fourth of all nests were unsuccessful before 2013. Preference for nest boxes has increased survival rates, and the nest success reached almost 94% after 2013 ($\chi^2 = 4.73$; $P = 0.03$; n = 86; Fig. 4). Only 1.1 nestlings would have fledged from one nest on average be-

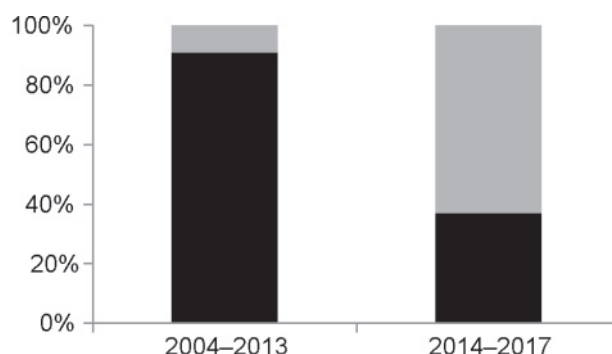


Fig. 2. Proportion of red-footed falcon nests situated in nest boxes (grey) and in abandoned corvids nests (black) in two time periods.

Obr. 2. Podiel hniezd sokola kobcovitého umiestnených v búdkach (sivá) a v opustených hniezdach krkavcovitých (čierna) v dvoch časových obdobiach.

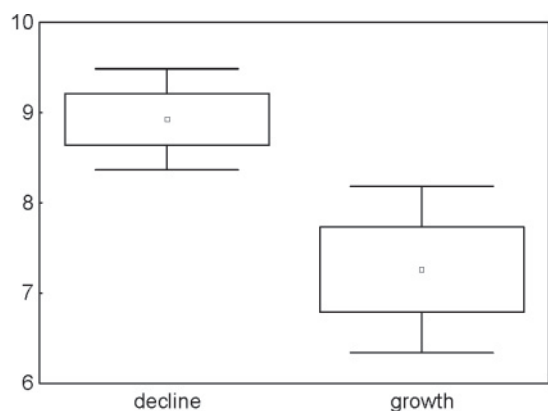


Fig. 3. Differences in red-footed falcon nest height (metres) in two time periods – during population decline and during population increase.

Obr. 3. Rozdiely vo výške umiestnenia hniezda sokola kobcovitého v dvoch časových obdobiach – počas populačného poklesu (decline) a počas rastu populácie (growth).

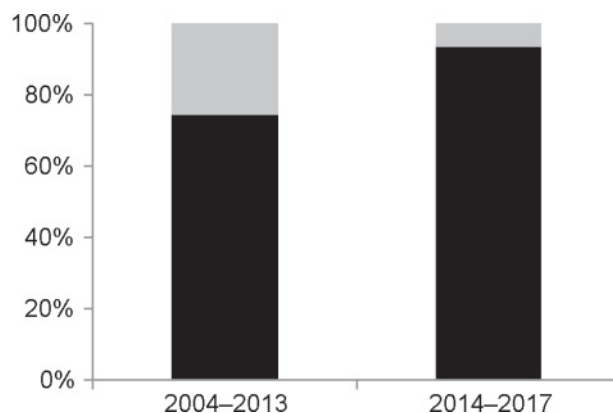


Fig. 4. Proportion of successful (black) and failed (grey) nests of the red-footed falcon in two time periods.

Obr. 4. Podiel úspešných (čierna) a neúspešných (sivá) hniezd sokola kobcovitého v dvoch časových obdobiach.

fore 2013. The mean number of fledged nestlings after 2013 was 2.5 per nest.

Artificial nest boxes are known as a factor influencing several aspects of breeding biology of birds, mainly clutch size and breeding success (e.g. Van Balen 1984, East & Perrins 1988). Several raptor species prefer this type of nest location (e.g. Bortolotti 1994, Slobodník et al. 2016) and achieve higher breeding success. This also seems to be true for the red-footed falcon (Fehérvári et al. 2012, 2015), however some information on reduced numbers of nestlings in nest boxes of this species is known (Bragin et al. 2017). Red-footed falcons in Central Asia tend to lay eggs earlier in nest boxes, but due to the inappropriate timing of breeding they achieve lower breeding success compared with pairs breeding in natural sites.

In conclusion, there are several factors influencing the breeding of the red-footed falcon in Slovakia, of which the most important are inappropriate agricultural methods and techniques reducing the food base in the breeding habitats of this species (Maderič 2007, 2008). However, the Slovakian breeding population of the red-footed falcon seems to be strongly dependent on the Hungarian population, and the number of breeding pairs in Slovakia seems to be mostly affected by the number of breeding pairs in Hungary. The way to stabilize/increase the number of breeding pairs in Slovakia is to enforce environmental techniques in agriculture around breeding (or potential breeding) sites, mainly in SPAs set up to protect this species (Gúgh et al. 2015). The

nest box programme is another important factor influencing the breeding of red-footed falcons in this area. Although some negative effects of nest boxes on the nesting success of this species are known (Bragin et al. 2017), we suppose that the positives markedly exceed the negatives, mainly in the area of south-western Slovakia where natural sites are deficient.

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