

Trend and conservation of saker falcon (*Falco cherrug*) population in western Slovakia between 1976 and 2010

Vývoj a ochrana populácie sokola rároha (*Falco cherrug*) na západnom Slovensku v rokoch 1976–2010

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Abstract: During the 35-year study period (1976–2010) the nesting distribution, population size and dynamics, as well as negative factors influencing the saker falcon population in western Slovakia were surveyed. After 1993 all of the nesting pairs have gradually resettled to the neighbouring agrocoenoses, previously used for hunting and wintering. This process was considerably influenced by management practices, especially the installation of 151 nest boxes on electricity pylons in lowland agrocoenoses in western Slovakia. Since 2009 all pairs have been nesting in agrocoenoses. During the last decade the number of nesting pairs has increased 145% and the nesting area of the saker has increased three-fold in western Slovakia. Data about 47 pairs and 345 nesting events were used to evaluate the population trend. The pairs raised 797 fledglings in 247 successful breeding attempts. Average success for all breeding attempts was 2.3 fledglings, and 3.2 fledglings for successful breeding attempts. The main reasons for losses during the study period are considered to be drastic changes in feeding and breeding habitats, illegal shooting and poisoning as well as nest robberies.

Abstrakt: V priebehu 35 ročného obdobia (1976–2010) bolo študované hniezdne rozšírenie, dynamika a veľkosť populácie a negatívne vplyvy pôsobiace na populáciu sokola rároha na západnom Slovensku. Od roku 1993 postupne došlo k celkovému presídleniu hniezdných párov do priľahlých agrocnóz, ktoré boli predtým rárohami využívané na lov potravy a zimovanie. Presídlenie populácie významne ovplyvnili zrealizované manažmentové opatrenia, najmä inštalovanie 151 hniezdných búdok na stožiare elektrických vedení v agrocnózach nížin západného Slovenska. Od roku 2009 už všetky páry hniezdili v agrocnózach. V priebehu posledného desaťročia došlo k nárastu početnosti hniezdiacich párov o 145 % a približne k trojnásobnému zväčšeniu plochy územia hniezdného areálu sokola rároha na západnom Slovensku. Východiskom pre hodnotenie vývoja populácie boli údaje o celkovom počte 47 sledovaných párov, ktoré zahniezdili 345 krát na území západného Slovenska. Z výsledkov monitoringu reprodukčnej dynamiky vyplynulo, že páry z 247 úspešných hniezdení vyvedli spolu 797 mláďat. Priemerná úspešnosť všetkých párov, ktoré zahniezdili, predstavovala 2,3 mláďaťa / obsadené hniezdo a úspešné páry vyvedli priemerne 3,2 mláďaťa / úspešné hniezdo. Za najvýznamnejšie vplyvy spôsobujúce straty v sledovanom období možno označiť intenzívne hospodárske využívanie krajiny s dopadom na premenu a zánik potravných a hniezdných biotopov, nezákonný odstreľ, trávenie a vykrádanie hniezd.

Key words: Falconiformes, population trend, nesting and foraging habitat, conservation, lowlands, mountains, Malé Karpaty Mts

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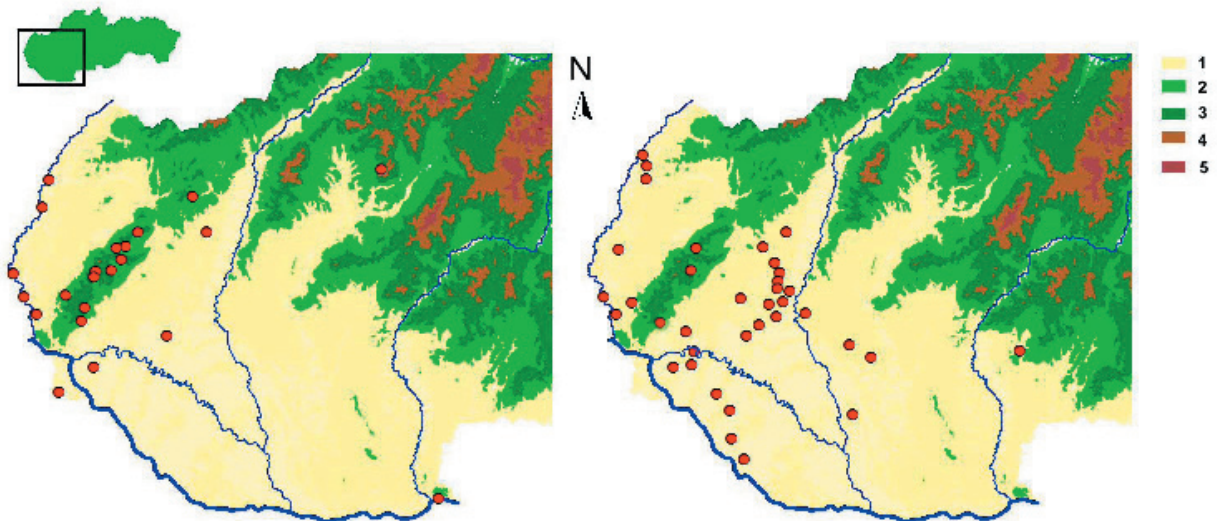
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Introduction

The saker falcon (*Falco cherrug* J. E. Gray, 1834) has Mongolian-Tibetan type of distribution, occurring in the Palaearctic region between 30° a 60° north latitude from Mongolia and Tibet to the westwards to Iran and central Turkey, and up to the steppe and steppe-forests of south Russia. In Europe the saker falcon occurs in Austria, Bulgaria, Croatia, Czech Republic, Georgia, Germany, Hungary, Moldova, Montenegro, Romania, Serbia, Slovakia, Ukraine and the European part of Russia. The European population is estimated to be 720–808 pairs (BirdLife International 2010). The western border of the saker falcon nesting area in central Europe crosses the Czech Republic and Austria (Orta 1994). The saker falcon is listed as Vulnerable in the IUCN Red List (IUCN 2010). The main reasons for the saker population decline in Europe are considered to be changes in diet caused by human activities influencing the dominant prey species, and nest robberies for falconry purposes (Horák 2000, Galushin et. al. 2001, Moseikin 2000, Karyakin 2001, 2005, 2008, Levin 2000, Levin et al. 2010).

The territory of western Slovakia belongs among the historical nesting areas of the saker falcon. The first specific data come from the years 1885 and 1886 from a rock at Devín castle situated in part of Bratislava called Devín. According to the information of Dutch ornithologist Schlegel to J. S. Petényi (1853, in litt.), Dutch falconers had noticed this nest even earlier and were using it as a source of fledglings (Chernel 1899). In the Danube floodplain forests, saker nesting was recorded in 1928, 1933 and 1934 (Kunszt 1929, Matoušek 1933, Csiba 1958). The main nesting area of the saker falcon in Slovakia was in the Malé Karpaty Mts. The first nesting in this area was recorded in 1931 (Janda 1932). Nesting events or fledglings were also recorded in 1946, 1949, 1953 and 1954 (Brtek 1956, Matoušek 1956). Ferienc (1964) estimated the saker population in the Malé Karpaty Mts to be six pairs. In the Považský Inovec Mts nesting events were recorded in 1954, 1956, 1957, 1960 and 1964 (Hell 1958a, b, Soviš & Šindár 1964, Varga 1969). In 1959 a nesting event was recorded in the Strážovské vrchy Mts and in 1961 in the Biele Karpaty Mts as well as in the



Figs 1, 2. Nesting territories of saker falcon in western Slovakia. 1 – territories occupied between 1976 and 2000 (on the left), 2 – territories occupied between 2001 and 2010 (on the right). Red point – nesting territory; altitude range: 1 – 110–250, 2 – 250–415, 3 – 415–680, 4 – 680–800, 5 – 800–1000 m a. s. l.

Obr. 1, 2. Hniezdne teritória sokola rároha na západnom Slovensku. 1 – teritória obsadené v rokoch 1976–2000 (vľavo), 2 – teritória obsadené v rokoch 2001–2010 (vpravo). Červený bod – hniezdne teritórium; nadmorská výška: 1 – 110–250, 2 – 250–415, 3 – 415–680, 4 – 680–800, 5 – 800–1000 m n. m.

Pohronský Inovec Mts (Soviš & Šindár 1964). Between 1951 and 1959 nesting of 1–2 pairs was recorded near Bratislava in a forest of the Šúr nature reserve (Brtek 1956, Hell 1958a, Ferienc 1964).

Previous hints in the literature about saker nesting in Slovakia were summarized by Matoušek (1962). Mošanský (1974) later evaluated the saker distribution in eastern Slovakia. After establishment of the Group for Research and Protection of Raptors and Owls in 1975 the monitoring of saker was intensified. The population size in the whole territory of Slovakia was estimated to be 35–40 pairs in 1990 (Danko et al. 1994). The saker diet was studied by Obuch & Chavko (1997). Changes in the distribution and abundance of the saker in Slovakia until 1999 were evaluated by Chavko (2002).

The aim of this article is to evaluate the results of 35 years of systematic saker falcon nesting population research in western Slovakia. Changes in the distribution, abundance, reproductive dynamics, nesting biology and diet composition were studied, as well as the adaptation of the species to the new habitats in open agricultural land.

Material and methods

Systematic monitoring of all known sites with the occurrence of saker falcon in western Slovakia has been carried

out since 1976. Between 1976 and 2000 the priority was given to monitoring in mountains, mostly in the Malé Karpaty Mts, Strážovské vrchy Mts, Burda Mts as well as in the borderline floodplain forests of the Morava River (Borská nížina Lowlands and Dolnomoravský úval Lowlands). Due to saker resettling to lowland agrocoenoses, the monitoring since 2000 has also been carried out in other orographic units; in the Podunajská rovina Plain, Trnavská pahorkatina Uplands, Borská nížina Lowlands, Nitrianska and Ipeľská pahorkatina Uplands. Besides this every other observation have been verified and all of the potential sites with prospective occurrence have been checked. Monitoring of nesting pairs has been carried out by direct observation using binoculars and telescope. Regarding the fact that the saker occupies the nests of other bird species, monitoring of larger nests of birds of prey and the black storks (*Ciconia nigra*) was carried out generally during autumn and winter period. Each nest was located on the map and recorded in the database. After each discovery of a new pair the territory was monitored regularly during all following seasons. Since 2000 the nests have also been located using GPS (Garmin 60 CSX). Locations of all nests, including those previously found, were marked on the digital map in the World Geodetic System (WGS84) format to evaluate the distribution and the temporal and spatial dynamics of the population.

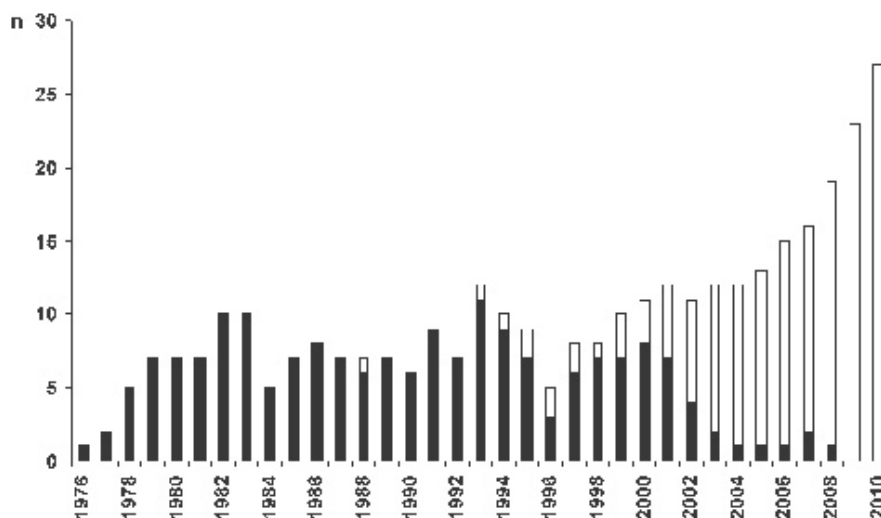


Fig. 3. Trend of saker falcon population, gradual resettlement from mountains and floodplain forests to agrocoenoses in western Slovakia between 1976 and 2010. n – number of pairs nesting in mountains floodplain forests (black columns) and in agrocoenoses (white columns).

Obr. 3. Vývoj populácie sokola rároha, postupné presídlenie hniezdísk z pohorí a lužných lesov do agrocenóz západného Slovenska v období rokov 1976–2010. n – počet hniezdiacich párov v pohoriach a lužných lesoch (čierne stĺpce) a v agrocenózach (biele stĺpce).



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Fig. 4. Typical original saker falcon nesting habitat in the Malé Karpaty Mts in 1985 (the nest was previously occupied by northern goshawk – *Accipiter gentilis* for several years).

Obr. 4. Typický pôvodný hniezdny biotop sokola rároha v Malých Karpatoch v roku 1985 (predtým bolo hniezdo viac rokov po sebe obsadené jastrabom veľkým – *Accipiter gentilis*).

The nesting sites have been identified during the period of display flights in February and March, when saker activity is highest and locating the nest is easiest for the observer. Sometimes it was very difficult to locate the occupied nest. On such occasions the results of previous monitoring of other species' nests have been very helpful. During the study period all occupied nests were directly inspected in order to identify the number of chicks and obtain particular biometric data, as well as to collect any food remains and abandoned eggs. Direct inspection of the nests was never done during the hatching. To identify the number of fledglings the inspections were done from the neighbouring trees or from other suitable observation points. Results of every visit were documented with pictures and recorded in the diary. About 90–95% of all pairs nesting in western Slovakia were included in the monitoring during the study period. Agrocoenoses in this study means lowland and upland areas with altitudes up to 300 m, with intensive agricultural land use and with scarce or absent tre-type vegetation. In this study, “successful breeding attempt” means all nests from which fledglings were flew out and “all breeding attempts” means all nests (both, successful and unsuccessful) to which at least one egg was laid. The monitoring and surveying was carried



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Fig. 5. Natural saker falcon nest in the central part of Malé Karpaty Mts in 1979.

Obr. 5. Prirodzené hniezdo sokola rároha v Malých Karpatoch v centrálnej časti pohoria v roku 1979.

Tab. 1. Direct causes of losses during saker falcon nesting in western Slovakia in the period between 1976 and 2010

Tab. 1. Priame príčiny strát pri hniezdení sokola rároha na západnom Slovensku v rokoch 1976–2010

reason / príčina	number / počet
unknown reasons / neznáme príčiny	24
nest robberies / vykradnutie hniezda	20
assumed nest robberies / predpokladané vykradnutie hniezda	12
human disturbance / vyrušovanie človekom	11
immature pair / mladý nevypelý pár	7
windthrow – extreme weather / polom – extrémne počasie	6
activities of hunters / poľovnícke aktivity	5
timber harvesting / ťažba stromov	4
predator / predátor	3
fall of the nest / pád hniezda	2
fall of the clutch inside the nest / prepadnutie násady do hniezda	2
lightning strike / úder blesku	1
destroying of nesting box by shooting / vystrelenie búrky	1
Σ	98

out in compliance with the valid legislation of the Slovak Republic.

Identification of individuals in the case of five pairs where the resettlement from mountains to agrocoenosis was recorded by direct observation, mostly during the display flights. In the event that the pairs changed their habitat, their presence at the other site was verified immediately. Besides this, wintering and hunting sites were also identified in those agrocoenoses, where the pairs started breeding after installation of nest boxes.

Results and discussion

Dynamics of nesting population between 1976 and 2010

Between 1976 and 1978 intensive monitoring was carried to gather information about numbers of nesting pairs. Since 1979 all of the pairs have been under systematic monitoring. Between 1976 and 2010, 47 pairs nested in western Slovakia in nine orographic units, nesting altogether 345 times, with 247 successful breeding attempts (Figs 1, 2, Appendix 1). Altogether 174 nesting events of 13 pairs were recorded in mountains. In floodplain forests it was 14 nesting events of five pairs and in agrocoenoses 157 nesting events of 29 pairs. In the Malé Karpaty Mts the first nesting was recorded in 1976 and by 2008 eleven



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Fig. 6. Saker falcon habitat with artificial nest.

Obr. 6. Biotop sokola rároha s umelým hniezdom.

pairs had nested here 157 times, with 100 successful breeding attempts. Five pairs nested alternately in the Malé Karpaty Mts and in agrocoenoses of the Trnavská pahorkatina Uplands and Podunajská rovina Plain. In the floodplain forests of the Podunajská rovina Plain the nesting of one pair was recorded in 1988, 1989, 1990 and 1993, with only one successful breeding attempt. Between 1994 and 2010 eight pairs nested 45 times in agrocoenoses in this orographic unit, with 39 successful breeding attempts. In the Borská nížina Lowlands the first nesting was recorded in agrocoenosis in 1988, and by 2010 seven pairs had nested here 36 times, with 25 successful breeding attempts (three pairs in the floodplain forests of the Morava River and four pairs in agrocoenosis). In the Trnavská pahorkatina Uplands the first nesting was recorded in 1997, and by 2010 twelve pairs had nested in agrocoenoses 69 times, with 56 successful breeding attempts. In the Nitrianska pahorkatina Uplands the first nesting was recorded in 2002, and by 2010 three pairs



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Fig. 7. Saker falcon habitat with a nest box.
Obr. 7. Biotop sokola rároha s búdkou.



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Fig. 8. Artificial nest in a beech tree.
Obr. 8. Umelé hniezdo na buku.



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Fig. 9. Nest box in a tree.
Obr. 9. Búdka na strome.

had nested here in agrocoenoses 13 times, with eleven successful breeding attempts. In the Strážovské vrchy Mts the first nesting was recorded in 1982, and by 1993 one pair had nested here 9 times, with seven successful breeding attempts. The nesting site was later occupied by a peregrine falcon (*Falco peregrinus*). In the Burda Mts the first nesting was recorded in 1992, and by 2001 one pair had nested here 8 times, with six successful breeding attempts. This nesting site was also later occupied by a peregrine falcon. In the Dolnomoravský úval Lowlands nesting of two pairs was recorded, with one successful breeding attempt in floodplain forest near the Morava River in 1993 and one unsuccessful breeding attempt in agrocoenosis in 2009. In the Ipeľská pahorkatina Uplands only one pair nested in agrocoenosis, and two breeding attempts – one successful and one unsuccessful – were recorded in 2005 and 2006.

Since 1993 important changes in nesting habitats have been recorded. All of the pairs nesting since 1976 in the Malé Karpaty Mts, Burda Mts and Strážovské vrchy Mts, in the Šúr nature reserve and in floodplain forests near the Morava River have gradually left their original nesting sites and resettled in agrocoenoses (Fig. 3). Since 2009 all of the pairs have nested only in agrocoenoses. During the last decade the number of nesting pairs has increased 145% and the nesting area has increased approximately three-fold in western Slovakia. Until 2000 nesting of between only five and twelve pairs had been recorded, but in 2010 27 pairs nested in the western part of the country. The most considerable occupancy of new territories was recorded in the Trnavská pahorkatina Uplands, Podunajská rovina Plain and Borská nížina Lowlands (Figs 1, 2).

Description of nesting events

Between 1976 and 2010 345 nesting events were recorded in eight different types of nests (Figs 4–14). The highest number of 136 nesting events was recorded in the nest boxes on electricity pylons, 113 in natural nests on trees, 31 in artificial nests on trees, 28 in nest boxes on trees, 13 in artificial nests on pylons, twelve in natural nests on rocks, seven in natural nests on pylons and five in artificial nests on rocks. The shortest distance between two nests occupied at the same time was 1.5 km in agrocoenosis on the Podunajská rovina Plain, 2.0 km in the Malé Karpaty Mts and 6.8 km in floodplain forest in the Borská nížina Lowlands.

Two pairs nested in isolated locations. One pair in the Strážovské vrchy Mts nested 67 km from the closest nest of a pair in the central population, and in the case of the pair in the Ipeľská pahorkatina Uplands it was 48 km



Fig. 10. Artificial nest on a pylon.
Obr. 10. Umelé hniezdo na stožiarí.



Fig. 11. Aluminium nest box.
Obr. 11. Hliníková búdka.

(Figs 1, 2). Until 2000 the majority of birds nested in trees. They preferred natural nests in beech trees (*Fagus sylvatica*) over 80 years in age in the Malé Karpaty Mts. Large nests were occupied preferably, especially those close to the boundaries of the forest. Old nests of birds of prey and other large species were used, e.g. nests of northern goshawk (*Accipiter gentilis*), common buzzard (*Buteo buteo*), lesser spotted eagle (*Aquila pomarina*) or black stork (*Ciconia nigra*). Sakers occasionally also occupied nests of eastern imperial eagle (*Aquila heliaca*).

In the Malé Karpaty Mts the species nested in beech trees 89 times in natural nests, 25 times in artificial nests and 28 times in nest boxes. In the Malé Karpaty Mts only two nesting events in an oak tree (*Quercus robur*) and one nesting event in a maple tree (*Acer pseudoplatanus*) were recorded. Two nesting sites in the Malé Karpaty Mts, situated on rocks and occupied by sakers in the past, were later occupied by pairs of peregrine falcon.

On electricity pylons in the Trnavská pahorkatina Uplands, Podunajská rovina Plain, Borská nížina Lowlands and Ipel'ská pahorkatina Uplands, sakers nested 136 times in nest boxes, 13 times in artificial nests, and 7 times in natural nests made by hooded crow (*Corvus cornix*) and common raven (*Corvus corax*).

In an ash tree (*Fraxinus excelsior*) in the floodplain forests of the Morava River, nesting was recorded 6 times in natural nests of common buzzard and goshawk and 3 times in artificial nests. In a hornbeam tree (*Carpinus betulus*) only one nesting event was recorded in the floodplain forest near the Morava River in the natural nest of a goshawk. Nesting in an alder tree (*Alnus glutinosa*) was recorded in the Šúr nature reserve 4 times in natural nests of common buzzard and goshawk. Nesting in a black locust tree (*Robinia pseudoacacia*) was recorded on the

Podunajská rovina Plain 2 times in natural nests of common buzzard and 2 times in artificial nests.

Nesting in a poplar tree (*Populus nigra*) was recorded in the Borská nížina Lowlands 4 times in a natural nest and 1 time in an artificial nest, in the Trnavská pahorkatina Uplands 3 times in a natural nest, on the Podunajská rovina Plain 1 time in a natural nest and in the Dolnomoravský úval Lowlands 1 time in a natural nest.

Nesting on rocks in natural and artificial nests was recorded altogether 17 times only at two nesting sites, in the Strážovské vrchy Mts and Burda Mts (Figs 12, 13). Both were later occupied by peregrine falcons.

Nesting habitats after resettlement of the population into agrocoenoses between 1993 and 2010 were represented by plain or partly-undulating agricultural land with occasional zones of windbreaks and bushes along the field roads. The character of these habitats has been strongly influenced by intensive large-scale agricultural production (Figs 15–19).

Influence of human factors on nesting habitats

Two areas can be considered as crucial for saker nesting in western Slovakia – the Malé Karpaty Mts and the floodplain forests near the Morava River, in the part between Bratislava and Brodské. During the study period human activities mostly influenced these two areas, which can be considered as the main reason for resettlement of the saker population. Up until the middle of the 20th century the foothills of the Malé Karpaty Mts were for a long time surrounded by many pastures with numerous colonies of European ground squirrel (*Spermophilus citellus*), the dominant prey of the species (Brtek 1956).



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Fig. 12. Natural nest on a rock.
Obr. 12. Prírodné hniezdo na skale.



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Fig. 13. Artificial nest on a rock.
Obr. 13. Umelé hniezdo na skale.



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Fig. 14. Abandoned saker falcon egg in a raven nest on pylon.
Obr. 14. Opustené vajce sokola rároha v hniezde postavenom krkavcami na stožari.

In the period between the 1960s and 1980s the habitats in the Malé Karpaty Mts as well as the close surroundings underwent considerable changes. The most important hunting habitats were ploughed up and overgrew with vegetation. The majority of the pastures was already used for growing crops after 1985. Only small areas of grassland remained here with just a few small isolated colonies of suslik (Grulich 1960, Ambros 2008). Once the availability of prey in the foothills of the Malé Karpaty Mts became reduced, the sakers had to fly longer

distances to reach food sources in the agricultural land. This was a big disadvantage from the energetic point of view. Transport of prey became much more difficult as the home range area became markedly enlarged. During breeding in the mountains the female was primarily responsible for ensuring the protection of chicks against predators. The food was brought in mainly by the male. Most of the Malé Karpaty Mts area underwent massive deforestation after 1980, causing the destruction of natural nesting habitats (Figs 4, 20). The area of beech trees in particular was evidently reduced during the deforestation process. One-sided interests of forestry were applied in this area, such as timber harvesting and the building of forestry approach roads.

To compensate for the lack of natural nests, 29 artificial nests and 21 nest boxes were installed in trees in nesting territories after 1981. These were then successfully used by sakers for breeding. However by 2008 also those parts of forest where the nest boxes and artificial nests were installed were harvested as well. Only three nest boxes and two artificial nests remained at their original sites after 2008, losing their suitability for saker nesting due to the huge habitat changes and disturbance. The last recorded nesting of sakers in an artificial nest in a tree was recorded in 2007. The nesting tree was felled in the next year. In most cases the responsible forestry authorities were informed about the importance of the forest (Fig. 20). The last breeding of



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Figs 15–19. Current saker falcon nesting and feeding habitats in western Slovakia. **15, 16** –Trnavská pahorkatina Uplands, **17** – Podunajská rovina Plain, **18** – Nitrianská pahorkatina Uplands, **19** – Borská nížina Lowlands.

Obr. 15–19. Súčasné hniezdne biotopy a potravné teritória sokola rároha na západnom Slovensku. **15, 16** –Trnavská pahorkatina, **17** – Podunajská rovina, **18** – Nitrianska pahorkatina, **19** – Borská nížina.

Tab. 2. Breeding success of saker falcon in western Slovakia in the period between 1976 and 2010

Tab. 2. Hniezdna úspešnosť sokola rároha na západnom Slovensku v období 1976–2010

parameter	
number of all breeding attempts / počet všetkých zaznamenaných hniezdení	345
number of successful breeding attempts / počet úspešných hniezdení	247
number of nesting events with known number of eggs / počet hniezdení so známym počtom znesených vajec	332
number of laid eggs / počet všetkých znesených vajec	1226
number of fledglings / počet vyvedených mláďat	797
losses (number of chicks / eggs) / straty (počet mláďat / vajec)	429
number of unsuccessful breeding attempts / počet neúspešných hniezdení	98
breeding success – all breeding attempts / prepočet úspešnosti – všetky hniezdacie páry	2.3
breeding success – successful breeding attempts / prepočet úspešnosti – úspešné páry	3.2
losses / straty [%]	35

sakers in the Malé Karpaty Mts was recorded in 2008 in a nest box on a pylon. The pair likewise left the site after enormous disturbance and timber harvesting in the vicinity of the nest box.

A similar situation concerning the negative effect of human activities was recorded in saker nesting habitats in the Morava floodplain forests, the Borská nížina Lowlands and the Dolnomoravský úval Lowlands. The most probable reasons why the sakers left the relatively narrow zone of Morava floodplain forests was the great increase in disturbance by people above all. Yet until 1990 this area near the national border was extremely protected. Once this area was opened up to the public it started being much more visited. Intensive fishing was the main reason for disturbance in the most valuable parts, as well as hunting and uncontrolled leisure activities.

The situation became worse with illegal activities in protected areas such as driving motor vehicles and building up angling infrastructure. These negative factors caused marked reduction in numbers of natural nests and in the favourable status of natural saker habitats in the whole complex of floodplain forests along the Morava River (Figs 21, 22). The last nesting in these floodplain forests was recorded in 2001, and continued subsequently only in the Borská nížina Lowland agrocoenoses, where new pairs also started nesting in 2007.

Influence of negative factors on nesting

When evaluating the direct reasons for losses associated with the total number of 345 nesting events between 1976 and 2010, human influences represent as much as 54.6%,



Fig. 20. Area in the Malé Karpaty Mts where the last nesting event of saker falcon was recorded in 2007. The forest was harvested in 2008 and 2009. The same nesting site can be seen in Fig. 4.

Obr. 20. Oblasť, v ktorej bolo zaznamenané posledné hniezdenie páru sokola rároha na strome v Malých Karpatoch v roku 2007, porast bol vyťažený v rokoch 2008–2009. Ide o hniezdisko, ktoré je prezentované aj na obrázku č. 4.



Fig. 21. Saker falcon nesting habitat in inundation area of Morava River.

Obr. 21. Hniezdny biotop sokola rároha v inundácii rieky Moravy.



Fig. 22. Natural saker falcon nest in floodplain forests near Morava River in 1993.

Obr. 22. Prirodzené hniezdo sokola rároha v lužných lesoch pri rieke Morave v roku 1993.

unknown reasons 23.7% and natural factors 21.7% of losses (Tab. 1).

Indirect reasons, mostly gradual changes in the majority of nesting and feeding habitats, clearly having the greatest influence on saker nesting in the Malé Karpaty Mts, were not included in the evaluation process. Cases of illegally shot individuals and poisoning in the feeding territories were not included either, although these must be considered as decisive for the overall population trend. As an example a case from 2009 can be mentioned. In a feeding territory near Malženice in the Trnava Region, four poisoned saker falcons were found, together with 16 common buzzards, one rough-legged buzzard (*Buteo lagopus*) and one common kestrel (*Falco tinnunculus*).

Human influences

1. Based on the analysis of direct reasons of losses, nest robberies can be considered to have the most important negative impact on the saker population. Between 1976 and 2010, 20 cases of confirmed nest robberies were recorded. In these cases the robbers left clear evidence, mostly of the usage of climbing equipment on a tree or other evidence of human climbing to the nest. Besides this another twelve cases of assumed nest robberies were recorded, however without enough evidence. The nests were robbed even with developed climbing techniques, mostly by shooting the rope into the tree-top and climbing with the use of ascenders, without leaving evident damage.
2. In cases of disturbance, mostly instances of fishermen or tourists camping just near the nest were recorded.

3. Several cases of building of hides in the vicinity of the nest causing the interruption of incubation were included in the category of activities of hunters.
4. A separate category is represented by one case when a nest box with clutch was destroyed by shooting.

Natural influences

1. Losses caused by immaturity of pairs includes one case where an adult bird was replaced by an immature individual and the nesting was not successful.
2. Among losses caused by predators a case was included when the fledglings were hunted by a goshawk in the nest. However several cases when the fledglings were hunted by predators after they fledged were not included. Such cases were not rare, especially in the mountains, but very difficult to prove. Usually it was only possible to recognise that the fledglings were absent from the nesting territory.
3. Two interesting cases of an incubated clutch falling through the rotten base of an old nest were recorded, as well as one case of fledglings killed in a nest box on an electricity pylon after lightning strike (Tab. 1).

Influence of management measures on the population

Due to the losses of most natural nesting habitats it was necessary to implement measures to increase the nesting opportunities. The most suitable solution was to install enough nest boxes and artificial nests. The first nest boxes were installed in trees in the Malé Karpaty Mts in 1981. The first nest boxes in agrocoenoses were installed on electricity pylons as early as 1994. The number increa-

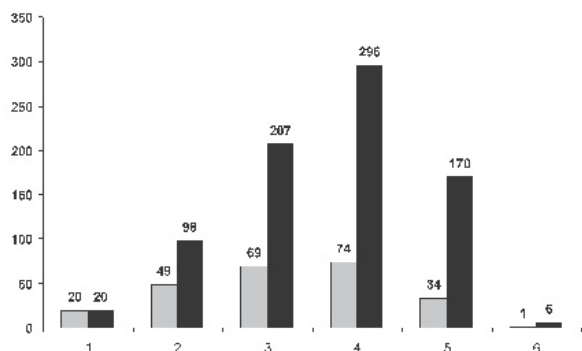


Fig. 24. Overview of successful breeding attempts ($n = 247$) and number of fledglings ($n = 797$) of saker falcon in 1976–2010. Axis x – number of fledglings from one nest: number of cases (grey column), number of fledglings (black column).

Obr. 24. Prehľad úspešných hniezdení ($n = 247$) a vyvedených mláďat ($n = 797$) sokola rároha v období 1976–2010. Os x – počet mláďat vyvedených z jedného hniezda: počet prípadov (sivý stĺpec), počet vyvedených mláďat (čierny stĺpec).

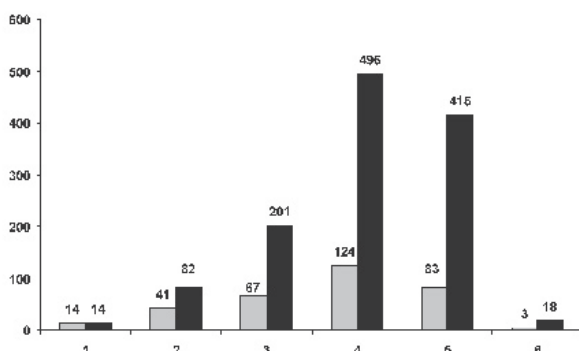


Fig. 25. Frequency of clutches of different size ($n = 332$ nesting events and 1226 eggs) of saker falcon in 1976–2010. Axis x – number of laid eggs in one nest: number of cases (grey column), number of eggs (black column).

Obr. 25. Frekvencia výskytu znášok rozličnej veľkosti ($n = 332$ hniezdení a 1226 vajec) sokola rároha v období 1976–2010. Os x – počet znesených vajec v jednom hniezde: počet prípadov (sivý stĺpec), počet vajec (čierny stĺpec).

sed up to 151 nest boxes and 15 artificial nests installed in agrocoenoses by the end of 2010. On the Podunajská rovina Plain the nest boxes were intentionally placed as near to the territory of Hungary as possible to enable communication of both populations. Between 2004 and 2010 four new pairs occupied nest boxes on pylons close to the Hungarian border (Fig. 2).

These management measures were implemented by RPS within different projects in cooperation with the responsible electricity companies SEPS, a. s. and ZSE, a. s.

The response of sakers was immediate, and as a rule the nest boxes and artificial nests were occupied 1–2 years after the installation. First nesting in a nest box on a pylon was recorded in agrocoenosis in the Borská nížina Lowlands in 1995. In 2009 and 2010 all of the pairs already nested in nest boxes and artificial nests on electric pylons. The average nesting success was higher compared to the natural nests or nest boxes and artificial nests located in trees.

Besides that special attention was given to the ecologization of dangerous constructions of 22 kV power lines representing serious threat for sakers in the agrocoenoses. Insulators effectively eliminating the danger of electrocution were given priority for installation in agrocoenoses. It is expected that by 2015 the major part of the power lines in nesting territories of the species in western Slovakia could be insulated (Fig. 23).

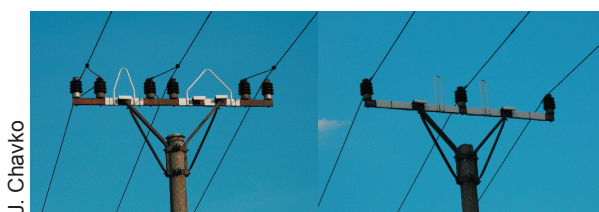


Fig. 23. Insulators on single-hanger (on the right) and on double-hanger (on the left).

Obr. 23. Ekochráničky na jednozávesnej konštrukcii (vpravo) a na dvojzávesnej konštrukcii (vľavo).

Discussion

Approximately in the same period, a similar phenomenon of population resettling was observed in the territory of eastern Slovakia, with a population of about 10–12 nesting pairs. Between 2007 and 2010 (but probably even before) all of the pairs nested in agrocoenoses in nest boxes on electricity pylons. Similarly as in western Slovakia, pairs previously nesting in the mountains resettled to agrocoenoses. Some of them nesting on rocks were displaced by peregrine falcon (Olekšák in verb., Danko et al. 2010).

Population resettlement has also been recorded in the neighbouring territory of the Czech Republic. Sakers have left the floodplain forests around the confluence of the Morava and Dyje Rivers, known as a nesting area since the mid-1990s. At the same time the population spread

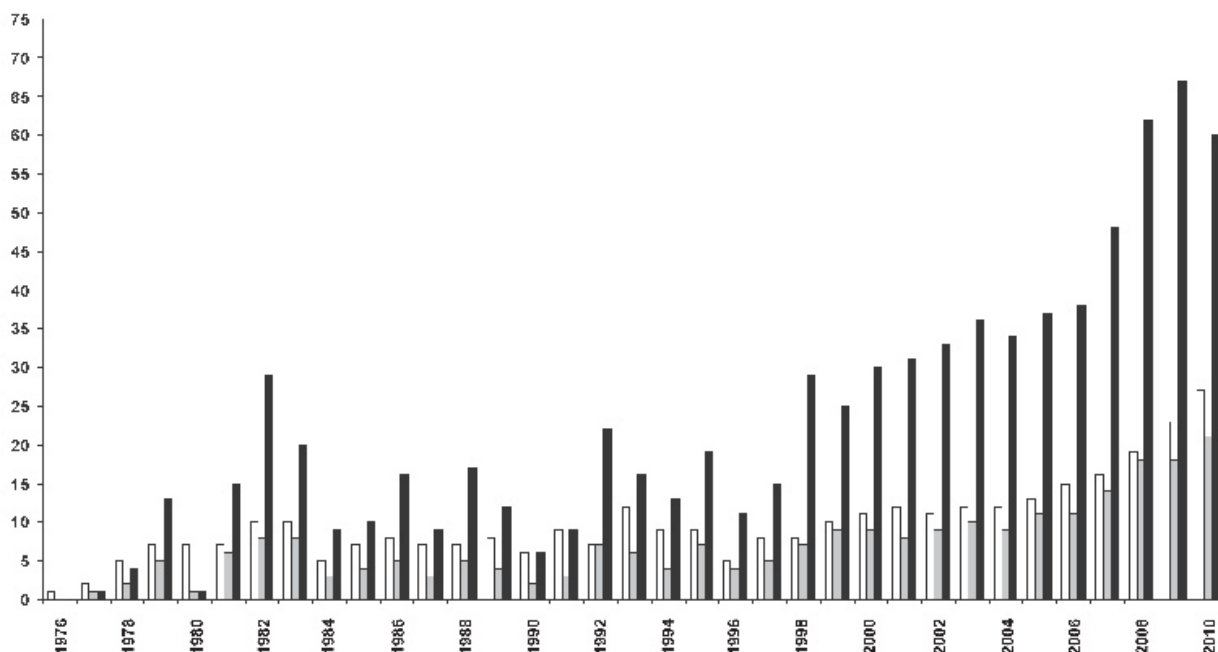


Fig. 26. Number of breeding attempts (all breeding attempts – white columns, successful breeding attempts – grey columns) and number of fledglings (black columns) of 47 saker falcon pairs in the period between 1976 and 2010 (n = 797 fledglings).

Obr. 26. Počet hniezdení (všetky hniezdenia – biele stĺpce, úspešné hniezdenia – sivé stĺpce) a počet vyvedených mláďat (čierné stĺpce) 47 párov sokolov ráhrov v období 1976–2010 (n = 797 mláďat).

westwards to agrocoenoses and the number of nesting pairs increased from five to 15 pairs. Analogously the pairs started using nesting platforms installed on electricity pylons (Horák 2000, Beran et al. 2010). It is also very interesting that sakers started nesting in the floodplain forests around the confluence of the Morava and Dyje Rivers after 1998 again, and 2–5 pairs have nested here every year since then (Beran et al. 2009). It is also quite remarkable that while sakers were resettling in Slovakia, they re-occupied their natural nesting sites in the Czech Republic after 1998.

Similarly sakers also started nesting in agrocoenoses more often in the above-mentioned period in Hungary as well (Bagyura et al. 2004).

The stability and trend in the population in Slovakia are mostly dependent on the favourable status of the numerous population of Hungary, with 216 known occupied territories (Bagyura et al. 2009). According to the occurrence of sakers with Hungarian rings it can be supposed that the Slovak population is supported mostly by the Hungarian population. Three records are especially important. On December 23, 1997 a female with an injured wing was found near Bratislava. She had been ringed on May 24, 1992 by Tamás Szitta near Tarnalelesz in Heves

County of Hungary as a chick in a nest 229 km away. On April 3, 2005 a dead female was found near Bratislava, known from the pair nesting on a pylon for several years. She had been ringed on May 13, 1995 near Sarud in Heves County in Hungary as a chick in a nest 280 km away. On March 19, 2009 a poisoned male was found near Trnava. The male had previously been observed with a female near a nest box on a pylon, and according to the ring he had been ringed by Miklós Váczi on May 10, 2007 near Hegyeshalom village in the Győr-Moson-Sopron County of Hungary as a chick in a nest 71 km away.

Some aspects indicate that this resettlement of the population, when some areas were abandoned by sakers and new nesting sites are being occupied, has been a continuous, gradual and logical process. Similar to the red-footed falcon (*Falco vespertinus*) nesting in colonies with a small dispersal of nests, the saker population nests analogously in a common space, but with higher dispersal of nests. The area of defended home ranges is the factor determining the distance between nests, which is usually about the distance of mutual visual contact. The nesting population is therefore probably mutually connected in this way. Nesting by pairs in isolated locations at a greater

distance from the centre of the population has only rarely been recorded. Only two cases like this have been recorded in western Slovakia. One pair nested in the mountains between 1982 and 1994, and the other between 2005 and 2006 in agrocoenosis (Figs 1, 2). According to the results the nesting population distribution is being influenced by natural as well as artificial nesting opportunities in relation to prey availability.

Management measures can be considered as one of the most effective tools for improving the favourable status of the saker falcon in current conditions. Results gained during the last few years more or less prove that the saker nesting population could not possibly be saved in its westernmost area of distribution without suitable management measures. We have to accept the fact that at present the saker can only survive at artificial man-made nesting sites, otherwise it would become extinct as a breeder. The population in Slovakia is to a certain degree also influencing the stability of small populations in the Czech Republic and Austria.

Reproduction dynamics of the population

Between 1976 and 2010 the reproduction dynamics of 47 pairs was studied. The average success was 2.3 fledglings/all breeding attempts ($n = 345$, Tab. 2) and 3.2 fledglings/successful breeding attempt ($n = 247$, Tab. 2).

From the total 345 known nesting events, data about number of laid eggs were obtained in 332 cases. From the total number of eggs laid and fledglings found alive or dead, a typical clutch size was calculated. In 332 nesting events at least 1226 eggs were laid, but only 797 juveniles fledged successfully. So the losses were at least 429 fledglings, which is 35% of the total number of eggs laid (Tab. 2).

It can be assumed that the identified losses were underestimated, because some of the nests were checked later in the period of raising fledglings, and therefore a number of eggs could previously have been lost. There is also a possibility that some fledglings which died before the first inspection were not recorded. Cases when the female was incubating the clutch and later the nest was robbed are also questionable because of the unknown number of eggs. For these reasons it can be assumed that the total number of eggs laid and the losses could have been higher compared to the results presented (Tab. 2).

When comparing nesting success (Figs 24, 25, 27, 28), the results indicate relatively large individual differences between pairs (Appendix 4). The results were most likely influenced by different feeding opportunities

and quality of nests, but probably also by biological individuality of the birds. Pair no. 10 can be considered as most successful, nesting without losses 6 times in the Malé Karpaty Mts and 12 times in the Trnavská pahorkatina Uplands, raising altogether 71 fledglings with an average breeding success of 3.9 fledglings/all breeding attempts. Pair no. 17 was also highly successful, nesting without losses 15 times in the Borská nížina Lowlands, raising altogether 51 fledglings (3.4 fledglings/all breeding attempts). Another successful pair was no. 30, nesting 8 times on the Podunajská rovina Plain, with seven successful breeding attempts, raising altogether 32 fledglings, which means four fledglings on average for all breeding attempts and 4.6 fledglings for successful breeding attempts. The highest number of nesting events was recorded by pair no. 5, nesting 24 times in the Malé Karpaty Mts and 6 times in the Trnavská pahorkatina Uplands, with 22 successful breeding attempts, raising 68 fledglings, representing average breeding success of 2.3 fledglings for all breeding attempts and 3.1 fledglings for successful breeding attempts. Pair no. 8 nested 24 times in the Malé Karpaty Mts and 2 times on the Podunajská rovina Plain, with 16 successful breeding attempts, raising altogether 58 fledglings, representing average success of 2.2 fledglings for all breeding attempts and 3.6 fledglings for successful breeding attempts. The third pair with a high number of recorded nesting events was pair no. 2, nesting 23 times in the Malé Karpaty Mts, with 14 successful breeding attempts, raising altogether 45 fledglings, which represents average success of two fledglings for all breeding attempts and 3.2 fledglings for successful breeding attempts. During the evaluation process it was necessary to consider primarily the results from the long-term nesting of the pairs (Appendix 4).

Until 1997 the numbers of fledglings raised fluctuated approximately at the same level. With the exception of the extremely successful year 1982 it never exceeded 22 fledglings raised in one year. After 1998 the numbers started rising more significantly with 29 fledglings raised in one year. This was related to the increasing number of pairs nesting in nest boxes on electricity pylons. The highest number of fledglings raised in one year during the whole study period was recorded in 2009. All of the pairs were already nesting on electricity pylons, and raised 67 fledglings. In the next year 2010 the average breeding success was much lower, most probably because of the extreme weather conditions, mostly the frequent heavy rain (Fig. 26). According to Hungarian ornithologists the same situation was recorded in that country, and for the same reasons (Bagyura in verb.).

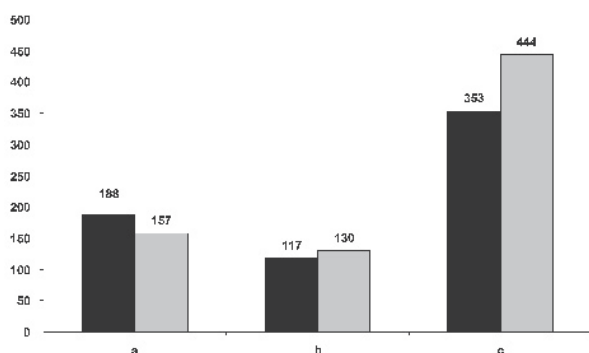


Fig. 27. Breeding success according to the number of fledglings in mountains / floodplain forests (black columns) and agrocoenoses (grey columns) in the period between 1976 and 2010. a – all breeding attempts, b – successful breeding attempts, c – number of fledglings.

Obr. 27. Porovnanie počtu vyletených mláďat v pohoriach / lužných lesoch (čierne stĺpce) a v agrocenózach (sivé stĺpce) v období 1976–2010. a – počet všetkých hniezdení, b – počet úspešných hniezdení, c – počet mláďat.

In the area occupied for the longest time, in Malé Karpaty Mts, 265 fledglings were raised between 1976 and 2008. In the agrocoenoses of the Trnavská pahorkatina Uplands, 212 fledglings were raised between 1997 and 2010. In agrocoenoses and floodplain forests of the Podunajská rovina Plain, 159 fledglings were raised between 1988 and 2010. In the agrocoenoses and floodplain forests of the Morava River in the Borská nížina Lowlands, 79 fledglings were raised between 1988 and 2010. In the agrocoenoses of the Nitrianska pahorkatina Uplands, 37 fledglings were raised between 2002 and 2010. In the Strážovské vrchy Mts 23 fledglings were raised between 1982 and 1994. In the Burda Mts 17 fledglings were raised between 1992 and 2001. In the floodplain forests of the Dolnomoravský úval Lowlands, three fledglings were raised in 1993. In the agrocoenoses of the Ipeľská pahorkatina Uplands, two fledglings were raised in 2005.

The most successful were pairs on the Podunajská rovina Plain, then in the Trnavská pahorkatina Uplands, Nitrianska pahorkatina Uplands, Strážovské vrchy Mts, Borská nížina Lowlands, Burda Mts, the Malé Karpaty Mts, and with only a few nesting events the Dolnomoravský úval Lowlands and the Ipeľská pahorkatina Uplands (Appendix 3).

Based on the evaluation of 247 nesting events, the highest breeding success was recorded by 116 nesting events in nest boxes on electricity pylons.

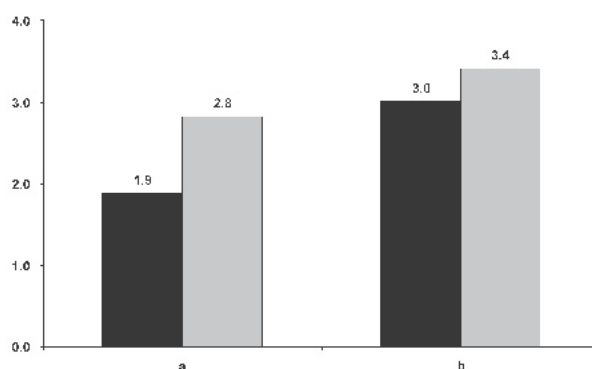


Fig. 28. Breeding success of saker falcon pairs in mountains / floodplain forests (black columns) and agrocoenoses (grey columns) in the period between 1976 and 2010. Average number of fledglings per nest: a – all breeding attempts, b – successful breeding attempts.

Obr. 28. Hniezdna úspešnosť párov hniezdiacich v pohoriach / lužných lesoch (čierne stĺpce) a v agrocenózach (sivé stĺpce) v období 1976–2010. Priemerný počet mláďat na hniezdo: a – všetky hniezdenia, b – úspešné hniezdenia.

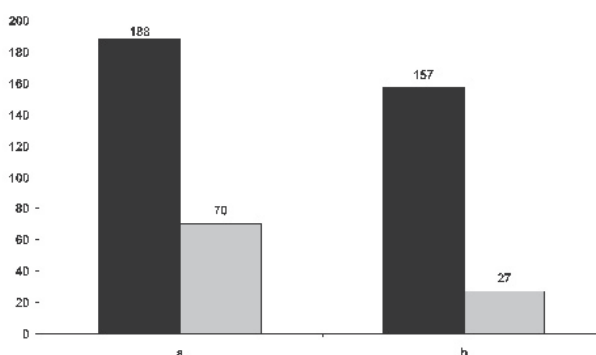


Fig. 29. Number of successful (black columns) and unsuccessful (grey columns) breeding attempts in mountains/floodplain forests (a) and agrocoenoses (b) in the period between 1976 and 2010.

Obr. 29. Počet úspešných (čierne stĺpce) a neúspešných (sivé stĺpce) hniezdení párov sokolov rárohov v pohoriach / lužných lesoch (a) a v agrocenózach (b) za obdobie rokov 1976–2010.

From the most important results the breeding success in nest boxes on pylons (4×1, 20×2, 27×3, 37×4 and 27×5 fledglings) can be compared with breeding success on trees (7×1, 20×2, 21×3, 15×4 and only 2×5 fledglings).

When comparing the numbers of cases with different breeding success on trees and pylons (nest boxes, natural and artificial nests), the numbers tend more positively towards nesting on pylons (Appendix 2).

During the whole period just three cases of laying six eggs were recorded, but only in one case the pair raised

all six fledglings in a natural way in a nest box on a tree in the Malé Karpaty Mts (Appendices 1, 2).

Breeding success in different types of nests is presented in Appendix 2.

Pairs nesting in agrocoenoses raised more fledglings than pairs nesting in mountains and floodplain forests (Fig. 27). When comparing the number of unsuccessful breeding attempts of pairs nesting in mountains and floodplain forests and pairs nesting in agrocoenoses, this number is much lower for pairs nesting in agrocoenoses (Fig. 29).

Appraisal and conclusions

1. Knowledge about complete resettlement of the population from mountains and floodplain forests to agrocoenoses was acquired (Fig. 3).
2. Growth of the population in the last decade as well as increase in the average breeding success were recorded only after the installation of nest boxes on electricity pylons in agrocoenoses. With these measures, suitable conditions for the communication of Slovak and Hungarian nesting populations were created.
3. The results gained in the last few years more or less prove that without proper management the saker nesting population could not be conserved in its westernmost area of distribution.
4. The number of nesting pairs has increased 145% and the saker nesting area has increased approximately three-fold in western Slovakia.
5. Intensive land use not respecting nature conservation, nest robberies, together with illegal shooting and poisoning can be considered the most serious human influences endangering the saker population. Due to human influences the original natural nesting habitats as well as feeding territories have been lost.
6. The saker belongs among the most adaptable species of birds of prey. During the study period the pairs used eight types of nests: natural nests on trees, artificial nests on trees, nest boxes on trees, natural nests on pylons, artificial nests on pylons, nest boxes on pylons, natural nests on rocks and artificial nests on rocks.
7. During the studied period several changes in prey composition were recorded. The sakers have adapted to the loss of their dominant prey (susliks) and started using other food sources.
8. During the 35-year study period the average recorded breeding success was 2.3 fledglings for all breeding attempts and 3.2 fledglings for successful breeding attempts. Altogether 345 nesting events were recorded,

with 247 successful breeding attempts producing 797 fledglings.

9. Pairs nesting in natural conditions in mountains and floodplain forests nested notably less successfully than the pairs nesting in agrocoenoses. This can be explained by the lower impact of negative effects of human as well as natural processes in agrocoenoses. Besides this, the advantage of nesting in agrocoenoses is lower energy consumption during hunting due to better availability of food.

Special attention was paid to evaluating the effect of human activities on the saker population. Changes in habitats, without respecting environmental aspects, were evaluated as the most important negative factors. The same trend can still be observed at the present time, when commercial interests are given priority over nature conservation. The degradation of the two most important saker nesting sites during the last 25–30 years due to human activities is an important fact. The conditions are no longer suitable there for successful breeding.

According to the results of this 35-year study, human influences caused 54.6% of losses during nesting. As revealed in the analysis of the direct reasons for losses, nest robberies can be considered to have the highest negative impact. Nest robberies for trade and breeding are a serious problem in the whole area of distribution of the species. Another very important problem lies in illegal activities such as shooting, poisoning and trapping in Slovakia as well as in many other countries. The legislation and policy measures in the EU countries cannot be considered as relevant or sufficient. Given the fact that the European saker population is endangered, it will be necessary to continue the conservation efforts by implementing suitable management practices within the area of distribution in all European countries. The current status with critically low numbers of nesting pairs represents a high level of vulnerability of the European population of the saker falcon.

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Appendices / Prílohy

Appendix 1. Results of breeding of 47 saker falcon pairs between 1976 and 2010 (n = 345 all breeding attempts)

Príloha 1. Výsledky hniezdenia 47 párov sokola rároha v období rokov 1976–2010 (n = 345 všetkých hniezdení)

year / rok	successful breeding / úspešné hniezdenia	unsuccessful breeding / neúspešné hniezdenia	number of fledglings frequency per nest / frekvencia počtu vyletených mláďat na hniezdo	number of fledglings / počet vyletených mláďat	average number of fledglings per nest / priemerný počet mláďat na hniezdo	
					all breeding attempts / všetky hniezdenia	successful breeding attempts / úspešné hniezdenia
1976	0	1	1×0	0	0.0	0.0
1977	1	1	1×0, 1×1	1	0.5	1.0
1978	2	3	3×0, 1×1, 1×3	4	0.8	2.0
1979	5	2	2×0, 3×2, 1×3, 1×4	13	1.9	2.6
1980	1	6	6×0, 1×1	1	0.1	1.0
1981	6	1	1×0, 3×2, 3×3	15	2.1	2.5
1982	8	2	2×0, 3×3, 5×4	29	2.9	3.6
1983	8	2	2×0, 2×1, 3×2, 3×4	20	2.0	2.5
1984	3	2	2×0, 1×2, 1×3, 1×4	9	1.8	3.0
1985	4	3	3×0, 2×2, 2×3	10	1.4	2.5
1986	5	3	3×0, 4×3, 1×4	16	2.0	3.2
1987	3	4	4×0, 1×2, 1×3, 1×4	9	1.3	3.0
1988	5	2	2×0, 1×2, 2×3, 1×4, 1×5	17	2.4	3.4
1989	4	3	3×0, 2×2, 2×4	12	1.7	3.0
1990	2	4	4×0, 2×3	6	1.0	3.0
1991	3	6	6×0, 3×3	9	1.0	3.0
1992	7	0	1×1, 1×2, 2×3, 2×4, 1×5	22	3.1	3.1
1993	6	6	6×0, 2×1, 3×3, 1×5	16	1.3	2.7
1994	4	6	6×0, 1×1, 1×3, 1×4, 1×5	13	1.3	3.3
1995	7	2	2×0, 3×2, 3×3, 1×4	19	2.1	2.7
1996	4	1	1×0, 2×2, 1×3, 1×4	11	2.2	2.8
1997	5	3	3×0, 1×1, 2×3, 2×4	15	1.9	3.0
1998	7	1	1×0, 1×2, 1×3, 2×4, 2×5, 1×6	29	3.6	4.1
1999	9	1	1×0, 1×1, 3×2, 3×3, 1×4, 1×5	25	2.5	2.8
2000	9	2	2×0, 1×1, 1×2, 3×3, 2×4, 2×5	30	2.7	3.3
2001	8	4	4×0, 1×2, 1×3, 4×4, 2×5	31	2.6	3.9
2002	9	2	2×0, 3×2, 3×4, 3×5	33	3.0	3.7
2003	10	2	2×0, 1×2, 4×3, 3×4, 2×5	36	3.0	3.6
2004	9	3	3×0, 2×2, 1×3, 3×4, 3×5	34	2.8	3.8
2005	11	2	3×0, 1×1, 2×2, 2×3, 4×4, 2×5	37	2.8	3.4
2006	11	4	4×0, 2×1, 1×2, 2×3, 2×4, 4×5	38	2.5	3.5
2007	14	2	2×0, 3×2, 4×3, 5×4, 2×5	48	3.0	3.4
2008	18	1	1×0, 3×2, 6×3, 7×4, 2×5	62	3.3	3.4
2009	18	5	5×0, 1×1, 2×2, 2×3, 9×4, 4×5	67	2.9	3.7
2010	21	6	6×0, 4×1, 4×2, 5×3, 7×4, 1×5	60	2.2	2.9
Σ	247	98		797	2.3	3.2

Appendix 2. Number of cases according to the number of saker falcon fledglings in different types of nest in the period between 1976 and 2010
Príloha 2. Počty prípadov vyvedených mláďat sokola podľa rároha podľa typov hniezd v období 1976–2010

different types of nest / typ hniezda	all breeding attempts / všetky hniezdenia	successful breeding attempts / úspešné hniezdenia	number of chicks frequency per nest / frekvencia počtu vylетенých mláďat na hniezdo	Σ
nest box on a pylon / búdka na stožiar	136	115	21×0, 4×1, 20×2, 27×3, 37×4, 27×5	408
nest on a tree / hniezdo na strome	109	65	44×0, 7×1, 20×2, 21×3, 15×4, 2×5	180
artificial nest on a tree / umelé hniezdo na strome	29	21	8×0, 3×1, 5×2, 6×3, 5×4, 2×5	61
nest box on a tree / búdka na strome	28	16	12×0, 2×1, 9×3, 4×4, 1×6	51
artificial nest on a pylon / umelé hniezdo na stožiar	12	11	1×0, 2×1, 1×3, 6×4, 2×5	39
nest on a rock / hniezdo na skale	18	9	9×0, 2×1, 2×2, 1×3, 3×4, 1×5	26
nest on a pylon / hniezdo na stožiar	8	6	2×0, 1×1, 1×2, 2×3, 1×4, 1×5	18
artificial nest on a rock / umelé hniezdo na skale	5	8	1×0, 2×3, 2×4	14
Σ	345	247		797

Appendix 3. Breeding success in different orographic units between 1976 and 2010

Príloha 3. Úspešnosť hniezdenia v jednotlivých orografických celkoch v období 1976–2010

orographic unit / orografický celok	nesting period / obdobie hniezdenia	number of nesting attempts / počet hniezdení	successful breeding / úspešné hniezdenia	number of fledglings / počet mláďat	average number of fledglings per nest / priemerný počet mláďat na hniezdo
Malé Karpaty Mts	1976–2008	157	100	265	1.7
Trnavská pahorkatina Uplands	1997–2010	69	56	212	3.1
Podunajská rovina Plain	1988–2010	49	40	159	3.2
Borská nížina Lowlands	1988–2010	36	25	79	2.2
Nitrianská pahorkatina Uplands	2002–2010	13	11	37	2.8
Strážovské vrchy Mts	1982–1993	9	7	23	2.5
Burda Mts	1992–2001	8	6	17	2.1
Dolnomoravský úval Lowlands	1993 and 2009	2	1	3	1.5
Ipeľská pahorkatina Uplands	2005 and 2006	2	1	2	1.0
Σ		345	247	797	2.3
					3.2

Appendix 4. Results of breeding of 47 individual saker falcon pairs between 1976 and 2010 (ba – breeding attempt)
Príloha 4. Výsledky hniezdzenia 47 individuálnych párov sokola ráhoňa v období rokov 1976–2010 (ba – hniezdenie)

pair no. / č. páru	nesting period / hniezdné obdobie	orographic unit / oroграфický celok	number of breeding attempts / počet hniezení	successful breeding attempts / úspesné hniezdenia	fledglings / vylетенé mláďatá	average number of fledglings per nest / priemerný počet mláďat na hniezdo	
						all breeding	successful
1	1976–1990, 1993	Malé Karpaty Mts, 12 ba until 1985 Podunajská rovina Plain, 4 ba since 1988	16	7	17	1.1	2.4
2	1977–1980, 1982, 1983, 1985–1991, 1994, 1995, 2003–2010	Malé Karpaty Mts, 23 ba	23	14	45	2.0	3.2
3	1978, 1979, 1981, 1982, 1991	Malé Karpaty Mts	5	3	8	1.6	2.7
4	1978–1981	Malé Karpaty Mts	4	0	0	0.0	0.0
5	1978–1996, 1998–2002, 2004–2006, 2008–2010	Malé Karpaty Mts, 24 ba until 2002 Trnavská pahorkatina Uplands, 6 ba since 2004	30	22	68	2.3	3.1
6	1979–1984, 1988, 1989, 1991–2000	Malé Karpaty Mts	18	11	33	1.8	3.0
7	1979, 1981–1983, 1985–1991, 1993–1995	Malé Karpaty Mts	14	9	22	1.6	2.4
8	1980, 1982–1990, 1994, 1995, 1997–2010	Malé Karpaty Mts, 24 ba until 2008 Podunajská rovina Plain, 2 ba since 2009	26	16	58	2.2	3.6
9	1980, 1983, 1984, 1986, 1991–1995, 1997–2002, 2006, 2007	Malé Karpaty Mts	17	11	28	1.6	2.5
10	1981–1983, 1990, 1997–2010	Malé Karpaty Mts, 6 ba until 1999 Trnavská pahorkatina Uplands, 12 ba since 2000	18	18	71	3.9	3.9
11	1982, 1983, 1985–1987, 1989, 2000–2003	Malé Karpaty Mts	10	7	20	2.0	2.9
12	1992–1994, 1996–2001	Burda Mts	9	6	17	1.9	2.8
13	1982, 1983, 1985–1987, 1991–1994	Strážovské vrchy Mts	9	7	23	2.6	3.3
14	1991, 1993, 1998–2001	Borská nížina Lowlands	6	1	2	0.3	2.0
15	1991–1995	Borská nížina Lowlands	5	3	10	2.0	3.3
16	1992, 1993, 1997	Borská nížina Lowlands	3	2	3	1.0	1.5
17	1998, 1993, 1995–2007	Borská nížina Lowlands	15	15	51	3.4	3.4
18	1993	Dolnomoravský úval Lowlands	1	1	3	3.0	3.0
19	1994–1997	Podunajská rovina Plain	4	3	7	1.8	2.3
20	1999–2010	Trnavská pahorkatina Uplands	12	12	46	3.8	3.8
21	1999–2010	Podunajská rovina Plain	12	10	33	2.8	3.3
22	2001–2004, 2006–2010	Podunajská rovina Plain	9	9	32	3.6	3.6
23	2001, 2010	Trnavská pahorkatina Uplands	2	2	4	2.0	2.0

Appendix 4. continuation
Príloha 4. pokračovanie

pair no. / č. páru	nesting period / hniezdné obdobie	orographic unit / oroграфický celok	number of breeding attempts / počet hniezdení	successful breeding attempts / úspešné hniezdenia	fledglings / vylatené mláďatá	average number of fledglings per nest / priemerný počet mláďat na hniezdo	
						all breeding attempts / všetky hniezdenia	successful breeding attempts / úspešné hniezdenia
24	2002, 2003, 2006–2010	Trnavská pahorkatina Uplands	7	7	25	3.6	3.6
25	2002, 2007–2010	Nitrianská pahorkatina Uplands	5	4	13	2.6	3.3
26	2003, 2005, 2008	Podunajská rovina Plain	3	3	8	2.7	2.7
27	2003–2010	Trnavská pahorkatina Uplands	7	4	9	1.3	2.3
28	2004, 2005, 2007–2009	Trnavská pahorkatina Uplands	5	3	13	2.6	4.3
29	2004, 2008–2010	Nitrianská pahorkatina Uplands	4	3	12	3.0	4.0
30	2003–2010	Podunajská rovina Plain	8	7	32	4.0	4.6
31	2005–2010	Trnavská pahorkatina Uplands	6	6	16	2.7	2.7
32	2005, 2006	Ipľská pahorkatina Uplands	2	1	2	1.0	2.0
33	2005, 2006	Trnavská pahorkatina Uplands	2	0	0	0.0	0.0
34	2008–2010	Trnavská pahorkatina Uplands	3	3	13	4.3	4.3
35	2007–2010	Borská nížina Lowlands	4	3	9	2.3	3.0
36	2007–2010	Nitrianská pahorkatina Uplands	4	4	12	3.0	3.0
37	2008–2010	Podunajská rovina Plain	3	3	9	3.0	3.0
38	2009, 2010	Trnavská pahorkatina Uplands	2	2	5	2.5	2.5
39	2009, 2010	Trnavská pahorkatina Uplands	2	1	4	2.0	4.0
40	2009, 2010	Trnavská pahorkatina Uplands	2	1	4	2.0	4.0
41	2009, 2010	Borská nížina Lowlands	2	1	4	2.0	4.0
42	2009	Dolnomoravský úval Lowlands	1	0	0	0.0	0.0
43	2010	Podunajská rovina Plain	1	0	0	0.0	0.0
44	2010	Podunajská rovina Plain	1	1	2	2.0	2.0
45	2010	Podunajská rovina Plain	1	1	4	4.0	4.0
46	2010	Trnavská pahorkatina Uplands	1	0	0	0.0	0.0
47	2010	Borská nížina Lowlands	1	0	0	0.0	0.0
Σ			345	247	797	2.3	3.2