AQUILA

2012

AQUILA

MADÁRTANI FOLYÓIRAT

Elindította Herman Ottó a Magyar Ornithológiai Központ folyóirataként 1894-ben

VOL. 119

FŐSZERKESZTŐ — EDITOR-IN-CHIEF

MAGYAR GÁBOR

BUDAPEST, 2012

Kiadja a Vidékfejlesztési Minisztérium megbízásából a Kiskunsági Nemzeti Park Igazgatóság

ISSN 0374-5708
Felelős kiadó: Dr. Boros Emil
Készült: ADVEX Design Stúdió Kft.
Felelős vezető: Herbály László ügyvezető

Contents – Tartalomjegyzék

Conference on the conservation of the Saker Falcon *(Falco cherrug)* in Europe

Organised by the Bükk National Park Directorate together with its project partners in the framework of the LIFE06 NAT/H/000096 project "Conservation of the *Falco cherrug* in the Carpathian Basin"

Eger, Hungary

16–18 September, 2010

Aquila (2012), Vol. **119**, p. 9–19

Conservation of the Saker Falcon *(Falco cherrug)* and the use of hybrids for falconry

Andrew Dixon

International Wildlife Consultants UK Ltd.

ABSTRACT—This paper discusses two mutually incompatible activities for the conservation of wild Saker Falcons. One action already being undertaken is to promote the use of captive-bred falcons instead of wild-sourced Saker Falcons in Arabic falconry. The promotion of captive-bred falcons depends largely on the production of hybrid falcons in order to overcome the negative aspects of captive-bred birds, which require longer more intensive training and expensive, time-consuming production effort. A second activity is the lobbying to ban the production of hybrid falcons in the European Union and beyond, in order to minimise a perceived risk of extinction of the Saker Falcon through genetic introgression caused by escaped falconry birds. In this paper I appraise the potential costs and benefits for global Saker Falcon conservation of these two mutually incompatible activities.

Keywords: Falcon, *Falco*, hybrid introgression, captive-breeding, falconry, wildlife trade

Correspondence: *Andrew Dixon*, International Wildlife Consultants UK Ltd, PO Box 19, Carmarthen, SA33 5YL, UK; E-mail: falco@falcons.co.uk

Introduction

The Saker Falcon *Falco cherrug* is a large falcon within the subgenus *Hierofalco*, which also includes the Gyrfalcon *F. rusticolus*, Lanner Falcon *F. biarmicus* and Lagger Falcon *F. jugger (Kleinschmidt, 1901; Nittinger et al., 2005).* The breeding distributions of these four closely-related taxa are largely allopatric, with Saker and Lanner being sympatric in Turkey and parapatric in the Balkan Peninsula, whilst there are possibly sympatric or parapatric breeding populations of Saker and Lagger in Northwest Pakistan and Afghanistan *(Ferguson-Lees and Christie, 2001; Nittinger et al., 2005).* All four taxa have sympatric breeding populations with either peregrine *F. peregrinus* or Barbary Falcons *F. pelegrinoides* and instances of natural hybrid pairs have been reported between Saker × Barbary Falcon (Angelov *et al*., 2006), Saker × Lanner *(Boev & Dimitrov, 1995),* Saker × Peregrine, Lanner × Peregrine, Peregrine × Gyrfalcon and Peregrine × Barbary Falcon *(McCarthy, 2006).* Morphologically the Saker Falcon cannot be clearly defined and shares overlapping phenotypic characteristics with Gyrfalcon especially *(Eastham et al., 2001),* though preliminary data suggest genetic distinctiveness of these two taxa *(Dawnay et al., 2008).* Taxonomic authorities differ in their opinion as to whether or not the Barbary Falcon is best regarded as a distinct species (with two subspecies: *Falco pelegrinoides pelegrinoides* and *F. pelegrinoides babylonicus*) or as a subspecies of the Peregrine Falcon (*Falco peregrinus pelegrinoides* and *F. peregrinus babylonicus*; see *Rodríguez et al., 2011* for a recent review).

Saker Falcons are currently classified as Endangered on the IUCN Red List of Threatened Species on the basis of a rapid population decline, particularly in Central Asia, primar-

ily as a result of excessive trapping for the falconry trade, as well as habitat degradation and poisoning *(IUCN, 2008)*. Electrocution on power lines, persecution and prey loss are further factors impacting on Saker Falcon conservation *(Gombobaatar et al., 2004; Levin, 2008; Chien and Smith, 2003)*. Intensive conservation effort in central Europe has seen a gradual increase in the Saker population of the Panonnian Basin mainly in Hungary, Slovakia and Serbia *(Bagyura et al., 2004)*. In eastern Europe and across Asia there are few accurate population estimates available to determine population trends in the early years of the 21st Century but there has been a marked decline in European Russia and evidence of a decline in the main population centre of central Siberia *(Karyakin, 2008)*. Significant breeding populations, each holding over 2,000 breeding pairs, also occur in Kazakhstan, China and Mongolia *(Dixon, 2009)*.

Additionally, there is a perceived conservation threat from hybridisation with escaped, captive-bred falconry hybrids, which could influence the genetic integrity of wild populations (BirdLife International, 2008a). In response, BirdLife International is calling for a ban on the production and keeping of hybrid falcons in the European Union and beyond *(BirdLife International, 2008b)*.

Active measures to promote Saker Falcon conservation include the use of captive-bred falcons as a means of substituting for wild-taken birds in falconry *(BirdLife International, 2008a)*. *The* importation of wild-caught Saker Falcons is prohibited across the European Union and the unlicensed taking of the species is prohibited by national laws in all of the Saker breeding range countries. The Saker is included within Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Among the Arabic falconry nations, the United Arab Emirates has banned the import and use of wild-taken falcons that do not have accompanying CITES documentation *(Perry, 2005)* and have instead met the demand for falconry birds primarily through captive-breeding. Captive-bred falcons are used, though to a much lesser extent, in the other major Arabic falconry nations of Kuwait, Qatar, Saudi Arabia and Bahrain.

Captive-bred falcons are generally more manageable than wild birds for falconry but require more effort and time in fitness training for hunting, and are expensive and time-consuming to produce. Among those falconers using captive-bred falcons, hybrids are commonly used in Europe, particularly for bird pest control, and by Arabic falconers, who frequently hunt with these birds outside the Middle East in North Africa and Central Asia. Typically, but not exclusively, these hybrids consist of hierofalcon taxa (especially Saker and Gyrfalcon) crossed with Peregrines or Barbary Falcons; these can be first generation crosses or later generation back-crosses that involve two, or sometimes more, different taxa. Hybrid falcons exhibit a combination of the phenotypic and behavioural attributes of their constituent taxa. Falconers use hybrids because these combined attributes are preferred (for reasons of suitability for purpose, husbandry and aesthetics) to the pure taxa. The attributes of hybrid falcons have been particularly important for promoting the use of captive-bred falcons in Arabic falconry.

This paper examines the issues surrounding the conflicting measures for Saker Falcon conservation of (i) promoting the use of captive-bred falcons through the use of hybrid falcons in Arabic falconry, in order to reduce the market demand for wild-taken Sakers and

(ii) attempting to ban the production and use of hybrid falcons, in order to remove the risk of genetic extinction of wild Sakers through introgression.

Escaped falconry hybrids and genetic introgression risk

Observations of hybridisation events involving wild-breeding Saker Falcons

Data on reported cases of hybrid breeding events involving Saker Falcons in the wild has been collated by *BirdLife International (2008b),* the International Association of Falconry (*C. de Coune* in litt., 2008), International Wildlife Consultants (UK) Ltd and through the European *Falco cherrug* Conservation Taskforce's (EFcCT) mailing list (Table 1).

In Slovakia there are dated records for eight instances of hybrid matings or suspected hybrid falcons breeding with Sakers in the period 1999–2003. With a Slovakian breeding population of 20-25 pairs in the period 1999–2003 *(Nagy & Demeter, 2006)* these 8 hybrid breeding events amount to 6.4–8.0% of the potential nesting opportunities over this five-year period.

BirdLife International (2008b) reported that the 2003 case in Slovakia related to a Peregrine × Saker hybrid, whereas *Michel Adamec* (EFcCT mailing list, 15 November 2007) reported that this case involved a Peregrine and a Saker or hybrid (from observation). Given that the DNA analysis apparently proved the offspring to be a 50:50 Saker × Peregrine hybrid, neither of the parents could have been a hybrid. *BirdLife International (2008b)* reported that the 1999 case in Slovakia involved a Peregrine × Saker hybrid, but this case related to a bigamous trio between a male Peregrine and a female Peregrine and female Saker (*J. Mihok,* EFcCT mailing list 25 November 2008). Four eggs were laid, it was not known whether one or both females laid these eggs, but both females shared incubation and chick feeding duties. Hybridisation was inferred in the 2002 case from Slovakia because two chicks were observed to have yellow legs. However, it is difficult to see how this could be the result of a hybrid pairing as back-crossed F2 generation chicks of hierofalcon hybrids have blue-grey legs, which are typical of hierofalcon species (*M. Patterson* pers. comm., 2008).

In Hungary there is a single reported case of a hybrid falcon breeding with a Saker in the wild, whilst the remaining reported cases all refer to natural hybridisation events. Two museum specimens, on the basis of plumage characteristics, were considered by *Boev & Dimitrov (1995)* to be the result of a natural hybrid pairings between Saker and Lanner Falcon, though genetic analysis of the 1884 male bird did not support the idea that this was a hybrid *(Nittinger et al., 2007).* A case in China involved a female Barbary Falcon, occupying a territory outside the known breeding range of this species, which was apparently paired with a male Saker Falcon; the pair occupied a nest with four eggs but incubation was never observed and the eggs were deserted and subsequently predated *(Angelov et al., 2006).*

Case No.	Hybrid Mate	Country	Year	Evidence/Observations	Outcome
1a	Peregrine ♂	Slovakia	1999	♀ Saker in bigamous trio with ♂ and ♀ Peregrines. 4 chicks, two had hybrid appearance	fledged
1b	Peregrine ♂	Slovakia	2000–2002	sterile eggs	failed
1c	Peregrine ♂	Slovakia	2003	one young proved by DNA analysis to be 50:50 Saker × Peregrine hybrid	chick removed
2	Hybrid ♂	Slovakia	2000–2001	observation of hybrid male	?
3	Peregrine or Hybrid	Slovakia	2002	observation of two chicks with yellow legs	fledged?
4	Hybrid ♂	Hungary	2000	hybrid observed and video-recorded; single chick ringed	fledged
5	Barbary Falcon ♀	China	2006	observation of pair at nest with eggs	failed
6	Lanner Falcon	Bulgaria	1987	hybridisation inferred from ♀ museum specimen	fledged
7	Lanner Falcon	Bulgaria	1884	hybridisation inferred from ♂ museum specimen	fledged

Table 1. Records of reported hybrid breeding events involving Saker falcons in the wild. References: 1a: Mihok, J. (EFcCT Mailing List, 2008); 1b: Kenward & Larsson (2007); 1c: Adamec, M. (EFcCT Mailing List, 2007); 2-3: Kenward & Larsson (2007); 4: M. Prommer (BirdLife Hungary); 5: Angelov et al. (2006); 6-7: Boev & Dimitrov (1995). Cases 1a-c refer to the same breeding site in the Slovak Karst National Park over the period 1999–2003

Genetic evidence of introgression in wild Saker Falcon populations

Researchers at the Museum of Natural History Vienna have undertaken a phylogenetic analysis of the hierofalcons *(Nittinger et al., 2005)* and have examined the influence of hybridisation on the genetic structure of Saker Falcon populations *(Nittinger et al., 2007).* Earlier publications arising from this work claimed that gene flow from escaped hybrid falcons has had a great impact on the gene pool of wild Saker Falcon populations in Europe *(Nittinger, 2004; Nittinger et al., 2004; 2006).* However, these claims were not repeated in two peer-reviewed publications arising from the same study *(Nittinger et al., 2005; 2007).* The original claim was based on mitochondrial and microsatellite DNA analyses, specifically the presence of a mitochondrial haplotype in a sample of contemporary European Saker Falcons but not in a historical sample from the same geographical region, and a low degree of differentiation between Saker Falcon and Gyrfalcons at seven microsatellite loci *(Nittinger et al., 2006).* The mitochondrial haplotype was common to all four hierofalcon species and was more frequent in eastern populations (southern Kazakhstan and Mongolia) than western populations of Saker Falcons (Europe and northern Kazakhstan). The presence of shared haplotypes in all four hierofalcon species could be the result of incomplete lineage assortment from a common ancestor and/or ancient hybridisation associated with range changes and glaciation events *(Wink et al., 2005; Nittinger et al., 2005);* it certainly cannot be ascribed to escaped falconry hybrids. Difference in frequency of the haplotype between western and eastern populations of Saker Falcons could be the result of ancient hybridisation, mainly in eastern areas of the Saker distribution range *(Nittinger et al., 2005),* or contemporary gene flow between eastern and western Saker populations. The absence of this haplotype in historical samples may simply be an artefact of the small sample size (n = 15 individuals; *Nittinger et al., 2007*).

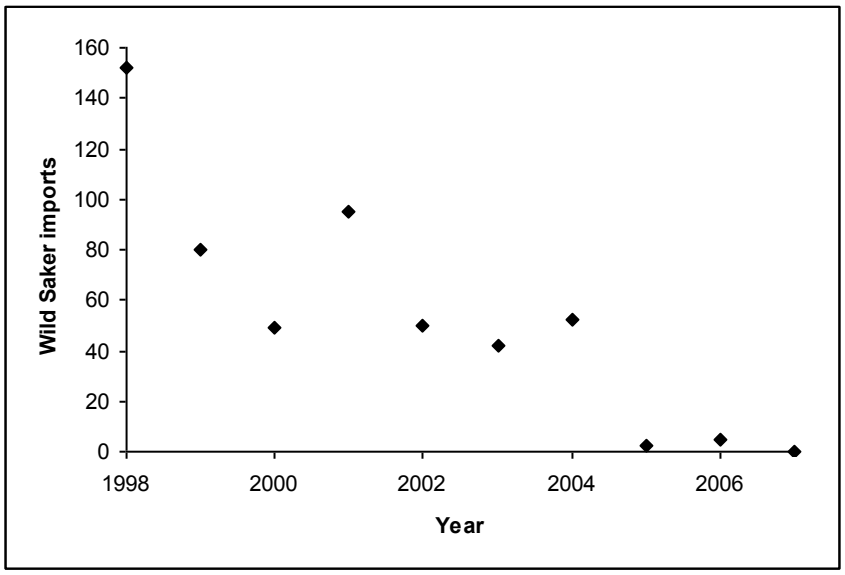


Figure 1. CITES trade data for the numbers of wild-sourced Saker Falcons imported into the UAE over the period 1998–2007

Hybrid falcons and the use of captive-bred birds in Arabic falconry

The use of captive-bred falcons in Arabic falconry

A previous analysis indicated that the number of Saker Falcons used for falconry in the United Arab Emirates (UAE) declined over the period 1993-98, whilst the use of captive-bred falcons increased *(Barton, 2000)*. In 2002, the UAE launched a CITES regulated falcon passport scheme in order to ensure that legal trade regulations were in place *(Perry, 2005)*. To qualify for a passport, falcons must be legally obtained/imported into the UAE and accompanied by all necessary permits. This process has promoted the use of captive-bred falcons in place of wild-caught falcons, which is reflected in the CITES import trade figures for wild-sourced Saker Falcons for the period 1998–2007 (Figure 1). CITES trade data reveals that in the five-year period 1998-2002, 426 wild-sourced Saker Falcons were imported into the UAE compared with just 101 for the period 2003-07. However, a decline in the importation of wild-sourced Sakers through CITES regulated trade can also be attributed to tighter restrictions imposed by export countries *(CITES, 2004)*. In this regard, a similar decline in the number of wild-sourced Sakers can be seen for Saudi Arabia where the use of captive-bred falcons is far less frequent than in the UAE (Table 2).

Since 2003, 57% of wild-sourced Saker Falcons entering the UAE have come from Mongolia, with the majority of the rest coming from Uzbekistan (13%; confiscated birds), Kuwait (11%) and Pakistan (10%). By comparison, Saudi Arabia has necessarily needed to

	UAE			Saudi Arabia		
	Captive-bred	Wild-sourced	% Captive-bred	Captive-bred	Wild-sourced	% Captive-bred
2003	549	42	92.9	124	783	13.7
2004	659	52	92.7	3	572	0.5
2005	346	2	99.4	2	152	1.3
2006	233	5	97.9	2	37	5.1
2007	105	0	100	0	60	0

Table 2. CITES trade data for the importation of Saker Falcons into the UAE and Saudi Arabia over the period 2003–2007

import wild Sakers Falcons from a larger number of exporting nations to meet their demand for wild-sourced birds. Since 2003, 31% of wild sourced Saker Falcons entering Saudi Arabia have come from Mongolia, with the majority of the rest coming from Russia (21%), Ukraine (8%), Kuwait (7%), Qatar (4%), Mali, Pakistan, Kazakhstan, Turkey (3% each), Syria, Morocco, Jordan, China and Iran (2% each).

The above relates only to CITES trade data, the accuracy of which cannot be verified and furthermore an unreported and illegal trade in Saker Falcons for Arabic falconry exists. In a situation with a limited CITES regulated trade in wild-sourced Sakers, the market demand for falcons can be met either by captive-bred birds or through an illegal, unregulated trade.

The use of captive-bred hybrid falcons in Arabic falconry

In addition to treating sick and injured birds, falcon hospitals in the Middle East frequently give health checks to falcons before they are purchased by prospective owners, consequently they can see many falcons that are available on the open market. Admission records from one falcon hospital illustrate how the proportion of Saker Falcons has declined over the period 2003–07, whilst the proportion of captive-bred hybrids has increased over the same period (Figure 2). Hybrid falcons have been a key driver in promoting the use of captive-bred falcons for falconry. All of the hybrids involved Gyrfalcons crosses, with Gyrfalcon × Peregrine and Gyrfalcon × Saker comprising 71% and 25% of the hybrids admitted respectively. Gyrfalcon hybrids have attributes that make them preferable to pure-species in that they are larger (cf. Peregrine and Saker), more suited to the climate of the Middle East (cf. Gyrfalcon) and can be bred to produce aesthetically pleasing plumage types.

Discussion

Direct observation of hybrid breeding events in populations of wild Saker Falcons are likely to be biased towards regions where a significant proportion of breeding pairs are frequently monitored, as in the Pannonian population of Central Europe. Identifying hybrid falcons can be problematic *(Gantlett & Millington, 1992)* and even when breeding pairs are

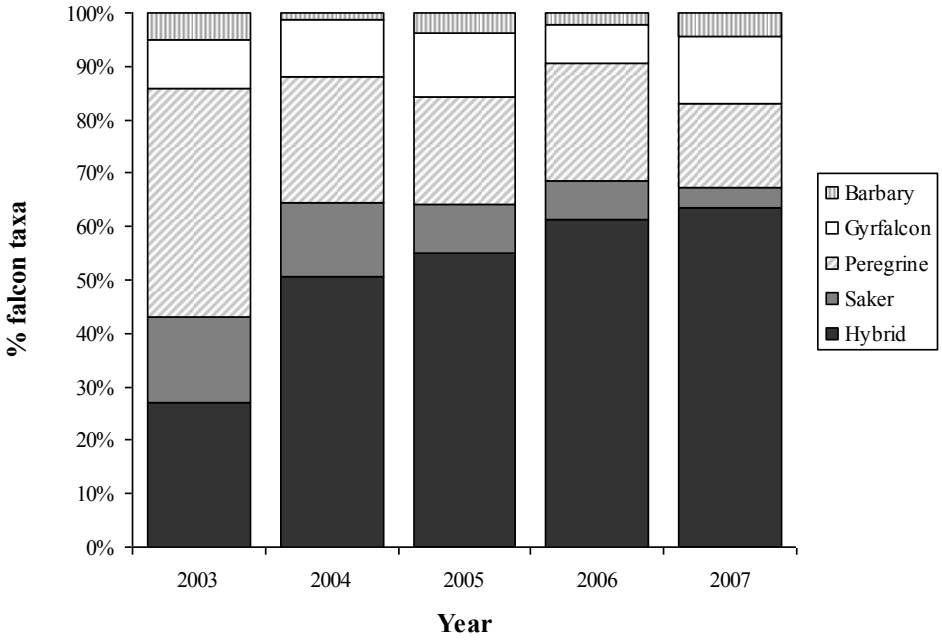


Figure 2. Proportions of five falcon taxa (hybrid, Saker Falcon, Peregrine, Gyrfalcon and Barbary Falcon) admitted to a falcon hospital over the period 2003–2007. The total number of falcons admitted annually was 1999, 454, 481, 513 and 364 from 2003–2007, respectively.

monitored, hybrid falcons could potentially be overlooked. Nevertheless, a disproportionate number of reported cases come from Slovakia in the years 1999-2003. This compares with a single recorded observation in the equally well-monitored population in neighbouring Hungary, where there was a breeding population of 130-150 pairs in the same time period *(Burfield & Bommel, 2004).* There is no evidence in any of the reported cases from Slovakia that escaped falconry birds were involved.

In Slovakia, from 1992–99, the State Nature Conservancy and Veterinary University fostered captive-bred Saker chicks into the nests of pairs in the wild as part of a population reinforcement effort *(Chavko & Adamec, 2003).* Close to the Slovakian border in the Czech Republic *ca*. 350 Peregrines and *ca*. 250 Saker Falcons were bred in captivity and released or fostered to nests as part of an official conservation effort for these species over the period 1990–2002 *(V. Beran* in litt., 2008). In several instances these releases involved fostering captive-bred Peregrine chicks into the nests of wild Sakers *(Horák, 2000).* Consequently, captive-bred Sakers and Peregrines were released to the wild which were either human imprints or else imprinted on the wrong parent species. The principal causes of hybridisation are early life imprinting which determines the future choice of mate and a shortage of

available mates of their own kind *(Hess, 1973: McCarthy, 2006);* both of which could explain the high frequency of hybrids reported in Slovakia. It is worth noting that several cases of hybrid falcons breeding with Peregrines in the wild have involved non parent-reared captive-bred Peregrines rather than wild bred individuals *(Fox, 2004).*

The frequency of reported hybrid events involving Saker Falcons in Slovakia is potentially skewed because of previous conservation management strategies which reduced behavioural barriers to hybridisation. In addition to natural behavioural barriers there are also fertility barriers in hybrid matings; females being the heterogametic sex are less fertile than males following Haldane's Rule *(Haldane, 1922).* Female hierofalcon × Peregrine hybrids are predominantly infertile in back-crosses with Peregrines and hierofalcon taxa; none are known to have been fertile in captivity (*M. Patterson,* pers. comm.), whilst hybrid males have reduced fertility resulting from a high frequency of spermatozoa deformities *(Kaltenpoth & Schulenburg, 1989).* Consequently, pairings involving escaped falconry hybrids are, in addition to being very infrequent, less likely to result in viable offspring than non-hybrid pairs. The low frequency of breeding and reduced fecundity of escaped falconry hybrids indicates that the risk of extinction of the Saker Falcon through genetic introgression via this route is minimal. Furthermore, it is unlikely that hybrid progeny have superior fitness benefits that would overcome these barriers to introgression. Peregrine Falcons have sympatric breeding ranges with all four hierofalcon species and infrequent natural hybrids have been reported *(McCarthy, 2006),* yet there is no evidence that there has been any natural genetic introgression that has threatened the genetic integrity of any *Hierofalco* taxa examined *(Nittinger et al., 2007; Johnson et al., 2007).* Previously published studies that suggested ancient introgression of Peregrine genes in Saker populations were incorrect and arose as a result of nuclear copies of the cytochrome b gene being sequenced by mistake *(Wink et al., 2004).*

Falconry has a long historical and cultural tradition in Arabic nations *(Al-Nayan, 1976; Al-Timimi, 2007)* and modern Arabic falconry practices result in a large demand for falcons *(Riddle and Remple, 1994; Barton, 2000).* This demand can be met through three routes: (i) captive-bred falcons, (ii) wild-sourced falcons through legal CITES regulated trade and (iii) wild-sourced falcons through unregulated, illegal trade. Restrictions on the availability of falcons through captive-breeding and CITES regulated trade routes can only result in an increased demand for falcons through unregulated, illegal trade. In addition to the potential conservation impact on source populations and the animal welfare problems associated with smuggling this illegal trade also risks introducing zoonotic diseases to the receiving countries. Consequently, there are conservation, animal welfare and biosecurity benefits in promoting the use of captive-bred falcons in Arabic falconry.

In the absence of empirical data on the numbers of falcons entering Arabia, it is difficult to prove that increased use of captive-bred falcons reduces demand for wild caught falcons; in such a scenario, an increase in falcon availability through the production of captive-bred falcons could simply be absorbed by market demand. However, there is a finite demand for falcons in Arabia, at least for captive-bred falcons, as the number of birds reared by falcon breeders is determined by how many they can sell, not as many as they can produce. Furthermore, many falconers in the UAE have switched from using wild-caught

falcons to captive-bred falcons, which represents a reduction in the size of the market for wild-caught falcons.

The argument that captive-breeding should be restricted to the production of pure-bred falcons is an issue closely-linked to the promotion of captive-bred falcons for falconry use. A falconer requires a bird that is fit-for-purpose and will, by preference, obtain the best falcon available to suit that purpose. Captive-bred falcons have advantages in that they tend to be more manageable than wild-sourced falcons but have disadvantages in that they require long periods of intensive fitness training and their production requires specialist skills and facilities. In order to promote the use of captive-bred falcons it is necessary to provide hybrid falcons that have characteristics that outweigh these disadvantages. A prohibition on the use and production of hybrid falcons for falconry is likely to significantly reduce the demand for captive-bred falcons in Arabic falconry and, in the current situation with a highly restricted legal CITES regulated trade, result in an increased demand for wild-sourced illegally traded falcons. Given that for the foreseeable future, in many of the Saker Falcon range states, trans-border controls will never be more than rudimentary, a pragmatic way to influence harvests of wild Sakers is by meeting market demand with captive-bred birds.

The prohibition of hybrid falcon production, in order to minimise the risk of causing extinction of the Saker Falcon, is not supported on observational, genetic or theoretical grounds and conflicts with IUCN guidance on invasive alien species *(Shine et al., 2000).* We suggest that a precautionary approach be adopted with continued production of hybrid falcons for falconry use, better management for the training of hybrid falcons (such as the prohibition of free-hacking training techniques in breeding range countries), an international marking scheme for captive-bred hybrids and closer monitoring of wild populations, especially employing molecular techniques. Although there is no evidence of deliberate release of hybrid falcons to the wild by falconers or breeders, this should never take place. Evidence of hybrid breeding events should be recorded and published and where possible any hybrid adults or their progeny removed from the wild.

Acknowledgements

I wish to thank *Nick Fox* and *HE Majid al Mansouri* (Environment Agency, Abu Dhabi) for discussions on the production and use of hybrid falcons; *Nick Kester* (Hawk Board), *Christian de Coune* and *Matthew Gage* (International Association for Falconry) for information on hybrid falcon use in falconry; *Istvan Balázs, Mátyás Prommer* and *Michel Adamec* for discussions on the EFcCT mailing list.

Conflict of interest declaration: I am employed as a research biologist by a UK company called International Wildlife Consultants Ltd (IWC). IWC commercially breeds falcons (including hybrids), mainly for Arabian falconry market.

References

Al Nahayan, Sh. Z. B. S. (1976): Falconry as a sport: our Arab heritage. Westerham Press, Westerham, Kent, UK.

Al Timimi, F. (2007): Falconry and hunting in Arabia. Gulfosaker, Canada 320 p.

Angelov, I., Lei, L., Mei, Y., Balázs, I., Ma, M. & Dixon, A. (2006): Possible mixed pairing between Saker Falcon *(Falco cherrug)* and Barbary Falcon *(Falco pelegrinoides)* in China. *Falco* **28,** p. 14–15.

Bagyura, J., Szitta, T., Haraszthy, L., Demeter, I., Sándor, I., Dudás, M., Kállay, Gy. & Viszló, L. (2004): Population Trend of the Saker Falcon *Falco cherrug* in Hungary between 1980 and 2002. In *Meyburg, B., Chancellor, R. D. (eds):* Raptors Worldwide (2004). WWGBP/MME. p. 663–672.

Barton, N. (2000): Trapping estimates for Saker and Peregrine Falcons used for falconry in the United Arab Emirates. *J. Raptor Res.* **34,** p. 53–55.

Birdlife International (2008a): Species factsheet: *Falco cherrug*. Accessed at *http://www.birdlife.org* on 19.11.2008.

Birdlife International (2008b): Minimising threats from hybrid falcons (originating from captive-bred birds) on wild European falcon populations. Position statement adopted by the BirdLife EU Birds and Habitats Directive Task Force on 23 April 2008.

Boev, Z. N. & Dimitrov, S. S. (1995): On the Lanner Falcon (*Falco biarmicus* Temminck, 1825) in Bulgaria. *Acta Zool. Bulgarica* **48,** p. 105–112.

Burfield, I. & Bommel, F. van (2004): Birds in Europe: population estimates, trends and conservation status. BirdLife International, Cambridge, 374 p.

Chavko, J. & Adamec, M. (2003): Conservation programme for Saker Falcon (*Falco cherrug*, J. E. Gray, 1834). Bratislava, Slovakia.

Chien, H. L. & Smith, A. T. (2003): Keystone status of plateau pikas *(Ochotona curzoniae):* effect of control on biodiversity of native birds*. Biodiversity and Conservation* **12,** p. 1901–1912.

CITES (2004): Progress on the implementation of the review of significant trade (phases V and VI). Review of significant trade in specimens of Appendix-II species (Resolution Conf. 12. 8 and Decision 12.75). Twentieth meeting of the Animals Committee, Johannesburg (South Africa), 29 March–2 April 2004. Working document AC20 Doc. 8.1. Convention on International Trade in Endangered Species of Wild Fauna and Flora, 25 p.

Dawnay, N., Mcewing, R., Thorpe, R. S. & Ogden, R. (2008): Preliminary data suggests genetic distinctiveness of Gyr and Saker Falcons. *Conservation Genetics* **9,** p. 703–707.

Dixon, A. (2009): Saker Falcon breeding population estimates. Part 2: Asia. *Falco* **33,** p. 4–10.

Eastham, C. P., Nicholls, M. K. & Fox, N. C. (2001): Morphological variation of the Saker (*Falco cherrug*) and the implications for conservation. *Biodiversity and Conservation* **10,** p. 1–21.

Ferguson-Lees, J. & Christie, D. A. (2001): Raptors of the world. Helm, London.

Fox, N. (ed.) (2004): The use of exotic and hybrid raptors in falconry: *information arising from the International Committee on Hybrids*. UK Hawk Board/North American Falconers Association.

Gantlett, S. & Millington, R. (1992): Identification forum: large falcons. *Birding World* **5,** p. 101–106.

Gombobaatar, S., Sumiya, D., Shagdarsuren, O., Potapov, E & Fox, N. (2004): Saker Falcon (*Falco cherrug milvipes* Jerdon) mortality in Central Mongolia and population threats. *Mongolian Journal of Biological Sciences* **2**(2), p. 13–21.

Hess, E. H. (1973): Imprinting. Early experience and the developmental psychobiology of attachment. Van Nostrand Reinhold Company, New York, 472 p.

Horák, P. (2000): Development of Saker Falcon *(Falco cherrug)* population between 1976–1998 in Moravia (Czech Republic). *Buteo* **11,** p. 57–66.

IUCN. (2008): 2008 IUCN Red List of Threatened Species. Accessed at: *http://www.iucnredlist.org* on 19.11.2008.

Johnson, J. A., Burnham, K. K., Burnham, W. A. & Mindell, D. P. (2007): Genetic structure among continental and island populations of Gyrfalcons. *Molec. Ecol.* **16,** p. 3145–3160.

Kaltenpoth, H. U. & Schulenburg, W. (1989): Muli oder Maulesel? *Greifvögel und Falknerei* 1988, p. 36–37.

Karyakin, I. V. (2008): Saker Falcon in Russia. *Raptors Conservation* **12,** p. 28–47.

Kleinschmidt, O. (1901): Der Formenkreis *Hierofalco* und die Stellung des ungarischen Würgfalken in demselben. *Aquila* **8,** p. 1–48.

Levin, A. S. (2008): Conservation problems of the Saker Falcon in Kazakhstan. *Raptors Conservation* **12,** p. 48–55.

McCarthy, E. M. (2006): Handbook of avian hybrids of the world. Oxford University Press, 608 p.

Nagy, S. & Demeter, I. (2006): Saker Falcon: European Single Species Action Plan. BirdLife International, 41 p.

Nittinger, F. (2004): DNA-Analysen zur Populationsstruktur des Sakerfalken (*Falco cherrug*) und zu seiner systematischen Stellung innerhalb des Hierofalkenkomplexes. Dissertation, Universität Wien.

Nittinger, F., Haring, E., Pinsker, W. & Gamauf, A. (2004): Molecular systematics and population genetic of the Saker Falcon *(Falco cherrug).* In *Bechley, G. (ed.):* Abstracts of the 7th Annual Congress of the GfBS (Society for Biological Systematics) Org. Divers. Evol. 4, Electr. Suppl. **6,** p. 91.

Nittinger, F., Haring, E., Pinsker, W., Wink, M. & Gamauf, A. (2005): Out of Africa? Phylogentic relationships between *Falco biarmicus* and the other hierofalcons (Aves: Falconidae). *Journal of Zoological Systematics and Evolutionary Research* **43,** p. 321–331.

Nittinger, F., Haring, E., Pinsker, W. & Gamauf, A. (2006): Are escaped hybrid falcons a threat to the Pannonian population of the Saker Falcon *(Falco cherrug)?* In *Gamauf, A. & Berg, H.-M. (Hrsg.):* Greifvögel und Eulen in Österreich. Naturhistorisches Museum, Wien, p. 21–26.

Nittinger, F., Gamauf, A., Pinsker, W., Wink, M. & Haring, E. (2007): Phylogeography and population structure of the Saker Falcon *(Falco cherrug)* and the influence of hybridisation: mitochondrial and microsatellite data. *Molecular Ecology* **16,** p. 1497–1517.

Perry, L. S. (2005): Does your falcon have a passport? *TRAFFIC Bulletin* 20(3), p. 95.

Riddle, K. E. & Remple, J. D. (1994): Use of the Saker and other large falcons in Middle East falconry. In *B-U. Meyburg & R. D. Chancellor (eds.):* Raptor conservation today. WWGBP/The Pica Press, Robertsbridge, p. 415–420.

Rodríguez B., Siverio F., Siverio, M. & Rodríguez, A. (2011): Variable plumage coloration of breeding Barbary Falcons *Falco (peregrinus) pelegrinoides* in the Canary Islands: do other Peregrine Falcon subspecies also occur in the archipelago? *Bulletin of the British Ornithologists' Club* **131**, p. 140–153.

Shine, C., Williams, N. & Gündling, L. (2000): A Guide to designing legal and institutional frameworks on alien invasive species. IUCN, Gland, Switzerland, 153 p.

Wink, M., Sauer-Gürth, H., Ellis, D. & Kenward, R. (2004): Phylogenetic relationships in the hierofalcon complex (Saker-, Gyr-, Lanner-, Laggar Falcon). In *Chancellor, R. D. & Meyburg, B-U.:* Raptors Worldwide. WWGBP/MME, p. 499–504.

Aquila (2012), Vol. **119**, p. 21–30

The breeding population of Saker Falcon *(Falco cherrug)* in the Czech Republic between 1999–2010

Václav Beran[1,2], Vlasta Škorpíková, Martin Valášek[3], David Horal[4] & Petr Horák

[1]Town Museum Ústí nad Labem, [2]ALKA Wildlife o.p.s., [3]Podyjí National Park Authority, [4]Agency for Nature Conservation and Landscape Protection of the Czech Republic, Brno Regional Office

ABSTRACT—The Saker Falcon *(Falco cherrug)* is a rare but regular breeder in the Czech Republic. It has only bred in the Pannonian part of Moravia over the past few decades, except for an isolated breeding locality in Northern Moravia/Silesia, occupied in 1989–1999 and 2003–2007. Between 1999–2010, the breeding of the species was confirmed in 15 grid squares. In total, 92 breedings were confirmed (5–11 annually); with at least a further 24 occupied territories found. At least 39 probable breedings were detected. The total population size of the Saker in the Czech Republic was estimated at 15–20 pairs during this period. Out of 89 breedings, 13 occurred on high voltage pylons, 75 on trees and one nest was situated on a cliff. In 47 cases, nests of other bird species such as Common Buzzard *(Buteo buteo),* White Stork *(Ciconia ciconia),* Northern Goshawk *(Accipiter gentilis)* and other species were used. Artificial nesting platforms or nestboxes were used in 30 cases, tree hollows in 10 cases. The following trees were used for nesting: *Quercus* sp. – 29 cases, *Populus* sp. – 22, *Fraxinus* sp. – 10, *Robinia pseudacacia* – 6 and *Alnus* sp. – 4. Out of 92 breeding attempts, 72 (78%) were successful; at least 200 young were fledged. The average breeding productivity was 2.2 young per nest and 2.9 young per each successful breeding. Out of all breeding attempts 22% failed because the nest was abandoned due to disturbance or for unknown reasons (8 cases), presumably predated by Marten (*Martes* sp.) (4 cases), chicks were found dead in the nests (two cases) or, in one case, a clutch probably went cold due to the death of one or both parents. In three cases broken eggs were found in the nests, and in one case, the clutch was not fertilized. In another case, the breeding probably failed due to the sexual immaturity of the parent bird(s). Egg-laying most often took place between March 1 and April 10; in nearly 65%, it occurred between March 21 and 31 (n = 68). Five replacement clutches were found. In these cases, the egg-laying occurred between April 15 and 30 (4 cases) or even as late as between May 1 and 5 (1 case). In 1999–2010, 159 Sakers were ringed (9 adults and 150 juveniles). A juvenile from the Bruntál district (North Moravia/Silesia) was found in Italy (660 km) after 214 days. In several cases, Sakers bred surprisingly close to the occupied nests of other raptors or wading birds. The minimum distance between two occupied nests of Sakers was 1.3 km (both pairs were successful).

Key words: *Falco cherrug*, breeding biology, population, Czech Republic

Correspondence: *Václav Beran,* Town Museum Ústí nad Labem, Masarykova 1000/3, 400 01 Ústí nad Labem, Czech Republic, e-mail: lutra@email.cz

Introduction

The Saker Falcon *(Falco cherrug)* belongs to the most endangered regularly breeding bird species in the Czech Republic (CR). There is a long term human interest focussed on this species not only because of its rarity, but because of its attractiveness as a falconry bird as well. Historical data about the Saker population in the Czech Republic is very scarce. We

only know that they bred in Bohemia in the 19th century *(Komárek, 2007)*. Only very few breeding records were documented from the first half of 20th century *(Hudec & Šťastný, 2005)*, but in the second half of the century, the breeding population in South Moravia was established. Systematic research started in 1976 by *Petr Horák* and *Vladimír Gahura*. We present data from the year 1999 onwards, since data from previous years have already been published *(Horák, 2000a)*. The Czech Republic recently forms the western- and northern-most part of the Saker´s global breeding range.

A management plan for the Peregrine and Saker Falcons was developed in 1996 *(Hlaváč, 1995)*. Since then, most of the activities connected with the Saker Falcon have been coordinated by a group of experts—ornithologists, amateur and professional conservationists, falconers and scientists. The group was dissolved in 2006. Since then, the monitoring and ringing of the Saker Falcon have been coordinated by the Agency for Nature Conservation and Landscape Protection of the Czech Republic (ANCLP). Monitoring has been carried out every year in the whole of the known breeding range, but, some breeding pairs have certainly not been found. Other activities are not centrally coordinated. The development of the Czech Saker population has been well documented since 1976, thanks to the work of *Petr Horák*, and since 2005 of other ornithologists as well. Obviously its size depends mainly on the status of the whole European population, in smaller part has been influenced by the coordinated activities. The results of the monitoring in 2005–2007 were summarised by *Hora et al. (2010)*. The Saker Falcon is classified as a "critically endangered species" under the nature protection legislation in the CR.

The aims of the present paper are: (1) to give an overview of the development of the Czech Saker Falcon population in 1999–2010 and to compare it with the situation in 1976–1998, (2) to provide some important data on breeding biology and ecology, and (3) to provide a reliable estimate of the current population size of Saker Falcon in Czech Republic, as well as (4) to discuss the most important threatening factors.

Materials and methods

Monitoring and protection of the Saker Falcon was realised almost single-handedly by the late *Petr Horák* between 1976–2005. He collected data on breeding biology, searched for the nests, carried out the protection of breeding sites, installed artificial breeding platforms and nest boxes or safeguarded the nests that were at risk of breaking up. After his premature death in 2005, the monitoring and protection of Saker has been coordinated by ANCLP. Field activities have been carried out by a group of 6–7 ornithologists, predominantly from February to July. Intensive and systematic searches for raptors' nests and checks on artificial breeding sites in selected areas (historical and potential suitable breeding sites) took place from February to April. Moreover, all observations of Sakers during the breeding season were registered and evaluated, new nests were continuously searched for on the basis of these records. All occupied nests were regularly checked for data on breeding biology, breeding success and to prevent nest robberies or breeding failures caused by human activities. In several areas, data on distribution and behaviour were collected in the non-breeding period as well. Finally, all accidental observations from the whole country were collected.

An area of 1400–3300 km^2 was regularly checked by *Petr Horák* in 1999–2005. Since 2006, an area of 3000–4000 km^2 has been under control.

Grid squares of c.11x12 km (traditionally used in CR) were used to present the results. Breeding cases were divided into two categories: confirmed breeding (documented occupied nest or observation of fledged juveniles up to first half of July, or observation of juveniles together with adults) and probable breeding (repeated observations of an adult or a pair without direct evidence of breeding). The probable breeding category can also include unsuccessful breeding attempts that were terminated before the nest was found.

Several pairs have bred in border regions with Austria or Slovakia. The hunting areas of these pairs are usually stable over the years, but the breeding sites frequently move from one side of the border to the other. These pairs were included into the results if the nest was found less than 1 km from the border or in the case of probable breeding.

Results

The breeding of the Saker Falcon in the Czech Republic has been repeatedly confirmed only in south Moravia – in floodplain forests along the Morava and Dyje rivers in its southernmost part and in "agricultural steppes" (agrocenoses) south of Brno and east of Znojmo. An isolated pair bred near the Polish border in Silesia. In central Moravia (south of Olomouc), the breeding of Sakers has been probable in some years.

The edges as well as the interiors of the forests were used by Sakers for breeding in floodplain areas. Groves, windbreaks or riparian forests were preferred in agricultural steppes, but if no suitable trees were available, breeding on high-voltage pylons in natural nests or on nest platforms occurred. Although an isolated pair breeding near the Polish border was 150 km away from the core population, the breeding habitat was the same as in south Moravia. The altitude of nest sites ranged from 150 to 250m, rarely up to 400 m. At least one breeding was confirmed in 16 grid squares (5672, 5772, 6966, 6967, 7064, 7065, 7161, 7163, 7164, 7165, 7263, 7264, 7265, 7267, 7268, 7367) in 1999–2010. Two squares were occupied every year and five squares only once during this twelve-year period.

Compared to the period 1976–1998, breeding in five previously occupied squares was not confirmed but on the other hand, seven new squares were used. All of them bordered on to other squares, which had previously been occupied, except for the 7161. The situation is shown on Table 1.

The probable breeding was recorded in 18 squares, but in nine of them, confirmed breeding was recorded as well. So in nine squares only probable breeding was known (6569, 6954, 7063, 7069, 7166, 7167, 7169, 7262, 7266).

An apparently geographically isolated breeding pair from Silesia was in fact strongly connected with the South-Moravian population. This was confirmed by a male born in this area in 1996, which bred in south Moravia (180 km S) four years later. This connectivity was also proven by the restoration of the breeding pair after its break-up. It bred continuously from 1989 to 1999. For the next three years, only the male was observed and no breeding was confirmed. The pair bred again from 2003 up to 2007. Since then, only the male has been observed. Despite the fact, that the breeding site is situated near the Polish border, breeding in Poland was confirmed only once *(Sielicki et al., 2009)*.

Square No.	Number of breeding pairs											
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
5672	1	–	–	–	1	2	–	–	–	–	–	–
5772	–	–	–	–	–	–	1	1	1	1	–	–
6966	1	1	1	–	1	2	1	1	1	1	1	–
6967	–	–	–	–	–	–	1	–	–	–	–	–
7064	–	–	–	–	–	–	–	–	–	–	–	1
7065	–	–	–	–	–	–	–	–	–	1	1	–
7161	–	–	–	–	–	–	–	–	–	1	–	–
7163	–	1	1	1	1	1	1	–	–	–	1	–
7164*	1	1	2	1	1	1	1	1	1	1	1	1
7165	–	–	1	–	–	–	–	–	–	–	–	–
7263	–	–	–	–	–	–	–	–	–	1	1	2
7264	–	–	–	–	–	–	1	2	2	1	1	1
7265	–	–	–	–	1	–	–	–	–	–	–	–
7267*	1	1	1	1	1	1	1	1	1	1	1	1
7268	–	1		–	–	1	–	–	–	–	–	–
7367	1	1	2	3	2	3	3	1	1	2	–	1
Total	5	6	8	6	8	11	10	7	7	10	7	7

Table 1. The number of confirmed breedings of the Saker Falcon *(Falco cherrug)* in the individual grid squares in 1999–2010. Grid squares where at least one breeding was confirmed in 1976–1998 were marked by '*'.

Horák (2000a) estimated the size of the Czech Saker population at 15 breeding pairs with a maximum of 11 confirmed breedings in 1991 and 2004. Since then, no dramatic changes have been observed wih only a slowly increasing population trend. The recent estimate for the Czech Republic is 15–20 pairs.

Out of 89 occupied nests found between 1999–2005, 13 were placed on high-voltage electric pylons (3 on natural nests, 10 on artificial breeding platforms), 21 were on trees on artificial breeding platforms or in nest-boxes, 44 breeding attempts were found on trees in the nests of other birds (Common Buzzard, *Buteo buteo* – 23, White Stork, *Ciconia ciconia* – 10, Northern Goshawk, *Accipiter gentilis* – 4, Grey Heron, *Ardea cinerea* – 2, Honey Buzzard, *Pernis apivorus* – 2 and Red Kite, *Milvus milvus,* White-tailed Eagle, *Haliaeetus albicilla* and Imperial Eagle, *Aquila heliaca* – 1 case, each), in 10 cases the breeding was performed in a natural tree cavity and once on a rock.

The tree species with the nest or artificial nest platform was known in 71 cases: Oak tree (*Quercus* sp.) – 29, Poplar (*Populus* sp.) – 22, Ash (*Fraxinus* sp.) – 10, Robinia (*Robinia pseudoacacia*) – 6 and Alder (*Alnus* sp.) – 4 cases. The elevation of the nests ranged from 6 to 30 metres.

One pair bred ten times (nine confirmed and one probable case) in a tree cavity *(Horák, 2000b; Horal et al., 2006; Horal, 2008)*. The female was presumably the same in all cases, but for two seasons she bred with a new male. Altogether three different cavities were used (in eight cases the same cavity up to its destruction), always in a solitary English oak *(Quercus robur).* This female reared at least 28 chicks (probably at least 31). After the

Year	Nests	Successful nests	Fledged young	Juv./nest	Juv./successful nest
1999	5	2	7	1.4	3.5
2000	6	5	17	2.8	3.4
2001	8	7	17	2.1	2.4
2002	6	5	16	2.7	3.2
2003	8	7	17	2.1	2.4
2004	11	8	18	1.6	2.3
2005	10	10	28	2.8	2.8
2006	7	7	19	2.7	2.7
2007	7	5	16	2.3	3.2
2008	10	5	14	1.6	2.8
2009	7	5	13	1.9	2.6
2010	7	6	18	2.6	3.0
Total	92	72	200	2.2	2.9

Table 2. Annual breeding success data of the Saker Falcon *(Falco cherrug)* in the Czech Republic in 1999–2010

disappearance of the former female in 2008, a new pair was established in 2009, but the pair started to breed on White Stork nests.

Breeding on cliffs is very rare in the Czech Republic. One recent case from Podyjí/Thayatal National Park is described by *Valášek (in press)* and is a part of the present paper. 51 nests (54%) were situated in agrocenoses, usually in groves, windbreaks or riparian forests. Other nests were situated in floodplain forests and one in the canyon of the Dyje river. Altogether 92 confirmed breeding attempts, at least 24 occupied territories and 38 probable breeding attempts were found in the period 1999–2010. 72 breeding attempts (78%) were successful and at least 200 juveniles were fledged. The average production per all nests is 2.2 individuals/nest and average production per productive nest is 2.9 individuals/nest (for more detailed information see Table 2).

Juveniles from captivity were occasionally added into the nests of Sakers up to 2005, usually only in cases when chicks from the nest died or when there was only one chick on the nest. Altogether 15 juveniles were added to the nests. At least 250 Sakers were released by other methods. Up to now, not a single case of successful breeding of these released Sakers has been confirmed.

Twenty breeding attempts (22% of all known breedings) were unsuccessful. This is a considerable decrease in nest-failures compared to the period 1976–1998, when 42 (41.6%) of breeding attempts failed. The nest was abandoned eight times because of human disturbance or for other unknown reasons, four times it was predated by Marten (*Martes* sp.) (always with chicks in the nest), twice juveniles died and once the clutch went cold because of the probable death of a parent (parents), three times broken and once unfertilized eggs were found and once the parent bird(s) were probably immature and therefore infertile.

Period	Nr. of cases
1–10 March	8
11–20 March	9
21–31 March	44
1–10 April	7

Table 3. Egg-laying dates of the breeding of the Saker Falcon *(Falco cherrug)* in the Czech Republic in 1999–2010

Without the effective protection of the nests and without improving the breeding opportunities, the losses would be at least twofold. For example, six nests that were at risk of falling or fell down were fixed in the period 2000–2002. One attempt to rob a nest was recorded as well. Many nest sites were protected against human disturbance such as forestry works, etc.

Sakers only breed once a year. If the clutch is lost at the beginning of the incubation, often, a replacement clutch is laid. We found replacement clutches in five cases (the first clutch was found as well). In another two cases it was not clear whether it was replacement clutch, or a late first clutch (7.7% of all clutches if two doubtful cases are included). In four cases, the replacement clutch was started between 15–30 April, in one case between 1–5 May. In three of these cases, we know the timing of the first clutch as well (four times the first clutches started between 20–30 March, the replacement clutches between 25–30 April, respectively 1–5 May, once the first clutch started in the first half of March, the replacement clutch in the second half of April).

Because of the high sensitivity of Sakers to disturbance in the early stage of breeding, no systematic data about clutch size was collected. Most of the egg-laying terms were counted backwards or were based on direct observations of incubation start, in 68 cases with accuracy to a decade (see Table 3). In 75 cases, the clutch was laid in the period between 1 March and 10 April, only six replacement clutches were started later. It is not possible to exclude that some of the clutches started in April were not the replacement ones.

Two males and five females were breeding as immatures. In one case it was an immature male with an adult female, once it was an immature couple and four times an immature female with an adult male.

Up to now, Sakers have mainly bred in the nests of other raptors. Artificial breeding opportunities (platforms and nest boxes) were mainly installed in 1990s. Some of them were used by Sakers, but many of them are now in poor condition. We started with the installation of aluminium nest boxes on selected high voltage pylons in 2010, but we plan to install nest boxes only in some well chosen localities where the lack of other breeding opportunities is obvious.

159 Sakers (150 chicks on nests) were ringed in the period 1999–2010 (captive bred birds are not included). 24 recoveries and several tens of ring-colour readings were collected. Up to 2009, only coloured, not observing rings with a code were used. Identifying the colour of a coloured ring (without reading the entire code) is not a proper recovery, because several birds were ringed with the same colour. But thanks to coloured rings, we were able to recognise individuals in pairs and get information about pair bonds, exchange

of partners or pair productivity. Red observing rings with silver codes have been used since 2009.

One male born in Silesia was breeding in south Moravia (180 km southwards) at the age of five and six years. One male and one female born in south Moravia were later breeding less than 40 km from their birthplace. Four Sakers ringed as adults were later breeding 0–7.5 km apart. The fidelity of breeding pairs to the breeding site and faithfulness of the breeding couple was documented by colour rings.

Two Sakers ringed as juveniles in Slovakia and one in Hungary were found dead or wounded in the Czech Republic. All of them were juveniles during their post-breeding dispersal (September, October and November). Another six Sakers (two males and four females) fitted with satellite transmitters in Hungary (two males and two females out of 39 tracked Sakers) and Slovakia (2 females out of six) passed over the Czech Republic between 2007 and 2010 (*http://www.sakerlife.mme.hu; M. Prommer,* in litt.).

Two ringed Sakers fledged in the Czech Republic were found dead in Hungary, one in Austria and one in Italy (after 214 days at a distance of 660 km). In all four cases, dead juveniles were reported *(Cepák et al., 2008)*.

Sakers may tolerate the proximity of other raptor (and other large bird) species breeding close to their nests even though males actively defend their nesting territories. Young Sakers very often attack other raptors, storks or herons after fledging. Some of the shortest distances documented between the nests of Sakers and other species during the study period are listed as follows:

- White-tailed Eagle (Soutok, 2008) – 500 m
- Imperial Eagle (Soutok, 2007 and 2008, the same breeding place) – 140 (!) and 745 m
- Red Kite (Soutok, e.g. 2007 and 2008, the same breeding place) – 125 and 290 m; (Soutok 2010) – two occupied nests of Red Kite (400 m from each other), both at a distance of 240 m from a Saker nest
- Black Kite *(Milvus migrans)* (Soutok 2008) – 285 m
- Honey Buzzard (Soutok, 2008) – 300 m; (Soutok, 2005 and 2008) – 475 and 655 m
- Common Buzzard (Soutok, 2005 and 2006) – 220 and 410 m; (Znojmo region, 2008) – 50 m, but breeding of Sakers was not successful
- Kestrel *(Falco tinnunculus)* (Soutok, 2006) – 195 m
- Black Stork *(Ciconia nigra)* (Soutok, 2010) – 490 m; (Soutok, 1998 and 1999–2001) – 250–300 m and 700–800 m
- White Stork (Soutok, 2009) – 30 m.

Sakers have been found breeding in a colony of Grey Herons several times: in Břeclav district in 2002 and 2004, and in Znojmo district in 2005 and 2006. Two occupied nests of Grey Heron were at a distance of 1.5 m from a successful Saker nest in 2005. In 2006, three heron nests were occupied within c. 2 m around a Saker nest.

Interactions with breeding Goshawks are difficult to evaluate. It seems these two species strongly avoid each other in agricultural areas with closest distances of occupied nests 3.3 or 4.6 km in 2007, 4.3 or 5.5 km in 2009 and 2.1 or 5.3 km in 2010. The situation may differ in floodplain forests.

Sakers commonly breed in White Stork nests in south Moravia. Strong fights between these two species may occur sometimes. Four from six breeding attempts of Sakers in

White Stork nests were unsuccessful due to Storks' attacks in the period 1976–1998. No failed breeding because of White Storks (ten cases of breeding in Stork nests) was found in the period of 1999–2010. To keep the nest undisturbed when the female is incubating is probably the most important factor for avoiding the breeding failure caused by Storks. The location of the nesting tree is crucial. The probability of destruction is much lower on solitary trees than in the forest edge, because the Saker male has much better view here and can defend the nest against Storks more easily.

The nearest distance of two successful Saker nests was only 1.3 km (Břeclav district, 2005) or 2.2 km (Znojmo district, 2010). The nearest distance of two occupied Saker nests was 1 km (Silesia, 1997) but one of the nests was occupied only by a solitary male.

Discussion

The breeding range of Saker has shown no significant changes since the 1990s (*Horák, 2000a*). Several squares have been occupied recently, but all of them are neighbouring previously occupied ones. The shift can be caused only by the movement of a breeding pair from one square to the neighbouring one. There is no obvious evidence for the spread of Sakers to new areas, an areal shift is not forecasted due to climatic changes, either *(Huntley et al., 2007)*.

Although no expansion has been confirmed, a positive trend in the breeding success, which started in 1990s has continued. Breeding success has increased significantly compared to the period 1986–1998. The number of confirmed breeding attempts increased from 81 to 92 (by 13.5%), but the number of successful breeding attempts increased from 49 to 72 cases (by 47%). The number of fledged juveniles increased from 140 to 200 (by 42%). When compared to similar data of the period of 1976–1986 an even more significant increase can be seen.

The breeding success increased significantly during the period 1999–2010. Only 20 (22%) breeding attempts failed. The reasons for nest-failure are similar to those in the previous period (*Horák, 2000a)* (mainly human disturbance caused by forestry or field works, predation, falling down of the nest, human persecution and unknown reasons). The increase in breeding success was influenced by intensive monitoring and minimisation of risk factors after the nest was found. The stabilisation of nests and installation of artificial breeding platforms help to reduce the losses caused by break down of the nests. Nest robbing was only confirmed in one case (near Drnholec, 1999). Direct persecution (shooting on the nest) was confirmed in 2010 (Dyjákovice). Nest robbing and persecution may be controlled more effectively by increased monitoring efforts as well. Raising public awareness by ornithologists by discourageing local hunters or falconers from persecution or nest robbing has an increasing relevance. Some of the nest sites are well known, but many of them are still kept secret.

A significant proportion of the known breeding population shifted from natural breeding sites to nest boxes situated on pylons in several European countries (e.g. Slovakia and Hungary). No large-scale installation of nest boxes has taken place up to now in the Czech Republic. Therefore, most of the breeding pairs breed in natural nests. It is more difficult to

find them and threatening factors can be more significant, but the necessity to carefully evaluate the effect of the shift of the population from trees to pylons is preventing a large scale action. Up to now, the effect of the nest-boxes on pylons on breeding seems to be positive (but still has not yet been fully evaluated as far as we now). The risks of the nest falling down, losses caused by extreme weather, as well as nest predation are reduced in nest boxes. It is much easier to confirm nesting in a nest box, than in a natural nest. This is an obvious advantage for monitoring of the population, but can be dangerous from the nest robbing or persecution point of view. The fixation of the whole population on the pylons owned by one (or a few) companies could be problematic. Nest boxes need maintenance and if this is absent, problems can occur. We focus our conservation activities not only on nest boxes but also preferably on general raptor conservation including protection of their natural nest sites and the whole habitat.

The Saker population has been relatively stable in recent years in the Czech Republic. When considering its small size (15–20 pairs) and the fact that it is situated on the north-west edge of the distribution range, the dependence on population trends in surrounding countries is obvious.

The most important current and potential threatening factors for Saker Falcons in the Czech Republic are human disturbance (forest and field works, photographers, etc.), collisions with power-lines and useless and irresponsible reintroduction experiments. The contamination of food chains by toxic chemicals is another possible risk (two cases of broken eggs on a nest in 2007 and 2008, another case with probably intoxicated eggs in 2009). Another potential threatening factor is the plans for construction of wind-turbine farms in south Moravia. The general persecution of raptors in the surroundings of pheasantries and in field hunting grounds with other small game species as Brown Hare *(Lepus europaeus)* is a long-term problem. One case of shooting at an occupied nest of Saker Falcon was documented in 2010. All four chicks and both adults survived the attack without injury. The local chief of the hunting association was informed. Several dead Common Buzzards were found on the nests during the regular monitoring. It was possible to prove that the bird was shot only in one case. Intensive monitoring and field activities are the best practice for effective protection. Effective protective measures can only be implemented once the nest has already been located.

The addition of captive-bred juveniles into the "wild" nests of Saker Falcons was halted in 2005. The releasing of Saker Falcons by other methods has not been supported by ANCLP since 2005. It is considered useless and ineffective *(V. Hlaváč, in verb.)*. As far as we know, at least 250 Sakers were released into the wild in the Czech Republic and not a single case of breeding of a bird released from the captivity has been confirmed. This type of conservation activity is, however, still continued by some organisations (Forests of the Czech Republic, State Enterprise, some town councils, etc.) using gaps in Czech legislation.

Acknowledgements

We are deeply indebted to *Petr Horák* (1956–2005) for his great effort and immense contribution to Saker monitoring and protection in the Czech Republic. Many thanks be-

long to all participants of the monitoring and to those who provided us with data: *Jan Absolín, Petr Berka, Dušan Boucný, Gašpar Čamlík, Vladimír Gahura, Tomáš Koutný, Václav Křivan, Vojtěch Mrlík, Vladimír Opluštil, Václav Prášek, Pavel Štěpánek, Jaroslav Zaňát* and others. Special thanks belong to *Alan Leath* for language corrections. We would like to thank to *Židlochovice Forest Enterprise* (Forests of the Czech Republic) for cooperation on nest protection, and also to the *Czech Bird Ringing Centre, National Museum Prague,* for gratuitous provision of Saker ringing data and recoveries.

References

Cepák J., Klvaňa P., Škopek J., Schröpfer L., Jelínek M., Hořák D., Formánek J. & Zárybnický J. (eds). (2008): Atlas migrace ptáku Ceské a Slovenské Republiky. Aventinum, Praha, 608 p.

Hlaváč V. (ed.). (1995): [Management Plan for Peregrine and Saker Falcons in the Czech Republic – a proposal]. AOPK ČR. Havlíčkův Brod. [In Czech, with English summary]

Hora J., Brinke T., Vojtěchovská E., Hanzal V. & Kučera Z. (2010): [The monitoring of the Birds Directive Annex I species and SPAs within the Natura 2000 network in 2005–2007]. AOPK ČR. Praha. [In Czech, with English summary]

Horák P. (2000a): [Development of Saker Falcon (*Falco cherrug*) population between 1976–1998 in Moravia (Czech Republic)]. *Buteo* **11,** p. 57–66. [In Czech, with English summary]

Horák P. (2000b): [Nesting of Saker Falcon (*Falco cherrug*) in a tree hollow]. *Crex* **16,** 110–112. [In Czech, with English summary]

Horal D. (2008): [Notes on interesting breeding of a Saker (*Falco cherrug*) pair in 2007]. *Crex* **28,** 130–134. [In Czech, with English summary]

Horal D., Horák P., Štěpánek P. (2006): [The interesting nesting of the Saker *(Falco cherrug)* in South Moravia in 2006]. *Crex* **26**, 73–76. [In Czech, with English summary]

Hudec, K. & Šťastný, K. (eds). (2005): [Fauna of the Czech Republic 29/1, 29/2. Birds Vols. II/1, II/2]. Academia, Praha. [In Czech, with German summary]

Huntley B., Green R. E., Collingham Y. C. & Willis S. G. (2007): A climatic atlas of European breeding birds. Durham University, RSPB and Lynx, Barcelona, 521 p.

Komárek S. (2007): [Birds in Bohemia between 1360–1890]. Academia. Praha. [In Czech, with German summary]

Sielicki, J., Prommer, M., Gamauf, A. & Kata, M., (2009): Saker Falcon *Falco cherrug* in Poland (2008–2009). In: *Wiacek J., Polak M., Kucharczyk M., Grzywaszewski G. & Jerzak L. (eds):* Ptaki-Środowisko-Zahroženia – Ochrona. Wybrane aspekty ekologii ptaków. LTO, Lublin, p. 273–285.

Valášek, M. (in press): [Saker Falcon *(Falco cherrug)* in the Podyjí/Thayatal National Parks]. *Crex* **31,** p. 133–145. [In Czech, with English summary]

Aquila (2012), Vol. **119**, p. 31–45

Conservation strategy of the Saker Falcon *(Falco cherrug)* in Bulgaria

Petar Iankov & Dimitar Gradinarov

Bulgarian Society for the Protection of Birds

ABSTRACT—Saker Falcon is currently threatened with extinction in Bulgaria. Nest robbing is considered to be amongst the main reasons for this, although a complex of other negative factors, affecting its habitats and sites have possibly additional causes. Different visions exist about how to reverse this negative trend. The conservation strategy on Saker of Bulgarian Society for the Protection of Birds (BSPB) is presented. The concept is based on: (1) current status of the species in the country (2006–2010); (2) the situation and trends of Central and Eastern European Saker populations; (3) the natural and socio-economic conditions in Bulgaria and (4) the results of previous conservation actions in Bulgaria. Out of the possible strategies the support of natural recolonization of Sakers in Bulgaria was considered as the most feasible. It lacks any risk of genetic interference to the wild Saker population (including those of the rest of Central and Eastern Europe) inevitable during a restocking programme. During the period 2006–2010, the presence of 2–9 pairs were assumed in Bulgaria, although no breeding was confirmed. The number of Sakers in Bulgaria during the study period was relatively stable, however lower values were observed in 2010. The conservation strategy was based on the following facts: (1) Saker populations in Hungary and Serbia are increasing; (2) juvenile Sakers as stragglers appear regularly in South-Eastern Europe; (3) Sakers are currently changing their traditional nest sites (cliffs and trees) to electricity pylons in the neighbouring countries. BSPB accepted to support the natural recolonization of the species through a variety of measures on habitat, site and species, especially by providing opportunities for the species to nest on high voltage pylons by installing artificial nest boxes.

Key words: Saker, *Falco cherrug*, state, conservation, strategy, Bulgaria

Correspondence: *Petar Iankov,* BirdLife Bulgaria/BSPB, BG-1111 Sofia, P.O.B. 50; E-mail: petar.iankov@bspb.org

Introduction

Relatively common at the end of 19th Century in Bulgaria, the Saker Falcon (*Falco cherrug* Gray, 1834) had been declining dramatically until the mid 20th Century *(Patev, 1950),* which was followed by a slight increase after 1970, reaching 20-40 pairs by about 1980 *(Michev & Petrov, 1985).* Population estimates indicated that around 1985 an accelerated decline started again, coinciding with the intensification of illegal nest robbing activities *(National Bird Databank with BSPB).* At the beginning of the 21st Century a population decline of about 50% was reported in comparison with 1980 *(Ruskov et al., 2007).* The last occupied nest was recorded in 2006 and in spite of a number of indications for nesting during the following years, no confirmed breeding exists since. Nest robbing is considered to be one of the main reasons for the decline after 1985, although a complex of other negative factors (large-scale changes in land use, transformation of key habitats, worsening of

Year	Numbers of records	Number of sites involved				Estimated pairs
		Total	Possible	Probable	Confirmed	
2006	34	19	10	5	4	6
2007	23	16	9	5	2	6-7
2008	44	17	9	6	2	7-8
2009	42	20	9	9	2	9 (min.)
2010	43	22	12	8	2	9

Table 1. Numbers of Saker Falcon in Bulgaria during the breeding periods 2006–2010 (for definitions see *Sharrock, 1976*)

food supply, disturbance, poisoning, electrocution and direct persecution) have possibly an additional negative effect *(Iankov et al, 2013)*. For the period 2006–2010, the Bulgarian population was presumed to be 5-9 pairs with very probable breeding of at least 2 of them. Numerous observations of both single individuals and pairs indicate that, according to IUCN criteria *(IUCN, 2001),* the Saker cannot be considered as extinct for Bulgaria (cf. *Ragyov et al., 2009*).

There are different visions about how to halt species decline and prevent extinction of Saker from Bulgaria, reflecting in various conservation actions. Most of them are carried out by BSPB as components of a complex approach, which includes functionally connected actions to improve the habitats and key sites required by the species, as well as activities to support natural recolonisation. Some actions have been executed by other NGOs (Birds of Prey Protection Society, Green Balkans) and research institutes (Institute of Biodiversity and Ecological Research). In recent years, preparation for restocking started *(Ragyov et al., 2009)*. All these activities urge the preparation of a national level conservation strategy of Saker Falcon.

Current status of Saker Falcons in Bulgaria (2006–2010)

A total of 186 Saker records have been collected by BSPB between 2006–2010 by systematic surveys of the during the breeding period (Table 1).

On the basis of the available data presence of 6-9 pairs is presumed, with at least two of them breeding with very high probability (e.g. juveniles were observed after the nesting season in an area, where previously bird carrying food recorded), although no occupied nest has been located. Breeding records are affiliated to 36 different areas. The numbers of sites with Saker occurrence during the breeding season remains relatively stable and in most of the cases these are in approximately the same areas. Although the increase of survey efforts may have resulted previously undetected pairs, it is clear, that the 1985–2007 decline of the Saker Falcon in Bulgaria is halted in light of new data acquired (cf. *Iankov, 2010*).

The recent distribution of the Saker is shown in Figure 1. At some former breeding areas birds suddenly appeared after period of years absence. At other places individuals or pairs occur around traditional breeding areas, without occupying the known nesting sites. There are records of Sakers, appearing at previously unknown sites. Some birds and pairs disappear from areas where during the previous year they showed regular presence. At some such areas there were indications of illegal activities against raptors, which may be the reason for disappearance of the falcons.

The breeding season of 2010 was unusual: extreme wheatear events (flooding, long periods with low temperature, rain- and hailstorms, etc.) occurred frequently and at many places, including areas with records of Saker in previous years. In addition to human pressure rodents as potential prey are disappearing at an accelerating rate on sites of former Saker hunting grounds.

Between 2006–2010 Saker Falcons have been reported in agricultural lowland landscapes in increasing numbers to the expense of mountain records when compared to data of previous decades. The reasons for this phenomenon are not fully understood yet. One of the reasons may be a reduction of, and more difficult access to prey animals (rodents and birds) in mountain grassland due to overgrowing vegetation. Some potential competitors, such as Peregrine *(Falco peregrinus),* Golden Eagle *(Aquila chrysaetos)* and to some extent – the Long-legged Buzzard *(Buteo rufinus)* are also on the increase. Understanding the process is difficult as nearby breeding used to exist in the past between Saker and both Peregrine and Golden Eagle *(Baumgart, 1966).*

Saker is regular on passage across Bulgaria during autumn and spring migration and the post-breeding and post-fledging movements. During the last years this fact is confirmed by both visual observations and satellite telemetry. Dynamics of numbers during autumn migration around Burgas for a 32-year-long period (1978–2009) is presented in Figure 2 *(Michev, Simeonov, 1981;, Michev et al, 2004; National Bird Databank with BSPB).*

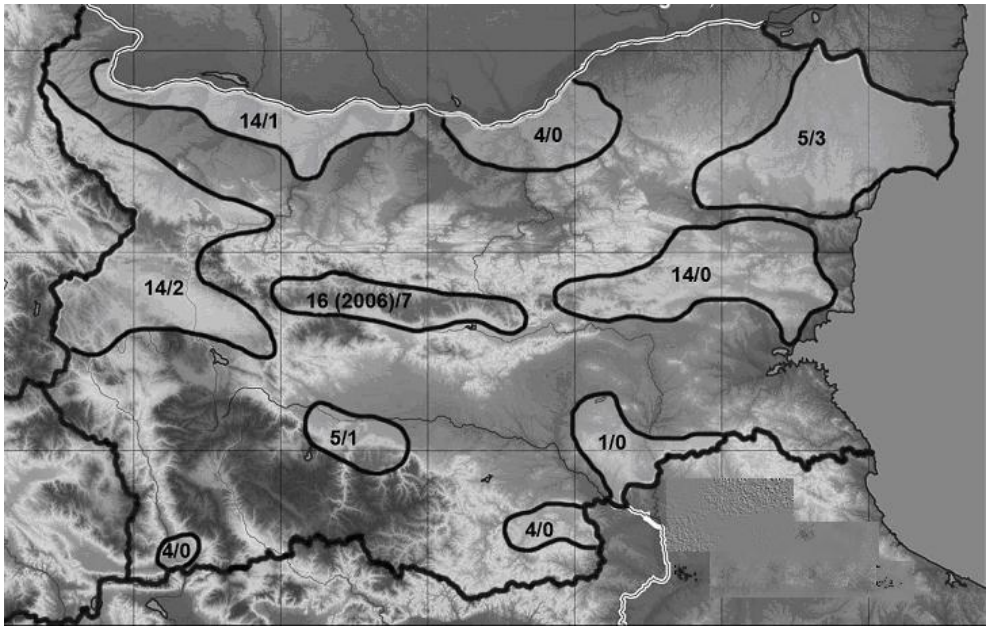


Figure 1. Distribution of the Saker in Bulgaria during the breeding period of 2006–2010 (records with breeding evidence/numbers of observations of pairs)

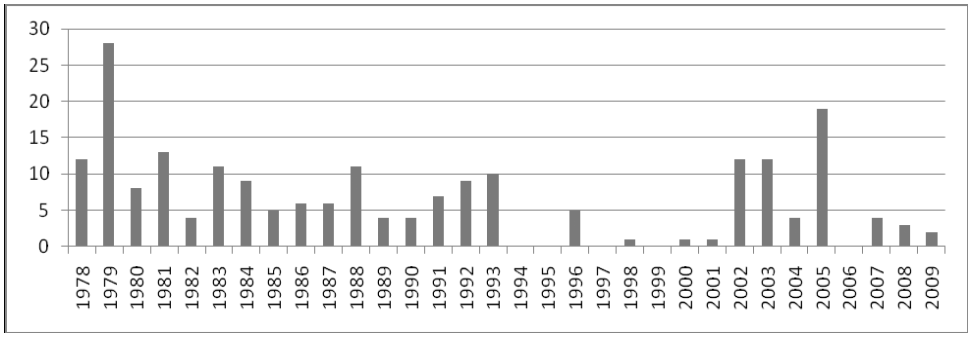


Figure 2. Dynamics of the numbers of Sakers, recorded during the autumn migration of the period 1978–2009 around Burgas

Sakers on passage have been recorded in both autumn and spring periods along the Black Sea coast and in other parts of the country.

In total 34 migrating Sakers were counted from several watch points in Southern Dobrudzha only for the period of 10 August – 30 October 2009. There are also 5 satellite-tagged juvenile Sakers from Hungary (out of 43 birds tagged) visiting Bulgaria during 2008–2009, one of which was staying for 36 days in an area of about 272 km² in North-Eastern Bulgaria, and another crossed the country three times.

Numbers of records show movements of individuals between Bulgaria and the neighbouring Serbia, Romania, Macedonia and Greece (both during the breeding season and outside the breeding period). In the light of the above mentioned migration records it is clear that Bulgaria is not just a destination of occasional migrants and stragglers of Sakers from Central and Eastearn Europe and at least 40-50 Sakers occur annually in the country, including during the pre-breeding period.

Winter records are from both direct observations in the recent years and from published and unpublished information sources. Single birds and, occasionally, pairs *(D. Domuschiev, in litt.),* have been observed in Bulgaria during winter time in different years, sometimes even around known (Central Balkan, *D. Domuschiev, in litt*.) or possible (Western Balkan, *Stoyanov, 2005*) breeding sites. Most of the other records originated from mass wintering grounds of birds *(Donchev, 1980; Vatev, 1983; K. Bedev, in litt.; National Bird Databank with BSPB):* Shabla and Durankulak Lakes complex (15 records; with some individuals probably keeping there the entire winter), Burgas area (9 records; one bird observed regularly for a month – *K. Bedev, in litt*.), Sofia Plain (8 records), Trakia Lowland (5 records) and different inland sites (5 records).

In the absence of systematically collected data on the Saker it is not possible to conduct a scientifically sound analysis on population dynamics, causes for decline, etc. Without such a work available for Saker, any kind of conservation action planning in Bulgaria must be done with special precaution.

Socioeconomic aspects with relation to Saker status and conservation

Bulgarian economy started to boost by around 2000 after a 10-years collapse and it accelerated in 2006–2010. Transformation of pastures and other grasslands in the foothills and lowlands (important Saker's foraging areas) into arable land or orchards, intensified use of pesticides, establishment of wind energy parks, increasing pressure by recreational activity, etc. all cause a threat to Sakers, with trends unlikely to change in the near future. In contrast, revitalisation of agriculture and husbandry in the mountains has still not started, which would turn highland pastures back into suitable feeding grounds. An almost unlimited number of seemingly suitable breeding sites are still deserted in the absence of proper feeding grounds and due to high disturbance by tourists and sport activities.

Nest robbing occurs still regularly in Bulgaria. In the case of a successful breeding in 2006 initially with two chicks in the nest just one juvenile fledged, possibly due to nest robbing. Those species not exposed to nest robbing—such as Long-legged Buzzard *(Buteo rufinus),* Kestrel *(Falco tinnunculus),* Eagle Owl *(Bubo bubo)* and some other birds of prey—breed favourably in most former Saker breeding sites. Step-ladders and ropes have been found at several Saker sites. Breeding records and specific conservation activities, therefore, must be kept confidential.

Since 1985 keeping falcons as pets has increased in Bulgaria, with birds often taken illegally from the wild. Although falconry is not legal in Bulgaria the numbers of the birds of prey kept in captivity has sharply increased. The community of falcon owners is quite heterogeneous, which makes the necessary cooperation with them very difficult, although they expressed their interest in general for the preparations of a reintroduction programme *(Ragyov et al., 2009)*.

Pigeon fanciers may also have conflicting interests with the conservation efforts on wild Sakers. Illegal gambling with pigeon racing is on the rise since 2000 in Bulgaria. Putting poisoned baits to eradicate raptors near the breeding sites of Sakers were believed to be the act of those people carrying out such activities *(Yankov & Gradinarov, 2009).*

Since 2008–2009, production of biofuel crops is increasing to the expense of grain cultures; resulting in a lower breeding density of Skylarks *(Alauda arvensis),* Corn Buntings *(Emberiza calandra)* and other potential prey for Saker. On the other hand, some of the cultures, such as sunflower, attract prey species such as Turtle Dove *(Streptopelia turtur)* and Wood Pigeon *(Columba palumbus),* both favourite Saker prey items during the post-fledging and autumn migration period of Sakers. Eventual increase of different pigeon species in future may contribute to the improvement of the Sakers' food supply in the rest of the year, too.

Main Saker conservation activities in Bulgaria

Saker conservation has been supported by a number of general conservation actions (legal protection, protected areas, etc.) taken by Bulgarian state for many decades. Species oriented activities started in the 1990s by BSPB, Birds of Prey Protection Society, Green Balkans, Balkani Wildlife Society, including data gathering and monitoring, dealing with cases of nest robbing, proposing designation of protected areas, etc. Since 2000, an integral conservation approach has been implemented by BSPB, including large-scale projects for

improving Saker habitats, conservation of key sites and modern species oriented activities.

Saker conservation is appropriately dealt with in the new Bulgarian conservation legislation (Biodiversity Act, Act on Protected Areas, Hunting and Game Protection Act). Introduction of BirdLife International's concept of Important Bird Areas (IBA) in the country prepared the ground for the establishment of Special Protection Areas (SPA) under the EU Birds Directive. Official assignment of this task to BSPB by the government allowed adequate designation of sites in this network to fulfil conservation needs of the Saker. In total, 29 of the SPAs have Saker as designating species. This number has increased up to 63 with the recent update of the SPA forms under a recent BSPB proposal. The Ministry of Environment and Water was encouraged to establish a DNA fingerprinting protocol and active cooperation started with the Ministry of Interior and the Ministry of Agriculture and Food on bird crime and poaching issues.

Large-scale measures for improving the Saker habitats are underway in two key regions (Ponor-Western Balkan and Besaparski Hills) with the aim to encourage sustainable and nature friendly agriculture and livestock breeding, introduction of policies to reduce chemical use in Saker areas and incentives for the farmers to maintain their lands favourable for the Saker. Electricity companies started the insulation of some of the most dangerous power lines.

All large areas with former Saker nesting sites are under legal protection and in favourable condition for potential Saker nesting: Central Balkan National Park, Vrachanski Blakan Nature Park, Sinite Kamani Nature Park, Rusenski Lom Nature Park, etc. The protection of those former breeding sites within smaller protected areas without administration, management plans and budgets is less favourable. In spite of the undoubted conservation achievements, in the national network of protected areas does not provide sufficient protection for the species in general. They cannot provide the necessary low level of disturbance and protection against nest robbing, either.

Special species oriented measures include nest guarding (until 1997), annual surveys of Saker (since 2006), anti-poaching actions and, recently, installation of artificial nests. Installation of artificial nests started in Bulgaria in 2008 and until now 221 such nests have been installed on electricity pylons, trees and on cliffs in different parts of the country by BSPB and 11 by the Saker reintroduction project. For selection the sites BSPB applies the following criteria: existing records of Saker in the area, low level of human presence and lack of extreme activities, presence of similar raptor species in the area (as indicator for good foraging conditions), lack of indications for use of poisons, absence of pigeon fanciers in nearby villages, good food supply, lack of 20 kV power lines around, preferable low altitude and open terrain, which is easy to survey. Artificial nests are monitored regularly by BSPB for possible appearance of the species and for their environmental conditions. As a result, the installation regime of artificial nests was significantly refined in 2010. A protocol for cases when a Saker pair is recorded to occupy an artificial nest is underway. Out of the 196 nest boxes in 2009–2010 ca. 23,5% have been occupied by Kestrels, in a single case by Common Buzzard *(Buteo buteo)* and, possibly, by Hobby *(Falco subbuteo)*. 'Hungarian' style roofed aluminium nest boxes appear to be the most effective. Their advantages are that they are nest robbing safe, being on 400 kV power lines; inaccessible for terrestrial predators; provide shelter to the birds under adverse weather conditions (hailstorm, pouring

rain); being deposited in the open they can be surveyed easily; unsuitable for breeding for Long-legged Buzzard; can be installed at selected sites where Golden Eagle, Peregrine, Eagle Owl and aggregations of Raven *(Corvus corax)* are absent; can be posted at suitable height with all advantages of the natural nesting site; nest guarding and providing supplementary food are applicable.

Just one year later Kestrels successfully bred in 75% of the 44 aluminium nest boxes installed in 2009. In Western Bulgaria their occupancy reached 94%. These facts show that any fear that artificial nests are 'ecological traps' has no grounds, similarly to the experience in Hungary (*J. Bagyura, M. Prommer,* pers. comm.). Monitoring aluminium nest boxes showed presence of prey animals in the areas around (Suslik—*Spermophilus citellus*, Grey Partridge—*Perdix perdix*, Turtle Dove, Wood Pigeon, etc.), and abundance of voles (*Microtus* spp.), Skylark, Corn Bunting, etc.; existence at the places of Brown Hare *(Lepus capensis),* Roe Deer *(Capreolus capreolus)* and other mammals indicates low level of human disturbance (full absence of disturbing activities such as extreme sports, entertainment gatherings, etc.). Installation of 106 additional nest boxes is planned while erecting artificial nests in trees will be discontinued.

Around 2003 development of wind energy parks started and affected several key Saker areas. In spite of initial success by preventing the establishment of such a park in the Balchik area, large territories along the migration flyway in North-Eastern Bulgaria had been covered by wind turbines, with some of them in important Saker foraging areas in South-Eastern Bulgaria. After a series of failed attempts to enforce the national and EU legislation for adequate protection of the SPAs, BSPB was forced to file a complaint in 2008 to the European Commission resulting in an infringement procedure against the Bulgarian government. In 2010 BSPB together with other NGOs and research institutes participated in the development of a map of sensitive areas for developing wind energy in Bulgaria within a project of the Ministry of the Industry, Energy and Tourism *(SER Report, 2010).* The measures implemented by BSPB as elements of an integral approach have been funded by various donors during the years, such as BirdLife International, RSPB, DEFRA (UK Government), UNEP, *Barbara* and *Mike Roberts,* and recently by BBC Wildlife Fund and by the Life+ Programme of the EU.

Along the conservation measures of Sakers in the wild, preparation for restocking activities started in 2006 by funding from the Environment Agency of Abu Dhabi, UAE and People's Trust for Endangered Species, UK *(Ragyov et al., 2009).*

Basic facts for developing a Saker strategy in Bulgaria

The following facts are of key importance for the Saker conservation strategy in Bulgaria:

- adult Sakers show fidelity to their nesting territory, juveniles roam long distances and they show a prominent migratory behaviourtowards South from the breeding sites;
- Sakers may breed as much as 340 km away from the nest of their origin *(M. Váczi, pers. comm.);*
- the Saker population is increasing in Hungary, Serbia and Ukraine with an ongoing process of shifting towards electricity pylons in these countries *(Ham & Puzović, 2000; Akimov, 2009);*

- the migration route and dispersion range of Sakers from Central and Eastern European countries, including these with the largest European Saker populations (Hungary and Ukraine) reach Bulgaria;
- records show bilateral movements of Sakers in the border areas between Bulgaria and neighbouring Serbia, Romania, Macedonia and Greece (National Bird Databank with BSPB);
- no consistent and systematic data collection exists on Sakers in Bulgaria, including threatening factors; there is a clear deficit of information on the species in the country;
- Bulgarian Saker nests in the past used to show a clustered distribution, expressed by existence of several occupied nests in relatively restricted areas;
- although no confirmed breeding of Sakers is known in Bulgaria since 2006, between 2007–2010 the presence of Saker pairs have been confirmed, with multiple Saker records during the breeding period, therefore Sakers cannot be considered extinct as yet in the wild for Bulgaria;
- Saker records during the breeding seasons of 2006–2010 were on agricultural lowland areas;
- anthropogenic pressure is continuing to increase on natural sites, resulting in further reduction of suitable traditional territories for Sakers;
- former foraging grounds of Sakers are under drastic transformation all over the country; there is disappearance or visible significant reduction of some Suslik colonies along the southern foothills of the Balkan Range, until recently regularly used by several Saker pairs for foraging;
- populations of competitor species, such as Peregrine, Long-legged Buzzard, Golden Eagle, Eagle Owl and Raven are increasing in Bulgaria *(Iankov, 2007);*
- bird crime activities are still present in Bulgaria;
- the protected areas network, which includes a number of former Saker nesting sites is not a good enough alternative for saving the species due to the existing high level of disturbance and risk of nest robbing even inside protected sites;
- the national breeding population of Peregrine and Saker Falcon have been successfully increased in Hungary (*J. Bagyura, M. Prommer,* pers. comm.) by a complex of conservation measures including installation of artificial nests;
- 75% of the installed 'Hungarian' style aluminium nest boxes in Bulgaria were successfully used for breeding by Kestrels by the year following installation;
- the first Saker (adult male) was observed on October 12th, 2010 a few meters from one of the aluminium nest boxes installed by BSPB in Northern Bulgaria;
- successful restoration of the Griffon Vulture *(Gyps fulvus)* by supporting natural recolonisation and integral approach to threats and ecological needs *(Iankov & Profirov 1991; National Bird Databank with BSPB)* is a positive example;
- any mistakes while restocking certain game bird species in Bulgaria must be prevented during Saker conservation efforts;
- saving the Bulgarian population of Saker is only possible by an integral approach, including a complex of functionally connected conservation measures at the level of habitats, key sites and the species itself.

Assessment of the possible strategies in Saker conservation in Bulgaria

Two main strategic approaches exist currently for the conservation of Saker in Bulgaria: promoting natural recolonisation of the species (NRS) by conservation of wild birds and by supporting favourable natural processes and reducing negative factors affecting the species; and restocking the wild population by release of captive individuals (RCI). NRS focusses on redirection of already ongoing activities in order to optimise the conditions in the areas where Saker occurs and to help Sakers to move to electricity pylons and to safe lowland areas. RCI is envisaged to take place in a mountain rocky area of Central Balkan National Park *(Ragyov et al., 2009)*. In both cases the following basic factors must be taken into consideration:

1) Correspondence between the level of knowledge on natural processes and on the impact of each threatening factor and the potential to reduce it: The present level of knowledge on intrinsic factors and mechanisms for the decline of Sakers in Bulgaria, together with historical changes of the population is very low. Therefore, the precautionary principle requires minimising the level of active intervention, as well as careful selection of the concrete site of restocking, which gives NRS an advantage over RCI.

2) Correspondence between the intervention level and the flexibility to modify the action in case it becomes necessary: The inversely proportional correlation between the level of intervention and space for future modification means that NRS can be modified much easier during implementation when compared with RCI.

3) Functional complexity of the activity: NRS aims to achieve a complete system of conservation measures, including legislation and policy work, habitat and site oriented measures, as well as public awareness and educational activities. When RCI is applied, inevitably, consecutive conservation measures must be introduced in the area of action since release of wild falcons may not be sufficient by itself to establish or reinforce a wild population in a long term.

4) Sustainability of introduced measures: Since NRS relies largely on natural processes higher sustainability is expected while sustainability remains highly man-dependent for RCI.

5) Ability to monitor conservation outputs or correcting actions: Monitoring may be similarly difficult during NRS or RCI within complex mountain ranges, while it is easily achievable during NRS in the lowland.

6) Learning from previous experience of similar activities in Bulgaria: The positive results with natural recolonisation of Griffon Vulture in Eastern Rhodopi and problems occurred while releasing captive-bred game birds of several species in Bulgaria give advantages to NRS over RCI.

7) Ability to prevent genetic interference to the falcons in the wild: RCI requires very high level of precaution, while no such risk exists with NRS.

8) Ability to prevent introduction of infectious agents and atypical behavioural traits in the wild: Since RCI inevitably involves the use of Sakers from other countries and a period of keeping them in captivity it poses some risk by potential introduction of infectious agents exotic to the region in spite of every prevention measure. Theoretically, unwanted behavioural or ecological traits that are not typical for the local population may also be introduced with the new birds. No such risk exists for NRS.

9) Consideration of possible negative impact on Saker populations taken from the wild: Taking Sakers from wild populations may reduce viability of the donor population through the loss of individuals, which may only be a problem during RCI.

10) Ability to prevent or reduce natural predation: Prevention or reduction of the impact of natural predators (e.g. Eagle Owl, Stone Marten /*Martes martes/*) is more difficult in mountain rocky terrain during RCI or during NRS actions near traditional Saker sites. Risk is much lower and prevention is easier during NRS actions in the lowland.

11) Risk of food shortage and ability to reduce it: Food shortage may occur during both approaches, but organising supplementary supply of food is easier in lowland areas giving some advantage to NRS. This risk may be negligible also for RCI if the released falcons use foothills or lowland for hunting, similarly to historical populations.

12) Ability to reduce natural competition with other raptor species: Equal for RCI and NRS in the mountain areas (where potential natural competition exist with Golden Eagle, Peregrine, Eagle Owl and Long-legged Buzzard), but there is very little potential competition in the lowland areas with artificial nests (Long-legged Buzzard being a potential species), which gives advantage to NRS.

13) Prevention of secondary poisoning: It is equally important during RCI and NRS.

14) Reduction of impact of pigeon fanciers: A factor probably equally significant both during RCI and NRS, this type of risk can only be reduced by an efficient dialogue with pigeon fanciers and by further improvement of law enforcement.

15) Prevention of nest-robbing: This is easier during NRS, given the protective effect of high voltage electricity power and easier guarding of the nest boxes positioned on high voltage electricity pylons.

16) Prevention of electrocution/collision with powerlines: Possibly similarly important during RCI and NRS.

17) Raising public awareness for proper conservation measures: RCI has a higher public awareness potential but overemphasising the importance of captive breeding and restocking may overshadow the necessity of integral measures for the conservation of the species, its sites and habitats.

18) Wise use of financial, material and human resources: RCI, similarly to any reintroduction/restocking programmes is expensive, which poses NRS in a better position with respect to the effectiveness of the use of the restricted conservation resources in Bulgaria.

Approach of BSPB toward an effective conservation strategy

Based on the above facts and considerations, natural recolonisation of the species (NRS) is the accepted strategy of BSPB as the most adequate approach for Saker conservation. It is considered to be the best choice as it includes an already existing integral complex of measures aiming at issues of habitat, site and species.

Important element of the strategy is the understanding that in the long term Saker has better chances to survive if its adaptive potential would be directed to inhabit agricultural landscapes rather to relay entirely on remote wild areas. To reduce the impact of the considerable threat of nest robbing, nest boxes on the high voltage electricity pylons seems to be the only relatively safe alternative. The NRS strategy lacks any risk of genetic intervention with wild Sakers.

As the main resource for the natural recolonisation of Sakers the tens of individuals are considered, which occur in the country all year round. Their numbers are increasing during the periods of dispersion and migration, when birds from other parts of the Central and Eastern European Saker populations visit Bulgaria. Higher numbers of Sakers during the pre-breeding period is a precondition for some newly formed pairs to find appropriate conditions and to remain for breeding. The results of hitherto prevailing conservation actions in Bulgaria show that 'Hungarian' style aluminium nest boxes provide all necessary conditions for successful breeding of Kestrels. In spite of the existing significant differences between the two species, this is clear indication that the areas in question provide suitable conditions for the Saker. Furthermore, the existence of numerous Kestrel pairs along power lines (often at a few hundred meters from one another) provides opportunities for additional food supply for Saker by cleptoparasitism.

A natural recolonisation will obviously take a longer time since birds need to get familiar with the artificial nest first, to occupy it, to find a mate and hunting grounds, etc. At the same time it will allow more time for steering, preventive or correction actions, which is not possible with a 'faster' approach. Any risk of possible genetic intervention with wild European Saker populations is fully eliminated as another important advantage. This approach will be in full compliance with any new pieces of knowledge acquired on the genetics of Saker and other large falcons. Insufficient knowledge on the relevance of each of the threatening factors, the intrinsic mechanisms of their impact on saker population, have minor importance with NRS as it relies on natural regulation mechanisms.

A limiting factor for the NRS strategy is the critically low number of Sakers during the breeding period in Bulgaria. With such a long distance straggler and mobile species and with proven population exchange with the most numerous European national populations, its role should not be overestimated. The restoration of the Bulgarian population of Griffon Vulture by natural recolonisation from just one breeding pair in 1978 *(Michev et al. 1980)* up to 38 successfully breeding pairs in 2009 *(M. Kurtev, pers.comm.)* is promising to succeed with Saker Falcons, too.

Requirements for future Saker Falcon conservation activities

In the future the continuation and optimisation of the ongoing integral complex of conservation activities has a critical role for both preservation of the Saker in the wild and for eventual restocking activities. On legislative and law enforcement level they should include preventing the possible liberalisation of some of the acts, measures against nest robbing and other forms of bird crime, enforcing DNA fingerprinting protocol, actions against poaching, etc. Continuation of the policy level measures is necessary to further 'greening' the national agricultural policies, financial instruments and practices in favour of Saker and other endangered species. On the level of preservation of favourable conditions of habitats halting the process of transformation of pastures and other grasslands should be a priority. On the level of preservation of key sites adequate regimes for SPAs should be ensured and properly reflected in management plans drafted in the future. Financing and effective implementation of these plans will have a critical role for achieving their goals. It is possible to increase the efficiency of Saker preservation by creating new protected areas under national legislation and optimising and enforcing the regimes of already existing ones. Sys-

tematic measures should continue to reduce significant threats, such as electrocution, use of poisoned baits, nest robbing and others. On species level, provision of artificial nests, supplementary feeding, as well as nest guarding are still actual measures.

In the conservation of wild Sakers the following requirements are obligatory (they affect mostly the artificial nests activities as the most prominent human intervention):

1. To dispose artificial nests for Saker only at sites with no visible indications for any threat to the pair eventually occupying the nest;
2. To annually monitor the artificial nests and the conditions around itand to take appropriate measures in case of any threat identified to wild Sakers;
3. In case the artificial nest is occupied by Sakers initiate a complex array of measures planned in advance to ensure safety and successful breeding of the pair;
4. In case a significant threat to Saker is identified at an artificial nest, and the threat cannot be eliminated, the nest must be repositioned within the shortest possible time;
5. At any occupied Saker nest no action of any kind, imposing a risk of nest abandonment must be taken (approaching the nest, taking samples, photography, etc.); this measure must be in force until the numbers of breeding pairs is below ten pairs in the country.

As a significant human intervention, a future restocking programme must correspond to the following criteria:

1. To use only birds originating from Central and Eastern European populations;
2. Damage to the wild donor population should be minimised;
3. Only saker falcons with no sign of hybridisation and lacking any genetic elements uncharacteristic for the species should be used, as approved by independent experts;
4. Only those organisations or institutions signatories to an official and public agreement on the commitment and clear responsibilities of participants in the project;
5. All individuals used in the reintroduction must be checked genetically and reliable individual markers for further identification should be established.
6. Reintroduction must not take place in a radius less than 20 km from existing or presumed nesting sites.
7. In areas, where ongoing direct *in-situ* Saker conservation activities are in place by other projects, reintroduction actions can only take place if officially coordinated with the organisation executing the *in-situ* action, and vice versa.

Initially the programme was announced as reintroduction *(Ragyov et al., 2009)* but since the Saker is not considered fully extinct as yet and because of other reasons the Bulgarian government supported it as a restocking project. Therefore the term ‘reintroduction’ should be considered also as ‘restocking’.

Acknowledgements

The Bulgarian Saker Falcon conservation strategy of BSPB would not be possible without the participation, scientific input, support and collaboration of many institutions, organisations and individuals from Bulgaria and abroad. BSPB/BSPB is deeply grateful to all above mentioned sponsors of the Saker conservation activities, to the list of which, respectable organisations as BirdLife International, RSPB and MME/BirdLife Hungary should be added.

Most significant contribution was received by the BSPB experts, staff members and volunteers through the 20-year-long history of the organisation: *†Dr. Anton Antonov, Anton Kovachev, Asen Ignatov, Barbara Cross, †Bob Scott, Boris Barov, Boris Belchev, Borislav Tonchev, Chavdar Nikolov, Cymbre Baseley, Daniel Mitev, David Baseley, Deyan Duhalov, Dimitar Demerdzhiev, Dimitar Georgiev, Dimitar Plachiyski, Dimitar Vladimirov, Dimitrinka Atanasova, Dobromir Dobrev, Elena Andonova, Eleonora Ilieva, Emil Dzhuninski, Emil Todorov, Gabriel Martin, Galya Nikolova, Georgi Gerdzhikov, Georgi Gruev, Dr. Georgi Popgeorgiev, Georgi Vlaev, Gerasim Gerasimov, Gordyn Ramelot, Grigor Penev, Prof. Hans Jornvall, Hristo Gurdov, Hristo Hristov, Hristo Valchanov, Jean-Mark Mitterer, Iliyan Iliev, Ilcho Kolev, Irina Mateeva, Iva Ivanova, Iva Lalovska, Ivan Dinchev, Ivan Kremov, †Dr. Ivan Mitev, Ivaylo Angelov, Ivaylo Dimchev, Ivaylo Ivanov, Kalin Velev, Kamelia Dimitrova, Kamen Ruskov, Kary Nachev, Kostadin Georgiev, Krum Kosharevski, Lyubomir Profirov, Maria Deridzhan, Marin Kurtev, Marko Ivanov, Mehmed Hasan, Milko Dimitrov, Mike Roberts, Mila Alexandrova, Milen Marinov, Minko Madzharov, Mihaela Ilieva, Mihail Iliev, Mladen Vasilev, Mladen Gramatikov, †Maurice Waterhouse, Nedyalka Ivanova, Dr. Nikolay Petkov, †Nikolay Stefanov, Nikolay Terziev, Petar Mateev, Peter Hetz, Radoslav Moldovansky, Rosen Ivanov, Rosen Shterionov, Rusi Mirchev, Ruslan Nedyalkov, Sasho Vasilev, Sergey Dereliev, Sergey Panayotov, Simeon Gigov, Stamen Stanchev, Stoyan D. Nikolov, Stoycho Stoychev, Svetoslav Spasov, Svetoslav Stoyanov, Svilen Cheshmedzhiev, Sylvia Barova, Sylvia Dyulgerova, Tanya Valchanova, Teodor Hristov, Teodora Ivanova, Tichomir Tenkov, Todor Todorov, Valentin Katrandzhiev, Valya Angelova, Velislava Spasova, Vladimir Alexandrov, Vladimir Dobrev, Volen Arkumarev, Yana Barzova, Yordan Ivanov, Yordan Hristov, Zhivko Barzov.*

Valuable data and expertise were received from ornithologists in research institutes and universities: *Dr. Stoyan Ch. Nikolov* and *Assoc. Prof. Tanyu Michev* (Institute of Biodiversity and Ecological Research), *Dr Petar Shurulinkov, Dr Stefan Donchev, Dr Bozhidar Ivanov, Dr Boris Nikolov, Georgi Koshev* (Institute of Zoology, BAS), *Dr Ventseslav Delov, Atanas Grozdanov and Dr Rosen Tsonev* (Sofia University), *Dr Zlatozar Boev, Tichomir Stefanov, Boyan Petrov, Nedko Nedyalkov* (National Museum of Natural History), *Viktor Vasilev* (Shumen University), *Dr Tseno Petrov* (Natural History Museum – Plovdiv), *Dr Iliya Vatev* (Academy of Medicine), *Dr Maria Paspaleva.*

Recognised international experts and experts from different European countries shared important information with BSPB: *János Bagyura, Matyas Prommer, István Balázs* (Hungary), *Slobodan Puzovich* (Serbia), *V. A. Kostyushin* (Ukraine), *Dan Hulea* (Romania) and others.

Experts and rangers from the National and Nature Parks and Regional Inspectorates of the Ministry of Environment and Water provided important information: *Eberhard Undzhiyan* ("Rusenski Lom" NP), *Anton Stanchev, Venelin Koychev, Stoyan Hristov, Georgi Gugushev* (NP "Central Balkan"), *Rumen Kolchagov* (NP "Rila"), *Girgina Daskalova* ("Sinite Kamani" NP), *Krasimir Andonov* ("Vrachanski Balkan" NP), K*rasimir Kirov* (RIEW – Ruse), *Stefan Staykov* (RIEW – Veliko Tarnovo).

Colleagues from other NGOs provided their records and shared important experience: *Kiril Bedev* (Green Balkans), *Geko Spiridonov* (Wilderness Fund), *Emilian Stoynov* (Fund for the Wild Flora and Fauna), *Georgi Stoyanov* (Birds of Prey Protection Society), *Kateri-*

na Zareva (Balkani Wildlife Society).

Important information was provided by the following falcon enthusiasts fanciers: *Dr Raycho Gunchev, Dimitar Velikov* and *Galin Gospodinov*.

We are thankful to all of them for their contribution to a more comprehensive knowledge on Saker Falcon in Bulgaria, on its problems and conservation approaches.

References

Akimov, I. A. (ed.) (2009): Red data book of Ukraine. Animal Life. Globalconsulting, Kiev, 600 p.

Baumgart, W. (1966): Der Würgfalke als Brutvogel im Gebirge der Volksrepublik Bulgarien. *Falke* **13,** p. 256–260.

BirdLife International (2010): Species factsheet: *Falco cherrug*. Accessed from: http://www.birdlife.org on 02.09.2010.

Cramp, S. & Simmons, K. E. L. (eds.) (1980): The birds of the Western Palearctic. Vol. 2. Oxford, Oxford University Press, 695 p.

Donchev, S. (1980): Bird migration along the Bulgarian Black Sea Coast. *Ecology* (BAS) **7,** p. 68–83.

Ham, I. & Puzović, S. (2000): Stepski soko *Falco cherrug* (Gray, 1834). In *Puzović et al (ed.):* Atlas ptice Grabljivica Srbije, Mape Rasprostranjenosti i Procene Populacija 1977–1996, Zavod za zashtitu prirode Srbije, p. 171–176.

Yankov, P. & Gradinarov, D. (2009): [Hopeful results about the status of the Saker Falcon *(Falco cherrug)* in Bulgaria]. Accessed at: http://bspb.org/show2.php?id=1196&menu_id=102 (in Bulgarian)

Iankov, P. (ed.) (2007): Atlas of the breeding birds in Bulgaria. Bulgarian Society for the Protection of Birds, Conservation Series, Book 10. BSPB, Sofia, 679 p.

Iankov, P. (2010): Würgfalken in Bulgarien. *Falke* **12,** p. 500–505.

Iankov, P. & Profirov, L. (1991): Contemporary state of the Griffon Vulture (*Gyps fulvus* Hablizl) population in Bulgaria. *Ecology* (BAS) **24,** p. 44–52.

Iankov, P., Stoyanov, G. & Ragyov, D. (2013): Action plan for conservation of the Saker Falcon (*Falco cherrug* Gray, 1834) in Bulgaria (2013–2022). Sofia. 120 p.

IUCN (2001): IUCN Red List categories and criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. ii + 30 p.

Michev, T. & Simeonov, P. (1981): Studies on the autumn migration of some waterfowl and birds of prey near Burgas (13–23.IX.1978). *Ecology* (BAS) 8, p. 43–48.

Michev, T., Pomakov, V. Stefanov, V. & Iankov, P. (1980): A Colony of the Griffon Vulture (*Gyps fulvus* Hablizl) in the Eastern Rhodopies. *Ecology* (BAS) **6,** p. 74–79.

Michev, T. & Petrov T. (1985): Distribution and numbers of the Saker Falcon, *Falco cherrug cherrug* Gray, 1834 in Bulgaria. In Int. Symp. Proj. 8-MAB (UNESCO) 'Conservation of the natural territories and their genetic fund', 23–28.09.1985, Blagoevgrad, Proceedings, V. 1, BAS, p. 314–323.

Michev, T., Profirov, L., Dimitrov, M. & Nyagolov, K. (2004): The birds of Atanasovsko Lake: status and check List. Second Edition. Bourgas Wetlands Publication Series, 5. 2nd ed. Bulgarian Biodiversity Foundation, Project 'Bourgas Wetlands', Bourgas, 44 p.

Patev, P. (1950) The birds of Bulgaria. Sofia, BAS, 364 p.

Ragyov, D., E. Kmetova, A. Dixon, K. Franz, Y. Koshev, &N. Nedialkov (2009): Saker Falcon *Falco cherrug* reintroduction in Bulgaria: feasibility study. SESN, Sofia, 69 p.

Ruskov, K., Tonchev, B. Petrov, T. Iankov, P. Stoychev, S. & Daskalova, G. (2007): Saker Falcon *Falco cherrug*. In *Iankov, P. (ed.):* Atlas of the breeding birds in Bulgaria. Conservation Series, Book 10. Bulgarian Society for the Protection of Birds, Sofia, p. 186–187.

SER Report (2010): Strategic ecological research report on the development of the wind energy in Bulgaria. Ministry of Industry, Energy and Tourism, 457 p.
Sharrock, J. T. R. (1976): The atlas of breeding birds in Britain and Ireland. Poyser, Calton, 479 p.
Stoyanov, G. (2005): Observation of Saker Falcon (*Falco cherrug*). *Acrocephalus*, **26 /127/,** p. 202.
Vatev, I. (1983): Records of some comparatively rare and new bird species of the Bulgarian Black Sea coast. *Larus* **33–35,** p. 93–97.

Aquila (2012), Vol. **119**, p. 47–55

Status of the Saker Falcon *(Falco cherrug)* in Italy: past, present and future

Andrea Corso & Paul Harris

ABSTRACT—Saker Falcon was a fairly common wintering and passage species in Italy from the 19th to the 20th centuries, when it apparently became much scarcer, in certain regions of Italy its status turned even to irregular or vagrant. In this brief overview, we provide a summary of its present status, giving some insight of its past, present and postulated future presence in Italy. The known records in the last 10 years in Italy range from a few birds up to twenty individuals annually; however, due to the extreme paucity of observers in Italy, the huge and varied territory potentially suitable, and the scarcity of focussed search for the species the number of birds annually wintering and passing though Italy is definitely much higher. An estimation, using percentage of those birds radio-tagged in Hungary reaching Italy (versus the birds choosing a different destination) and the number of adult breeding birds, is given in order to make an attempt to define a first, though only indicative, figure of the potential number of Sakers reaching annually Italy, in order to show that this country is a fairly important area for the species and where urgent protection actions should be undertaken.

Key words: *Falco cherrug*, Italy, past and recent status, estimation of occurrences

Correspondence: *Andrea Corso,* Via Camastra, 10, 96100 Siracusa, Italy;
E-mail: voloerrante@yahoo.it

Introduction

Italy is one of the richest European country for bird diversity, and a very important area for breeding, migrating and wintering raptors *(Corso & Iapichino, 1998; Corso, 2001, 2005; Brichetti & Fracasso, 2003)* with the most important known world population of Lanner *(Falco biarmicus)* of the ssp. *feldeggii (Corso, 2001c)* and a healthy and expanding population of Peregrine *(Falco peregrinus) (Brichetti & Fracasso, 2003; Corso, 2005).* The country lies to the West of the known breeding range of Saker Falcon *(Falco cherrug) (Cramp & Simmons, 1980).* This latter, endangered species was formerly regular and fairly common during winter time and on migration in Italy *(Arrigoni degli Oddi, 1929; Martorellli, 1931; Brichetti & Fracasso, 2003),* and the southern regions such as Apulia were proably amongst the most important wintering areas of the species in Europe *(Foschi, 1986).* The records became scarce and irregular during the mid 20th century. In the last fifteen years radio-satellite tracked birds from Hungary and also from other countries (Austria, Slovakia e.g.) have shown together with an increasing number of observations that Italy should still be considered a very important area for Saker Falcon. In this paper, a brief overview of the past and recent status of Saker is given, while tentatively, an estimation of the number of birds reaching Italy is furnished according to the percentage of radio-satellite tagged birds that reached the country in the last decade.

Figure 1. Past records (1800–1986) of Saker Falcon *(Falco cherrug)* in Italy. Most records are concentrated in the Puglia region, with >40 specimens collected (see text) and between Calabria and Sicily, chiefly at the Strait of Messina area. It was quite frequent in Central Italy but fairly scarce in Northern Italy.

Figure 2. Recent Italian records (1987–2012) of Saker Falcon *(Falco cherrug)* in Italy. Most records are concentrated in Sicily, where it is a regular wintering and migrant bird at the Strait of Messina area. It is also regular, chiefly during winter, in Central Italy (like Lazio, Tuscany, Abruzzo and Marche) while it is scarce in Northern Italy.

Analysis of data

Past Italian records of Saker Falcon (from 1800 to 1986)

According to historical records (1800 till 1980), the species was regular in Italy, found mainly in the Southern regions (Figure 1). It was common and widespread, especially during pre-breeding migration and winter, with several dozen birds captured in Apulia, Southeast Italy (>40 specimens), showing that this region must have been a main wintering ground for European Sakers at the time *(Arrigoni degli Oddi, 1929; Foschi; 1986).* In addition, there were several records from Sardinia as well, where the species is only recorded occasionally in more recent times *(Brichetti et al., 1992; Brichetti & Fracasso, 2003).*

The information found in major historical ornithological reference works for Italy is summarised as follows. According to *Arrigoni degli Oddi (1929)* the species was difficult to obtain, being the commonest in Puglia and Calabria regions, but also frequently recorded in Sardinia. In *Arrigoni'*s bird collection, nowadays preserved at Museo Civico di Zoologia di Roma (MCZR), there are still 12 specimens, mostly taken in Southern Italy; of those, four birds were taken during the pre-breeding migration in April–May at Reggio Calabria,

Strait of Messina, while three were collected in Sardinia in spring and autumn, two in Northern Italy and one in Central Italy (*Foschi et al. 1996; AC,* unpubl., *C. Marangoni,* pers. com.). The species, however, was probably more common than shown by such a few number of captures and, based on some summer records, there were even speculations that it might have bred in Italy *(Arrigoni degli Oddi, 1929). Giglioli (1886, 1907)* characterised the species as fairly common both in winter and during migration. He mentioned 22 records, and he referred to Calabria, chiefly the Strait of Messina, as an area where the species was a regular pre-breeding migrant between March and May. According to *Martorelli (1931)* the species was also common and possibly even a breeding bird. *Foschi (1986)* quoted 20 individuals captured with traps in Foggia province, Puglia region (South Italy) between 1905 and 1927; in his bird collection, preserved at Museo Ornitologico Ferrante Foschi in Forlì, there are three juvenile females caught in September 1911, February 1930 and November 1942 *(Foschi, 1984).* Interestingly, one of the authors *(AC),* during an extensive study of skins in various European museums, found as much as 40 skins (mostly juvenile) preserved (Tring, Wien, Paris, Malmo, Milan, Roma, etc.) all labelled as being collected in Apulia, Foggia area, either in February or November between the years of 1911 and 1930.

These data prove that southern Italy, and Apulia in particular, was certainly well-known to bird collectors and ornithologists as an important wintering ground for Sakers, and that many birds were easily found in this area. Further south, *Lucifero (1901)* recorded the capture of two birds while migrating at the Strait of Messina, Reggio Calabria, in April 1892 and 1899. *Brichetti et al. (1992)* mentioned 40 records up to 1992, mostly from the period between 1800 and 1950 with records becoming scarcer afterwards. According to certain authors (*Martorelli, 1931; Foschi, 1986; Sorci et al., 1972* e.g.), most birds were aged as juveniles or immatures.

Recent data of Sakers in Italy (from 1987 to 2012)

Current assessment of the Italian status of Saker is biased for at least two known reasons: the species is easily misidentified and the sampling effort considerably increased recently due to migration monitoring campaigns and due to a much higher number of observers in the country nowadays. While it was relatively easy to collect or at least see the species by bird collectors or ornithologists (chiefly in the 19th to mid 20th century), the species became scarcer and the species was considered a rare vagrant after the mid 1980s. From this time on, confirmed records became scarcer in Italy. In particular, examination of the photos of claimed records from 1990 to 2012 (checked by *AC*) indicate that 20 out of 31 birds claimed (64.5%) were misidentified juvenile Peregrines (*Falco peregrinus calidus* Latham, 1790) from the North (mostly females due to their huge size). Similarly, 15 of the 32 (46.8%) specimens (analysed by *AC*) in Italian museums and bird collections were indeed re-identified as being juvenile *calidus,* captured during migration or winter—this subspecies is regular and common as well as being widespread throughout italy *(Corso, 1999; 2001);* the same problem occur regularly elsewhere in Europe (*Corso,* pers. obs. and data from the Association of European Rarities Committees) and being recognized as a common pitfall identification problem with *Falco biarmicus* and *Falco cherrug (Duquet, 2011).*

Year	No. of birds	N Italy	C Italy	S Italy
2003	3 (3 juv.)		2	1
2004	6 (5 juv.)		4	2
2005	5 (1 juv.)	2	3	
2006	4 (4 juv.)	1	3	
2007	8 (6 juv.)		6	2
2008	12 (8 juv.)	2	5	5
2009	11 (8 juv.)		6	5
2010	13 (7 juv.)	1	3	9
2011	3 (3 juv.)		2	1
2012	6 (6 juv.)		2	4
Total	71 (51 juv.)	6	36	29

Table 1. Number of Saker Falcons *(Falco cherrug)* reported in Italy annually in the EBN Italia annual report for the years 2003–2012 according to diffrent geographical areas (Northern, Central and South Italy – as shown in Figure 1); numbers of juveniles (juv.) are indicated in brackets

Brichetti & Fracasso (2003), reported that the species was a regular on passage during both the pre- and post-breeding migration, while it was irregular in winter; Saker records were far more abundant in historical times, decreasing progressively after the mid 20th century. The same authors also reported that the migration was more regular and conspicuous in southern Italy, while scarcer in central Italy and occasional, if not very rare, in north Italian regions (Figure 2). According to them four birds were counted at Monte Brisighella (Marche, central Italy) during spring 1993 and one at the nearby Mt. Conero during the 1987–1990 spring surveys.

For Sicily, only six old records were listed between 1967 and 1989 and eight records between 1990 and 2005 *(Corso & Iapichino, 1998; Corso, 2005)*. One to three birds were counted annually at the Sicilian side of the Strait of Messina during pre-breeding migration by the MAN-WWF group *(Corso, 2001b; 2005)*.

In the annual reports of EBN Italia a total of 71 Sakers were reported from 2003 to 2012 *(Ruggieri, 2003, 2004, 2005; Ruggieri & Sighele, 2007, 2008; Ruggieri & Nicoli, 2009, 2010, 2011, 2012, 2013),* of which 51 (71.8%) were aged as juveniles. The geographical distribution of data indicates a concentration of observations in central and southern Italy, with 36 records in the former and 29 in the latter area, respectively. However, due to the paucity of birdwatchers and ornithologists in the southern regions, the species is far more common than what data indicate. In particular, Sicily and Apulia are definitely the most important wintering areas in Italy (*Corso, 2005)* and possibly one of the most relevant ones in the Mediterranean basin (*M. Prommer,* pers. com.).

Considering also unpublished records, we are aware of 21 records during the years 2003–2005, 31 records during 2006–2008 and more than 20 records in 2009 alone (mostly during the winter of 2009/2010) and a total of 35 records from 2010 until January 2013 (*Corso,* pers. data; EBN list and forum online). As far as seasonality is concerned, 40 records refer to wintering and 18 records to—mostly pre-breeding—migration. We can state therefore that this species winters regularly in Italy and is also a relatively regular passage migrant. The higher number of spring records is most probably because there are far more raptor migration surveys throughout Italy during this season. The species is most abundant

	2007	2008	2009	2010
Estimated breeding population in Hungary (pairs)	172-190	180-200	216-230	220-230
Number of fledged juveniles	348	341	429	176
Total number of adults	≥ 344	≥ 360	≥ 432	≥ 440
Total number of 1st year birds	348	341	429	176
Total number of 2nd year birds			?	
Total number of 3rd year birds			?	

Table 2. Breeding numbers and success rates of Saker Falcon *(Falco cherrug)* in Hungary, during 2007–2010 (*M. Prommer,* pers. com.; Saker Group).

	2007 (M+F)	2008 (M+F)	2009 (M+F)	2010 (M+F)
Number of satellite-tagged birds of same year	10 (5+5)	19 (9+10)	13 (5+8)	2 (0+2)
Cumulative number of satellite-tagged birds	10 (5+5)	29 (14+15)	42 (19+23)	44 (19+25)
Calculated number of 1CY birds wintering in Italy	61	60	75	31

Table 3. Satellite-tagged Saker Falcons *(Falco cherrug)* in Hungary between 2007–2010 (M = males; F = females) with the calculated minimum numbers of first calendar year (1CY) birds wintering in Italy (method of calculation is explained in the text)

in Central and Southern Italy (Table 1, Figure 2) with Sicily being the most important wintering region in Italy (Figure 3).

Interesting records, the southernmost known for Italy and one of the southernmost records in Europe, were done during migration movements on islands of the Sicilian Channel: 1 juv. observed by the MISC group at Linosa, Pelagie Archipelago (AG) (Sicilian Channel, Sicily) in November 2010 and in November 2012, 1 observed at Lampedusa island (AG) (Sicilian Channel, Sicily) in September 2012 *(Ruggieri & Nicoli, 2011; 2012; 2013),* as well as from the past records, 1 bird being collected in April 1910 at Pantelleria island (Agri-gento, Sicily, Sicilian Channel) (preserved in *Arrigoni degli Oddi*'s collection at MCZR).

Mathematical evaluations from the project data

A preliminary calculation, largely based on the results from the Hungarian satellite-tracking project, estimates that at least 30 to 75 1CY Sakers may be expected to winter in Italy annually (Tables 2 and 3 and estimated values given below). In future years, with more data available hopefully, it will be possible to estimate this value with more precision. Thanks to satellite tracking studies on Sakers it is possible to have precise data on their winter movements, and even though the total number of tracked individuals is not extremely high currently, some conclusions can be drawn from the data available. The aim of this brief mathematical study is to estimate how many of those Sakers born in Hungary winter in Italy. As input data we used the breeding survey data in Hungary from 2007–2010 (Table 2) and the total number of satellite-tagged Sakers in Hungary (Table 3) (*M. Prommer,* pers. com.).

Figure 3. Known wintering areas of Saker Falcon *(Falco cherrug)* in Sicily; sites with fewer records were indicated in light grey while areas with records annually were indicated in dark grey (based on data from Hungarian and Austrian birds tracked with radio-satellite telemetry and from direct field observations)

The following Hungarian Sakers wintered in Italy or visited the country at least briefly: *Barna*—2007/8, 2008/9, 2009/10; *Julia, Konrád, Boglárka, Csanad, Izabell* (brief visit), *Romi*—2008/9; *Attila, Lucia*—2009/10 (the names were given to the individuals at the time of their tegging). Altogether, there were 11 Sakers from Hungary occurring in Italy during the winters 2007/2008, 2008/2009 and 2009/2010. *Barna* wintered in the same area in Sicily for 3 consecutive winters.

Izabell's case was also unique as she had a very short visit to Italy, from 29–30 October 2008, much in the same way as *Julia* briefly visited Sardinia on the 19th/20th November 2008. Thus *Izabell* cannot be considered as a true wintering Saker in Italy, and so we can calculate only with 10 true wintering records, of which three refer to the same individual *(Barna)*. But what is the total sample size of wintering Sakers for these three years? Eliminating the wintering of individuals where data is unavailable for some reason (death, malfunctioning, etc.), there are 43 wintering seasons of tagged Sakers with their movements accurately recorded. Of these records, 10 (or 23.3%) refer to Italy. However, several Sakers did not migrate very far and therefore cannot be considered as true migrants. If we calculate only the true migrant Sakers, there are 16 cases and Italy represents 10/16 = 62.5% of the raptors' choice as a wintering destination (in both cases we counted all the repeated visits of *Barna* to Italy; we do not know yet if such a wintering site fidelity is an exceptional case or it represents accurately the wintering behaviour of Sakers). So how many Sakers can be estimated to winter in Italy? The sample size is not very large, so we need to be careful not to over-estimate this value. Therefore we assume that only juveniles (1CY) migrate extensively (we only have four Sakers which have been monitored for more than one winter, and out of these three were basically non-migratory, the 4th being *Barna*). A total of 31 1CY birds were providing satellite data during their 1st winter with 26 (84%) being migratory and 5 non-migratory *(Prommer et al., 2012)*.

We have accurate data for 43 wintering seasons of Sakers, of these in 27 cases the birds were relatively "sessile" in the Carpathian basin, while 14 birds in 16 cases (*Barna* wintered 3 times) were long-distance migrants. Out of these 14 individuals, 8 wintered (in 10 cases) in Italy. Data on the migration behaviour of 2CY and 3CY birds is not sufficient to draw any conclusion. At this time we can only apply conservative calculations using these figures. We must also bear in mind that 7 young Sakers out of 44 (15.9%) certainly died before they had time to migrate. A further 6 birds seized to provide signals due to malfunction of the transmitter or they may have perished together with the unit before their migration age, so it is safe to say that, according to our data, 31 out of 44 (70.5%) 1CY Sakers survived definitely long enough to start migration. Out of these 1CY birds, 8 (30.7% of the 26 true migrants or 25.8% of all 1CY birds providing satellite data during migration time) wintered in Italy.

If we assume that 70% of young Sakers reach a migrating age and only 25% of these birds winter in Italy (instead of the calculated 70.5% and 25.8%, respectively) then 17.5% (70% times 25%) of the fledged juveniles in Hungary can be expected to winter in Italy in any year. This would mean, using the fledged young figures in the first tables, that at least 61, 62, 78, and 32 1CY Sakers may be expected to have wintered in Italy during the winters of 2007/8, 2008/9, 2009/10 and 2010/11, respectively. These figures may overestimate real values due to a possible statistical distortion resulting from a relatively small sample size, but it is much more likely that numbers are significantly higher, rather than smaller, for 3 reasons. (1) We assumed only 1CY birds are long distance migrants for winter (we know this is certainly not always true from the example of *Barna;* and from Table 1 we can see that only 72% of the Sakers observed in Italy are juveniles). (2) We have rounded down the percentage values used for our calculations (to 70% from the 84.1% of probable and 70.5% of definite surviver rate of all Hungarian juvenile Sakers and to 25% from 25.8% for 1CY Hungarian migrants wintering in Italy). (3) Most importantly, we have only considered Sakers born in Hungary, i.e. deriving from the population figures given in the Hungarian Saker satellite study. It is certainly possible, given the very long distances some of these Sakers undertake, that a significantly higher number of Sakers visit Italy from other countries with viable populations. Radio-tagged birds from Slovakia and Austria have in fact reached Italy in the last few years (*A. Gamauf,* pers. com.; *M. J. Riesing,* pers.com.).

Discussion

In the past, Saker Falcon was more common with a more widespread breeding range *(BirdLife, 2010),* and therefore Italian records were also more numerous. However, as shown by the latest available data it seems that there has been a positive trend during the last 15 years. With the present state of knowledge it is premature to state if this is mainly due to an increase in awareness—also thanks to the radio-satellite projects in Hungary, Austria and other countries—and better identification skills and increasing numbers of Italian birdwatchers, or whether the positive trend is also due to a real increase in Saker occurrences in Italy. Some data indicate that latter is the case: in Sicily, where observation efforts and skills can be considered stable for the last 20 years, there is an increase in the

numbers of Sakers observed (*Corso, 2005; Brichetti & Fracasso, 2003; Ruggieri, 2003, 2004, 2005; Ruggieri & Sighele, 2007, 2008; Ruggieri & Nicoli, 2009, 2010, 2011, 2012, 2013*). Radio-satellite projects demonstrated that the number of wintering and migrating birds in Italy is even higher, and this difference is due to the very scarce numbers and localised distribution of observers in such a large and habitat-rich country, where a good coverage of the territory is not possible. Direct passage observations also support the overlook hypothesis: *Thiollay (1977)* reported up to 25 Sakers observed at Cap Bon, Tunisia, during pre-breeding migration, flying towards Sicily.

We urge extensive surveys on the presence of Saker in the future all over Italy with more skilled observers involved. Also, Italy being without doubt one of the most important wintering country, at least in Europe, for this endangered species, conservation measures and actions should be undertaken by LIPU.

Acknowledgements

We wish to thank *Andrea Ciaccio, Roberto Gildi, Mario Cappelli, Carmelo Iapichino, Marco Gustin* and LIPU as well as many other observers. *Andrea Nicoli*, *Luciano Ruggieri* and *Maurizio Sighele*, of EBN Italia, are thanked for the help and data given to us. The MISC group is also thanked: *Ottavio Janni, Michele Viganò, Lucio Maniscalco* and *Igor Maiorano. Anna Giordano, Gianluca Chiofalo, Deborah Ricciardi, Simonetta Cutini, Carmeluccia Cardelli, Roberto Garavaglia* and others are thanked for the data about the Strait of Messina survey. The work of a number of museum curators has been invaluable for checking the skins in various parts of Europe. In particular, we wish to thank *Dr Carla Marangoni* of the Museo Civico di Zoologia di Roma (MCZR), *Dr Katrina Kook* and *Dr Mark Adams* of the British Natural History Museum, Tring (NHM) for their continuous help.

References

Arrigoni Degli Oddi, E. (1929): Ornitologia Italiana. Hoepli, Milano, CLI + 1046 p.

BirdLife International (2010): Species factsheet: *Falco cherrug.* Retrieved from: *http://www.birdlife.org* on 8/9/2010.

Brichetti, P., De Franceschi, P., & Baccetti, N. (eds) (1992): Fauna d'Italia. Aves I. Gaviidae-Phasianidae. Calderini, Bologna, xxviii, 964 p.

Brichetti, P., & Fracasso, G. (2003): Ornitologia Italiana. Vol. I Gaviidae–Falconidae. Alberto Perdisa Editore, Bologna, Italia.

Corso, A., (1999): Il Falco pellegrino siberiano *(Falco peregrinus calidus)* in Italia e problemi sulla sua identificazione. Quaderni di birdwatching, 2. CD ROM.

Corso, A. (2001): Raptor migration across the Strait of Messina, southern Italy. *British Birds* **94,** p. 196–202.

Corso, A. (2001b): First data on the migration of Siberian Peregrine *Falco peregrinus calidus* at the Straits of Messina and comments on its status in Italy. *Avocetta* **25,** p. 196.

*Corso, A. (2001*c): Biologie, Verbreitung und Bestimmung des Lannerfalken *Falco biarmicus* in Europa. *Limicola* **15,** p. 1–41.

Corso, A. (2005): Avifauna di Sicilia. L'EPOS, Palermo, 323 p.
Corso, A. & Iapichino, C. (1998): I rapaci svernanti in Sicilia negli anni 1990–1997. *Alula* **5,** p. 125–130.
Cramp S. & Simmons K. E. L. (1980): The Birds of the Western Palearctic. Volume II. Oxford University Press, Oxford, 695 p.
Duquet, M. (*2011):* Pièges de l'identification. Le jeune Faucon pèlerin *Falco peregrinus* de type *calidus*. *Ornithos* **18**(2), p. 106–112.
Foschi, U. F. (1984): Catalogo delle collezioni del Museo ornitologico Ferrante Foschi. Comune di Forlì, 112 p.
Foschi, F. (1986): Uccelli di Romagna. Maggioli, Rimini, 248 p.
Foschi, U. F., Bulgarini, F., Cignini, B., Lipperi, M., Melletti, M., Pizzarri, T. E & Visentin, M., (1996): Catalogo della collezione ornitologica "Arrigoni degli Oddi" del Museo Civico di Zoologia di Roma. *Ric. Biol. Selvaggina* **97,** p. 1–311.
Giglioli, H. E., (1886): Avifauna Italica. Le Monnier, Firenze 623 p.
Giglioli, H. E. (1907): Secondo resoconto dei risultati dell'Inchiesta Ornitologica. Avifauna Italica. Le Monnier, Firenze, XXIV, 784 p.
Lucifero, A. (1901): Avifauna Calabra. Elenco delle Specie di Uccelli Sedentari e di Passaggio in Calabria. Lazzeri, Siena, 166 p.
Martorelli, G. (1936): Gli Uccelli d'Italia. 2. ed. Rizzoli, Milano, 860 p.
Prommer, M., Bagyura, J., Chavko, J. & Uhrin, M. (2012): Migratory movements of the Central and Eastern European Saker Falcons *(Falco cherrug)* from juvenile dispersal to adulthood. *Aquila* **119,** p. 111–134.
Sorci G., Massa B. & Cangialosi, G., (1972. Osservazioni e catture interessanti in Sicilia. *Riv. ital. Orn.* **42,** p. 232–247.
Ruggieri, L. (red.), (2003): Annuario 2003. Edizioni EBN Italia.
Ruggieri, L. (red.), (2004): Annuario 2004. Edizioni EBN Italia.
Ruggieri, L. (red.), (2005): Annuario 2005. Edizioni EBN Italia, 48 p.
Ruggieri, L. & Sighele, M. (red.).(2007): Annuario 2006. Edizioni EBN Italia. Verona, 48 p.
Ruggieri, L. & Sighele, M. (red.).(2008): Annuario 2007. Edizioni EBN Italia. Verona, 48 p.
Ruggieri, L. & Nicoli, A. (red.) (2009): Annuario 2008. Edizioni EBN Italia. Verona, 44 p.
Ruggieri L. & Nicoli A. (red.) (*2009):*Annuario 2008. Edizioni EBN Italia. Verona, 44 p.
Ruggieri L. & Nicoli A. (red.) (*2010*): Annuario 2009. Edizioni EBN Italia. Verona, 47 p.
Ruggieri L. & Nicoli A. (*red.*) (*2011*) : Annuario 2010. Edizioni EBN Italia. Verona.
Ruggieri L. & Nicoli A. (red.) (*2012*) : Annuario 2011. Edizioni EBN Italia. Verona.
Ruggieri L. & Nicoli A. (red.) (*2013*) : Annuario 2012. Edizioni EBN Italia. Verona.
Thiollay J. M. (1977): Importances des populations de rapaces migrateurs en Mediterranee Occidentale. *Alauda* **45,** p. 115–121.

Aquila (2012), Vol. **119**, p. 57–64

Population of Saker Falcon *(Falco cherrug)* in Western Slovakia between 1976 and 2010

Jozef Chavko & Lucia Deutschová

ABSTRACT—The population of Saker Falcon in Western Slovakia was under a systematic monitoring since 1976. Gathered data were used to assess the distribution and population trends. The population has grown almost fourfold, from 7 pairs in 1979 to 27 pairs in 2010. During the study period nesting of 47 pairs was recorded. A total of 797 juveniles fledged successfully from the nests. The area of distribution has changed and increased significantly, majority of the pairs from mountains has moved to the lowland cultivated land. Management measures, such as guarding of the nests and installation of nest boxes, were of crucial importance for the population. Nowadays the population is dependent on artificial breeding opportunities and alternate feeding sources, as Feral Pigeon is the most common prey at present. Negative factors were surveyed as well. Several actions for its elimination were carried out, such as insulation of dangerous power lines, reduction of illegal activities, management of nesting and breeding habitats. Implementation of most of the measures would not be possible without different conservation programmes.

Key words: Saker Falcon, *Falco cherrug,* Slovakia, population trend, conservation

Correspondence: *Jozef Chavko,* Raptor Protection of Slovakia, Kuklovská 5, 841 04 Bratislava; E-mail: chavko@dravce.sk

Introduction

The territory of Western Slovakia is an important nesting area of the Saker Falcon. The first specific data about nesting of a Saker in Slovakia come from 1885 and 1886 from a rock at Devín castle situated in part of Bratislava called Devín *(Chernel, 1899)*. *Ferianc (1964)* described nesting of the species between 1928 and 1964. In that period the Malé Karpaty Mts were the most important breeding territory, with 6 recorded nesting pairs. Another 6–9 pairs were nesting in different orographic units in the western part of the country. It can be assumed, that there were another pairs nesting in the borderline floodplain forests of the River Morava, which was a strictly protected area until 1990. Until 1976 the population of Saker Falcon in Slovakia was not under systematic monitoring.

For the conservation of Saker Falcon in Slovakia implementation of three projects was very important. The project "Falco—Saker Falcon nest protection in the Malé Karpaty Mts", implemented between 1990 and 1994, has saved the population from a drastic decline due to nest robberies. Between 2006 and 2010 an international project for the conservation of Saker Falcon in Slovakia and Hungary was implemented. The project was supported within the programme of European Commission LIFE-Nature and contributed significantly to the conservation of the species. In 2010 a project supported from the Southeast Europe Saker falcon Network and Environment Agency (Abu Dhabi) was implemented in Southwest Slovakia. As the main result of this project, conditions for connection between Slovak and Hungarian population were created by installation of nest boxes in border area.

Material and methods

Monitoring of population and prey composition

Until 1976 all data came from incidental observations. Since 1976 a systematic monitoring of the Saker population in Western Slovakia has been carried out. The aim of the monitoring was to determine the real number of nesting pairs, trophic and habitat preferences of the species, habitat conditions and influences, as well as the trends of these factors. Surveys of the negative factors were also part of the survey. Since 1990 the borderline floodplain forests of the River Morava has been included in the surveyed area. The monitoring was carried out by the same methodology *(Chavko, 2010).* We suppose that between 1979 and 1990 approximately 69% of all nesting pairs in Western Slovakia were under the systematic monitoring, while since 1991 it was 92%. Regular ringing of chicks was carried out as a supplementary method of monitoring. In 2008 a solar Argos/GPS transmitters were used for the first time in Slovakia to follow the movement of Saker Falcon individuals. Altogether 6 females were tagged with this type of transmitter between 2008 and 2010 in Slovakia within the above mentioned LIFE project.

The monitoring of prey composition was carried out systematically since 1976 by analysis of food remains collected from the nests, mostly after the juveniles fledged. The monitoring was carried out by the same methodology during the whole period. The remains were analysed by an expert

Management measures

Different management measures were implemented. Creating of artificial nesting opportunities can be considered for crucial. Since 1981 31 artificial nests and 28 nest boxes on trees were installed, mostly in Malé Karpaty Mts. After 1994 the nest boxes and nests were installed also on high-voltage pylons, mostly in cultivated land. Until 2010 altogether 151 nest boxes and 15 artificial nests were installed. Since 2007 aluminium nest boxes were used within the LIFE project and the project supported by SESN (85 out of 151), and were installed in cooperation with the responsible company Slovenská elektrizačná prenosová sústava, a.s. The sites for artificial nesting opportunities were selected after considering the biological requirements of the species.

Crucial for the practical conservation of Saker Falcon was the guarding of the nests after 1990, by physical guarding and phototraps. Until 1995 a physical guarding of the whole population in Malé Karpaty Mts was ensured. 2–3 nests were guarded each year within the LIFE project. The guarding was done by volunteers, experts or by members of cooperating local hunting associations.

The repatriation of suslik *(Spermophilus citellus)* was done on foothills of Malé Karpaty Mts, on historical hunting territories of Saker in Western Slovakia, on sites where the suslik was a common species in the past. Between 2007 and 2010 a total of 574 suslik individuals were released on the area of 40 hectares. Monitoring of the repatriated individuals as well as suitable sustainable management of the site was ensured.

To prevent the electrocution more than 1000 pylons of dangerous 22 kV power lines were insulated in Western Slovakia, mostly within the LIFE project. Another 1000 pylons

						Average number of fledglings per nest	
		All breeding attempts	Successful breeding attempts	% of success	Number of fledglings	All attempts	Successful attempts
Tree	**natural nest**	109	64	59%	180	1.7	2.8
	artificial nest	29	21	72%	61	2.1	2.9
	nest box	28	15	54%	51	1.8	3.4
Pylon	**natural nest**	8	7	88%	18	2.3	2.6
	artificial nest	12	11	92%	39	3.3	3.5
	nest box	136	116	85%	408	3.0	3.5
Rock	**natural nest**	18	9	50%	26	1.4	2.9
	artificial nest	5	4	80%	14	2.8	3.5
	Total	345	247	72%	797	2.3	3.2

Table 1. Overview of breeding success of 47 Saker pairs in Western Slovakia between 1976 and 2010, according to different types of nests

	Breeding attempts				Average No. of fledglings per nest	
	Total	Successful	% of success	No. of fledglings	All attempts	Successful attempts
Mountains & floodplains	174	113	65%	305	1.8	2.7
Lowlands	171	134	78%	492	2.9	3.7

Table 2. Overview of breeding success of 47 Saker Falcon pairs in Western Slovakia between 1976 and 2010, comparing mountains and lowlands

were insulated in Eastern Slovakia. This action was implemented in cooperation with the responsible Companies Západoslovenská energetika, a.s. (which was also a partner of the LIFE project) and Východslovenská energetika, a.s.

Results and discussion

Population

Article about trend and conservation of Saker Falcon population in Western Slovakia between 1976 and 2010 was published previously *(Chavko, 2010)*. Some data have been specified and are published in modified form in this article.

In the study period significant changes in size and distribution of the Saker Falcon population in Western Slovakia were recorded (Figure 1). As mentioned in the methodology, majority of the pairs was known only since 1979, when 7 pairs were recorded (69% out of estimated total number of 10 pairs). In 2010, 27 pairs were known (92% out of estimated 29 pairs). Between 1976 and 2010 the reproduction dynamics of 47 pairs in Western Slovakia was studied. The average success between 1976 and 2010 was 2.3 fledglings/all breeding

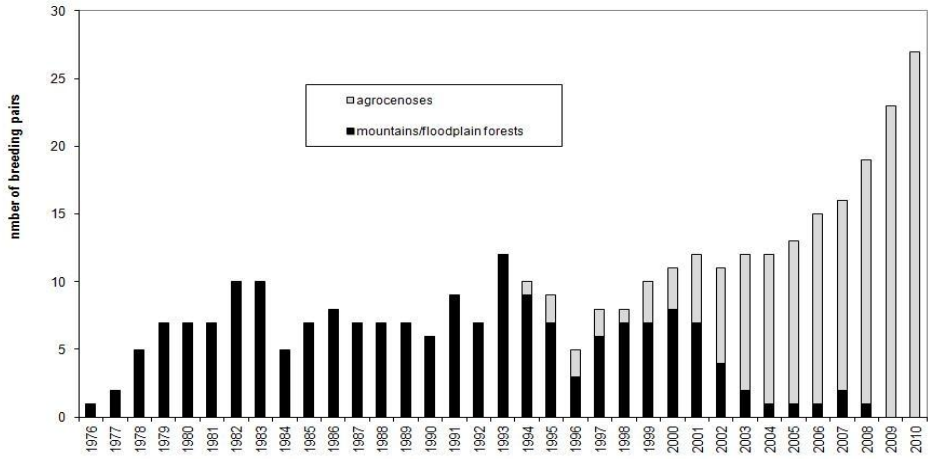


Figure 1. Trend of Saker Falcon population in Western Slovakia between 1976 and 2010 (after *Chavko, 2010*)

attempts (n = 345) and 3.2 fledglings/successful breeding attempts (n = 247), 47 pairs raised 797 fledglings (Table 1). From 1994 on, most of the pairs have moved gradually to cultivated land in lowlands with the last breeding in mountains or floodplain forests in 2008 (Figure 2). Out of the 345 recorded breeding attempts between 1976 and 2010, 153 were in mountains, 15 in floodplain forests and 177 in cultivated land. In Table 2 the success of nesting in traditional sites(mountains and floodplain forests) and lowlands is compared. The resettlement has been subject to significant negative impacts on nesting sites in mountains and floodplain forests, as well as to installation of nest boxes on high-voltage pylons in cultivated land. The new nesting areas were also suitable as feeding sites. In parallel with the relocation, a positive trend of the population (Figure 1), as well as an increase in the breeding success (Figure 2) were observed.

The losses represent 28% of all breeding attempts. Reasons of losses are listed in Table 3. Negative factors recorded during the monitoring are listed in Table 4. The influence of negative factors was so serious, that the population has stagnated until 2004, between 5 to 12 pairs. The threats and negative impacts are described by *Chavko (2010)*. Nest robbery was in the 1970s and 1980s of the 20th century one of the major factors endangering Saker population in Western Slovakia. Only by intensive guarding of the nest between 1990 and 1995 it was managed to maintain the population. Out of the negative factors the illegal activities have the most serious impact on the population at present, mostly in lowlands, where the major part of the population is nesting.

Creation of artificial nesting opportunities is considered as the most important management measure for the Saker Falcon in Western Slovakia. At present, the whole population is nesting in artificial conditions. Without implementation of management measures, the nesting population of Saker Falcon in Slovakia would likely disappear.

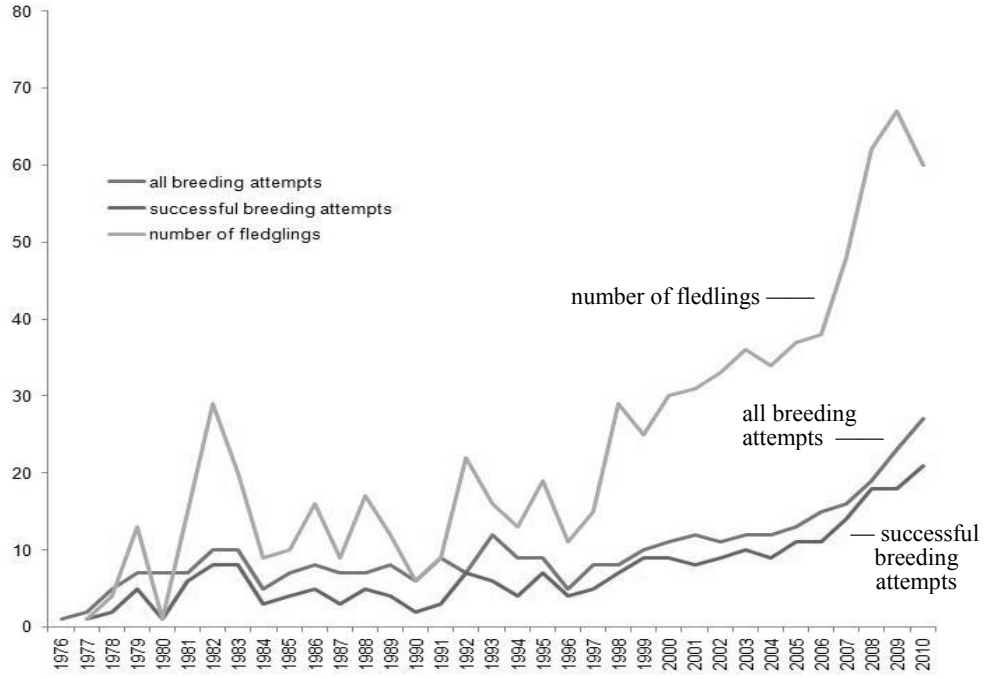


Figure 2. Breeding success of Saker Falcon in Western Slovakia between 1976 and 2010 (all breeding attempts and successful breeding attempts are in pairs, number of fledglings is in individuals)

Prey composition

In this article results of analysis of food remains collected between 2000 and 2009 are presented. Complete results from 1976 will be published in a separate article. The suslik was previously the dominant prey of Saker Falcon. As a result of intensive management practices, the structure of the country has significantly changed and the pastures with suslik colonies have disappeared *(Ambros, 2008).* As shown in Table 5, due to these changes the Saker Falcon adapted to other prey species. At present the Feral Pigeon *(Columba livia* f. *domestica)* is dominant in the prey of Saker Falcon in Western Slovakia. This situation is unsatisfactory mainly for two reasons. The first is food addiction of Sakers on pigeons as unnatural food sources. The second reason is the negative attitude of pigeon fanciers towards the Saker and the ensuing persecution of the species. For these reasons, it is necessary to continue the repatriation of suslik in Saker feeding territories, to re-establish the colonies. By analyzing the food remains it was also proved that the Saker feeds also on cadavers. The results show that most of the animals were killed by agricultural mechanism or road transport, what is documented by remains of a deer *(Capreolus capreolus),* fox *(Vulpes vulpes)* and an adult hare *(Lepus europaeus)*. This fact increases the risk of death

Reason	Number of cases
Nest robbery	20
Assumed nest robbery	12
Human disturbance	21
Natural reasons	21
Unknown	24
Total	**98**

Table 3. Direct reasons of losses between 1976 and 2010

Threatening factor	Mountains	Lowlands
Lack of feeding opportunities, loss and degradation of hunting sites	important	not important
Lack of nesting opportunities, loss and degradation of natural nesting sites	important	not important
Nest robberies	important	not important
Poisoning	not important	important
Shooting	not important	important
Predation	important	not important

Table 4. Importance of different negative factors on population of Saker in Slovakia in mountains and lowlands

due to feeding on poisoned bait. The analyses have proved presence of at least 41 bird species (81% of prey) and 10 mammal species (19% of prey).

Acknowledgements

Saker conservation work in Slovakia was supported by the LIFE06 NAT/H/000096 project. We would like to thank to all people who have contributed to the conservation of Saker Falcon in Western Slovakia, mainly to *Michal Ambros, Juraj Andre, János Bagyura, Alžbeta Darolová, Andrej Dubravský, József Fidlóczky, Dalibor Greguš, Martin Gič, Richard Galaš, Milan Gerthofer, Ervín Hapl, Stanislav Harvančík, Miroslav Holeša, Jirko Hološka, David Horal, †Peter Horák, Jozef Izakovič, Viliam Klescht, Ján Krištofík, František Karika, Mário Kern, Ondrej Koporec, Martin Kaľavský, Milan Královič, Jozef Lengyel, Ján Lipták, Boris Maderič, Milena Martinská, Lucia Matejovičová, Mária Nováková, Ján Orlovský, Milan Olekšák, Ján Obuch, Leonidas Prešinský, Mátyás Prommer, Dimitar Ragyov, Peter Rác, Slávka Siryová, František Szkuby, Ján Sekereš, Vojtech Szücs, Jozef Tóth, Fridrich Tóth,* and *Marcel Uhrin.* Special thanks for constructive cooperation and support go to the Slovenská elektrizačná prenosová sústava, a. s. (SEPS, a. s.), Západoslovenská energetika, a. s. (ZSE, a. s.) and several offices and employees of State Nature Conservancy of the Slovak Republic.

Species	Number of individuals	%
Columba livia forma *domestica*	3433	61.8%
Sturnus vulgaris	386	6.9%
Cricetus cricetus	355	6.4%
Phasianus colchicus	242	4.4%
Columba oenas	198	3.6%
Spermophilus citellus	166	3.0%
Columba palumbus	127	2.3%
Perdix perdix	120	2.2%
Larus ridibundus	107	1.9%
Lepus europaeus	96	1.7%
Microtus arvalis	93	1.7%
Streptopelia turtur	32	0.6%
Coturnix coturnix	29	0.5%
Pica pica	22	0.4%
Vanellus vanellus	22	0.4%
Streptopelia decaocto	21	0.4%
Alauda arvensis	18	0.3%
Turdus philomelos	11	0.2%
Coccothraustes coccothraustes	10	0.2%
Turdus merula	8	0.1%
Garrulus glandarius	6	0.1%
Talpa europaea	5	0.1%
Lullula arborea, Rattus norvegicus, Capreolus capreolus, Nyctalus noctula, Passeriformes sp.	15 (5 species x 3 individuals)	0.3%
Turdus viscivorus, Crex crex, Scolopax rusticola, Passer montanus, Passer domesticus, Anas platyrhynchos, Corvus corone, Falco tinnunculus, Apodemus sylvaticus, Aves sp. juv	20 (10 species x 2 individuals)	0.4%
Dendrocopos major, Loxia curvirostra, Pyrrhula pyrrhula, Galerida cristata, Lanius collurio, Anas crecca, Asio otus, Tyto alba, Gallus gallus dom., Apus apus, Aves sp., Apodemus flavicollis, Ondatra zibethicus, Vulpes vulpes, Philomachus pugnax, Larus canus	16 (16 species x 1 individual)	0.3%
Total	**5558**	**100.0%**

Table 5. Prey composition of Saker Falcon in Western Slovakia between 2000 and 2010

References

Ambros, M. (2008): Stav poznania rozšírenia sysľa pasienkového *(Spermophilus citellus)* na Slovensku v rokoch 1996 až 2008. Lynx n.s., Praha, **39**(2), p. 219–233.

Chavko, J. (2010): Trend and conservation of Saker Falcon *(Falco cherrug)* population in western Slovakia between 1976 and 2010. *Slovak Raptor Journal* **4,** p. 1–22.

Chernel I. (1899): Magyarország madarai különös tekintettel gazdasági jelentőségökre. Második könyv. Magyar Onitholóiai Központ, Budapest, 416 p.

Ferianc, O. (1964): Stavovce Slovenska II. Vtáky I. Vydavateľstvo SAV, Bratislava, 595 p.

Aquila (2012), Vol. **119**, p. 65–78

Satellite telemetry of Saker Falcons *(Falco cherrug)* in Austria: juvenile dispersal at the westernmost distribution limit of the species

Anita Gamauf[1,2] *& Robert Dosedel*[3]

[1] Museum of Natural History, 1st Zoological Department, Vienna; [2] University of Vienna, Dept. Evolutionary Biology, Vienna; [3] GVZ-Lobau, Vienna

ABSTRACT—Juvenile Saker Falcons *(Falco cherrug)* frequently travel long distances after leaving their natal areas. Documenting such movements and identifying areas where they make short stopovers and settle temporarily are important for understanding factors that influence the birds' survival and are necessary for conservation. In eastern Austria, at the westernmost limit of the distribution of this species, three juvenile females were fitted with 22g solar ARGOS/GPS PTTs-100 transmitters in 2009 and 2010. The birds left the hacking site at an age of 62-65 days. Between fledging and dispersal, 95% of relocations were confined to an area of 350 m around the hacking site. Before leaving the "natal area", the maximum distances covered were 1.9–3.6 km. The dispersal of the three siblings was abrupt, different and unpredictable. Food availability in the area surrounding the natal site did not appear to influence dispersal behaviour. During their movements, the birds mainly oriented between eastern and northerly directions, and clearly preferred habitats at elevations below 350 m a.s.l. One individual showed only a short-distance movement pattern with mean individual distances of <100 km away from the natal site. It largely remained in an area of 4,458 km² (95% Kernel) (1,503 km² (50% Kernel)) in SW Slovakia for about 3 months. In mid-October she migrated 1300 km south to Sicily for the winter. In contrast, the second individual was very mobile and showed multidirectional and long-distance movement, although she did not range farther than 700 km from the natal area by flying to Ukraine in the east and even reaching the Baltic Sea coast in the north before being killed by a car. The third individual made a round trip heading south to Slovenia, east to Hungary and north to the Czech Republic. In between, she crossed the Alps in eastern Austria and made a temporary stopover in SW Slovakia.

Key Words: *Falco cherrug,* satellite telemetry, juvenile dispersal

Correspondence: *Anita Gamauf,* Museum of Natural History Vienna, 1st Zoological Department Burgring 7, 1010 Vienna, Austria; E-mail: anita.gamauf@nhm-wien.ac.at

Introduction

The Saker Falcon *(Falco cherrug)* is widely distributed across Eurasia, ranging from central Europe to Mongolia *(Baumgart, 1991; Ferguson-Lees & Christie, 2001).* In eastern Austria, as in the Carpathian Basin, the subspecies *F. c. cyanopus* Thinemann, 1846, reaches the westernmost limit of its regular breeding range. As its absolute breeding numbers are low in all countries, the species is included on all national red lists within its range *(Frühauf, 2005),* and is furthermore protected by international legislation. Due to intensive conservation efforts in parts of the Carpathian Basin, especially in Hungary and Slovakia, where they have been running for many years *(Bagyura et al., 2010),* the European core population is increasing and Saker populations in neighbouring countries are growing. This

is also true for Austria where the current population is around 25-30 pairs and breeding pairs are concentrated in the NE of the country. In recent decades the population has recovered, and is currently stable or slightly increasing *(Gamauf, 1991; Berg, 2000; A. Gamauf* in *Mebs & Schmidt, 2006)*. In the open agricultural landscape of the Austrian part of the Pannonian region with its mild climate, Sakers are present throughout the year. Nevertheless, the extent to which Sakers remain in their breeding territories throughout the year or disperse to other regions is still unclear. To date nothing is known about species dispersal, migratory behaviour or space utilization, either for adult falcons or for juveniles. Documenting movements and identifying areas used by this species are important in understanding the factors that influence the survival of the birds. The tendency to disperse is presumably inherent and endogenously controlled, but the actual distances that individuals move are variable and may be influenced by environmental conditions *(Newton, 2008)*. Satellite telemetry is a useful tool to address questions of this kind *(Meyburg & Fuller, 2007)*. Satellite tracking has revolutionized the study of bird migration and bird life histories. The method has been widely applied to the study of raptors for many years, especially for larger and medium-sized species (e.g. *McGrady et al., 2003; Meyburg et al., 2006; McIntyre et al., 2009*).

Juvenile dispersal, here in the sense of postnatal dispersal or the movement of wandering individuals from their birthplace to their first breeding place, is one of the most important yet least understood features of population ecology and evolution. Many dispersal patterns follow a flow that is polarized along both a specific axis and direction *(Penteriani & Delgado, 2009)*.

Mortality in juvenile birds of prey is high, so only a small proportion of birds that hatch reach adulthood *(Newton, 1979)*. Loss of young birds can be particularly high during the first weeks of independence. First-year survival is estimated at between 23% and 40-50% in the releative Peregrine Falcon *(Falco peregrinus) (Tordoff & Redig, 1997; White et al., 2002)*. For this reason and because of the expense associated with the acquisition and handling of satellite-transmitters, studies have generally focussed on adult birds. However, it is important to obtain more detailed information on dispersal routes, range requirements and locations of young birds because it is possible that these show substantial differences to those of adults *(Hake et al., 2003)*. In the case of the Saker Falcon, knowledge of this kind is also relevant to conservation measures.

The project presented here focusses on (1) post-fledging dispersal of Sakers, (2) space-utilization and (3) exploration of temporary environments.

Materials and methods

In the Viennese raptor rehabilitation centre (GVZ-Lobau), 16 captive-bred Sakers from the autochthonous Pannonian population have been released since 2006 using the hacking technique, a training method that helps young falcons to reach their hunting potential by providing them exercise and experience. The hacking platform was located 50 m from the breeding aviary, so that the parents and their juveniles could be in contact with one another. The release site is situated at the border of the Donau-Auen National Park. The closest pair

Figure 1. Tagging a Saker Falcon with a solar ARGOS/GPS transmitter (Photo: *R. Dosedel*)

of wild Saker bred in 2009 about 7 km from the release site. In the course of the project "Born to be Wild", a total of three siblings (females) were fitted with 22g solar ARGOS/GPS PTTs-100 transmitters (Microwave Telemetry, Columbia, Maryland, USA) (Figure 1). We tagged two birds in 2009 and one in 2010, a few days before fledging. The transmitters were mounted as "backpacks", using a 6 mm Teflon ribbon (Bally Ribbon, Bally, Pennsylvania, USA). As the weight of the birds varied between 1040 g and 1200 g, the transmitter comprised 1.8-2.1% of the body weight, well below the 3% conventional guideline value for telemetric studies of birds *(Caccamise & Hedin, 1985; Kenward, 2001).* PTTs were powered by solar energy and transmitted (duty cycle) for 12 hours every 24 to 72 hours. We assume that the dispersal behaviour of released Sakers mirrors that of wild birds, as has been shown to be the case for many different raptors, including falcons (e.g. *Sherrod et al., 1987; Brown et al., 2004; Fremuth et al., 2008; Lindberg, 2009; Stout et al., 2009*).

All birds were also ringed with an aluminium leg band from the Vogelwarte Radolfzell as well as with a coloured leg band. The GPS locations were uploaded via the Argos system of satellites, and were accurate to within a few metres (user manual, CLS/Service Argos,

Bird ID	Weight	Satellite-tagged at	No. of signals	No. of applicable signals (%)	Post-departure tracking period	Dispersal pattern
PTT 93397	1040 g	16-06-2009	582	472 (81.1%)	109 days	unidirectional short-distance movement
PTT 93398	1060 g	16-06-2009	113	90 (79.6%)	46 days	multi-directional long-distance movement out of breeding range
PTT 93401	1200 g	14-06-2010	101	78 (77.2%)	19 days	multi-directional (?) long-distance movement out of breeding range

Table 1. Identification codes, weight, signal quality and duration and dispersal pattern of three juvenile female satellite-tagged Saker Falcons released in the course of a hacking project in eastern Austria

	Cumulative post-departure tracking distance (km)					Straight-line distance from natal/hacking area (km) [1]				
Bird ID	**before leaving hacking site**	**after 1 week**	**after 2 weeks**	**after 3 weeks**	**after 4 weeks**	**before leaving hacking site**	**after 1 week**	**after 2 weeks**	**after 3 weeks**	**after 4 weeks**
PTT 93397	62	259	320	1110	310	2,3	99	83	95	93[2]
PTT 93398	58	2412	?	?		1,9	649	731	?	686
PTT 93401	71	1329	?			3,6	123	218		

Table 2. Movements of juvenile Saker Falcons at the westernmost breeding range in Austria before and up to 4 weeks after leaving the hacking site as determined by satellite tracking (? = incomplete data due to bad weather conditions; [1] maximum distance; [2] similar distance for two more months)

Toulouse, France[1]). We calculated total distance moved during the tracking period as the cumulative tracking distance. However, we recognize that the figures represent minimum estimates as tracking was not continuous and movements were certainly not strictly linear between the locations in the consecutive duty cycles.

All elevation positions (metres above sea level) of PTT fixes were compared with those of random spots. Per locality, 4 random spots were used, each 5 km away from PTT fixes in N (0°), E (90°), S (180°), and W (270°) directions. Home range size was calculated from the fixed Kernel on the certain data set and using the Minimum Convex Polygon (MCP) method (95% isopleth). Core area was calculated by using the 50% isopleth of the same distribution (Animal Movement Arcview Extension 2.0). All statistical analyses were undertaken with the aid of the SPSS 17.0 software package.

As the data from the three Sakers are not homogeneous with regard to the number of signals and the length of the post-departure tracking period, juvenile dispersal is presented at an individual level (Figure 1; Tables 1–2).

[1] *http://www.argos-system.org/manual*

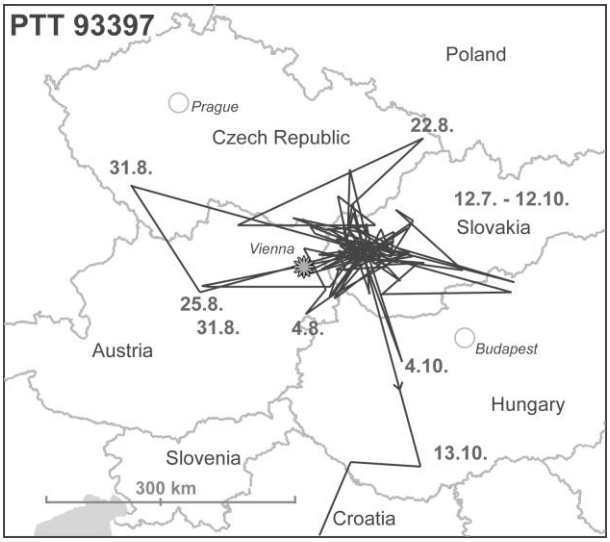


Figure 2. Juvenile dispersal routes of a female satellite tagged Saker Falcon marked PTT 93397

Results

Individual and unpredictable dispersal routes

Saker 1 (PTT 93397; Figure 2) was seen for the last time at its hacking site on the morning of 7 July (age: 64 days). Due to bad weather conditions, no signals were received for several days. Initially the bird did not move very far (Table 2), only flying about 100 km east to SW Slovakia (Trnva district), where she was recorded for the first time on 12 July. During the following three months the core area of her extensive home range was centred in the Trnava valley between the rivers Trnávka and Váh, east of Malé Karpathy Mts (Figure 3). The MCP area used by her was 6,776 km², the 95% kernel area was 4,458 km². The core area extension was relatively large (2,119 km²—MCP, 95% of all locations; 1,503 km²—50% Kernel). The bird moved its centre of activity regularly, sometimes weekly or every other week (mean number of days per centre of activity *11.2 ± 2.3 days; n = 8*). On this more short-term level the home ranges were much smaller (MCP *48.1 ± 22.6 km²;* MCP range 23-74 km²). There was no significant difference between the size of the home range and the number of days the bird used them *(Mann–Whitney U test = 39.4, p = 0.291, n. s.).* The distance between these activity centres varied from 16 km to 41 km. No significant difference was found between the distances and the number of days the home ranges were used *(Mann–Whitney U test = 53.7, p = 0.862, n. s.).* Especially after mid-August, PTT 93397 made longer one-day excursions (Table 3). On one such trip in Austria she even reached the border of the Northern Calcarious Alps. There, and at other localities such as in

Locality	Coordinates	Meters above sea level	Distance (km)	Direction	Date
Austria					
Siegendorf, Burgenland,	47° 46' 29"N, 16° 32' 42"E	188	111	SSW	4 Aug
Neuhofen/Ybbs, Lower Austria	48° 02' 43"N, 14° 52' 16"E	410	275	WSW	25 Aug
SE Neuhofen/Ybbs, Lower Austria	48° 01' 19"N, 14° 53' 26"E	647	297	WSW	31 Aug
Czech Republic					
Vrbice, SW Bohemia	49° 09' 03"N, 13° 40' 58"E	811	352	WNW	31 Aug
Komorni Lhotka, 28 km SE Ostrava	49° 39' 35"N, 18° 32' 39"E	476	105	NNE	22 Aug
Hungary					
Szuha, Bükk, Nagyvisnyó	47° 58' 59"N, 19° 55' 31"E	346	173	ESE	4 Oct

Table 3. The most distant records during one-day excursions of Saker PTT-93397 in 2009 outside its Slovakian core area

S and E Czech Republic and N Hungary, PTT fixes came from higher elevations than the localities she normally used (see below). On the way back from such an excursion the flight speed was 111 km/h (Gänserndorf, Austria – N Bratislava, Slovakia, in 20 minutes); typically, flight speed was 36–51 km/hour. It was not possible to determine with certainty whether the bird visited her hacking site, as was occasionally observed for other birds released in the previous year, which visited their hacking sites until October of the year they were released.

After the sudden onset of winter weather, PTT 93397 left her Slovakian home range on 14 October stopping only for a short time 260 km south, near Pécs, in SW Hungary. Only five days later she was found in W Sicily, c.1200 km SSW from the hacking site and 1300 km from her Slovakian home range. Unfortunately, due to bad weather conditions no signals were received during the migration, so it is not clear which route she took across the Adriatic Sea and how long the crossing took. In Sicily, the transmitter stopped working on 22 October. Surprisingly, sightings of a female 1st-year Saker were reported by an Italian ornithologist (*A. Corso,* pers. com.). His observations in December and mid-January 2010 in the surroundings of Siracusa, SE Sicily, suggested that the bird in question was PTT 93397 and that she was still alive and on the island Although Sicily is very mountainous, all but one location where she was recorded were below 250 m a.s.l.

On 3 March, 2013, PTT 93397 was found in its 5th year electrocuted near Donji Miholjac, NE Croatia, close to Drava River. This location was 302 km (154.1°SSE) away from the releasing site. It cannot be excluded that it settled there for breeding, as the locality was situated inside the breeding range, the bird was already mature and at that time usually breeding starts *(Gamauf & Dosedel, submitted).*

Saker 2 (PTT 93398; Figure 4) left the hatching site three weeks after being tagged on 6 July (age: 65 days). As with her siblings, when she was independent she was repeatedly observed to exhibit kleptoparasitic behaviour, snatching prey items from Kestrels *(Falco tinnunculus)* and Common Buzzards *(Buteo buteo)* and independently hunting voles (*Microtus* sp.). Based on the time between their departures and the bearing of their movements away from the hacking site, the two siblings left the areas where they were released in 2009 independently. Before finally leaving the hacking site, they showed no difference in cumulative tracking distance (km) or mean distance (in a straight line) from the natal/hacking area

Figure 3. Habitat in the core area of Saker PTT 93397 near Bohunice, SW Slovakia (Photo: *A. Gamauf*)

(Table 2), but this changed rapidly afterwards. After the end of a rainy period the bird became very mobile, stopping only for a short time in Trnva district, SW Slovakia, where PTT 93397 chose her core area, and continuing to Starokostiantyniv, Khmel´nyts´ka oblast, W Ukraine. Within two days she covered a distance of >700 km. A further two days later, on 11 July, she was recorded in S Poland, c. 500 km WNW of her easternmost location in Ukraine. During the following days she moved northwards (>700 km from the hacking site). Signals were received from the area W of Gdańsk up to the coast of the Baltic Sea (Słowiński National Park) and including a short trip across the open sea. At the end of July, six weeks after fledging, the bird was killed by a car in Recki, N Poland (close to Gdańsk), about 700 km away from its hacking site. Although she covered a very long distance in total, it is remarkable that she only moved in a radius of around 700+ km from the site of release.

Saker 3 (PTT 93401; Figure 5) undertook her first long trip on 28 June at the age of 62 days. It is remarkable that this journey also led her to the Trnava district, SW Slovakia, where she spent half a day. Presumably the Danube valley functioned as a kind of guideline eastwards into the Carpathian Basin. During subsequent days, under very summery weather conditions, she flew a wide route across W Slovakia and E Austria, where she crossed the Alps at 900-1000 m a.s.l. between Lower Austria and Styria (presumably between Göller 1766 m a.s.l. and Schneealpe 1903 m a.s.l.) 80 km W of the breeding range. This is a region

Figure 4. Juvenile dispersal routes of a female satellite tagged Saker Falcon marked PTT 93398

where no Sakers have been recorded previously. Following the river Mur from the city Bruck/Mur southwards, she finally reached Slovenia (Ptuj). On her return journey she flew northwards through the Little Hungarian Plain and back to her starting point at Komjatice, SW Slovakia. After a short stopover in the Nitra valley, she continued north to NE Czech Republic, from where the last good signals were received (near Kyjovice). A few days later, on 10 July, a single, poor quality signal came east from the city of Ostrava. Despite the help of Czech colleagues *(D. Horal, P.* and *V. Zvolanek)* it was not possible to obtain a final clarification of her whereabouts.

The natural potential of Saker for range extension

Despite being closely related and of the same sex, the three birds behaved very differently. With regard to the directions they flew, the mean post-departure bearing for the three Sakers differed markedly from one another *(Watson U^2 test = 0.73, df =2, P<0.001)*. PTT 93397 definitely tended towards the ENE (75%), whereas 52% of all locations of PTT 93398 pointed in N direction, and PTT 93401 dispersed primarily in ENE to ESE directions (Figure 6).

During their juvenile dispersal phase, the three Saker Falcons clearly preferred open plains, basins and hilly areas at low elevations between 100 m and 350 m a.s.l., although the variation was relatively high, especially resulting from occasional excursions outside the core areas. PTT 93397, for example, expanded her range to elevations up to >800 m a.s.l., e.g. in the Northern Calcarious Alps, mountain massifs in eastern Alps and the foothills of the Bohemian Forest. The same behaviour was observed for PTT 93401, who also

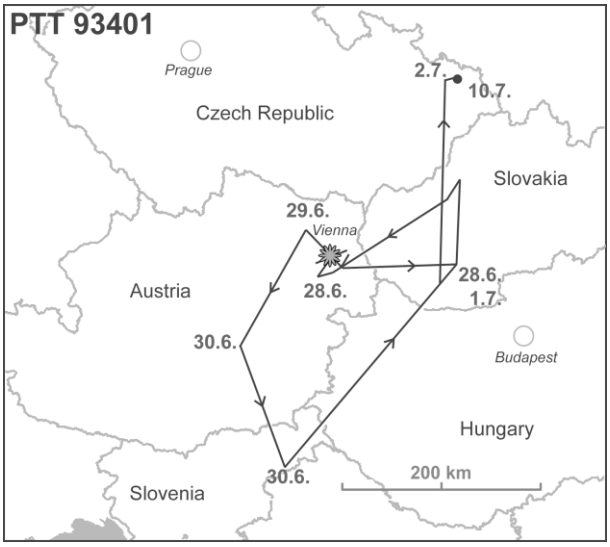


Figure 5. Juvenile dispersal routes of a female satellite tagged Saker Falcon marked PTT 93401

avoided higher ridges and mountain ranges but once directly crossed the alpine massif. Comparing elevations of the PTT fixes with random points, no significant differences were detected for PTT 93397 and PTT 93398. The significant differences for PTT 93401 (*Mann–Whitney U test = 28, p = 0.031;* Figure 7) might result from the relatively low sample size.

Although the wider surroundings of the release site were rich in food sources (Feral Pigeons /*Columba livia* f. *domestica/*, Starlings /*Sturnus vulgaris/*, voles */Microtus* sp./)—which resulted in a high breeding density (e.g. three nests separated by nearest-neighbour distances of 2-3 km)—it had no apparent influence on the start of dispersal or on the movement itself (i.e. it affected neither distance nor direction).

Discussion

Released Saker Falcons from the westernmost limit of the species' breeding range exhibited a wide range of movement patterns. Despite the small sample size, the data show that juvenile Sakers disperse far, outside the closed breeding range in an easterly and northerly direction, e.g. up to Ukraine and the Baltic Sea (Poland). That Poland is visited more frequently than the relatively scarce observations would indicate, was shown by *Sielicki et al. (2009)* and the finding is underlined by another record of an Austrian Saker from June 2009. A 2nd year male hacked at GVZ in the previous year was killed in the southern part of the country (Góra near Pszczyna) by a pigeon breeder. As Sakers prefer lowlands and big river valleys when dispersing, it seems that Austrian birds regularly follow the Moravian

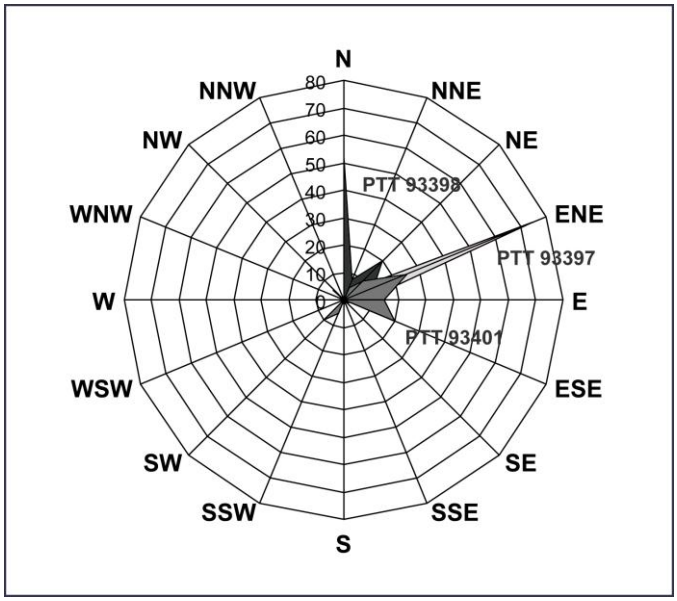


Figure 6. Post-departure direction (% of observations) of three satellite-tagged Saker Falcons from eastern Austria (n=209)

valley in a northerly direction. On the way they pass the Moravian Gap between the Sudety and Beskid Mountains and reach the valley of the Oder River in southern Poland. Three (PTT 93397, PTT 93401, 2nd year male) out of the four birds discussed in this manuscript followed that route (Figure 8).

Topography may play a role in the pattern of dispersal. For example, by following the Drava valley, Sakers could gain access even to inner Alpine areas. Short trips to these areas by Sakers may be the reason that they have been found in these places (records often without details). Among them was a juvenile bird, ringed on the 2nd July 1991 in W Hungary and found one week later on the 9th July in the Klagenfurter Basin, Austria, in a weak condition *(Feldner et al., 2008)*. Otherwise, the eastern orientated Danube valley and the Carpathian Basin *per se* play very important role for Austrian Sakers.

Our study confirmed that satellite telemetry is a useful tool to investigate the movements and stopovers of juvenile Sakers at a critical stage of their lives. The results did not only reveal far-reaching dispersal routes, but also highlighted the importance of the Carpathian Basin for Austrian Sakers. The efficiency of satellite tracking technology enables the collection of more precise and reliable information than can be obtained with a small network of observers.

The large distances over which the species roams confirm the potential for gene flow between distant populations, which genetic analyses have proven to occur *(Nittinger et al., 2007). The* ability to expand by means of juvenile dispersal in different directions and over long distances, where even high mountains are not a barrier, requires the ability to settle in suitable habitats outside the closed breeding range. To facilitate this, Sakers are very flexi-

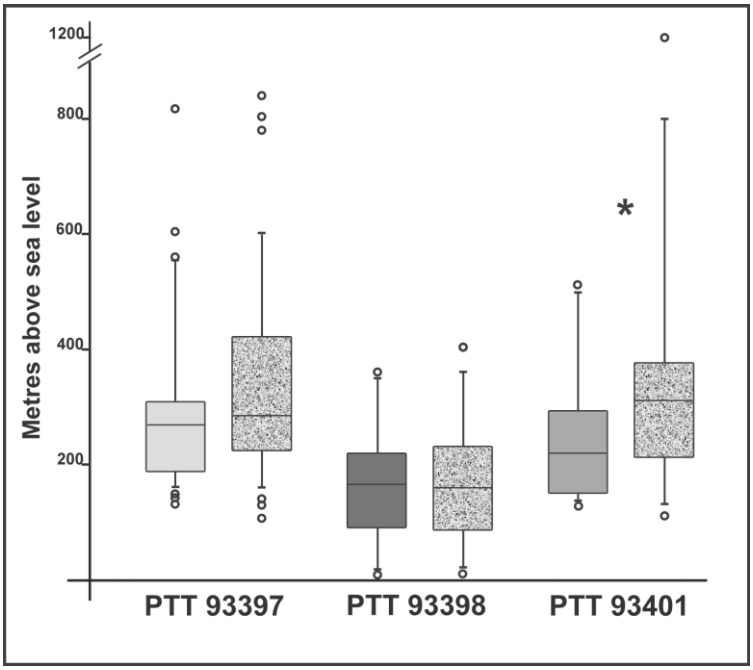


Figure 7. *Box-plots* of metres above sea level of all PTT fixes (left) in comparison with random spots (right) for each of the three tagged Sakers *(* P < 0.05)*

ble hunters and their diet includes small mammals and birds, depending upon the local conditions (*Frey & Senn, 1980; Bagyura et al., 1994;* authors' own data).

An additional key factor in the extension of the species' range is the growing population in the core of its breeding range, the Carpathian Basin. As the population is continuing to grow, especially in the species' Hungarian stronghold *(Bagyura et al., 2009),* it is perhaps only a question of time before new breeding territories are established outside the present range, perhaps initially N–NW of the current range where dispersal might follow the Danube and Morava valleys as a first guideline. The rather recent records in Saxonia, Germany (1997–2001) and S Poland (1998) should be seen in this light and the historical evidence of "blue-footed falcons" in Germany *(Augst, 1998; Barthel, 2011).* The oldest evidence are dated from the 14th century in Baden-Württemberg (*Gatter & Bizer, 2012*). Other evidence from Hessen and Saxony in the 16th and 17th centuries cannot be dismissed without considering it, either (discussed by *Augst, 1998; Barthel, 2011*) (Figure 8). The fact that these observations did not take place in a climatically warm period but in the "mini ice-age" (c. 1400–1800) is not particularly surprising, as (1) the sightings may relate to relict populations from the former late medieval climatic optimum, and (2) the conditions in the core area of the distribution at that time might have been optimum, allowing the species to spread in a NW direction. (3) Additionally it has to be considered that at that time Germany was largely deforested and often used as pasture land *(Gatter & Bizer, 2012).*

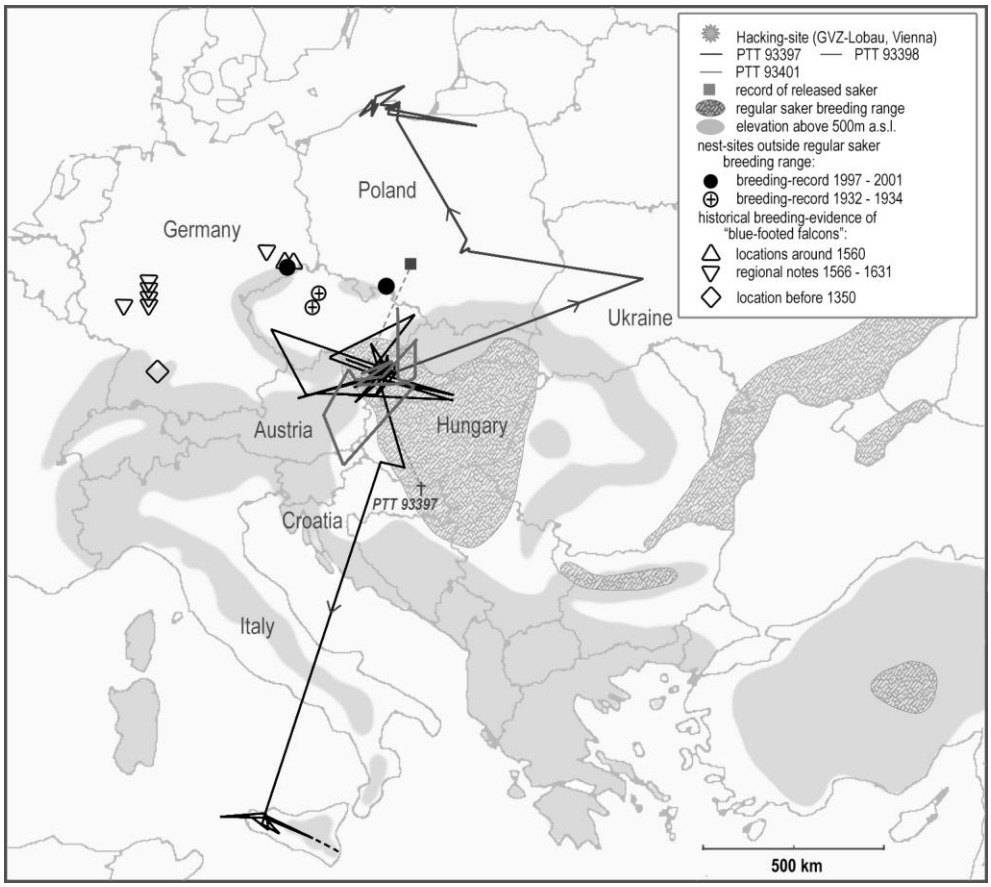


Figure 8. Dispersal routes of three juvenile Saker Falcons at the westernmost distribution limit of the species in connection with current distribution range (after *Mebs & Schmidt 2006*) and historical breeding evidences (after *Augst, 1998; Barthel, 2011* and *Gatter & Bizer, 2012*)

At any rate, young birds from this westernmost portion of the breeding range are especially prone to disperse in increasingly more northerly directions. In contrast, from more eastern populations in the Carpathian Basin of Hungary and Slovakia, only a few out of 43 young Sakers that were fitted with satellite tags visited these regions *(Prommer & Bagyura, 2009; Bagyura et al., 2010).* Birds from that study apparently followed the big valley systems (Danube, Tisza, Drava) that have S to SE orientation on their early dispersal routes instead. It is clearly not possible to predict, apart from initial suppositions *(Huntley et al., 2007),* how the current range of the Saker Falcon will develop as a result of global climate change.

It should be noted that this far reaching dispersal behaviour also represents a potential threat to the Saker, which is associated with agricultural development in central Europe.

Apart from direct persecution (shooting, trapping, poisoning), electrocutions and mechanical accidents (with power lines, cars) are especially noteworthy *(Nagy & Demeter, 2006)*. Furthermore, the protected areas are too small to ensure protection of such a mobile raptor.

As Saker Falcons move over large geographic areas and across different international boundaries (seven in this single study) it is obvious that conservation efforts need to address both regional and international issues.

Acknowledgements

For various kinds of support with this project we are indebted to *M. McGrady* (Austria, United Kingdom); *M. Prommer* (Hungary); *N. Wurzinger, A. Kummer* and *E. Dosedel, R. Matz, M. Riesing* (Austria); *M. Matysiak, J. Sielicki, J. Tekesz* (Poland); *J. Chavko, M. Kalavsky* (Slovakia); *D. Horal, P.* and *V. Zvolanek* (Czech Republic); *A. Corso* (Italy) and *A. Floreani* (Croatia). Many thanks also to *G. Tebb* (Austria) for his helpful comments on the manuscript. The project was funded by MA-22, HJST, Friends of NHM, HGG fly:way and SIGMA^{jazz}.

References

Augst, U. (1998): Die Ansiedlung des Würgfalken *Falco cherrug* als Brutvogel in Deutschland. *Limicola* **12,** p. 297–313.

Augst, U. (2001): Die ersten erfolgreichen Bruten des Würgfalken *Falco cherrug* in Deutschland. *Limicola* **15,** p. 137–146.

Bagyura, J., Szitta, T., Haraszthy, L., Fidlóczky, J. & Prommer, M. (2009): Results of Saker conservation programme in Hungary, 1980–2006. In *Sielicki J. & Mizera T. (eds.):* Peregrine falcon populations—status and perspective in the 21st century. Turul, Poznan, p. 749–756.

Bagyura, J., Haraszthy, L. & Szitta, T. (1994): Feeding biology of the Saker Falcon *Falco cherrug* in Hungary. In *Meyburg B.-U., Chancellor R. (eds.):* Raptor conservation today. WWGBP, Berlin, p. 397–401.

Bagyura, J., Fidlóczky, J., & Prommer, M. (2010): Conservation of *Falco cherrug* in the Carpathian Basin (LIFE06 NAT/H/000096). MME/BirdLife Hungary, Budapest.

Barthel, P. H. (2011): Zwischen Freiland und Gesetz–der Würgfalke *Falco cherrug* als heimische Vogelart. *Limicola* **25,** p. 284–316.

Baumgart, W. (1991): Der Sakerfalke. 3. Auflage. Neue Brehm Bücherei 514. Ziemsen, Wittenberg, 159 p.

Berg, H.-M. (2000): Zwischenbericht über die Kartierung des Sakerfalken *(Falco cherrug)*—Vorkommen in Ostösterreich. Manuscript, Vienna.

Brown, J. L., Heinrich, W. R., Jenny, J. P. & Mutch, B. D. (2004): Development of hunting behaviour in hacked Aplamado Falcons. *J. Raptor Res*. **38,** p. 148–152.

Caccamise, D. F. & Hedin, R. S. (1985): An aerodynamic basis for selecting transmitter loads in birds. *Wilson Bulletin* **97,** p. 306–318.

Feldner, J., Petutschnig, W., Wagner, S., Probst, R., Malle, G. & Buschenreiter, R. K. (2008): Avifauna Kärntens 2. Die Gastvögel. Naturwissenschaftlicher Verein für Kärnten, Klagenfurt, p. 150–151.

Ferguson-Lees, J. & Christie, D. A. (2001): Raptors of the World. Christopher Helm, London.

Fremuth, W., Frey, H. & Walter, W. (2008): Bearded Vulture back in the Alps—30 years of breeding and resettlement. *Natur und Landschaftsplanung* **40,** p. 121–127.

Frey, H. & Senn, H. (1989): Zur Ernährung des Würgfalken (*Falco cherrug*) und Wanderfalken *(Falco peregrinus)* in den niederösterreichischen Kalkvoralpen. *Egretta* **23,** p. 31–38.

Frühauf, J. (2005): Rote Liste der Brutvögel (Aves) Österreichs. In *Zulka K. P. (ed.):* Rote Listen

gefährdeter Tiere Österreichs. Grüne Reihe, Bd. 14/1. Wien, p. 63–166.
Gamauf, A. (1991): Greifvögel in Österreich: Bestand–Bedrohung–Gesetz. Monographien 29. Umweltbundesamt, Wien, 136 p.
Gamauf, A. & Dosedel, R. (submitted): Stromtod eines in Österreich mit Satellitensender versehenen Sakerfalken (*Falco cherrug*) in Kroatien.
Gatter, W. & Bizer, C. (2012): Ein weiterer historischer Brutplatz des Würgfalken *Falco cherrug* in Deutschland an der oberen Donau. *Limicola* **26,** p. 141–145.
Hake, M., Kjellén, N., & Alerstam, T. (2003): Age-dependent migration strategy in Honey-buzzard *Pernis apivorus* tracked by satellite. *Oikos* **103,** p. 385–396.
Huntley, B., Green, R. E., Collingham, Y. C. & Willis, S. G. (2007): A climatic atlas of European breeding birds. Lynx Edicions, 521 p.
Kenward, R. (2001): A manual of wildlife radio-tagging. Academic Press, London, 311 p.
Lindberg, P. (2009): Colour-ringing of Swedish Peregrine Falcons migration and natal dispersal. In *Sielicki, J. & Mizera, T. (eds.):* Peregrine Falcon populations—status and perspective in the 21st century. Turul, Poznan, p. 145–152.
McGrady, M. J., Ueta, M., , Potapov, E. R., Uthekina, E., Masterov, V., Ladyguine, A., Zykov, V., Cibor, J., Fuller, M. & Seegar, W. S. (2003): Movements by juvenile and immature Steller´s Sea Eagles *Haliaeetus pelagicus* tracked by satellite. *Ibis* **145,** p. 318–328.
McIntyre, C. L., Douglas, D. C. & Adams, L. G. (2009): Movements of juvenile Gyrfalcons from western and interior Alaska following departure from their natal areas. *J. Raptor Res.* **43,** p. 99–109.
Mebs, T., Schmidt, D. (2006): Die Greifvögel Europas, Nordafrikas und Vorderasiens. Kosmos-Verlag, Stuttgart, 496 p.
Meyburg, B.-U., Matthes, J. & Matthes, H. (2006): GPS satellite tracking of Lesser Spotted Eagles *(Aquila pomarina):* home range and territorial behaviour. *Vogelwelt* **127,** p. 127–144.
Meyburg, B.-U., & Fuller, M. R. (2007): Satellite tracking. In *Bird D. M. & Bildstein K. L. (eds.):* Raptor research techniques manual. Hancock House, Blaine, p. 242–248.
Nagy, S. & Demeter, I. (2006): Saker Falcon. European single species Action Plan. BirdLife International. Cambridge, UK, 41 p.
Newton, I. (1979): Population ecology of raptors. Poyser, Berkhamsted, 432 p.
Newton, I. (2008): The migration ecology of birds. Academic Press, London, 984 p.
Nittinger, F., Gamauf, A., Pinsker, W., Wink, M. & Haring, E. (2007): Phylogeography and population structure of the Saker Falcon *(Falco cherrug)* and the influence of hybridization: mitochondrial and microsatellite data. *Molecular Ecology* **16,** p. 1497–1517.
Penteriani, V. & Delgado, M. (2009): Thoughts on natal dispersal. *J. Raptor Res.* **43,** p. 90–98.
Prommer, M. & Bagyura, J. (2009): Dangerous journeys of Sakers of the Carpathian basin. In *Sielicki, J. & Mizera, T. (eds.):* Peregrine falcon populations—status and perspective in the 21st century. Turul, Poznan, p. 765–776.
Sherrod, S. K., Heinrich, W. R., Burnham, W. A., Barclay, J. H. & Cade, T. J. (1987): Hacking: a method for releasing peregrine falcons and other birds of prey. 3rd ed. Peregrine Fund, Inc., Boise.
Sielicki, J., Prommer, M., Gamauf, A., & Kata, M. (2009): Saker Falcon *Falco cherrug* in Poland (2008–2009). In *Wiacek, J., Polak, M., Grzywaczewski, G., Jerzak, L. (eds.):* Ptaki–Srodowisko–Zagrosenia–Ochrona Wybrane aspekty ekologii ptakow. LTO, Lublin, p. 273–285.
Stout , W. E., Greene, V. L. & Postupalsky, S. (2009): Migration routes, reproduction and lifespan of a translocated osprey. *Wilson Journal of Ornithology* **121,** p. 203–206.
Tordoff, H. D. & Redig, P. D. (1997): Midwest peregrine falcon demography, 1982–1995. *J. Raptor Res.* **31,** p. 339–346.
White, C. M., Clum, N. J., Cade, T. J. & Hunt, W. G. (2002): Peregrine Falcon *(Falco peregrinus).* In *Poole A. (ed.):* The birds of North America online. Cornell lab. of ornithology, Ithaca, New York. Accessed: *http://bna. birds. cornell. edu/bna/species/660* doi:10. 2173/bna. 660.

Aquila (2012), Vol. **119**, p. 79–90

Field observations of a Saker Falcon *(Falco cherrug)* holding a satellite transmitter on its wintering ground in Niger

Housseini Issaka[1,2] *& Joost Brouwer*[2]

[1]Sahara Conservation Fund, Niamey, Niger; [2]Brouwer Environmental & Agricultural Consultancy

ABSTRACT—Late October 2009 a female satellite-tracked Saker Falcon, "*Dorottya*" arrived in Niger from Hungary. She spent most of the following four months 25–50 km NNE of Zinder (roughly 14.00 9.00E). The areas where she stayed were mostly quite flat coversands with a local rainfall of 300-400 mm/year and with millet as main crop. From 7–16 February, 2010 field work was carried out to investigate the behaviour of the tagged falcon and to collect data on the ecology of the area. The falcon was observed twice during the survey. One regurgitation pellet and remains of one plucking were also found. The pellet contained beetle and bird remains, no mammal hair was found. Twenty km of the power line crossing the area and 25 prey-and-vegetation transects of about 2 km each were walked. The local vegetation structure proved to be very open, with less than 20 trees/ha. The area where *Dorottya* stayed the first two months around Dania, still contained some more or less natural habitat. The area around Toumnia where she stayed in the following two months had been converted to millet fields. A third area, 70 km further southwest, where she stayed only one night, had higher density of trees (70 trees/ha) but was also mostly covered by millet fields. Local bird biomass observed varied from 1 to 2.5 kg per km of transect. Grasshopper and reptile presence was low, signs for the presence of burrowing mammals was not very frequent, either. The main danger to Saker appears to come from local boys with slingshots and from local hunters. On the other hand birds of prey like the Saker are considered to bring good luck, and to be useful for millet crops pest control by feeding on songbirds such as Red-billed Quelea *(Quelea quelea)* and rodents. These aspects may be entry points for a future conservation campaign for Saker and other raptors in the region.

Key words: *Falco cherrug,* overwintering, satellite telemetry, Niger.

Correspondence: *Housseini Issaka,* Sahara Conservation Fund, BP 981, Niamey, Niger; E-mail: housseissaka@yahoo.fr

Introduction

In the Sahel, the Saker is a rare visitor from Europe during the dry season. It has been recorded only three times during a six-year-long intensive raptor survey in West Africa (Mauritania–Nigeria) in the late 1960s, early 1970s *(Thiollay, 1977; 1978),* and on two occasions during similar surveys in 2002 and 2003 (*J. Thiollay,* pers. comm.). Yet, the species has been very rarely observed in northern Cameroon *(Vielliard, 1971; Thiollay, 1978)* and has not been recorded at all by *Scholte et al. (1999).*

Saker Falcon *(Falco cherrug)* is a threatened species throughout its breeding range, including Hungary and Slovakia. To better know what threats it faces during migration and overwintering, a number of Saker Falcons in Hungary and Slovakia were fitted with satellite-tracking devices in the context of an EU LIFE project. Recently, we had evidence of the overwintering of two tagged Saker Falcons in southern Nigeria. One female, tagged in

Area	No. of transects	Distance covered	Habitat type	Degradation	Grass cover %	Grass height (m)	No. of shrubs/ha	No of trees	No of trees/ha
Toumnia	16	15.2 km	FT	0.06	96.56	0.46	1.44	9.50	17.94
Dania	7	26.3 km	FT, GB, GT	0.39	90.95	0.40	1.31	6.96	12.94
Doungou Haoussa	2	4.5 km	FT	0.52	85.02	0.36	1.28	6.99	19.93

Table 1. Average of main habitat features in the overwintering area of the Saker Falcon (FT = combination of farmland and trees; GB = grassland and shrubs; GT = combination of grassland and trees)

Slovakia spent much of the winter of 2008/2009 in southern Niger, near Madaoua (14ºN 6ºE) and Birni N'Konni (14ºN 5ºE). Another female, called *Dorottya* and tagged in Hungary stayed in 2009/2010 also in southern Niger, but further east and largely in an area some 150 km north of Zinder, at approximately 14ºN 9º E. Due to the rarity of the species in this part of Africa and to the importance of data collection about its wintering ecology in the Sahel, a small project was developed in February 2010 in the region where *Dorottya* was wintering.

The main goals of our research were to: (1) observe the behaviour of the tagged falcon; (2) describe the overwintering habitats; (3) estimate the potential prey abundance in the area; (4) evaluate potential threats to, and promote conservation of, raptors in general and Saker Falcon in particular.

Methods

The field work took place from 7 to 16 February 2010, in the form of daytrips by motorbike from Zinder. On the basis of coordinates provided by the satellite tracking, potential roost sites were visited early in the day, in order to have the best chance of observing the tagged bird. During visits later in the day the presumed roost sites were searched for regurgitation pellets and prey remains. Photographic documentation of the area, habitats and roost sites was made by a digital photo camera. For an evaluation of land use and cover and for quantitative estimation of the presence of potential prey species for Saker Falcons, a number of linear transects of approximately one hour duration each was walked. We adapted the method described by *Trierweiler et al. (2007)* for surveys of Montagu's Harrier *(Circus pygargus)* in Niger. Date, locality and weather were noted, as well as the GPS coordinates of the starting and finishing points. Times of starting and finishing were also recorded. Transect length was calculated from the coordinates using Google Earth maps.

The following habitat characteristics were recorded: land use, land cover or habitat type; degree of degradation (from 0 = no degradation visible, to 5 = complete destruction); grass cover percentage (from 0 = bare spots to 100% full coverage); height of grass, shrubs and trees (in metres); presence of tree species (1= rare, 2 = frequent, 3 = dominant); number of trees per hectare (Table 2). Potential prey items for Sakers include birds, grasshoppers, small mammals and reptiles. Out of these mammals are the most difficult to estimate, but the presence of holes dug by burrowing mammals can be considered a good proxy *(Trierweiler et al., 2007).*

	Location	Start N	Start E	End N	End E	Dist. (Km)	Weather	Habitat	Degradation	Cover %	Grass height (M)	Shrubs	Trees	Tree/Ha
Toumnia														
7 Feb (10:14–11:12)	Babban Toudou	13.98884	8.96804	13.99040	8.97373	0.63	C	FT	1	100	0.50	1.5	12	19
7 Feb (13:49–14:45)	Babban Toudou	14.00528	9.04011	14.00888	9.03897	0.42	C	FT	0	100	0.30	1.0	12	20
8 Feb (17:15–18:11)	Garin Elhadji	14.00744	9.04056	14.01880	9.03967	1.25	C	FT	0	100	0.40	2.0	7	10
9 Feb (8:40–9:33)	Zongo Samia	14.00580	9.04596	14.01218	9.06144	1.81	C	FT	0	80	0.50	1.0	7	19
9 Feb (9:50–10:52)	Zongo Samia	13.98978	9.02493	13.96987	9.02515	2.20	C	FT	0	100	0.50	1.0	10	15
9 Feb (12:00–13:02)	Zongo Samia	13.98982	9.02499	13.98820	9.00439	2.22	C	FT	0	100	0.40	1.0	10	15
9 Feb (14:39–15:32)	Zongo Samia	14.00252	8.97314	13.98670	8.97280	1.75	C	FT	0	100	0.40	2.0	7	16
9 Feb (17:00–18:00)	Zongo Samia	14.00628	9.02400	14.00573	9.01126	1.37	C	FT	0	70	0.50	2.0	12	27
10 Feb (10:50–11:55)	Garin Chouri	14.00781	9.03726	14.00938	9.03779	0.18	C	FT	0	100	0.50	1.5	7	12
11 Feb (9:30–10:33)	Garin Chouri	14.00281	9.03699	14.00281	9.01949	1.89	C	FT	0	95	0.50	1.5	13	18
11 Feb (13:20–14:22)	Garin Chouri	14.03602	9.03798	14.04984	9.04125	1.57	C	FT	0	100	0.50	1.5	7	6
11 Feb (15:40–16:39)	Katourjé	14.03459	8.98885	14.05289	8.98592	2.04	C	FT	0	100	0.50	1.0	7	18
12 Feb (8:20–9:15)	Katourjé	14.03457	8.98875	14.02725	8.96737	2.46	C	FT	0	100	0.50	1.5	7	16
12 Feb (10:40–11:41)	Mairouwa	14.03284	8.99610	14.02853	9.01854	2.44	C	FT	0	100	0.50	1.5	12	13
12 Feb (14:30–15:25)	Babban Toudou	14.00235	8.97093	14.00324	8.98911	1.95	O	FT	0	100	0.40	1.5	7	35
12 Feb (16:10–17:06)	Aroungouza	14.00250	8.97009	14.02129	8.96842	2.08	O	FT	0	100	0.50	1.5	15	28
Dania														
13 Feb (9:40–10:30)	Sabon Rouwa	14.12439	9.12357	14.10602	9.12274	2.03	O	GT	3	95	0.30	1.0	4	7
13 Feb (11:00–12:04)	Sabon Rouwa	14.12409	9.12550	14.13435	9.15504	3.37	O	GT	0	60	0.15	0.7	4	11
13 Feb (13:00–13:58)	Sabon Rouwa	14.13218	9.11816	14.14306	9.10618	1.77	O	FT	0	100	0.50	1.0	6	21
13 Feb (14:40–15:43)	Sabon Rouwa	14.12300	9.11257	14.12831	9.09731	1.75	O	FT	0	100	0.50	1.5	13	5
16 Feb (9:00–9:57)	Dania	14.19131	9.10971	14.19975	9.12615	2.00	C	FT	0	100	0.40	1.5	4	4
16 Feb (11:00–12:05)	Dania	14.19172	9.10839	14.20372	9.09345	2.08	C	GB	0	100	0.50	2.0	0	0
16 Feb (13:15–14:05)	Dania	14.18839	9.10883	14.16959	9.11524	2.19	C	GB	0	100	0.15	1.5	0	0
Doungou Haoussa														
15 Feb (11:00–12:02)	Taramni bougajé	13.45571	8.69590	13.43420	8.70001	2.43	O	FT	0	100	0.40	1.5	15	82
15 Feb (12:55–13:52)	Taramni bougajé	13.45607	8.69411	13.46668	8.67852	2.04	O	FT	0	100	0.50	2.0	13	58

Table 2. Basic information of transects walked to assess land use and prey availability of a satellite-tagged Saker Falcon wintering in the area

During transects all potential preys were recorded on both sides up to 1 m lateral distance. All reptiles and birds seen were counted, grasshoppers were recorded according to categories (small < 3 cm, medium 3–7cm, large green and large red > 7 cm), similarly to the active mammal holes (small < 3 cm and large > 3 cm).

In order to evaluate the knowledge on raptors and their threats and to raise public awareness we made interviews starting with specific questions in order to elicit discussions with local people encountered during the transects or in villages. All discussions were held in a positive, non-judgmental setting. To raise awareness of bird conservation and raptors and falcons in particular, discussions were held with villagers in subgroups and with some local teachers in villages.

Eventually, to evaluate specific threats in the Saker Falcon wintering areas, an approximately 10-km-long section of power line along the Zinder–Tanout road on the western edge of the Toumnia region was checked for potential bird victims of electrocution or wire collision.

	Presence % (n times recorded in transect/total transects)				Occurrence[1]		
	Toumnia	Dania	Doungou Haoussa	Total area	Toumnia	Dania	Doungou Haoussa
Faidherbia albida	1	0.43	1	0.84	1	2	1
Guiera senegalensis	0.87	0.86	0	0.80	1	1	a
Sclerocarya birrea	0.812	0.57	0	0.68	2	2.5	a
Boscia senegalensis	0.56	1	0	0.64	1	1	a
Piliostigma reticulatum	0.56	0.71	0.5	0.60	2	3	1
Euphorbia balsamifera	0.56	0.14	0	0.40	3	3	a
Leptodenia pyrotechnica	0.5	0	0	0.32	2	a	a
Ziziphus mauritiana	0.12	0.43	0.5	0.24	3	3	3
Acacia nilotica	0	0.57	1	0.24	a	2	3
Acacia senegal	0	0.57	0	0.16	a	2	a
Combretum glutinosum	0.12	0	0.5	0.12	2.5	a	3
Hyphaene thebaica	0	0	1	0.08	a	a	1
Comiphora africana	0	0.29	0	0.08	a	2	a

Table 3. Presence and occurrence of woody species in the vegetation ([1] codes for occurrence: a = absent; 1 = rare; 2 = frequent; 3 = dominant)

Results

Field search for Dorottya

One of the authors *(HI)* visually recorded *Dorottya* in two occasions, on the 7th and 10th February. All roosting sites in the Toumnia area were not very far from villages. *Dorottya* used to roost at night in *Sclerocarya birrea* (n = 2) and *Acacia* sp. (n = 1) trees. We have limited evidence of *Dorottya*'s diet by a few pellets containing bird and beetle remains.

Description of the landscape, land use and habitats

From Google Earth maps, provided by the LIFE Saker project, and from the relevant 1 : 200.000 IGN map sheets (Zinder, Tanout, Miria and Gamou), it looked like *Dorottya* spent most of her time in January–February 2010 on quite flat terrain at about 470–490 m a.s.l. When the maps, which date from the 1960s, and Google Earth images were compared, tree cover in both the Toumnia and Dania areas appear to have decreased considerably over the past 50 years, while the number of millet (and sorghum) fields, and the population, have increased significantly.

People living in the Dania and Toumnia areas are mostly Hausa farmers and Fulani pastoralists who move with their livestock. Average rainfall is 300-400 mm/year, falling between June or July and September. Going north from Sabon Rouwa (Toumnia area, transects 3–6), this is a flat or very gently undulating cover sands area. Only few isolated hills rise to 50 m above the ground in more than 100 km^2.

A total of 25 transects were walked to assess land cover and prey availability: 7 in the Dania area (total length 15.2 km), 16 in the Toumnia area (26.3 km), and 2 in the Doungou Haoussa area (4.5 km) (Tables 1 and 2). Of the 7 transects in the Dania region, 3 were in farmland with trees, two in grassland with trees and two in grassland with shrubs (Table 1).

In the Dania region cover percentage was almost always 100%, except for transects 5 and 6 (60 and 95%, respectively). These latter were also the only two transects with moderate erosion/degradation (Category 3). Grass height was only 0.15 m on two transects, and varied from 0.3–0.5 m on the others. Shrub height varied from 0.7–2.0 (average 1.3) m, and tree height from 4–13 (average 6.2) m. Tree density varied from 0–21, on average 7 trees/ha.

All 16 transects in the Toumnia region were across farmland with trees: there is virtually no uncultivated land left there. Cover percentage was almost always 100% and there was almost no degradation. Grass height varied from 0.3–0.5 m, shrub height from 1.0–2.0 (average 1.5) m, and tree height from 7–13 (average 9.5) m. Tree density varied from (6) 10–28 (35), averaging 18 trees/ha.

At Doungou Haoussa 2 transects were walked, starting out from the *Dorottya*'s roosting site. Cover was 100%, grass height 0.4 and 0.5 m, shrub height 1.5 and 2.0 m, tree height 15 and 13 m, respectively. Tree density was 82 and 58 trees/ha, respectively. Woody plant species recorded in the areas are listed in Table 3.

		No. of transects where present/all transects				**Individuals/km transect**			
	Weight (g)	**Toumnia**	**Dania**	**Doungou Haoussa**	**Total area**	**Toumnia**	**Dania**	**Doungou Haoussa**	**Total area**
Bubulcus ibis	345	0.44	0	0	0.28	1.37	0	0	0.78
Small *Falco* sp.	200	0.13	0	0	0.08	0.11	0	0	0.07
Vanellus spinosus	150	0.19	0.29	0	0.2	0.57	0.33	0	0.44
Streptopelia senegalensis	100	0.69	0.57	0.50	0.64	1.82	1.25	0.89	1.55
Streptopelia sp.	100	0.50	0	1.00	0.4	1.06	0	0.89	0.70
Oena capensis	35	0.38	0.57	0.50	0.44	0.57	0.59	0.67	0.59
Centropus senegalensis	170	0.13	0.43	0	0.2	0.08	0.20	0	0.11
Caprimulgus eximius	80	0.06	0	0	0.04	0.08	0	0	0.04
Coracias abyssinicus	120	0.88	0.71	0	0.76	1.14	0.53	0	0.83
Upupa epops	55	0.50	0.43	0	0.44	0.30	0.39	0	0.30
Phoeniculus purpureus	70	0.13	0.14	0	0.12	0.19	0.07	0	0.13
Tockus nasutus	210	0.38	0	0.50	0.28	0.80	0	0.45	0.50
Tockus erythrorhynchus	150	0.13	0	0	0.08	0.19	0	0	0.11
Lanius meridionalis	50	0.88	0.71	1.00	0.84	1.86	0.66	0.67	1.35
Corvus albus	500	0.38	0.57	1.00	0.48	0.42	0.26	0.45	0.37
Alaudidae sp.	20	0.38	0.71	0	0.44	0.68	1.45	0	0.87
Lamprotornis pulcher	65	0.75	0.86	0.50	0.76	3.72	2.24	2.46	3.11
Lamprotornis sp.	90	0.19	0	0	0.12	0.46	0	0	0.26
Cercotrichas podobe	25	0.06	0	0	0.04	0.04	0	0	0.02
Oenanthe sp.	25	0.56	1.00	0.50	0.68	0.61	0.59	1.12	0.65
Bubalornis albirostris	70	0.75	0.57	0.50	0.68	2.92	0.79	0.89	2.03
Amadina fasciata	18	0.06	0	0	0.04	0.42	0	0	0.24
Motacilla flava	18	0.31	0.14	0.50	0.28	0.30	0.07	0	0.20
Small passerine sp.	30	1.00	0.71	1.00	0.92	12.10	2.63	3.80	8.19

Table 4. Presence and densitiy of birds as potential Saker prey items along the transects in the three different survey areas

	Toumnia	Dania	Doungou Haoussa	Total area
All birds	838	273	118	1229
Total bird biomass (g)	64 932	17 843	8 020	90 790
Individuals of birds/km	31.91	17.97	26.40	26.76
Bird biomass (g/km)	2 470	1 170	1 630	1 980

Table 5. Total amount, calculated total biomass, bird and biomass density of birds as potential Saker prey items along the transects in the three different survey area

Estimation of the potential prey presence in the area

Birds

The birds recorded along the prey availability transects are shown in Table 4. In total 1305 birds were observed along 45.9 km of prey transect (61 unidentified birds, as well as 9 raptor sightings, all considered to be unlikely prey for Saker: Lanner—*Falco biarmicus,* Saker?, two Short-toed Eagles—*Circaetus gallicus,* two Dark Chanting Goshawks—*Melierax metabates* and one unidentified raptor)—were not included in Table 4). Average number of birds per km was 26.7 overall: 18 in the Dania area (ranging from 5 to 46), 31.9 in the Toumnia area (ranging between 15–86; 167 for the extremely short transect 8), and 26 in the Doungou Haoussa area (ranging between 16–38). The number of birds per km of transect was thus highest in the Toumnia area. For a raptor that also preys on birds, bird biomass availability is even more important than the number of individual birds. Biomass availability in g per species per km of transect is given in Table 5. Most relevant bird species available to Saker, in terms of their number and total biomass per kilometer, as well as their ranking as potential food source for Sakers are shown in Table 6.

Birds like Pied Crow *(Corvus albus),* Cattle Egret *(Bubulcus ibis),* Grey Hornbill *(Tockus nasutus)* and Spur-winged Plover *(Vanellus spinosus)* are important because of their considerable weight. Small passerines in general, Chestnut-bellied Starling *(Lamprotornis pulcher)* and White-billed Buffalo Weaver *(Bubalornis albirostris)* in particular, and also Laughing Dove *(Streptopelia senegalensis)* and other turtle dove species, are important because of their high density. Grey Hornbills were not present in the north (Dania), Chestnut-bellied Starlings decreased in density while Buffalo Weavers increased in density towards south.

Total bird biomass per km of transect was lowest at Dania (1 175 g/km, range 308–2 8923), and roughly equal at Toumnia and Doungou Haoussa: 2 473 (range 723–6 190) and 2 361 (range 1 044–3 929) g/km, respectively. The outstanding value of 8 222 g/km at Toumnia was again in the extremely short transect 8. In the Toumnia area, *HI* noted bird nests in almost every tree.

Grasshoppers, mammal holes and reptiles

The presence of grasshoppers, mammal holes and reptiles is shown in Table 7. The density of small grasshoppers (<3 cm) was by far the greatest in the Toumnia area, but still rather low (14.8/km), against 4.2 in the Dania area and 0.9 in the Doungou area. Hardly any medium-sized (3–7 cm) grasshoppers were found, and even less large ones (>7 cm).

Small mammal hole density (<3 cm diameter) was similar in the Dania and Toumnia ar-

	Weight	All reas			Dania			Toumnia			Doungou		
	(g)	g/km	rank	i/km	g/km	rank	i/km	g/km	rank	i/km	g/km	rank	i/km
Bubulcus ibis	270	270	**3**	0.78	0	–	0	473	**1**	1.37	0	–	0
Vanellus spinosus	150	65	**11**	0.44	49	**7**	0.33	86	**11**	0.57	0	–	0
Streptop. senegalensis	100	155	**6**	1.55	125	**4**	1.25	183	**6**	1.83	89	**6**	0.89
Streptopelia sp.	100	70	**10**	0.70	0	–	0	107	**9**	1.07	89	**7**	0.89
Coracias abyssinicus	120	99	**8**	0.83	99	**5**	0.53	137	**8**	1.14	0	–	0
Tockus nasutus	210	105	**7**	0.50	0	–	0	168	**7**	0.80	94	**5**	0.45
Lanius meridionalis	50	73	**9**	1.46	43	**8**	0.86	93	**10**	1.87	56	**8**	1.12
Corvus albus	500	327	**1**	0.65	263	**1**	0.53	209	**4**	0.42	1230	**1**	2.46
Lamprotornis pulcher	65	228	**4**	3.51	227	**2**	3.49	243	**3**	3.73	145	**4**	2.24
Bubalornis albirostris	70	171	**5**	2.44	92	**6**	1.32	205	**5**	2.93	235	**3**	3.36
Passerine sp. (small)	30	298	**2**	9.93	170	**3**	5.66	364	**2**	12.15	342	**2**	11.41

Table 6. Availability of bird species as prey for Saker Falcon in the different areas given in weight (g/km) and number (i/km=individual/km) per kilometre with their ranking of importance as potential food source

eas (24 and 27.6 per km), and slightly less in the Doungou area (18.6 per km). Larger mammal hole density (>3 cm diameter), however, was approximately six times greater in the Toumnia area (2.9 holes per km) than in the Dania and Doungou area (0.5 and 0.4 holes per km).

Reptile density was quite similar and low at the three sites: 0.5 reptiles per km at Dania, 0.7 at Toumnia and 0.4 at Doungou Haoussa, mostly Common Agamas *(Agama agama).*

Threat evaluation and awareness raising

Local population

Interviews were held with two village chiefs, three farmers, one group of villagers and the Forest Service in Zinder. Overall conclusions are as follows. The interviews have brought to light that very few villagers know the Saker. Overall villagers do not eat Saker but they know that children (youngsters) may kill them with slingshots. There were even villagers accusing their neighbours in the north of killing everything they find on their way when they go to hunt for they possess traditional firearms (villages of Dania, Sabon Rouwa). The majority wishes this kind of bird to be protected because it brings good luck according to them. The presence of this kind of falcon reduces the damage caused by certain crop pests like *Quelea quelea* e.g. They have no problems with them and even want them to be protected becasue where they are there is always the blessing of God. It is a species that does no harm at all to the farmers and its existence in the area would even be beneficial for them because it hunts the birds and kills the rats that threaten their crops.

Dorottya's fate

The words by local villagers about youngsters with slingshots were almost prophetic. From 7 March *Dorottya*'s signal remained stationary, at 13.90583 N 9.30183 E, between Kirchia and Zemrou. On 20 March *Halimatou Amadou* went to investigate. *Halimatou* found that *Dorottya* was killed by a young Fulani herder with a slingshot. In the last week of April 2010 the PTT that used to be carried by *Dorottya* was recovered by *Issaka Houdou* of the Antilopes Sahélo-Sahariennes project who went to the village for this purpose.

Location		Toumnia	Dania	Doungou Haoussa	Total area
No of transects		16	7	2	25
Km total		26.26	15.19	4.47	45.92
		Total number recorded			
Grasshoppers	**<3 cm**	389	64	4	457
	>3 cm	8	2	0	10
Mammal holes	**<3 cm**	725	364	83	1172
	>3 cm	77	8	2	87
Reptiles		18	7	2	27
		Number/km			
Grasshoppers	**<3 cm**	14.81	4.21	0.89	9.94
	>3 cm	0.30	0.13	0.00	0.22
Mammal holes	**<3 cm**	27.61	23.96	18.57	25.50
	>3 cm	2.93	0.53	0.45	1.89
Reptiles		0.69	0.46	0.45	0.59

Table 7. Presence of potential Saker prey items along the transects: grasshoppers, mammal holes (as a proxy for small mammals) and reptiles

Power lines

Approximately 20 km of power line was surveyed along the Zinder–Tanout road, on the western edge of the Toumnia region (Kania-Babban Toudou). No dead birds were found on the ground or on the lines, either. Local people said they had never seen a bird that had been victim of the power lines and that they saw birds perching on the lines all the time.

Awareness raising

It has proven that raptors on the whole, and the Saker Falcon in particular, are not considered harmful. The Saker has value in several ways, economical (protection of crops and thus indirect increase of income and reduction of hunger) and cultural (with the myths that people subscribe to in relation to the Saker when they see it during a trip, and the luck that it brings to a person). On the whole, Villagers think it would be important to protect the Saker. An awareness campaign could be started on the basis of these findings in order to make the local inhabitants accept and protect them.

Discussion and conclusions

Dorottya arrived in southern Niger late October 2009, spending most of November and December in the Dania area, and most of January and February 2010 in the Toumnia area, some 25 km further south-west. During these months she made several short trips outside her regular 'territory', among others to Doungou Haoussa (approx. 13.46 N 8.70 E), where she spent the night of 12–13 February. Of interest is why she stayed in this particular area and why she did not stay in the areas she visited only briefly, and what threats she faced. Of interest is also how she behaved, and what she consumed.

Observation of the tagged falcon

During our study *Dorottya* was observed twice. The trees she was seen in and other trees she roosted in were often leafless or partly leafless marula trees *(Sclerocarya birrea)*, arguably so she could see better what was around her. Note that when *Dorottya* first arrived late October, not long after the end of the rains, marula trees would have more leaves but other suitable perches would still have been available.

During one of the encounters *Dorottya* was watched for fourteen minutes until a pedestrian made her take off. No exact estimate was on her fleeing distance but as she was killed with a slingshot later, probably she could not have been disturbed too easily by people. Local people also explained that this kind of bird was generally not hunted, and many roosting trees were not far from villages.

A regurgitation pellet, approximately 50-55 mm in length, was found under the tree where *Dorottya* perched 11–12 February. It contained an elytron (wing cover) of a beetle, an upper mandible of a bird, feathers and bones. No hairs of rodents or other mammals were present. It looks like *Dorottya* was at least in part an opportunistic feeder, or stretched to find prey, unless the beetle remains came from a beetle very recently eaten by a bird subsequently eaten by *Dorottya*. Plucking remains found under another roosting or perching tree may have been from a domestic chicken.

The main areas where *Dorottya* stayed, around Dania and around Toumnia, are at just under 500 m a.s.l., on rather flat cover sands deposited by the wind. The population consists mostly of Haussa farmers and Fulani pastoralists who move with their livestock. Local rainfall averages 300-400 mm/year, enough to grow a decent millet crop in some years but not in others. Over the past fifty years tree cover appears to have decreased considerably, while the number of millet fields has greatly increased. The latter has been caused by a significant population increase and also, it is said, by a reduction in yield per field. The yield reduction is most likely related to reduction in useful rainfall and/or depletion of the nutrients stored in the soil. Over the period 1960–2010 the population of Niger as a whole more than quadrupled, from 3.9 to 15.9 million. At present the population of Niger as a whole is estimated to grow by 3.8% per year. This implies a population would duplicate in 18-19 years. Migration can locally increase or reduce population growth. If man-caused changes in land cover and land use affect Saker on their wintering grounds in the Sahel, than clearly those effects will increase during the coming years and decades.

Description of the landscape, land use categories and habitats

The vegetation surveys carried out in February showed that at the three sites visited by *Dorottya* non-farmland habitat existed only in the north (Dania). From north to south (Dania–Toumnia–Doungou Haoussa), average shrub height increased slightly (1.3–1.4–1.75 m), while average tree height (6.2–9.5–14.0 m) and tree density (7–18–70 per ha) increased considerably. This coincides with an increase in average rainfall from north to south, but may also be influenced by geology and soils.

In the two areas most frequented by *Dorottya*, Dania and Toumnia, vegetation was thus quite open, averaging only 7 (range 0–21) and 18 trees (range 6–35) per ha, respectively. Trees were also not very tall, averaging 6 (Dania) and 9.5 (Toumnia) m. Where there were

more trees, in the Doungou Haoussa area (70 per ha), *Dorottya* only stayed one night. It would be interesting to investigate further what influence vegetation structure may have on the presence of Saker in the Sahel.

Woody species composition at Dania and Toumnia was in part quite similar, in part different. Individual woody species are unlikely to be important to the presence of Saker in the Sahel, unless they greatly influence vegetation structure, or unless the individual woody species influences the presence of the basic needs of Saker (food and roosting site), and/or access to those basic needs (via good sentinel posts, a good field of view, and not too much disturbance). Data were insufficient to draw any conclusions on that.

Estimation of the potential prey presence in the area

As mentioned, analysis of the pellet produced by *Dorottya*, and of prey remains below one of her perching trees, showed only bird and beetle remains. Total bird biomass observed per km of transect was lowest at Dania in the north: 1 175 g/km (range 308–28 923), and roughly equal in Toumnia and Doungou Haoussa: 2 473 (range 723–6 190) and 2 361 (range 1 044–3 929) g/km, respectively. Birds like Pied Crow *(Corvus albus),* Cattle Egret *(Bubulcus ibis),* Grey Hornbill *(Ocyceros birostris)* and Spur-winged Plover *(Vanellus spinosus)* were important because of their considerable weight. Small passerines in general, Chestnut-bellied Starling *(Lamprotornis pulcher)* and White-billed Buffalo Weaver *(Bubalornis albirostris)* in particular, and also Laughing Dove *(Streptopelia senegalensis)* and other turtle dove species, were important because of their high density. None of the top ten birds available in terms of biomass were Palearctic migrants and only very few birds observed were Palearctic migrants in general: only 16 wheaters (*Oenanthe* spp.), 7 Yellow Wagtails *(Motacilla flava)* and 2 kestrels (*Falco* spp.), a maximum of 25 birds out of 1229 individuals.

In February 2010, bird biomass density at Dania was much lower than at Toumnia. It therefore makes sense that *Dorottya* preferred the Toumnia area to the Dania area at that time of year. In November–December 2009 bird biomass density at Dania may have been higher. Not long after the end of the rainy season more shrubs and trees, and perhaps even some annual grasses and herbs, would still have been green at Dania, and there would have been more grass and other seeds left on the ground. There would have been therefore more insects and insect- and seed-eating birds, making the area around Dania more attractive to a raptor like *Dorottya*. Drying out of the vegetation progresses from north to south as the dry season develops. Montagu's Harriers *(Circus pygargus),* too, have been shown to move further south in Niger and Nigeria gradually during the dry season (cf. Dutch Montagu's Harrier Foundation, *www.grauwekiekendief.nl*).

Moving of Montagu's Harriers to south during the dry season appears to be related to the availability of the large grasshoppers as prey: later in the dry season fewer green bushes are available that these grasshoppers feed on. No grasshopper remains were found in *Dorottya*'s pellet, and grasshopper availability at the three sites was very low: no large grasshoppers, hardly any medium-sized ones, and an average of only 14.8 small grasshoppers (<3 cm) per km at Toumnia, 4.2 at Dania and 0.9 in the Doungou area was detected. If *Dorottya* ate beetles she probably would have eaten also grasshoppers if they crossed her path, but it is unlikely they were a major food item for her in February 2010.

Mammals are a major food item for Sakers in Europe. Because of the high daytime temperatures even during the dry season (many days with maximum temperatures over 30°C), most mammals in the Sahel are diurnal or at best crepuscular. The behaviour may make them less attractive to Sakers. The density of small holes (<3 cm diameter) of mammals (mostly small rodents) in the study areas was not very high: 24 and 27.6 per km (approximately 120 and 140 per ha) in the Dania and Toumnia areas, and slightly less in the Doungou area (18.6 per km or 93 per ha). Larger mammal hole density (>3 cm diameter), of e.g. larger rodents, squirrels and mustelids, was approximately six times greater in the Toumnia area (2.9 holes per km or 15 per ha) than in the Dania and Doungou area (0.5 and 0.4 holes per km or 2-3 per ha). In addition no mammal hairs were found in the pellet of *Dorottya*. In conclusion, there is no indication that mammals play a significant role in the diet of Sakers in the Sahel. The same applies to reptiles, with reptile density equally low at the three sites: 0.5 reptiles per km at Dania, 0.7 at Toumnia and 0.4 at Doungou Haoussa.

Threat evaluation and awareness raising

Dorottya often roosted only 500–1000 m from a village or hamlet, yet very few villagers knew the species. While local power lines do not appear to be a problem the main dangers to Sakers appear to be young boys with slingshots and local hunters. *Dorottya*'s death early March 2010, caused by a young herder with a slingshot, about 35 km ESE of the Toumnia area, further testifies to that. On the other hand a number of people in the area believe that birds like Sakers reduce damage to on crops by rats and by millet-eating birds such as Quelea *(Quelea quelea),* locally known as "mange-mils" in French (millet-eaters) and Sudan Golden Sparrows *(Passer luteus)*. It is also believed that birds like Sakers bring good luck. Based on these facts a successful awareness campaign could be completed. We know that WWF Niger would be interested in such a project.

Acknowledgements

It is a pleasure to acknowledge the enthusiastic support for this project by *Mátyás Prommer* MME (BirdLife Hungary) and *József Fidlóczky* of Bükk National Park Directorate (Hungary). Financial support was provided under the EU LIFE project *'Conservation of Saker* (Falco cherrug) *in the Carpathian Basin'* LIFE06 NAT/HU/000096.

In Niger logistical support was provided by the Projet Antilopes Sahélo-Sahariennes, which is managed by the Sahara Conservation Fund and the Ministry of Environment. We would like to thank in particular *Thomas Rabeil* (SCF-Niamey and Zinder, general support), *Issaka Houdou* (SCF-Zinder, recovery of PTT transmitter), *Abdoulaye Harouna* (WWF Niger), the late *Ms. Halimatou Amadou* (student at the Université Abdou Moumouni), and *Sama Gagaré* (Centre Agrhymet, Niamey) for identification of prey remains from a regurgitation pellet.

We would also like to thank *Ralph Buij* (Institute for Environmental Sciences, University of Leiden, based in Maroua, Cameroon) and *Wim Mullié* (ecotoxicological and ornithological consulant based in Dakar, Senegal) for their contributions.

It is with great sadness that we report the death of *Ms. Halimatou Amadou,* only a few

weeks after her involvement in the Saker Falcon project in Niger. *Halimatou* was a student at the Université Abdou Moumouni in Niamey. To help locate the Saker Falcon *Dorottya* and her tracking device, *Halimatou* took time off from her thesis research on bats at Tessaoua, not far from Zinder. A few weeks after having found *Dorottya* she became ill as one of the victims of an encephalitis epidemic in the region where she worked. She passed away in hospital twelve days later. Our thoughts are with her parents and other family, who have lost such a promising young daughter, sister and relative.

References

Scholte, P, de Kort, S. & van Weerd, M. (1999): The birds of the Waza-Logone area, Far North Province, Cameroon. *Malimbus* **21,** p. 16–50.

Thiollay, J. M. (1977): Distribution saisonnière des rapaces diurnes en Afrique occidentale. *L'Oiseau et la Revue française d'Ornithologie* **47,** p. 253–294.

Thiollay, J. M. (1978): Les plains du nord Cameroun. Centre d'hivernage de rapaces palearctiques. *Alauda* **46,** p. 314–326.

Trierweiler, C., Koks, B. Harouna, A., Issaka H. & Brouwer, J. (2006): Montagu's Harrier research in the Sahel 200–2007. Aims, findings, methods used and plans for the future. Dutch Montagu's Harrier Foundation, Scheemda, The Netherlands, 14 p.

Trierweiler, C., Brouwer, J. Koks, B. Smits, L., Harouna A. & Moussa, K. (2007): Montagu's Harrier expedition to Niger, Benin and Burkina Faso, 9 January–7 February 2007. Report to Vogelbescherming Nederland. Dutch Montagu's Harrier Foundation, Scheemda, The Netherlands, 47 p. + appendix.

Aquila (2012), Vol. **119**, p. 91–103

Preparatory activities for Saker Falcon *(Falco cherrug)* reintroduction in Bulgaria: habitat management and electrocution risk assessment

Dimitar Ragyov[1], Yordan Koshev[2], Elena Kmetova[3], Gradimir Gradev[3], Georgi Stoyanov[4], Iliyan Stoev[3] & Dimitar Marinov[3]

[1]Institute of Biodiversity and Ecosystem Research - Bulgarian Academy of Sciences; [2]Institute of Biodiversity and Ecosystem Research - Bulgarian Academy of Sciences; [3]Green Balkans Federation of Nature Conservtion NGOs; [4]Central Balkan National Park Directorate

ABSTRACT—The Saker Falcon *(Falco cherrug)* is a rare species with a very controversial present breeding status in Bulgaria. In 2009 a team of Bulgarian and foreign organizations came up with a feasibility study, discussing the need for reintroducing Saker Falcons and the means of completing the task in the country. That study formulated a number of criteria for Saker Falcon site suitability and identified the area of the Central Balkan Mountains as most suitable to support and maintain a reintroduced population of the species. This article presents a set of preparatory pilot measures aiming at guaranteeing optimal conditions for the Saker Falcon reintroduction in terms of food supply and electrocution risk mitigation. A set of activities were carried out to support a colony of European Susliks (an important prey for Saker Falcons) through mowing and clearing tall grass and shrub vegetation, preparing temporary holes for the animal. The management measures did not lead to a visible effect on the Suslik population during the first project year. Habitat management and the monitoring should continue 2-3 more years to see if these measures would increase Suslik numbers and enlarge their occupied area. In addition to that, a section of 20 kV electricity distribution network in the proposed reintroduction area was studied in order to assess the potential electrocution risk for the birds. The study located a total of 488 pylons of 6 different types and evaluated their potential threat. As a result a region with a relatively low electrocution risk was identified to assist the selection of initial Saker Falcon releases by hacking.

Key words: *Falco cherrug,* reintroduction, European Suslik, habitat management, electrocution

Correspondence: *Dimitar Ragyov,* Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences; 2, Yurii Gagarin Str., Sofia 1113, Bulgaria;
E-mail: dimitar.ragyov@gmail.com

Introduction

Saker Falcon *(Falco cherrug)* is a rare species, included in the Red List of the International Union for Conservation of Nature and Natural Resources (IUCN) as "Vulnerable" *(IUCN, 2010).* The last confirmed successful nesting of the species in Bulgaria dates back to 1997, while the last breeding attempt (unsuccessful) was documented in 1998 (*D. Domuschiev,* in litt.). In 2005 two adults and a young bird were observed in the beginning of August in the vicinity of the Central Balkan Mountains (*V. Koychev,* pers. comm.) it is therefore possible that a pair had nested somewhere in the area. Otherwise in the period 2006–2009 only single birds, possibly from the wandering non-breeding Western Palearctic population were regularly seen in Bulgaria *(Ragyov et al., 2009).*

In 2009, after 4 years of surveys in Bulgaria, an international team of organizations (Institute for Biodiversity and Ecosystem Research, Green Balkans, International Wildlife Consultants, National Museum of Natural History, Institute on Zoology, Helmholtz Centre for Environmental Research) came up with a feasibility study, discussing the need for reintroducing Saker Falcons and the means of completing the task in the country *(Ragyov et al., 2009)*. The study was a vital element, required by the IUCN prior to the initiation of a release programme *(IUCN, 1987; 1998)*. The Feasibility Study discussed the population status of the species (past and present), factors that caused decline and extinction, as well as main habitat and food requirements of the Saker Falcon. It sets up particular criteria (i.e., food supply, nest base and protection level) and explored the potential of 15 key areas to sustain reintroduced Saker Falcons. The study pointed out the area of the Central Balkan Mountains and the adjacent territory (Figure 2) as most suitable for initiating a Saker Falcon reintroduction programme.

As a second phase of the reintroduction programme, a series of activities were initiated to prepare the area of the Central Balkan Mountains for a potential start of Saker Falcon releases i.e., (1) habitat management; (2) study on the potential effect on electricity distribution lines; (3) assessment of local people's attitude towards Saker Falcon and the reintroduction of the species; (4) consultations with relevant governmental and non-governmental organisations regarding the species conservation in Bulgaria.

The present paper aims at describing particular actions for the restoration of European Suslik *(Spermophilus citellus)* habitats in a model colony, and comparing the present status of the Susliks with previous investigations carried out in the area. The paper also presents a pilot survey on the medium voltage (20 kV) power lines in terms of their potential negative influence on the birds in order to identify "safe" locations for the initial Saker Falcon reintroduction.

European Suslik

Susliks *(Spermophilus citellus)* are considered among the main potential prey of Saker Falcons *(Cramp & Simmons, 1980)*. There are several threats to the European Suslik in Bulgaria, most importantly pasture degradation and agricultural intensification. Pasture degradation is usually caused by inappropriate grazing practices and has negative impact on the Susliks in two main ways, overgrazing or insufficient grazing. Insufficient grazing leads to overgrowing of the pastures with shrubs and trees. This factor was very clearly expressed in mountainous regions of the country. Intensification of agriculture has negative impact through enlargement of the agricultural lands and increased use of agrochemicals for crop protection. The transformation of pastures, natural grasslands and meadows into arable fields and perennial plantations also threatens Susliks *(Koshev, 2008)*.

European Suslik is a widespread species with fragmented distribution in the Central Balkan Mountains *(Stefanov, 2003)*. Some of the Suslik colonies in the area and its adjacent areas have vanished lately while other colonies presently consist of lower numbers of individuals as compared to the past. The decline of the Suslik population was generally caused by ecological succession. Reduced number of grazing animals enabled the growing of tall and compacted grass, which is unfavourable for this small rodent. This was accompanied with a gradual change of the grasslands species composition, which probably turned into

yet another causal factor for Suslik population decline and fragmentation *(Stefanov, 2003; 2005; 2006)*. Presently a total of 30 Suslik colonies are found in the area of Central Balkan Mountains, covering a total area of 29.5 km^2, which represents 2.44% of the site *(Ragyov et al., 2009)*. Our work hypothesis was that the colony on the study area is declining due to overgrowing with vegetation and once cleared, we would expect an increase of the number of individuals and an extension of the area inhabited by Susliks.

Electricity distribution network

Saker Falcons have been proven to willingly use electricity pylons as lookout points, perching sites and nesting platforms, where they occupy nests built by other species and also nest boxes *(IWC, 2011; Puzovic, 2007; Puzovic, 2008)*. However, the species can also be negatively affected by the pylons. For instance electrocution on power lines has turned out to be a major cause of Saker Falcon mortality, and the electrocution risk is determined by the pylon type and design *(IWC, 2011)*. A satellite tagged male Saker Falcon from Hungary has been found electrocuted in Russia while a female (also satellite tagged) was most probably electrocuted in Western Kazakhstan *(Prommer, 2008)*. Approximately 5 cases of electrocution have been recorded in Eastern Slovakia for the past 30 years (*Y. Liptak* per *L. Deutschova*). In January 2005 *K. Bedev* (in litt.) reported a dead Saker Falcon found under a 20 kV pylon near Bourgas, Bulgaria; most probably the bird got electrocuted.

Several studies on the interactions between electricity distribution networks and birds have been accomplished in Bulgaria. *Nankinov (1992)* was the first who outlined the problem between birds and electricity networks in Bulgaria. He studied 315 White Stork *(Ciconia ciconia)* deaths caused by the electricity network and found considerable increase of that type of mortality during the period of 1950s–1980s (2.38% in 1950s to 40.47% in 1980s of the White Stork ring recoveries were due to this type of mortality). This coincides with the development of the electricity distribution network in the country after World War II. This dramatic increase is however possibly biased by increased ornithological efforts and better reporting. *Stoychev & Karafeizov (2004)* first made an assessment of the structure of the power lines in relation to the risk for birds of prey. Later *Demerdzhiev et al. (2009)* and *Gerdjikov (2010)* implemented large scale surveys in Southeast Bulgaria and classified the type of the electricity pylons according to their effect on bird mortality caused by electrocution. The main types of pylons used in Bulgaria are presented in Figure 3.

Our survey represented a pilot study for the area of the Central Balkan Mountains. The structures of the pylons however appeared to be the same or similar to the ones in other parts of the country, and therefore the publications mentioned above can be used as a reference for assessment of the risk for the released Saker Falcons.

Materials and methods

Both pilot measures for habitat maintenance and improvement, and the electrocution risk assessment were undertaken in the area of the Central Balkan Mountains site, identified of highest potential to host a reintroduced Saker Falcon population. The methods used to obtain the results were as follows.

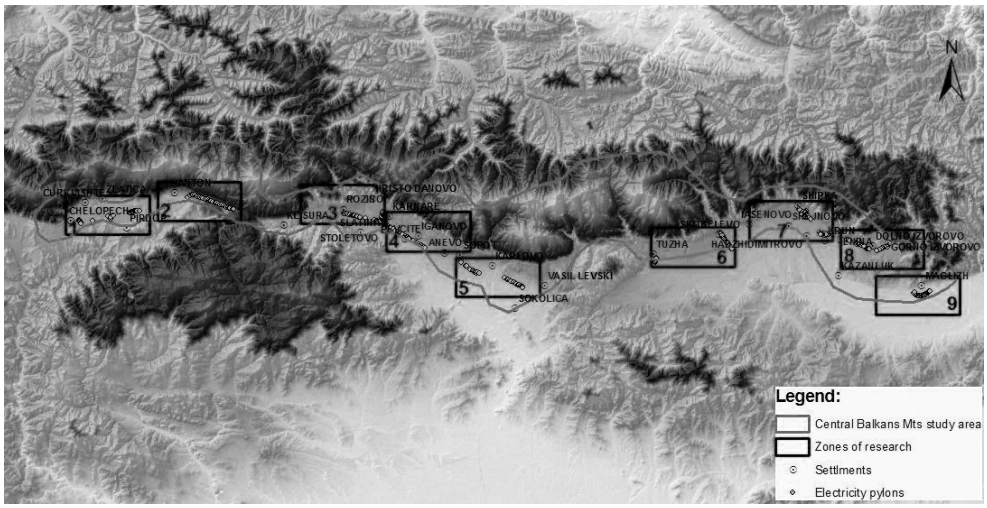


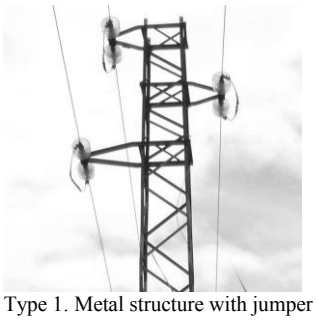
Figure 2. Potential reintroduction area of Sakers in the Central Balkan Mountains with the 9 study zones

Suslik habitat restoration

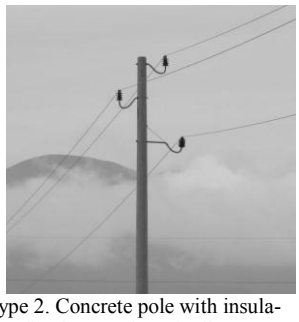
The selection of a model territory for restoration of the Suslik habitat was based on expert analysis, information provided by the Central Balkan National Park Directorate and authors' preliminary field studies. The summary of the data showed that in "Paradzhika" site (N42°40' E24°57'; 890–1209 m a.s.l.) there is a Suslik colony in a degrading habitat. The Suslik density and the area of the colony declined during the last years. The Suslik colony is situated in a pasture habitat with the following composition: 10% tree species (fruit trees—Wild Plums *Prunus spp.*, Sessile Oak, *Quercus petraea* and Beech, *Fagus sylvatica*; 20% Bracken, *Pteridium aquilinum*; 20% thicket forming shrubs (Briar, *Rosa canina* and Hawthorn, *Crataegus* spp.); and 50% open grass area of no particular habitat type (*I. Nikolov,* pers. comm.).

According to park employees and local people, there has been a significant population decline in the project regions in recent years. Probable reasons are intensive succession as well as shrub and tree overgrowth of large areas.

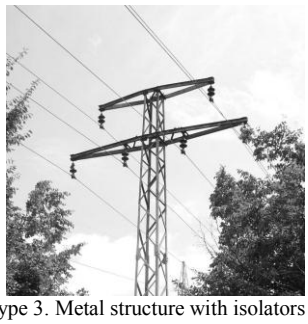
The team visited the area in April 2010 to identify the appropriate approach and observed the appearance of the first active Susliks in the region 15–20 April. The sites were cleared in July by employees and volunteers of Green Balkans NGO and the National Park Directorate. Shrubs, thorns, ferns, and tall grass were removed, using two mowers (bush trimmers: Husqvarna and Stihl) and two chainsaws (Stihl). Early in October the mowing was repeated to remove the newly emerged vegetation (ferns need to be mowed repeatedly in order to be eradicated). The vegetation removed during the clearing was left near eroded sections of the area.



Type 1. Metal structure with jumper wires and 3 lines

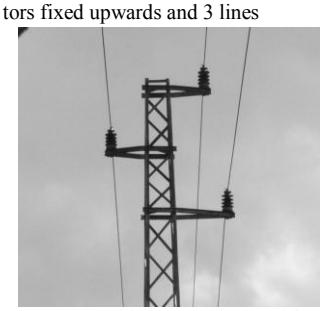


Type 2. Concrete pole with insulators fixed upwards and 3 lines



Type 3. Metal structure with isolators fixed downwards and 6 lines

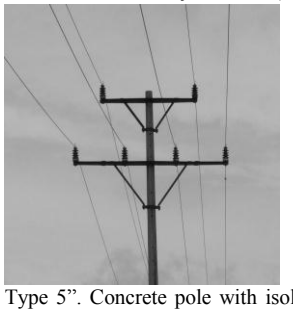
Type 4. Concrete pole with insulators fixed downwards and 3 lines



Type 5. Metal lattice structure with isolators fixed upwards and 3 lines

Type 6. Switch tower (reproduced from *Gerdjikov, 2010*)

Type 1". Metal structure with jumper wires and 6 lines



Type 5". Concrete pole with isolator fixed upwards and 6 lines

Figure 3. The most common types of 20 kV pylons used in the electricity distribution network in Bulgaria

About 3 ha of the area were cleared out in total. Twelve plots (0.25 ha) in the cleared territory were chosen—six control and six experimental plots. The control plots were chosen so they are inhabited by Susliks, and the density and abundance of Susliks were estimated. The experimental plots were not inhabited by Susliks, but they were situated next to the control plots, so occupancy of that territory is expected to prove the work hypothesis.

Density and abundance of the Susliks were estimated through linear transects, each 50 m long and 5 m wide (9-10 transects in each plot, 58 transects in total). Four types of Suslik

Suslik hole type	Number of transects	Number of holes	Average number of holes per transect
Horizontal hole with material	58	28	0.5
Vertical hole with material	58	26	0.4
Horizontal hole, no material	58	10	0.2
Vertical hole, without material	58	6	0.1
Total	232	70	1.2

Table 1. Relative abundance of different types of Suslik holes (±SD) in the studied area. Transect length 100 m, covering an area of 0.05 ha

holes were recorded during the transects: horizontal holes with material, horizontal holes without material, vertical holes with material and vertical holes without material. Thirty new holes (7 cm diameter, 40-50 cm depth) were made in the experimental plots to encourage the expansion of the colony. A motor drill (Stihl) was used for digging holes.

Assessment of the electricity network threat

The field work was completed at the end of July by three participants in three days. The assessment was done through on-foot covering of linear transects of the electricity grid (20 kV power line) within the project area. The electricity network in each zone was inspected only once during the study. The study area was divided into 9 zones, starting from the town of Chelopech to the West and ending near the town of Maglizh to the East (Figure 2). These zones are found along the lowland near the mountain foothills where the expected hunting range of the released Saker Falcons lies.

The location of every pylon was recorded with a GPS device and plotted on map (Figure 2). The total length covered was 64 km and comprised a total of 488 electricity pylons of different types. The individual length of the transects in each zone varied between 6.3 km and 9.1 km, and the number of pylons mapped in each transect varied from 30 to 88. For the estimation of the electrocution risk we however only used a random selection of 270 of the pylons (30 in each zone). The Microsoft Office Excel 2007 program was used for the randomization.

The most frequent types of pylons used in Bulgaria are presented in Figure 3. Pylons in our study area were recorded in a standard data sheet describing several elements of the object i.e., (1) material of the basic construction (metal or concrete); (2) number of wires; (3) direction of the insulators (downward or upward); (4) availability of jumper wires along the insulators. Every type of pylon was compared with the type of the pylons described in *Demerdzhiev et al. (2009)* and *Gerdjikov (2010). Demerdzhiev et al. (2009)* classified the different structures of the power lines in the following order: Type 1 (most hazardous), Type 5 (second most hazardous), Type 2 (third most hazardous) and Type 4 (safe for the birds). According to the results of *Gerdjikov (2010)* Type 1 was the most dangerous structure as well, followed by Type 2. Type 5, however, was presented in his study area with only 1 pylon. Type 4 ranked last by risk with only 2 victims during the study period. Pylons

Site	Date of inspection	Relative density	
		Number of transects	Average number of holes per 100 m transect
Ravniya Buk	12.6.2005	19	8 ± 2,98
Karamandra	29.8.2005	4	0,25 ± 0,5
Boluvanya	30.8.2005	9	6,8 ± 3,3
Ravna	07.10.2005	16	1,8 ± 1,7
Paradzhika – *Y. Koshev*	20.07.2009	9	0.4*
Paradzhika – *present study*	2010	58	1.2 ± 1.4

Table 2. Relative density of European Suslik found by *Stefanov (2005)* and the present study (* only 2 holes recorded)

with insulators fixed downwards (like Type 4) are considered by *Stoychev & Karafeizov (2004)* as relatively safe for the birds too. *Gerdjikov (2010)* calculated an index of mortality, called Killing Rate (KR), for the most numerous types of pylons. The KR index varies from 0 to 1; the higher the rate the more dangerous type of pylon it is. Type 1 was with KR = 0.19 while Type 2 with KR = 0.16. Based on findings of *Demerdzhiev et al. (2009)* we estimated that the KR index of the Type 5 would be in the range of 0.16–0.19, in case that type was presented in the study of *Gerdjikov (2010).*

Based on these indices for the purpose of our study we established a Risk Coefficient (RC) for each type of pylon presented in the Central Balkan Mountains area, as follows:

RC = 0 for Type 4, being safe for the birds;
RC = 1 for Type 1, 2 and 5, as the KR is almost the same according to the other studies;
RC = 2 for Type 1" and 5", as those pylons are similar to Types 1 and 5 but constructed with 6 lines instead of 3 and therefore expose the birds to an approximately twice as high risk of electrocution.

In order to estimate the electrocution risk we established the Electrocution Risk Index (ERI) in each transect calculated as follows:

$$ERI\ (zone\ n) = SUM\ [N\ (pylon\ type\ m) \times RC\ (pylon\ type\ m)]$$

The Electrocution Risk Index was the basis for choosing the most suitable area for initial releases in terms of avoiding potential electrocution problems.

Additionally we recorded the number and species of birds found under the wires and around the electricity poles. All victims within 5 meters of the pylon were considered electrocuted and birds found within 10 m on either side of the lines were considered victims of collision with power lines (following the methodology in *Demerdzhiev et al., 2009*). For future studies habitat type of each pylon was also classified i.e. (1) cultivated land (crop), (2) orchards, vineyards and rose plantations, (3) abandoned land, (4) pasture, (5) swamp, (6) forest.

	Pylon type					
Zone #	**1**	**2**	**4**	**5**	**1"**	**5"**
1	6	22	2	0	0	0
2	0	0	0	0	30	0
3	10	16	4	0	0	0
4	7	23	0	0	0	0
5	2	18	0	0	3	7
6	12	18	0	0	0	0
7	7	22	1	0	0	0
8	13	15	0	2	0	0
9	12	12	0	6	0	0
Total	69	146	7	8	33	7

Table 3. Distribution of the various types among the 9 study zones in the Central Balkan Mountains area.

Results and discussion

Suslik habitat restoration

The initial field visit completed in April showed that Susliks in "Paradzhika" site left their holes and became active two weeks later than the individuals of the plain colonies situated in the foothills of the Balkan Mountains in the same region and more than a month and a half later than those in Southern Bulgaria, the Tundzha river valley. The life cycle of the mountain population was therefore much shorter. This has to be taken into consideration when implementing concrete conservation activities targeting Saker Falcon.

The Suslik abundance in the control plots varied from 2 to 24 holes, probably because of the specific conditions of the habitats (Figure 4). The general abundance of the species found was about 1.2 vertical holes without material/0.05 ha (±0.4) (individuals respectively, (Table 2). According to a large scale research carried out by *Straka (1961),* there were 13 holes per individual. As a total 70 holes were recorded altogether in our study area, it can correspond by calculation to at least 5.38 individuals on the control sites. We therefore consider the overall relative density of the species in the study area as extremely low.

As far as a comparison with the results of *Stefanov (2005)* for other regions in the Central Balkan Mountains is possible, it shows that the relative density of Suslik in the study area is one of the lowest (Table 2).

In 2010, the team did not record any reoccupation by Susliks to the newly cleared territories of the experimental plots. Possible resettlement and expansion of the colony could be expected in a year or two.

Yet, regular grazing of farm animals has already been recorded in the experimental plots. Being attracted to the region by the fresh green grass, the animals maintain the vegetation low through grazing and trampling. The presence of farm animals in these areas is of particular importance for their maintenance in a condition favourable for Susliks. Currently, 120 sheep and ca. 10 cattle are declared to be grazing in the region of the Suslik colony in "Paradzhika" site in an area of 70 ha, although in certain periods, during transhumance, these numbers get higher. The norm of the grazing animals in the National Park is one

No	Species	Cause of death	
		Electrocution	Collision with lines
1	*Circus* sp. (male)	1 (pylon type 2)	–
3	*Pica pica*	4 (pylon type 2 and 1'')	–
4	*Corvus corax*	1 (pylon type 2)	–
	Total	6	–

Table 4. Species composition of the victims, cause of death and the types of pylons that caused fatalities

sheep per minimum 0.4 ha at present (according to Central Balkan National Park Management Plan), therefore a maximum of 175 sheep can inhabit those 70 ha pastures. It will be have to be tested in a future study if this value for the livestock at the area can maintain favourable conditions for the Susliks.

The monitoring on the pilot sites will continue in order to trace the success of the habitat conservation measures and secure appropriate and sufficient food source for the Saker Falcons to be introduced on the site.

Electrocution risk estimates

Six types of pylons were recorded in our study area (Table 3). They were all among the most common pylon types used in Bulgaria (Figure 3). Four of those types matched the constructions classified by *Demerdzhiev et al. (2009)* and *Gerdjikov (2010)* (types 1, 2, 4, 5). Two types (1" and 5") were similar to type 1 and 5 but had 6 lines instead of 3. Three of the types described by the authors mentioned above were not recorded in the Central Balkan Mountains (types 3, 6 and 7). Type 6 is considered as particularly dangerous for the birds *(Demerdzhiev et al., 2009)* and type 7 is among the most dangerous ones according to *Stoychev & Karafeizov (2004),* while type 3 is assessed as favourable for the birds due to suspended direction of the isolators *(Demerdzhiev et al., 2009).* The distribution of the various types of pylons among the 9 zones and the total number of pylons is presented in Table 3.

The results of the assessment of the electrocution risk in the study area are presented in Figure 4. As shown, the majority of the zones hold a relatively similar Electrocution Risk Index. The potentially most dangerous zones appear to be N2 or the region on the east of the town of Anton. The second most dangerous transect is N5, the region south-eastwards of the town of Sopot, around Karlovo and west of the town of Vasil Levski. The third most dangerous zone is N9, the territory in the vicinity of the town of Maglizh. These sections should therefore be avoided in the selection of sites for an initial release.

Three zones represent an average threat of electrocution. These are: N4—the territories southeast of Karnare village, around the village of Iganovo and northwest of the town of Sopot; N6—east of the village of Tuzha and southwest of the village of Skobelevo; as well as N8—northeast of the town of Kazalnluk and around the village of Gorno Izvorovo.

The zones with the lowest risk for birds of prey are: N3—a territory east of the town of Klisura, around the village of Rozino and west of the village of Karnare. The second lowest threat is zone N1—the region around the towns of Chelopech, Zlatitsa and Pirdop. The

third least dangerous zone is N7—east of the village of Iasenovo, south of the village of Shipka and northwest of the village of Krun. The exact hacking place should therefore be constructed somewhere near these territories. Zone N7 is surrounded by 2 transects of medium level threat only, which provides a large and relatively safe hunting area for the young falcons between the villages of Tuzha and Gorno Izvorovo. Another large area with a relatively low risk of electrocution is found between the town of Klisura and the village of Anevo, comprising a low level risk zone and a medium level risk zone.

A total of 6 dead birds of 3 species from 2 families were found during the present pilot study. All of them were suspected electrocuted and no birds were found under the wires which could potentially be considered as casualties of collision. Among the studied overall number of 488 pylons, pylon type 2 (concrete poles with 3 lines and insulators turned upwards) was proven the most dangerous with a total of 5 casualties found from a total of 42 pylons. In addition, type 1" (metal pylon with jumper wires and six lines) also caused the death of one1 bird. These results (despite the limited numbers of victims found) are in line with the findings of *Demerdzhiev et al. (2009)* and *Gerdjikov (2010)* on the most dangerous types of pylons.

In addition to that, numerous bird species were observed to perch on the wires and the pylons during the field work—especially Common Kestrels *(Falco tinnunculus)*. At the same time a total of 63 birds of prey from seven species were observed in the area, including species such as Imperial Eagle *(Aquila heliaca)*, Golden Eagle *(Aquila chrysaetos)* and Short-toed Eagle *(Circaetus gallicus)*. These observations for only three days once again prove the significance and conservation value of the selected reintroduction site.

Conclusions

Our study showed that the situation of the European Suslik colony in the region of "Paradzhika" site is almost critical—both in terms of abundance as well as occupied territory size. The existing and collected data suggest that without direct conservation measures, the habitat at the "Paradzhika" site will be destroyed by overgrowth of tall shrubs, trees and grass. Our working hypothesis "*Clearing of the territory will increase the numbers and enlarge the area occupied by Susliks*" was not proven during the first season of field work. A few more years of habitat monitoring and maintenance are needed to prove or reject it.

Grazing animals (sheep, cattle and goats) occupied the managed territory quickly after clearing it out. However whether or not their current numbers can maintain suitable habitat for the Suslik is unknown yet and future studies are needed to clarify it.

The level of electrocution risk is relatively similar along the study area (with one exception of Zone N2). The study however helped to identify the least and the most dangerous territories in regards of the potential electrocution threat. The area between Tuzha village and the town of Kazanluk are considered the most favourable places for constructing hacking facilities and implementing initial Saker Falcon releases.

Despite the limited number of bird victims found during the power line survey, the results support the findings of previous studies namely i.e. (1) pylons with insulators fixed upwards are the most dangerous for birds; (2) pylons with insulators fixed downwards are

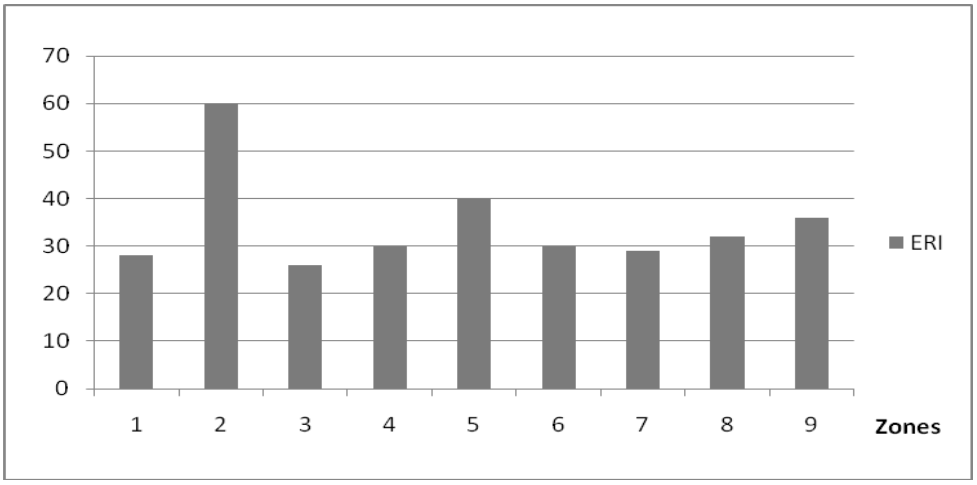


Figure 4. Electrocution risk assessment (columns represent the level of Electrocution Risk Index /ERI/ in each zone of the study area)

safe for birds; (3) pylons with jumper wires (see Type 1", Figure 3) cause considerable mortality but they are relatively rarely used in Bulgaria.

Recommendations

The efforts aiming at managing and supporting the habitats need to be continued in the future, namely:

1) Mowing of already cleared territories and continuing the monitoring of the Suslik colony in order to record the effect of the measures applied. If the activity has a positive effect on the Suslik population more territories should be included in the project (i.e. other colonies in the reintroduction area). Clearing, mowing, and removing ferns should be carried out at least twice or three times a year, depending on the plant growth rate before the process becomes "natural" by using livestock.

2) Reducing the bracken coverage from 20% to 5% through cutting and uprooting. This is not a plant species of Community importance, neither is it protected nationally or of particular conservation significance. Moreover, according to the agricultural regulations, this is a weed, obstructing pasture management. However, small percentage of this species has to be preserved, since it is a pioneer plant species for these particular areas.

3) Supervising the owners of farm animals grazing in the region to secure maintenance of the pastures in good agricultural and environmental condition in conformity with national park regulations. If possible, the owners have to clear on their own the pastures used. For sustainability of the process, once the habitats are cleared and made suitable for Susliks, the future maintenance should be done through animal grazing.

4) Future studies are needed for revising the regulations related to the number of grazing animals per area unit in the region (one sheep per minimum 0.4 ha) in order to understand if this is enough for maintaining the habitats in favourable conditions for the Susliks.
5) Placing an information signboard describing the importance of the colony, considering the tourist route passing the area.

We consider these measures of extreme importance for securing the survival and expansion of the Suslik colonies and therefore guaranteeing sufficient food source for the Saker Falcon population to be introduced within the target area.

The recommendations in regards to the electrocution threat are as follows:
1) Appropriate measures should be undertaken to retrofit the sections especially in the territory around the selected initial hacking site and in those territories that pose the greatest threat for the birds in the area. These measures should also be undertaken considering the concentration and species composition of the birds observed during the field studies.
2) Further research is needed in order to fully understand the impact of power lines in the area and be able to completely minimize the threat of electrocution.

Acknowledgements

The study was a part of the activities of the Southeast European Saker Falcon Network *www.cherrug.org*. It was funded by International Wildlife Consultants (UK) Ltd. acting on behalf of the Environment Agency (Abu Dhabi). We are grateful to the Green Balkans' volunteers who implemented the bulk of the field work: *Aleksandar Mechev, Georgi Dilovski, Dimitar Popov, Pavlin Zhelev, Silvia Cherkezova, Todor Pepov*. Acknowledgements to the Central Balkan National Park Directorate staff: *Nela Rachevic* (Director), *Anton Stnachev, Ivaylo Nikolov, Nanko Minkov* and *Venelin Kojchev* for their support during the project implementation. Special gratitude goes to *Mira Kosheva* for her assistance.

References

Cramp, S. & Simmons, K. E. L. (1980): The Birds of the Western Palearctic Volume II. Hawks to bustards Oxford University Press, Oxford, 695 p.

Demerdzhiev, D., Stoychev, S., Petrov, T., Angelov, I., Nedyalkov, N. (2009): Impact of power lines on bird mortality in Southern Bulgaria. *Acta Zoologica Bulgarica* **61**(2), p. 175–183.

Dixon, A., Ragyov, D., Ayas, Z., Deli, M., Demerdzhiev, D., Angelov, I., Kmetova, E. & Nedyalkov, N. (2009): Population status of breeding Saker Falcons *Falco cherrug* in Turkey. *Avian Biology Research* **2**(4), p. 213–220.

Domuschiev, D., Michev, T., Stoyanov, G., Vatev, I., Petrov, C., & Ruskov, K. (2011): Loven sokol. In *Golemanski, V. (ed.):* Red data book of Republic Bulgaria. Volume 2. Animals. Second Edition [in Bulgarian].

IUCN (1998): Guidelines for re-introductions. Prepared the IUCN/SSC Re-introduction Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. 10 p. Accesssed at: *http://www.lcie.org/Docs/LCIE%20IUCN/IUCN%20Reintroduction%20guidelines.pdf*.

IUCN (2009): IUCN red list of threatened species. Version 2009.1. Accessed at: *http://www.iucnredlist.org* on 24.09.2009.

IWC (2011): Other research project: China. Accessed at: *http://www.mefrg.org/china.asp*.

Koshev, Y. (2008): Distribution and status of European Ground Squirrel *Spermophilus citellus* in Bulgaria. *Lynx* (Praha) n.s. **39**(2), p. 251–261.

Puzovic, S. (2007): Dalekovodi kao strukturni faktor staništa ptica. Doktorska Disertacija. Novi Sad, 315 p.

Puzovic, S. (2008): Nest occupation and prey grabbing by Saker Falcon *Falco cherrug* on power lines in the province of Vojvodina (Serbia). *Arch. Biol. Sci.*, Belgrade **60**(2), p. 271–277.

Ragyov, D., Kmetova, E., Dixon, A., Franz, K., Koshev, Y. & Nedialkov, N. (2009): Saker Falcon *Falco cherrug* Reintroduction in Bulgaria: Feasibility Study. SESN. Sofia.

Straka, F. (1961): Beitrag zur Bioökologie und Bekämpfung des Europäischen Ziesels *Citellus citellus* L. in Bulgarien. *Bulletin of the Central Scientific Research Institute of Plant Protection* **1,** p. 24–63 [in Bulgarian, German summary].

Stefanov, V. (2003): Methodology for European ground squirrel monitoring – proposals. In *Boteva, D. (ed.):* Development and applying system of ecological monitoring in National Parks "Rila" and "Central Balkan", p. 187–216. [in Bulgarian].

Stefanov, V. (2005): Report: Prakticheskо obuchenie na sluzhiteli ot Direkciiata po prilagane na metodikata za monitoring na systoianieto na evropejskiia laluger v NP "Centralen Balkan, unpublished [in Bulgarian].

Stefanov, V. (2006): Conception for conservation of European Ground Squirrel's *Spermophilus citellus* habitats in NATURA 2000, 42 p.

Aquila (2012), Vol. **119**, p. 105–110

Results of the Saker Falcon *(Falco cherrug)* conservation programme in Hungary between 1980–2010

János Bagyura[1], Tamás Szitta[2], László Haraszthy, Levente Viszló[3], József Fidlóczky & Mátyás Prommer[2]

[1]BirdLife Hungary, [2]Bükk National Park Directorate, Hungary, [3]Pro Vértes Public Foundation, Hungary

ABSTRACT—Saker Falcon has not only been a mythical bird for Hungarians but also a highly appreciated bird of prey for falconry. Because of its high economical value population was monitored through centuries although not with scientific scrutiny. Scientifically acceptable research started only in the 20th century. Monitoring showed a dramatic population decline by the 1970s. Conservation efforts have started in the mid 70s and included nest guarding, Suslik *(Spermophilus citellus)* repatriation and installation of artificial nest sites. Due to the efforts the breeding population increased from an estimated 30 pairs in 1980 to about 240 pairs in 2010. While maintaining existing elements of the conservation programme new activities like migration studies using satellite telemetry, insulation of pylons of mid-voltage power lines and habitat analysis based on aerial and satellite photos have been included in current conservation activities.

Key words: *Falco cherrug,* conservation, Hungary, LIFE programme

Correspondence: *Bagyura János,* MME/BirdLife Hungary, H-1121 Budapest, Költő utca 21., Hungary, E-mail: bagyurajanos@invitel.hu

Introduction

Various Hungarian legends describe the behaviour of the mythical Turul, which enables us to identify this bird with a high probability as the Saker Falcon. Hungarians already knew the art of falconry at the time they were occupying the Carpathian Basin. They were monitoring falcon nests for centuries and sometimes they even used falcons as tax payment to the king. When selling private property in the Middle Ages, sellers sometimes maintained their rights on local falcon nests regardless of the new owner of the estate where the nest was located. Locations of nests were very well known from ancient times—it is proven through geographical names as well.

Sakers currently inhabit extensive open areas, mostly steppes and agricultural areas, in Hungary. However, raptors including Saker Falcons met heavy persecution in the lowlands during the 20th century right until the 1980s. Hunters considered them as competitors for small game species. As a consequence, most raptor species retreated to the mountains where big game hunting dominated thus birds of prey were not persecuted. That time Sakers mostly occupied mountain cliffs for nesting. However, the world has changed in the beginning of the1990s. Persecution stopped in the lowland almost entirely. Parallel to that husbandry in mountains ceased giving space to forestation thus making prey species like European Suslik disappear from mountain areas. As a consequence of all these, Sakers reconquered the lowlands *(Bagyura et al., 2004).* By 2007, all breeding pairs disappeared

entirely from Hungarian mountains. Peregrines, being extinct from Hungary for more than four decades, now occupy the ancient eyries again.

No accurate data exists on the Saker population in the ancient and medieval times in Hungary, however—considering original habitats—the estimation of more than a hundred pairs may not be far from the reality. Unfortunately, due to human activities like shooting and use of pesticides, the Saker population in Hungary did not count more than 8 nesting pairs in 13 known territories in 1980 *(Bagyura et al., 2003)* when organised Saker conservation started.

Main achievements of Saker conservation in Hungary

The first decades of Saker Falcon conservation in Hungary (1980–2006)

One of the first aims of BirdLife Hungary, formed in 1974, was to save the Saker from extinction. Major causes of breeding failure were illegal shooting, disturbance by tourists and/or rock climbers, electrocution, changing land use and loss of appropriate food supply as a consequence, nest robbing by egg-collectors and for falconry. Although the effects of pesticides like DDT on the Saker population was not studied in detail, it is assumed that they affected its population similarly to that of Peregrine.

BirdLife Hungary started an organised Saker conservation programme in 1980, which focusses on the elimination of the most important threatening factors. Involvement of volunteers was a crucial element of the programme, which included the activities listed below.

Nest guarding and public awareness raising

The conservation programme has been running now for more than 30 years. The main elements of the programme and its major achievements are: guarding of endangered nests was the first step, because illegal trade of falcons was still a crucial threat at that time. Various nests were guarded on 101 occasions between 1977 and 2006, out of which breeding failed only 22 times. A total of 238 juvenile Sakers fledged from guarded nests and these contributed significantly to the increase of the Saker population in the Carpathian Basin. With the threat of nest robbing gradually disappearing, the emphasis was put on awareness raising during conservation activities. Many of the volunteers were students in schools in game management or agriculture, because raising awareness amongst those people possibly getting into contact with Sakers (and other birds of prey) later during their career was a priority action. The plan has proved to be successful, as nowadays we regularly meet game wardens in the field, who participated in the nest guarding and who have now a fully different attitude towards Sakers than the previous generation. Altogether, 1600 volunteers participated in nest guarding during the years.

Installing artificial nests

Installing artificial nests to provide safe nesting places for Sakers was another crucial element in Hungarian Saker conservation. Although placing artificial nests had started already during the period Sakers still tended to occupy mountain territories, its importance

increased significantly when lowland territories became dominant. Since human persecution in the lowland affected all raptors and almost all corvid species, only an insufficient number of good quality nests were available for Sakers at the time they moved to the lowland. Sakers, therefore, occupied any nest available, which caused breeding failure in many cases. The mortality of Saker broods was especially high (ca. 46%) in Carrion Crow *(Corvus corone cornix)* nests. To prevent further loss, members of BirdLife Hungary started to replace Carrion Crow nests with artificial nests in known eyries. The action proved very successful and since then artificial nests have been placed to many sites where Sakers had been regularly seen but no eyries were known *(Bagyura et al., 2004).* Another phenomenon was in the 1990s that Sakers started to breed on the pylons of high voltage power lines. However, nest quality problems occurred on pylons as well, thus—in co-operation with the electricity provider companies—installation of artificial nests started also on pylons, which gave a new momentum to the programme. It was much easier to install artificial nests on pylons, and covered nest boxes proved to be safer than open nest platforms. Also, Sakers had a tendency to occupy artificial nests on pylons rather than on trees, because pylons were higher than the highest trees in the lowland. As a result, 85.4% of known pairs bred in artificial nests by 2006, out of which 43.5% were on pylons of high-voltage power lines and only 41.9% were on trees. Altogether, 3573 juveniles fledged from 1189 successful broods between 1980–2006, most of them from artificial nests *(Bagyura et al., 2006).*

Suslik repatriation

As part of the conservation programme, 3 000 European Susliks (favourite prey of Saker) were translocated in the indicated period of the project from airports to new or former (improved) habitats. The main reason for the decline of this mammal was—as mentioned above—the abandonment of mountain meadows by farmers. As grazing livestock disappeared, the habitat became inappropriate for Susliks. The species disappeared from many sites, unfavourably affecting the Saker as well. However, after the year 2000, grazing restarted in some mountain meadows and they became appropriate for Susliks again. Renaissance of this practice was also beneficial to the raptors of Susliks, especially to Sakers.

Insulation

In order to diminish mortality caused by electrocution, following our proposal, electric companies insulated about 30 000 pylons of medium-voltage power lines, which was good news for other bird species as well. The final aim is to eliminate the threat completely; however there are more than 600 000 pylons of such type so there is still a long way to go.

Monitoring and ringing

Besides systematic annual ringing, other monitoring projects and data collection had also been carried out during the programme. Data were collected on nesting habits, habitat types, behaviour, dietary habits, breeding success and reasons for breeding failures. Prey remains were collected from 444 nests between 1992 and 2006 and in total 10 830 individuals of 114 species were identified. Analysis of data is still in progress.

Conservation of Saker Falcon in recent years (2006–2010)

The first Saker conservation LIFE project

Saker conservation in the Carpathian Basin has arrived to a new stage in 2006 when a Hungarian–Slovak project proposal on Saker conservation in the Carpathian Basin was approved by the LIFE financial instrument of the European Union (LIFE06 NAT/HU/000096). The project building on the main elements of the already running programme, also introduced new technologies and methods—like satellite tracking and habitat analyses based on aerial and satellite photos—to make conservation efforts more efficient. The project consisted of the following main elements each having significant importance in Saker conservation.

1. Providing nest sites. The population was strengthened by conserving old nest sites and creating new ones by placing artificial nests on potential or existing nesting areas.

2. Studying agricultural subvention schemes and effects of the related habitat management. Various schemes were analysed in order to propose a subvention system that supports those agricultural activities the most, which are favourable for the species.

3. Conserving Suslik as the most important prey. A proposal was created for a suslik-friendly habitat management on SPAs. In addition, another proposal was submitted to amend agri-environmental schemes in favour of suslik conservation. Suslik as the most important prey of Saker was re-introduced to certain Natura 2000 areas that were potential breeding sites of Saker.

4. Insulating pylons of electric power lines. Maybe the most important activity to reduce mortality was insulation of dangerous pylons of medium-voltage power lines in the nesting and foraging sites.

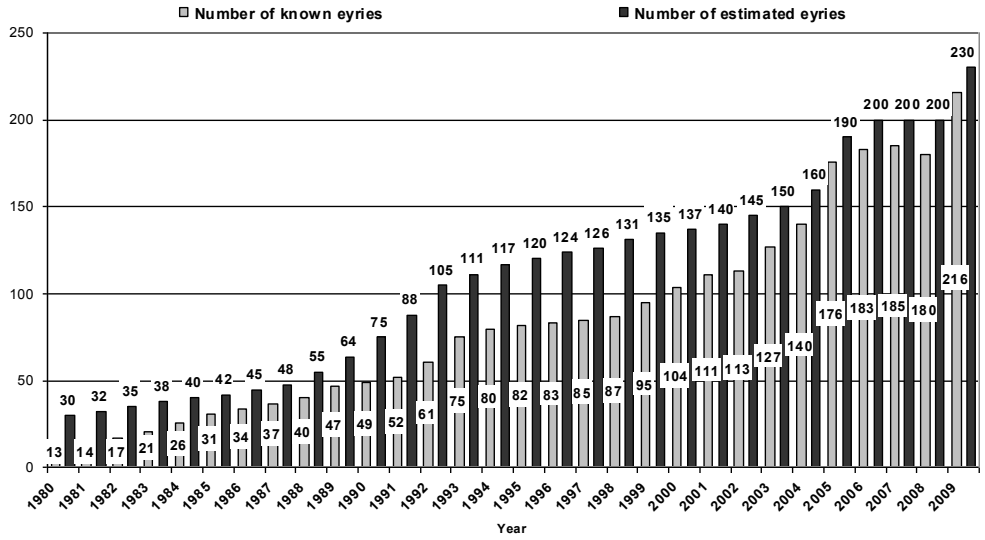


Figure 1. Changes in the Saker Falcon population in Hungary between 1980–2010

5. Nest guarding. In order to prevent human disturbance including nest shooting, guarding of endangered nests was organised with the involvement of many volunteers.

6. Exploring the threats on migrating Sakers. In order to better understand the mortality factors during migration and on wintering sites Sakers were fitted with satellite tags and an international mailing list was set up.

7. Increasing environmental awareness. During the project various stakeholders (farmers, game managers, politicians on local and national levels) were contacted and information signposts were erected to gain support for the conservation programme.

8. Monitoring. A standardised monitoring system was established, which provided precise information about changes of both Saker and suslik populations. By using the capture-recapture method, wintering success of susliks was evaluated and information was collected from the wintering areas of Sakers by using an international mailing list. Both actions were necessary to follow the changes and to evaluate the success of the conservation measures.

9. Developing human resources and technical possibilities. To implement conservation actions, development of both human resources and technical equipments were necessary and they were parts of the project.

10. Ringing. Ringing was an integral part of the project as a traditional element to gather information on the population dynamics and movements. Saker chicks were ringed with ornithological and so-called PIT (Passive Integrated Transponder) rings.

The project ended in 2010 and brought a large amount of new information on habitat use, diet, juvenile dispersal, migration and threats on the species. New findings on the specific topics are to be published at a later stage.

Population status of the Saker Falcon population in Hungary in 2010

The rainy spring of 2010 did not favour Sakers. In the last year of the first LIFE project, only 176 juveniles fledged (from 68 nests), which is about one quarter of juveniles fledging in an average year. As the population was estimated at approximately 220 pairs (with 172 known eyries), the low number is the result of low breeding success rather than that of a possible population decline: only 68 pairs were successful, the worst ratio in the last 30 years, and even they had a very low number of chicks (2.59 chicks/nest).

In 2010, 90.6% of the Hungarian Saker population bred in artificial nests (on trees or pylons) with 75% of the pairs choosing artificial nests on pylons. A total of 7.6% of the pairs bred in natural nests on trees and 1.8% in natural nests on pylons. These numbers indicate the importance of the artificial nest programme.

The second Saker conservation LIFE programme

As a sequel of the first LIFE project, a second LIFE Saker conservation programme (LIFE09 NAT/HU/000384) was launched in 2010 with the participation of Hungary, Slovakia, Romania and Bulgaria by the support of the European Union. At the same time, the project also aimed to eliminate some endangering factors in the core area, too. In 2010, the total European breeding population was estimated at 450 pairs, with Hungary and Slovakia holding about 47% of it.

During the programme, which lasts until 2014, the Hungarian and Slovak participants will share their experience with their partners to contribute to a more efficient conservation

Saker programme in those countries as well. The second project will focus on the protection of existing nest sites and the establishment of new ones by attracting Sakers there with the installation of nest boxes. Special effort will be taken to better understand the food and habitat preference of the species, Suslik *(Spermophilus citellus)* friendly habitat use will be introduced on SPAs and proposals will be made to the Agri-Environmental Scheme to reach an even better level of habitat management. Susliks will be reintroduced to some potential Saker habitats. The project takes actions to eliminate the key factors of mortality. This involves insulation of dangerous electric pylons around nesting and feeding sites and guarding nests to reduce illegal culling by hunters. To evaluate changes in population trends the project evaluates migrating losses by satellite telemetry and gathers information from the wintering grounds. Application of satellite transmitters will also provide data for mapping the habitat use of adult birds in the area of existing or planned wind farms in order to better understand their effects on Saker behaviour. This type of data collection can be used during the planning or permitting process of wind farms. An intensive communication programme targeting farmers, game managers and decision makers at local and national level, together with the posting of attention signs, will raise awareness in the target groups and create support for conservation measures for Sakers. To evaluate changes in population trends and to assess the success of conservation actions of the project a comprehensive monitoring programme will inform about the changes in population parameters both in case of Susliks and Sakers.

As a result of this project, the conditions for the conservation of Saker will improve significantly in the entire project region.

Acknowledgement

We thank to the more than 1 600 volunteers who have been participating in the Saker conservation programme in Hungary since its beginnings until today. All of them played an important role in conserving the species in Hungary. Also, we would like to thank the invaluable help that has been given by the relevant ministries, national park directorates, MAVIR (Hungarian electricity provider company), local NGOs, municipalities and many other organisations that supported the Saker conservation programme in various ways.

References

Bagyura J., Szitta T., Haraszthy L., Demeter I., Sandor I., Dudas M., Cally Gy., Viszlo L. (2004): Population trend of the Saker Falcon *Falco cherrug* in Hungary between 1980 and 2002. In *Chancellor, R.D; Meyburg, B.-U. (eds):* Raptors Worldwide. Berlin, p. 663–672.

Bagyura J., Szitta T., Haraszthy L., Fidlóczky J., Prommer M., Solti B., Fatér I., Dudás M., Tihanyi G., Zalai T., Váczi M., Viszló L., Klébert A., Kazi R., Puskás L., Tóth I., Török H. & Zalai T. (2008): Kerecsensólyom-védelmi Munkacsoport 2006. évi beszámolója. *Heliaca* 2006, p. 25–31.

Bagyura, J. (2010): A Kerecsensólyom-védelmi Munkacsoport 2010. évi beszámolója. *Heliaca* 2010, p. 22–29.

Aquila (2012), Vol. **119**, p. 111–134

Migratory movements of Central and Eastern European Saker Falcons *(Falco cherrug)* from juvenile dispersal to adulthood

Mátyás Prommer[1], János Bagyura[1], Jozef Chavko[2], Marcel Uhrin[3]

[1]MME/BirdLife Hungary, [2]Raptor Protection of Slovakia, Bratislava; [3]Institute of Biology and Ecology, Faculty of Science, Pavol Jozef Šafárik University, Slovakia & Department of Forest Protection and Wildlife Management, Faculty of Forestry and Wood Sciences, Czech University of Life Sciences

ABSTRACT—The Saker Falcon is a partial migrant species of Eurasia, but there is little information on the species' migratory movements. This article attempts to compile the available information describing the migratory movements of Sakers breeding in Europe. In addition, data from satellite-tracking of 45 juvenile Saker Falcons tagged in the frame of a LIFE project were analysed. The results suggest that juveniles show partial and parallel autumn migration in their first calendar year starting in October–November. Regardless of their starting position, all migrating juvenile Sakers migrate southwest (210° on average). The distance of the autumn movements varies between a few dozen to a few thousand kilometres. They cross large water bodies on a broad front and do not congregate at straits as soaring raptors do. Females travel further for winter than males. The main wintering areas for the birds leaving the breeding range of the species are in the Central Mediterranean region. To date, only juvenile females have been proven to spend the winter in the Sahel. First spring migration starts late March–early April and slower than autumn migration. From the second year, Sakers return to their previous wintering sites in the subsequent years and the time spent in the wintering areas becomes shorter.

Keywords: *Falco cherrug,* temporary settlement area, migration, satellite tracking, ringing data, Hungary, Slovakia

Correspondence: *Prommer Mátyás* MME, H-1121 Budapest, Költő u. 21.;
E-mail: mprommer@yahoo.com

Introduction

In their European range Saker Falcons breed in the European part of Kazakhstan, Russia, Turkey, Georgia, Ukraine, Moldova, Romania, Serbia, Croatia, Hungary, Slovakia, Austria and the Czech Republic. Sakers have no recent confirmed breeding records in Macedonia and Bulgaria although once the used to breed there. Occasional breeding of 1-2 pairs have been confirmed at least once in the past in Germany and Poland. There is no confirmed historical or recent record of Sakers breeding in other European countries; however the species may occur in most of them on passage or as vagrant *(Baumgart, 1991; Baumgart & Haraszthy, 1997; Orta, 1994; Makatsch, 1950; Sielicki et al., 2009; Augst, 2000; Ragyov et al., 2006).*

According to the literature, the Saker is a partly migratory species *(Porter & Beaman 1985)*; a certain part of the population is resident, another part migrates, while some birds leave their breeding area only when weather conditions become unfavourable *(Baumgart, 1991).* Sakers in Mongolia, located in the northern part of the distribution range of the spe-

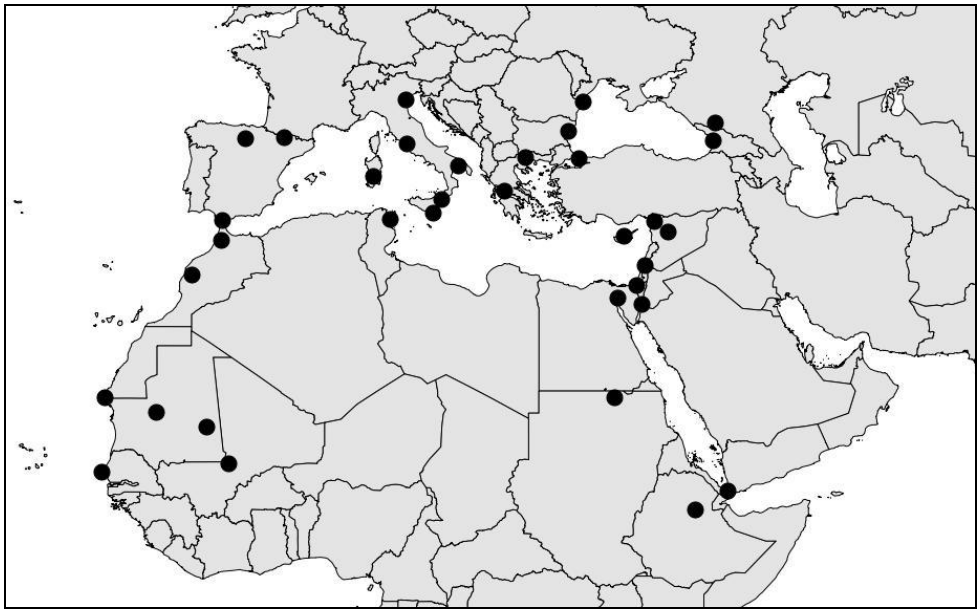


Figure 1. Relevant sites within the Eurafrican region where occurrence of Saker was indicated during migration or wintering in the literature (those records where exact location was missing and literature data describing the movements of satellite-tracked individuals were both omitted)

cies, can be either nomadic or migratory or stay in the breeding area all year round *(Potapov, 2002)*. All the descriptions that can be found in the literature are based on visual observations, a few recoveries and satellite-tracking of a few individuals. Detailed studies based on well replicated samples of ringing or satellite-tracking data are not available for the migration of Sakers.

In this article we attempt to describe the migration patterns of the Central-Eastern European populations of the species and map their passage and wintering areas by analyzing available literature and ringing data and the results of a large-scale satellite-tracking project.

Review of literature data on the migration of Sakers

The following review is based on extensive research of both the printed literature and internet soruces relating to raptor surveys at the most relevant migration bottlenecks (the most important data were summarised in Appendix 1 and relevant wintering sites mentioned in the literature are sown in Figure 1). The discussed sites are—apart from Măcin Mts. in Romania—outside the recent breeding range of Sakers *(Orta, 1994)*, hence, data refer to true migrants or stragglers. Some notes on winter findings of Sakers outside of their breeding range are also provided.

Middle East

The most important raptor migration bottleneck for Western Palearctic raptors is situated south of the Caucasus (Georgia) where thousands of raptors migrate. Only single birds pass through there. During wintering only four Sakers were recorded in December 1998 south of the Caucasus *(Galushin & Moseikin, 2000).*

The species may breed in Central and Eastern Turkey; however it is more widespread on passage and winter *(Acar et al., 1975).* On the well-known passing site at Bosporus the species is seen only in small numbers during autumn *(Porter & Willis, 1968; Sutherland & Brooks, 1981; Üner et al., 2010).* Individuals are seen occasionally also elsewhere (Camili, Artvin, *Perktaş & Turan, 2007;* Belen Pass, *Acar et al., 1975).*

In Israel, the Saker is a rare passage migrant, generally seen during migration after mid October with fewer than 20 records each year *(Christensen et al., 1982; Géroudet & Juillard, 1990; Alon et al., 2004; CITES, 2004)*. It is also a winter visitor in small numbers here, mainly in the lowlands of northern and central Israel and the Negev Desert *(Shirihai, 1996; Shirihai et al., 2000; Alon et al., 2004).*

Records from the Arab Peninsula are scarce. In the Syrian Desert, six Sakers were captured between 2000 and 2003 during autumn migration *(Serra et al., 2005a; 2005b)*. In Yemen, it has been recorded during autumn at two sites *(Porter & Christensen, 1987; Welch & Welch, 1989).* In Oman, the Saker is a passage migrant and winter visitor mostly from September to April. Some records may refer to ex-captive birds *(Sargeant et al., 2008)*.

Eastern Mediterranean region

In the Balkans, data are available from Romania, Bulgaria, Macedonia, Serbia and Greece. In the Măcin Mountains of Romania several Sakers were recorded during the autumn raptor censuses *(Milvus, 2008),* but they may refer to individuals of the three resident breeding pairs near the observation sites. While no confirmed breeding of Sakers has been reported since 1998 in Bulgaria, it is regular on passage all over the country with most records concentrating in the Burgas region at the Black Sea coast *(Michev et al., 2011)*. The oldest record from Greece refers to a subadult Saker collected on the Rhodes island in 1913 (Turin Museum of Natural History). In recent years, there have been 2–4 verified records of Saker in Greece annually according to the reports of the *Hellenic Rarities Committee (2011).* Sakers are suspected to breed in North-Thrakia (*Handrinos & Dimitropoulos, 1983*). Saker Falcon for Macedonia was mentioned already by *Makatsch (1950)*, three further specimens are known in museums (Natural History Museum in Skopje) originating from Macedonia and one from Serbia (Vranje), from the autumn migration and/or wintering period (Ovche Pole, Skopsko Pole, Negotino). *Dimovski (1972)* mentions the species from Skopje Valley only during the migration.

In Cyprus, Saker Falcon is regarded as a scarce migrant in spring but commoner in autumn. It is reported sporadically in some years also in winter (December–January). Migration through the Akrotiri peninsula had been monitored on a daily basis in the period 2004–2007, when the number of passing Sakers were negligible compared to those in the 1960s *(M. Miltiadous,* pers. comm.).

Western Mediterranean region

The species used to be a fairly common wintering and passage bird in Italy from the 19th to the mid 20th centuries, when it apparently became much scarcer. It is considered now a regular winter visitor in Italy, with somewhat fewer records during spring and even fewer during autumn passage—most probably because there are far more observation surveys in spring in the country *(Corso & Harris, 2012,* with a detailed review of Italian data there). The Saker Falcon is a rare vagrant on the Maltese Islands during spring and autumn *(Sammut & Bonavia, 2004; Raine & Vella, 2007; Galea & Vella, 2012).* Out of the 49 records between 1908 and 2007, 69% were seen in the autumn months, 27% were observed in spring, while 4% were recorded in the winter (*R. Vella,* pers. comm.). Sixteen records relating to 20 individuals of Sakers have been accepted in France up to 2010 *(Reeber & le CHN, 2011).* The first official record for Spain was accepted in 2004 *(De Juana, 2006).* Another record, a satellite tagged Hungarian bird was reported in 2009 *(Dies et al., 2011).* The first confirmed record for Portugal was also provided by the same individual detected in August 2009 in Guarda district *(Matias et al., 2011).*

Africa

The Saker has been known as a scarce winter migrant to Northwest and Northern tropical Africa south to Sudan, Ethiopia reaching the Equator in Kenya *(Brown et al., 1982).* According to more recent literature the species occurs throughout the Sahel region from Senegal to Sudan *(Dejonghe, 1980; Thiollay, 1989; Ash & Nikolaus, 1992; Dixon, 2005),* although Sakers can be seen still mainly in North Africa during the migration period and in winter *(Global Raptor Information Network, 2012)*. In Tunisia Sakers are passage migrants and winter residents in small numbers *(de Balsac & Mayaud, 1962; Isenmann et al., 2005)* with most data from Cap Bon during spring passage between the end of March and May *(Thiollay, 1977; De Jong et al., 2009)*. A few winter records have also been recorded here *(Isenmann et al., 2005; Global Raptor Information Network, 2012)*.

There are further, unverified records indicating the occurrence of Sakers in the sub-Sahel countries. One Hungarian and one Slovak satellite-tracked Saker reached even Niger *(Issaka & Brouwer, 2012)*.

Material and methods

Analysing ring recoveries

Ringing and recovery data were collected from available papers relating to range states of Saker Falcons, data of ringing atlases *(Schröpfer, 2008; Bagyura & Szitta, 2009)* and reports. In case of Hungary, a total of 2570 ringing and 94 recovery data were analyzed with a special emphasis on the relationship between recovery distance and age.

Satellite-tracking

Out of the different migration study methods available, satellite tracking provide the most accurate and detailed information on the movements of animals. Satellite-tracking of birds started in the early 1990s and by the mid 2000s the development of technology made

	Total	Male	Female
Number of tagged birds	45	19	26
Sakers perished or PTTs broken before their 1st migration period	13	6	7
Bird migrated but no accurate data were available for analysis	1	0	1
Sakers providing satellite data during migration	31	13	18
Types of movements according to migration distance			
No migratory movement shown from the pre-migration TSA	5 (16.1%)	3 (23.0%)	2 (11.1%)
Short-distance movements detected	11 (35.4%)	6 (46.1%)	5 (27.7%)
Medium distance migration (Mediterranean Europe)	10 (32.2%)	4 (30.8%)	6 (33.3%)
Long distance migration (Africa)	5 (16.1%)	0	5 (22.7%)
Sakers showing migratory behaviour in total	**26 (83.8%)**	**10 (76.9%)**	**16 (88.8%)**

Table 2. Distribution of the numbers of satellite-tracked juvenile (1CY) Sakers according to migration type

it possible to apply the technique on a number of species *(Meyburg & Fuller, 2007)*.

In Hungary 39 juvenile and 5 adult Sakers, in Slovakia 6 juveniles were tagged between 2007 and 2010. The tagged Sakers represented both sexes in a similar ratio (Table 1). In 2009 two adult males were tagged in western Hungary as part of an environmental impact assessment study of a planned wind farm *(Váczi & Prommer, 2010)*. Information was also used from an Austrian Saker satellite tracking project, where three captive-bred juvenile females were released with satellite transmitters (PTTs) in 2009 and 2010 *(Gamauf & Dosedel, 2012)*. In total, over ten thousand fixes from 53 satellite-tracked Sakers were available in the Central European region.

The satellite-tracked Sakers were fitted with solar-powered transmitters (so-called PTTs; Platform Transmitter Terminals). The Argos satellite system was used to communicate with the PTTs. In the Hungarian-Slovak LIFE project in 2007 five 20g solar Argos PTTs (NorthStar ST) were applied that did not have an embedded GPS unit but the Argos system located them by using the Doppler-effect. They did not work very accurately in Central Europe due to the high level of background noise in the used frequency. Another five units with GPS capability (manufactured by Microwave Telemetry Inc.) provided accurate data. Based on that experience, from 2008 only GPS-embedded 22g solar Argos/GPS PTT-100 units (Microwave Telemetry Inc) were used, which gave more accurate positions in Central Europe than simple Argos-located PTTs. In the wind farm project, as well as in the Austrian project, the same type of 22g solar Argos/GPS PTTs were again used. The PTTs represented ca. 2.6% of the mean weight of the males (730–950 g) and only 2% of the females (970–1300 g; *Cramp & Simmons, 1980*).

PTTs were mounted on the birds as a backpack by using a special teflon ribbon for harnessing. The teflon ribbon was run through the three loops of the PTT—one in the front and two on the flanks and fixed by sewing at the connections. We did not use metal crimps as they might cut the teflon ribbon as previous studies suggest *(Steenhof et al. 2006)*. End cuts of the teflon ribbon were folded back under itself before sewing and covered by small rings from the same material to prevent linting. Dental floss was used for sewing and finishing knots were fixed by using superglue. Three independent stitches were made at one sewing point. The harnesses were very similar to the ones used for the Marshall telemetry equip-

ment in falconry. Harness straps were crossed on the breast above the sternum and fixed with a sewn knot. PTTs were placed on the centre of the back of the birds to cause the least disturbance in the centre of gravity of the bird. Harnesses were just loose enough to let one finger fit between the PTT and the bird's back.

GPS-embedded PTTs are able to locate the bird with an accuracy of approximately 12 × 20 meters. Considering the weaker performance of the PTTs during the winter of 2007/2008, when they were set to locate the birds six times a day all year and to transmit the data on every third day, and considering the purpose of the tracking (studying dispersal and migration or habitat use), from 2008 the PTTs on juveniles in the Hungarian-Slovak project were set to locate the birds six times a day between 1 April and 30 September and three times a day in the rest of the year. PTTs were set to locate adult Sakers ten times a day all year round as the main aim in their case was to study habitat use. This latter setting resulted fewer locations in winter owing to lack of light; however the amount of data was still sufficient to evaluate the winter movement of those birds. As soon as the raw data arrived in the French-based database available online, they were downloaded, processed and evaluated. When mapping and analysing the dispersal data, movements on the temporary settlement areas (TSAs) and migration, the WGS84 system was used to map the locations of the birds. Satellite-tracked birds were also fitted with aluminium rings.

Results and discussion

Ringing data

Extensive ringing projects have been running only in three countries (Hungary, Slovakia and the Czech Republic) within the European range of the species, and even in those countries large-scale systematic ringing started only in the 1980s. The ringing activity has been focusing on ringing nestlings in all three countries mentioned above, which is occasionally complemented by trapping and ringing fledged juveniles and adults. Other European range countries that hold a significant Saker population—like Serbia, Ukraine and Austria—carry out no systematic, long term ringing projects.

Czech Republic and Slovakia

Up to 2002, 312 Sakers were ringed in the two countries including the period when they formed one country, Czechoslovakia *(Schröpfer, 2008).* Between 1999 and 2009 in the Czech Republic 151 Sakers were ringed *(Beran et al., 2012);* and between 2007–2010, 240 Saker nestlings were ringed in Slovakia. Most of the recoveries were in the Czech Republic, Slovakia and the neighbouring countries confirming a relationship between the Czech and Slovak and also with the Hungarian and Austrian populations. Recoveries confirm that some of the juveniles stay in the breeding area for winter. However, there are only a few recoveries providing further information on the migration and wintering habits. A juvenile ringed as a nestling in the Czech Republic on 20 May 1993 was found dead on 21 December in the same year near Venice, Italy. A Saker ringed on 21 May 2005 in the Czech Republic was found on 8 January 2006 in Western Hungary. Another Czech bird, ringed on 27

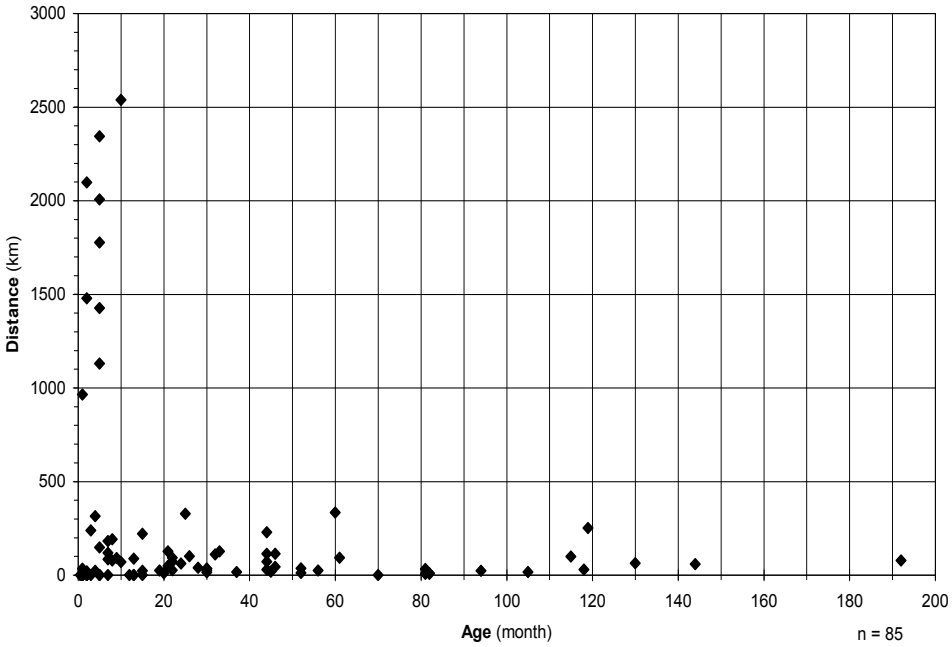


Figure 1. Age related distance of recoveries of Sakers ringed as pullus in Hungary (1950–2010)

May 1986, was found during its first winter in Western Hungary on 12 January 1987. An individual ringed in May as a nestling was trapped in October of the same year in Libya—2539 km away—by a falconer. Other recoveries can be considered as post-fledging dispersal, and as they are indirectly linked to migration movements they need to be mentioned. A Saker ringed as a nestling on 29 May 1982 collided with a small airplane two and a half months later, on 16 August near the town of Tarbes-Ossun-Lour, SW France *(Schröpfer, 2008)*.

The following recovery shows an opposite dispersal direction: a nestling, ringed on 14 May 2003 in eastern Slovakia, was found electrocuted in November in the same year, near Moscow, Russia, 1200 km away. A male sibling of this latter bird was also found on 20 January 2004 in Serbia, 450 km south of the nest showing a different dispersal and migration/wintering strategy *(Bagyura & Szitta, 2009)*.

Hungary

Between 1954 and 2010, 2570 Sakers were ringed in Hungary (more than 95% as nestlings) and 94 recoveries have been recorded. Regardless of age, most of the recoveries occurred in Hungary or in neighbouring countries, mainly Slovakia, throughout the year. There are, however, recoveries suggesting that some Hungarian Sakers do migrate and

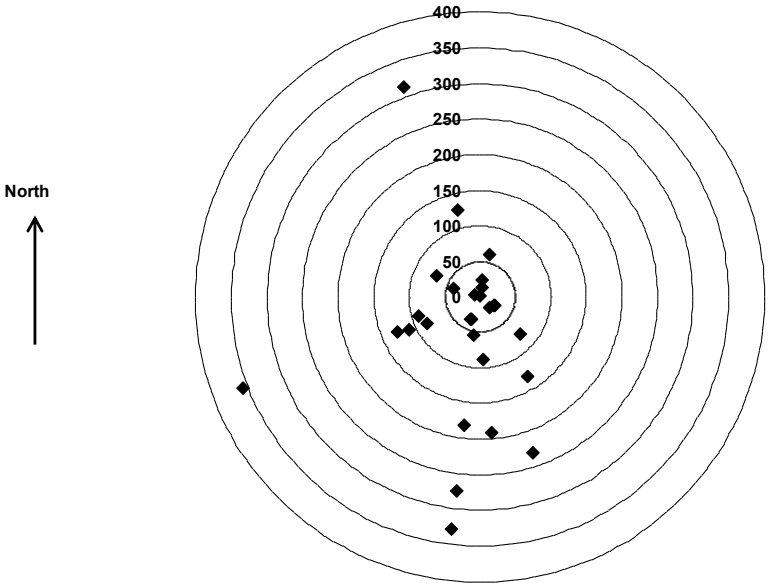


Figure 2. Directions and distances of recoveries of juvenile Sakers ringed in Hungary between 1951–2010 (circles represent distances in kilometres; diamonds show the distance of recovery and the direction from the ringing site)

foreign birds found in Hungary confirm that Sakers of more northern origin may spend their winter in Hungary. Age-related distance of recoveries strongly suggest that only juveniles migrate, as none of the recoveries exceeding 500 km is related to Sakers older than 11 months (Figure 1).

Juveniles recovered within 500 km tend to show clear southerly and south-westerly movements (Figure 2), while recoveries of adult birds (ringed as nestlings) were distributed in every direction except for north (Figure 3).

Long-distance recoveries can be divided into two groups: (1) Recoveries occurring during the post-fledging period, usually within 1-2 months after fledging, but before the migration season. A juvenile Saker ringed as a nestling in eastern Hungary on 31 May 1996 and was found dead on 26 July 1996, 1478 km away from the place of ringing. The bird had left the nest exceptionally early and covered a very long distance within a short time. One more post-fledging movement also deserves to be mentioned: a juvenile Saker ringed as nestling on 18 June 1983 in North Hungary was found dead in Germany (at a distance of 964 km) only 27 days later, on 15 July. (2) Long-distance recoveries related to migratory movements. Migration related movements are shown by the four recoveries from Libya between 1996 and 2009, all recoveries relating to juvenile Sakers (1st migration/winter) and they are from between October and March; one juvenile ringed as a nestling on 16 May 1993 was found on 15 October in the same year, near Poros, Greece; and a dead Saker was found in Malta on 12 October 1996 that had been ringed as a nestling on 25 May 1996.

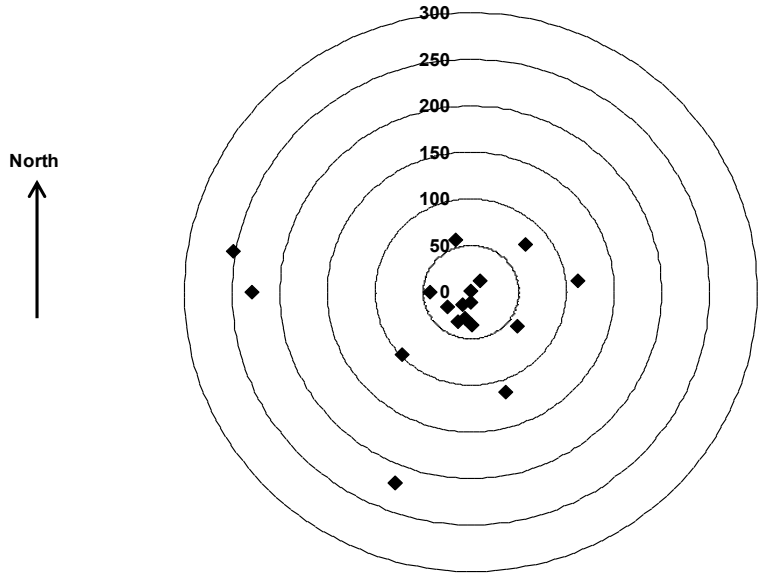


Figure 3. Directions and distances of recoveries of adult Sakers ringed in Hungary between 1951–2010 (circles represent distances in kilometres; diamonds show the distance of recovery and the direction from the ringing site)

Ring recoveries in the past 30 years have not demonstrated any gene exchange between the Hungarian and Eastern European (east from the Pannonian Basin) Saker populations. No emigration to or immigration from either population was observed. Recoveries of breeding adults prove the strong relatedness between the Hungarian and Slovak populations. Communication between the Czech and Hungarian populations is confirmed by ring recoveries, although only non-breeding juveniles have been recovered so far. The Hungarian population most likely relates also to the Austrian, Croatian and Serbian Saker populations, however, no ring recoveries have confirmed that theory yet.

Other countries

Ring recoveries show that Sakers from North Kazakhstan may migrate in a southwesterly direction using the Eastern European flyways. One Saker ringed in Naurzum State Reserve was shot in Georgia in November, 2040 km southwest from the place of ringing. Another Saker ringed in the same area was shot three years later in spring, near Chelkar railway station, 540 km southwest of Naurzum. Sakers in Southeast Kazakhstan seem to move also to a southwesterly direction according to Kazakh ring recoveries. However, they do not cross the border of Europe, but stay in Asia when migrating *(Gavrilov & Erokhov, 1994)*.

Despite all ringing information one must note that ringing is not the most efficient way to study raptor movements due to the very low recovery rate. Recovery rates of birds of

Figure 4. Main directions of long-range post-fledging (pre-migration) dispersal of satellite-tracked juvenile Sakers (black diamonds show TSAs in the first summer established by some of the satellite-tracked birds and dark areas show the recent breeding range of Saker Falcon in Europe)

prey ringed in Hungary range between 0.6 and 9.5% but higher rates usually relate to colour-ringing projects. Only 3.6% of Saker Falcons ringed in Hungary between 1951 and 2006 were ever recovered *(Bagyura & Szitta, 2009)*.

Data from satellite-tracking in Hungary and Slovakia

Transmitters of Saker Falcons tagged during the project were active during 10.4 months on average. Extreme values range from a few days to 51 months (and still working at the time of submitting this manuscript). Due to natural mortality and technical problems, we have data on 17 out of 45 satellite-tracked juvenile Sakers covering at least one full autumn migration and wintering period.

Dispersal

Although this paper aims to describe primarily the migration and wintering patterns of Central and Eastern European Sakers, some basic results of satellite-tracking about juvenile dispersal and roaming of immature birds must be presented for better understanding of the findings on migration and wintering.

Juveniles lefte the natal area one and a half month after fledging on average. The direction and distance of their first journeys varied greatly (Figure 4). In general, juveniles established their first TSA after an extended period of nomadic travel, although most of them stayed strictly within the Pannonian Basin and only few of them left it *(Sielicki et al., 2009; Uhrin & Chavko, 2008)*. Typically, juveniles used one or a few TSAs until the migration season. Using their TSAs as a base, juveniles made 'exploring trips' ranging from a few to several hundred kilometres in all directions. Post-fledging movements lasted until the mi-

gration season when most of the juveniles started to show other movement patterns.

A minority of juveniles show an entirely different movement pattern. They left their natal area very early, only about a month after fledging and covered great distances, sometimes over 1000 kilometres before they established their first TSA. In most cases they headed east and flew as far as eastern Ukraine, Southwest Russia or Western Kazakhstan. According to our results, survival chances of those juveniles were minimal.

Juveniles leaving their natal eyries in 'normal' time may also leave the Pannonian Basin before the migration season. During their migration they may behave in different ways, like the juveniles that stay in the Pannonian Basin.

As autumn migration starts from the last pre-migration TSA, the direction and the distance of dispersal determine the starting point of autumn movements. The location of the last TSA, however, does not affect the direction and length of the migration.

Migration

Already at an early stage of the satellite-tracking programme it became clear that there are strong individual differences in the migration behaviour of juvenile Saker Falcons in their migration distance and routes *(Prommer & Bagyura, 2009; 2010)*. It is possible, however, to establish a few categories. According to our results satellite-tracked first calendar year (1CY) Sakers can be divided into the following groups according to the length of their migration route.

Residents or short-distance migrants

Almost half of all satellite-tracked falcons—and more than half of those surviving the first winter—stayed in the Pannonian Basin for winter. Even Sakers staying in the Pannonian Basin made a southward movement when the migration season arrived. Unlike long-distant migrants, however, they regularly did not cross the natural borders of the Pannonian Basin; they did not move more than 200-300 km at most.

'True' (mid to long distance) migrants

One-third of satellite-tracked juveniles left the Pannonian Basin in autumn. Juvenile Sakers started migration between early September and early December, the majority of them leaving typically between early October and mid November. Seemingly no direct trigger such as food shortage or weather conditions initiated migration. Of two satellite-tracked juvenile females having almost overlapping TSAs in Vojvodina, one moved to Africa in October and the other stayed to winter in the same area. It is thought, therefore, that more complex external conditions or/and genetic factors are likely to determine differences in their migration behaviour.

All mid and long distance satellite-tracked migrants showed a statistically identical angle of migration (190–200° south-southwest) confirmed by the *Welch'*s test: all birds started to migrate to the same direction regardless the location of the last pre-migratory TSAs (Figure 5). The longitude data of the position of the last TSA, therefore, determine the possible wintering range. Latitude did not play a role in this respect.

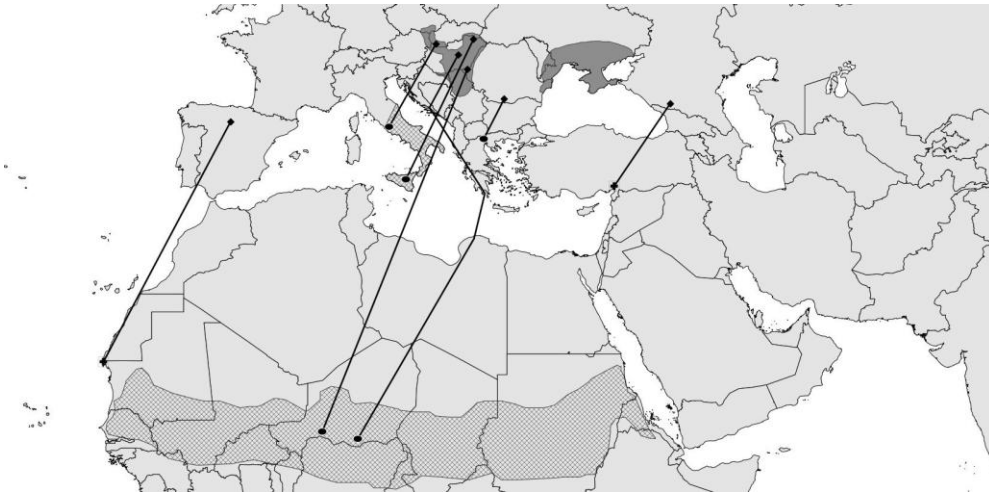


Figure 5. Main directions of migration routes of satellite-tracked first year Saker Falcons from the last pre-migration TSA (black square) to known wintering grounds (black ellipsoid in grey field) outside the known European breeding ground (dark grey). Crosses show when birds failed to reach the wintering ground (not every migrating bird with satellite data were shown; however, all typical routes are represented)

Average speed during migration was almost identically 40-50 km/h over sea and approximately 30 km/h over mainland in case of all satellite-tracked Sakers. Compared to movements during post-fledging dispersal—when Sakers tend to restrict their movements to the lowlands—they may cross high ridges and extensive mountain ranges on migration, but they prefer to follow the valleys where possible rather than crossing high altitude barriers directly.

All satellite-tracked long-distance migrants that crossed the Mediterranean Sea were females. They used the same routes from the Pannonian Basin to the Adriatic coast as medium distance migrants, but unlike those medium distance migrants crossing the sea, three out of four long-distance migrants turned to south and followed the coastline to Greece. They crossed the Mediterranean Sea between the Greek islands and the North-African coast (Libya and Egypt). They always took off in the morning and their flights over the sea lasted 8–13 hours. Once they arrived at the African coast they immediately adjusted their route to the initial southwesterly direction and continued crossing the Sahara Desert.

One female Saker tagged in Slovakia chose a different route: she crossed the Adriatic Sea like medium distance migrants, but then carried on towards the southwest making an exceptional 24-hour non-stop flight from Montenegro to Tripoli, Libya covering 1100 km over the sea (average speed approximately 46 km/h).

As the direction of the migration was almost identical for different individuals, but the starting point (the location of the last pre-migratory TSA) varied, juveniles used different routes and they had different wintering areas depending on whether they dispersed from the Pannonian Basin to the west or to the east. One satellite-tracked male, which fledged in

Southeast Hungary, spent the summer in Dobrugea, Romania. In autumn, he migrated southwest and ended up in North Greece, where he spent the winter. A female fledged in western Hungary moved as far as North Spain, from where she was visiting several sites including Portugal. In autumn, she started to head south-southwest, crossed the Gibraltar Straits and continued her way along the Atlantic coast as far as the peninsula at Nouadhibou, North Mauritania. There she perished as the peninsula—without prey and fresh water—works as a natural trap for birds of prey having several hundred kilometres of desert behind it. The site was just a few kilometres away from the place where another dead Saker had been found during the winter of 1978/1979 in the water of Star Bay *(Dejonghe, 1980).* In both cases 1st calendar year (1CY) Sakers started their autumn migration in southwesterly direction, exactly like the juveniles remaining within the Pannonian Basin.

'Multiple migrants'

Multiple migrations within one—first autumn—migration season were also recorded. Two satellite-tracked females covered the Pannonian Basin—Italy distance multiple times (one flew there and back, and the other one there and back and there again) within one autumn migration season.

Analyzing the migration data of those 1CY Sakers (n = 26) clearly showing migratory behaviour by using the *Welch's* test, we received the following results. There was a significant difference between the migration distance and time of males and females. Females migrated further and for a longer time (p = 0.05) when compared to males; no significant difference was found in the speed and in the direction of migration.

Migration of subadult Sakers

Satellite tracking revealed that the migration pattern of Sakers changed after the first winter. They were imprinted on revisiting their previous wintering sites and they returned there regardless where they had spent the summer. In general, summer dispersal of young males covered even shorter distances each year until they established their own eyrie. After that they stopped summer nomadism. However, satellite-tracked males re-visited their traditional wintering sites even after their first active breeding period.

Satellite-tracked females showed a different summer nomadic behaviour in their second calendar year. Female Sakers staying in the Pannonian Basin did not disperse after their first winter. Females dispersing beyond the Pannonian Basin and wintering further away returned after the winter and remained for summer. For more detailed information on the migration patterns of subadult female Sakers, however, more birds need to be tagged.

Migration of adult Sakers

Satellite-tracked adult males did not migrate and they did not show nomadic movements, either. However, the possibility cannot be excluded that adults do migrate in certain cases, as the winter disappearance of some—untagged—individuals from certain eyries suggests. None out of the five adult male Sakers occupying eyries in western Hungary (n = 2), Central Hungary (n = 2) or East Hungary (n = 1) left the region throughout the year. They happened to leave to a few dozen kilometres for shorter periods (weeks) when

weather conditions (snow, cold) reduced prey availability, but even in those cases they visited the nest site from time to time. Otherwise they spent the winter within a few kilometres of the nest site.

Fewer data are available on adult females. There was only one adult female that had been tagged and provided information for two years. She spent only the breeding period at the nest. Outside the breeding season she followed a similar movement pattern in both years having three different TSAs according to seasons. She occasionally visited other areas as well.

Timing of migration

The timing of migration depended on the age of the bird and on the season. In the first calendar year Sakers started their autumn migration between late September and mid November, with most of them leaving in early October. Spring migration until the second year was more uniform: all the eight satellite-tracked falcons that survived until the second year left the wintering area between 26 March and 8 April regardless of whether they spent the winter within the Pannonian Basin or in Africa. The birds wintering in the Pannonian Basin left the wintering ground a few days earlier (end of March) than the birds wintering further away (first days of April). Individuals often returned to the area of their last TSA before autumn migration, however usually they did not stay there for long, and they continued wandering instead. Spring migration in the second calendar year was slower than the autumn migration in the first.

The start of autumn migration of older birds showed individual differences, spring migration, however, started earlier as the birds got older. During the spring of the third calendar year satellite-tracked males left the wintering ground in early/mid March and from the fourth calendar year they left the wintering ground as early as the end of February. A satellite-tracked adult female wintering in the Pannonian Basin—some distance from her eyrie—also left for the breeding site at the end of February.

Conclusions

Migration studies of similar falcon species

Movements of three other large falcon species—the Gyrfalcon *(Falco rusticolus)*, the Prairie Falcon *(Falco mexicanus)* and the Peregrine Falcon *(Falco peregrinus)*—were studied extensively by using ringing and satellite-tracking. Based on our findings the movements of Sakers show different patterns from theirs. Although a massive satellite-tracking programme on Saker Falcons was carried out in Central Asia, a detailed analysis of the results has not been published yet (*A. Dixon,* pers. comm.).

The movement patterns of Gyrfalcons, the closest relative of Sakers, are somewhat similar—e.g. adults tend to remain around the eyrie all year in some areas of the distribution range—but Sakers show an even more complex migration pattern compared to them. According to ringing and satellite-tracking data, movements of Gyrfalcons are determined by food supply rather than by instincts *(Sale & Potapov, 2005; Burnham & Newton, 2011)*.

Prairie Falcons, which occupy habitats in North America very similar to those used by

Sakers in Eurasia, migrate on two separate routes and use grassland areas consistently. According to Canadian ringing results, adults also migrate from the northern edge of the distribution range *(Schmutz et al., 1991)*.

Out of the discussed species Peregrine Falcons were studied at the broadest geographical scale, but this species shows the least similarity to Saker Falcon. Most of the Peregrine studies focussed on the entirely migratory Arctic population. Individuals of the North American population travel to South America *(Fuller et al., 1998)*, while the North Russian population shows a fan-shaped migration with diverting routes from the breeding grounds to the wintering grounds *(Dixon et al., 2012)*. Satellite-tracking studies of Peregrines at lower latitudes reveal more individual variation in migration, but apparently those are less systematic than the migratory movements of Sakers *(Gahbauer, 2008; Mojica et al., 2011)*.

Juvenile Saker Falcons in their first calendar year

European juveniles are partial migrants. Almost all 1CY Sakers move southwest in autumn, but only about one-third of them leave the breeding range of the species and show medium or long distance migration. The rest of the birds remain within the breeding range and show only local or regional movements in the same direction—or no movement at all. The direction of the movements of 1CY Sakers is between 180° and 240° and seems to be universal: it is applicable to 1CY juveniles from Austria (Spain) as well as from western Kazakhstan.

Apart from ring recoveries mentioned above, satellite tracking studies also confirmed the southwesterly autumn movements of 1CY Sakers in West Kazakhstan (*A. Dixon*, pers. comm.). Juveniles of more eastern populations (Southern parts of Asian Russia, Altai Mountains, Mongolia), however, show a fan-shaped migration from the breeding ground to central and west China *(Eastham, 1998; Eastham et al., 2000; Karyakin et al., 2004; 2005; Potapov et al., 2001; 2002; Sumya et al., 2001; Batbayar et al., 2009).* Based on the data, the frontier between Sakers showing the 'Western' or 'European', and those moving on the 'Eastern' or 'Asian' migration patterns may be somewhere in the Altay-Sayan region. The two different migration patterns suggest that they have evolved separately by adapting to the geomorphologic features of the occupied areas in parallel with the gradual segregation of the two populations.

Uniformity of the migration patterns of 1CY Sakers suggests that direction (it seems to be uniformly southwesterly between 180°and 240° for 1CY Sakers in Central and Eastern Europe), timing of migration as well as the distance of the movements (of the given individual) are driven by inherited instincts.

The universal southwesterly autumn movement results in a parallel movement—or parallel migration—of 1CY juvenile Saker Falcons. The last pre-migratory TSA, as the starting point of autumn migration and the 'pre-set' direction for migration, therefore, determines the migration routes and the location of the potential wintering areas. The parallel migration explains why Sakers—according to data from observations—do not concentrate during migration as soaring raptors: individuals travel on a broad front and they are able to cross large water bodies by using powered flight.

As a result of parallel migration, wintering Sakers are sparsely scattered along the appropriate habitats mainly in the Central Mediterranean region in Europe and in the Sahel in

North Africa. However, as Central European Sakers may establish a TSA in Eastern Europe, juveniles seen on migration e.g. along the western Black Sea coast, are not necessarily East European Sakers, but may come from Central Europe.

Indirect data support the hypothesis of parallel migration. Literature data presented above shows that the number of migrating and wintering Sakers dropped dramatically by the 1950s–1960s in southern Italy, as well as in Sardinia. Similarly, the number of migrating Sakers in Cyprus declined after the 1960s—beforehand, the species was considered a relatively frequent autumn visitor. That was exactly the time, when Sakers in Central and Eastern Europe decreased significantly, due to habitat change (caused by human land use), persecution, nest robbing and other unknown factors. Since the 1990s, the number of migrating and wintering Sakers has been increasing in southern Italy, reflecting the positive trend of the Central European breeding population *(Corso & Harris, 2012; Bagyura et al., 2012)*. The number of Saker observations, however, has not increased in Cyprus despite a more systematic autumn raptor censussing on the island *(M. Miltiadous,* pers. comm.). It is in line with the parallel migration theory suggesting that Sakers visiting Cyprus come from the easternmost parts of Europe (European Russia and western Kazakhstan) and westernmost parts of Asia (East Turkey), where the population still has not recovered (*Dixon et al., 2009; I. Karyakin,* pers. comm.).

Autumn movements start between early September and early December with no obvious trigger (like weather or abundance of food supply) for timing found. During their autumn movements Sakers keep strictly to southwest and some individuals showing a long-distance migratory behaviour are able to cross considerable geographical barriers (e.g. the Mediterranean Sea). Those barriers, however, may temporarily diverge a certain number of individuals. Some of the migrating Sakers of the Pannonian Basin did not cross the Adriatic Sea, but continued moving southward, along the Adriatic coast deviating from the original south-western direction. However, they always crossed the Mediterranean Sea once they reached the tip of the Greek islands and they never turned to east to continue the migration over the mainland. Arriving in Africa, they returned to the original southwestern direction up to their wintering ground in Sahel (when crossing the sea between Greece and Africa they chose the southern direction probably to minimize the time spent above the open sea).

The first spring migration (in the second calendar year) starts in a very narrow time window—from late March to early April—regardless the distance between the wintering site. Spring migration after the first winter is slower than autumn migration beforehand.

Immature (second calendar year) and 'floater' birds

Sakers follow a different strategy from their second autumn on. Once they overwintered successfully, they return to the same place in subsequent winters, regardless where they spent the summer.

Floater males—those non-breeding adults that do not possess their own eyrie—migrate as well. No information on floater females is available as yet. With the progress of their age spring migration of Sakers starts earlier. Floater males in their fourth calendar year may start the spring migration already at the end of February.

Breeding adults

Tagged breeding males occupying their eyries did not migrate, but stayed in or near the eyrie all-year-round. It cannot be excluded, however, that some of the adult males of established pairs migrate as well, as some observations suggest.

Limited data on adult females of established pairs suggest that they visit the same places in the same periods of the year, regardless whether they remain around the eyrie with the male or show a special dispersal pattern in the non-breeding period within the breeding range. It is most likely a learnt behaviour and probably follows a food-availability pattern throughout the year; however more research is needed to confirm that.

Wintering areas

The main wintering areas of the migrating Central European Sakers are in Italy south of the Rome–Ancona line. According to the calculation of *Corso & Harris (2012),* from the Hungarian population alone a few dozen individuals may winter in Italy. There are also wintering areas in Northeastern Greece; those areas host, however, fewer individuals considering the smaller size of East European populations.

In Africa the main wintering area is the Sahel, where Sakers can be found sparsely scattered from the Atlantic Ocean to Sudan occupying the appropriate habitats. They prefer dry semi-desert areas and grasslands. Study on a Hungarian satellite-tracked Saker wintering in Niger showed that the bird used millet fields and open areas with 20-70 trees/ha on average *(Issaka & Brouwer, 2012).* Some individuals may travel further south and spend the winter on the savannas of Kenya and Tanzania; it is unclear however, which part of the distribution range they are from.

Other findings

When comparing the data of ringing records and those of satellite tracking, the extensive and long-term ringing of Sakers swhowed the main directions of their large-scale movement (juvenile dispersal and migration) even if the recovery rate was only 3.6% for the species. Ringing, however, failed to reveal any fine movement patterns as well as a possible individual fidelity to a certain site (TSA or wintering site) in consecutive years. Ringing as a method, at that scale, is not adequate to describe accurately the movement patterns of those raptors using active (non-soaring) flight during migration like the Saker Falcon.

Satellite-tracking and ringing results suggest that there is no significant gene exchange between the disconnected Central European and Eastern European populations, although their flyways overlap significantly. Flyways of juvenile Central European Sakers certainly overlap with the western Asian (West- and Central-Kazakh) Sakers, but after a certain time of dispersal all nomadising birds return to their respective natal areas. Ring recoveries confirm that Sakers show the largest movements in their first year then they tend to find their own eyrie around their natal area. Our research has not confirmed that Sakers have a nomadic behaviour as it was suggested by *Ellis et al. (2011)*.

Acknowledgments

In the Hungarian-Slovak project "*Conservation of Falco cherrug in the Pannonian Basin*" (LIFE06 NAT/H/000096) was one of the actions aiming to learn more about the species' movements in order to prepare a more efficient international conservation plan. The project was supported by the LIFE-Nature fund of the European Union.

We would like to thank the kind support we received from our colleagues without whom we would not have been able to accomplish this study: *Tamás Szitta* and *József Fidlóczky* (Bükk National Park Directorate), *Miklós Váczi* (Fertő–Hanság National Park Directorate), *István Balázs* and *Anna Kálmánczi* (MME/BirdLife Hungary), *Lucia Deutschová* (Raptor Protection of Slovakia), *Levente Viszló* (Pro Vértes Public Foundation), *Antal Klébert* (Duna–Ipoly National Park Directorate), *Petar Iankov* and *Dimitar Gradinarov* (Bulgarian Society for the Protection of Birds), and many rangers of the Hungarian national parks were the main contributors.

We also thank the great help to *Mike McGrady* (Natural Research), *Tom Maechtle* (Falcon Research Group), *Paul W. Howey*, *Cathy Bykowsky* and the Microwave Telemetry team, *Anna Giordano* (WWF Italy), *Andrea Corso* (Italy), *Igor Karyakin* (Siberian Research Centre), *Alexandre Pazhenkov* (Volga-Ural ECONET Assistance Centre), *Joost Brouwer, Housseini Issaka* (Niger), *Med Saleh Menna* and his fellow rangers in Banc d'Arguin National Park in Mauritania, *Jan Lontkowski* (Wroclaw University, Poland), *Marko Tucakov* (Institute of Nature Conservation of Serbia), *Ray Vella* (BirdLife Malta), *Michael Militiadous* (BirdLife Cyprus), *Janusz Sielicki* (Sokol Nature Conservation Association), *Tomáš Belka* (the Czech Republic), *Marcello Grussu* (Sardinia), *Andrew Dixon* (International Wildlife Consultants), *Ohad Hatzofe* (Israel Nature & Parks Authority) and *Paul Harris* (Italy).

References

Acar, B., Beaman, M. & Porter, R. F. (1977): Status and migration of birds of prey in Turkey. In *Chancellor, R. D. (eds.):* World conference on birds of prey: report of proceedings, Vienna 1975. International Council for Bird Preservation, London, p. 182–187.

Alon, D., Granit, B., Shamoun-Baranes, J., Leshem, Y., Kirwan, G. M. & Shirihai, H. (2004): Soaring bird migration over northern Israel in autumn. *British Birds* **97**, p. 160–182.

Ash, J. S. & Nikolaus, G. (1992): Birds in the hot season along the Nile in the Sudanese eastern Sahara. *Scopus* **16**, p. 22–28.

Augst, U. (2000): Remarks on the Saker *Falco cherrug* at its first breeding place in Germany. *Populationsökologie Greifvogel und Eulenarten*, **4**, pp. 313–322.

Bagyura J. & Szitta T. (2009): Kerecsensólyom. In *Csörgő T., Karcza Z., Halmos G., Magyar G., Gyurácz J., Szép T., Bankovics A., Schmidt A. & Schmidt E. (eds.)*: Magyar madárvonulási atlasz. Kossuth, Budapest, p. 246–249.

Bagyura, J., Szitta, T., Haraszthy, L., Viszló, L., Fidlóczky, J. & Prommer, M. (2012): Results of the Saker conservation programme in Hungary, 1980–2010. *Aquila* **119,** p. 103–112.

Balmer, D. & Betton, K. (2003): Around the region. *Sandgrouse* **25**(1–2), p. 76–80, 154–159.

Balsac, H. H. de & Mayaud, N. (1962): Les oiseaux de nord-ouest de l'Afrique: distribution géographique, écologie, migrations, reproduction [Encyclopédie ornithologique 10]. Lechevalier, Paris, 486 p.

Batbayar, N., Batsukh, B., Stacey, J. & Bräunlich, A. (2009): Houbara Bustard and Saker Falcon surveys in Galba Gobi IBA, southern Mongolia. Preliminary technical report to the World Bank and BirdLife International. Wildlife Science and Conservation Center of Mongolia, Ulaanbaatar, 41 p.

Baumgart, W. (1991): Der Sakerfalke. Die neue Brehm Bücherei 514. Westarp Wissenschaften, Hohenwarsleben, 176 p.

Baumgart, W. & Haraszthy, L. (1997): *Falco cherrug* Saker falcon. In *Hagemaijer, W. J. M. & Blair, M. J. (eds.)*: The EBCC atlas of European breeding birds: Their distribution and abundance. Poyser, London, p. 190.

Beran, V., Škorpíková, V., Valášek, M. & Horal, D. (2012): The breeding population of Saker Falcon (*Falco cherrug*) in the Czech Republic between 1999–2010. *Aquila* **119**, p. 21–30.

Borioni, M. & Baldoni, M. R. (2009): La migrazione primaverile nel Parco del Conero (AN). *Infomigrans* **23**, p. 8.

Brown, L. H., Urban, E. K., Newman, K. (eds) (1982): The birds of Africa. Vol. 1. Academic Press, London, 521 p.

Burnham, K. K. & Newton, I. (2011): Seasonal movements of gyrfalcons *Falco rusticolus* include extensive periods at sea. *Ibis* **153**, p. 468–484.

Chiofalo, G., Cutini, S., Giordano, A. & Ricciardi, D. (2006): La migrazione primaverile sullo Stretto di Messina – Monti Peloritani (ME). *Infomigrans* **17**, p. 2.

Christensen, S., Lou, O., Miller, M. & Wohlmuth, H. (1982): The spring migration of raptors in southern Israel and Sinai. *Sandgrouse* **3**, p. 1–42.

CITES (2004): Progress on the implementation of the review of significant trade (phases V and VI). Review of significant trade in specimens of Appendix-II species (Resolution Conf. 12. 8 and Decision 12.75). In Twentieth meeting of the Animals Committee Johannesburg (South Africa), 29 March–2 April 2004. Working document. Convention on International Trade in Endangered Species of Wild Fauna and Flora, 25 p.

Corso, A. (2001): Raptor migration across the Strait of Messina, southern Italy. *British Birds* **94**(4), p. 196–202.

Corso, A. & Harris, P. (2012): Status of the Saker Falcon (*Falco cherrug*) in Italy: past, present and future. *Aquila* **119**, p. 47–55.

Cramp, S. & Simmons, K. E. L. (1980): The Birds of the Western Palearctic Volume II. Oxford University Press, Oxford, New York, 695 p.

Cutini, S., Chiofalo, G., Flott, J. P., Vanni, L., Ricciardi, D. & Giordano, A. (2008): Stretto di Messina: 25° anno di attività 2 aprile – 27 maggio 2008. *Infomigrans* **21**, p. 2–3.

Dejonghe, J.-F. (1980): Analyse de la migration prénuptiale des rapaces et des cigognes au Cap Bon (Tunisie). *L'Oiseau et la Revue Française d'Ornithologie* **50**(2), p. 137–138.

De Juana, E. (2006): Observaciones de aves raras en España, 2004. *Ardeola* **53**(1), p. 163–190.

Dies, J. I., Lorenzo, J. A., Gutiérrez, R., García, E., Gorospe, G., Martí-Aledo, J., Gutiérrez, P., Vidal, C., Sales, S. & López-Velasco, D. (2011): Observaciones de aves raras en España 2009. *Ardeola* **58**(2), p. 441–480.

Dimovski, A. (1972): Changements dans la composition de l'ornithofaune de la plaine de Skopje. *Acta Musei Macedonici Scientiarum Naturalium* **13**(3/113), p. 41–46.

Dixon, A. (2005): Saker Falcons in north-east Africa. *Falco* **25/26**, p. 9.

Dixon, A., Ragyov, D., Ayas, Z., Deli, M., Demerdziev, D., Angelov, I., Kmetova, E. & Nedyalkov, N. (2009): Population status of breeding saker falcons (*Falco cherrug*) in Turkey. *Avian Biology Research* **2**(4), p. 213–220.

Dixon, A., Sokolov, A. & Sokolov, V. (2012): The subspecies and migration of breeding Peregrines in northern Eurasia. *Falco* **39**, p. 4–9.

Eastham, C. (1998): Satellite tagging sakers in the Russian Altai. *Falco* **12**, p. 10–12.

Eastham, C. P., Quinn, J. L. & Fox, N. C. (2000): Saker *Falco cherrug* and peregrine *Falco peregrinus* falcons in Asia; determining migration routes and trapping pressure. In *Chancellor, R. D. & Meyburg, B.-U. (eds.):* Raptors at risk. Proceedings of the 5th World Conference on Birds of Prey and Owls. Hancock House Pub / World working group on birds of prey and owls, Blaine, Washington, USA, p. 247–258.

Ellis, D. H., Kitowski, I. & Roundy, T. B. (2011): Nomadism in large falcons: lessons from the saker falcon in Mongolia. In *Watson, R. T., Cade, T. J., Fuller, M., Hunt, G. & Potapov, E. (eds.):* Gyrfalcons and ptarmigan in a changing world. Volume II. The Peregrine Fund, Boise, Idaho, USA, p. 291–306.

Fuller, M. R., Seegar, W. S. & Schueck, L. S. (1998): Routes and travel rates of migrating Peregrine Falcons *Falco peregrinus* and Swainson's Hawks *Buteo swainsoni* in the Western Hemisphere. *Journal of avian biology* **29**, p. 433–440.

Fusari, M. (2012): La migrazione preriproduttiva dei rapaci sul Monte Conero (AN): Primavera 2012. *Infomigrans* **29**, p. 6.

Gabhauer, M. A. (2008): Breeding, dispersal and migration of urban Peregrine Falcons in eastern North America. p. 178. [Depon. in Department of Natural Resource Sciences, MacDonald Campus, McGill University, Montreal]

Galea, R. & Vella, R. (2012): La migrazione post riproduttiva a Malta agosto–ottobre 2012. *Infomigrans* **30**, p. 2.

Galushin, V. & Moseikin, V. (2000): The saker falcon in European Russia. In *Chancellor, R. D. & Meyburg, B.-U. (eds.):* Raptors at risk. Proceedings of the 5th World Conference on Birds of Prey and Owls. Hancock House Pub / World working group on birds of prey and owls, Blaine, Washington, USA, p. 275–278.

Gamauf, A. & Dosedel, R. (2012): Satellite telemetry of Saker falcons (*Falco cherrug*) in Austria: juvenile dispersal at the westernmost distribution limit of the species. *Aquila* **119**, p. 65–78.

Gavrilov, E. I. & Erokhov, S. N. (1994): The results of ringing of sakers in Kazakhstan. *Raptor Link* **2**, p. 1.

Géroudet, P. & Juillard, M. (1990): Attaques de faucons sacres sur des avocettes migratrices devant de la côte de Palestine. *Nos Oiseaux* **40**, p. 429–430.

Giordano, A. (1991): The migration of birds of prey and stork in the Strait of Messina. *Birds of prey bulletin* **4**, p. 239–250.

Giordano, A., Adami, I., Cutini, S., Flott, J. P., Garavaglia, R., Martinez Lopez, M., Ricciardi, D., Vella, R. & Vilchez, O. (2012): 29° campo internazionale per lo studio e la protezione dei rapaci e delle cicogne in migrazione sullo Stretto di Messina (ME). *Infomigrans* **29**, p. 2–3.

Global Raptor Information Network (2012): Species account: Saker Falcon *Falco cherrug*. Accessed from: *http://www. globalraptors. org* on 1.11. 2012.

Gustin, M. (2005): Progetto rapaci migratori. *Infomigrans* **15**, p. 10–11.

Gustin, M. (2007): Progetto Rapaci Migratori. Primavera 2007. *Infomigrans* **19**, p. 5–6.

Handrinos, G. & Dimitropoulos, A. (1983): Raubvögel in Griechenland. P. Efstathiadis & Sons., Athens, 132 p.

Hellenic Rarities Committee (2011): Rare birds in Greece. Accessed from: *http://www.ornithologiki.gr/page_cn.php?tID=1892&aID=925* on 03.05.2013.

Isenmann, P., Gaultier, T., El Hili, A., Azafzaf, H., Dlensi, H. & Smart, M. (2005): Oiseaux de Tunisie. Société d'études ornithologiques de France, Muséum national d'histoire naturelle, Paris, 432 p.

Issaka, H. & Brouwer, J. (2010): Field observations of a Saker Falcon *(Falco cherrug)* holding a satellite transmitter on its wintering ground in Niger. *Aquila* **119,** p. 79–90.

Jong, A. de, Van Der Kamp, J., Mullié, W. C. & Bijlsma, R. G. (2009): Raptor migration at Cap Bon, Tunisia, in April 1974. *De Takkeling* **17**, p. 256–267.

Karyakin, I., Konovalov, L., Moshkin, A., Pazhenkov, A., Smelyanskiy, I. & Rybenko, A. (2004): Saker falcon (*Falco cherrug*) in Russia. *Falco* **23**, p. 3–9.

Karyakin, I. V., Nikolenko, E. G., Potapov, E. R. & Fox, N. (2005): Preliminary results of the project on migration studies of the saker falcon in Russia. *Raptors conservation* **2**, p. 56–59.

Lucia, G., Agostini, N., Panuccio, M., Mellone, U., Chiatante, G., Tarini, D. & Evangelidis, A. (2011): Raptor migration at Antikythira, in southern Greece. *British Birds* **104**(5), p. 266–270.

Makatsch, W. (1950): Die Vogelwelt Macedoniens. Akademische Verlagsgesellschaft, Leipzig, IX&452 p.

Matias, R., Alfrey, P., Costa, H., Jara, J., Moore, C. C., Santos, J. L. & Tipper, R. (2011): Adições e alterações à lista das aves de Portugal Continental: primeira actualização. *Anuário Ornitológico* **8,** p. 105–117.

Meyburg, B.-U. & Fuller, M. R. (2007): Satellite tracking. In *Bird D. M. & Bildstein K. L. (eds.)*: Raptor Research and Management Techniques. Hancock House Publishers, Surrey, Canada & Blain, WA, USA, p. 242–248.

Milvus (2008): Măcin Mountains raptor migration watchsite 2002–2007. Migration data. *Retrieved from http://milvus. ro/images/PDF/osszesen2002-2007. pdf.*

Michev, T., Profirov, L., Nyagolov, K. & Dimitrov, M. (2011): The autumn migration of soaring birds at Bourgas Bay, Bulgaria. *British Birds* **104**(1), p. 16–37.

Mojica, E. K., Watts, B. D. & Padgett, S. M. (2011): Virginia peregrine falcon monitoring and management program: Year 2011 Report. CCBTR-11-14. Center for Conservation Biology Technical Report Series, College of William and Mary, Williamsburg, VA, 21 p.

Orta, J. (1994): Saker falcon *Falco cherrug*. In *Del Hoyo J., Elliott A. & Sargatal J. (eds.)*: Handbook of the birds of the world. Volume 2. New World vultures to Guineafowl. Lynx Edicions, Barcelona, p. 273–274.

Perktaş, U. & Turan, L. S. (2007): Birds of Camili (Artvin, Turkey). *Hacettepe journal of biology and chemistry* **35**(2), p. 83–87.

Porter, R. F. & Beaman, M. A. S. (1985): A resume of raptor migration in Europe and the Middle East. In *Newton, I. & Chancellor, R. D. (eds.):* Conservation Studies on Raptors. Proceedings of the ICBP World Conference on Birds of Prey, April 1982, Thessaloniki, Greece [Technical publication No. 5]. International Council for Bird Preservation, Cambridge, p. 237–242.

Porter, R. & Christensen, S. (1987): The autumn migration of raptors and other soaring birds in north Yemen. *Sandgrouse* **9**, p. 121–124.

Porter, R. & Willis, I. (1968): The autumn migration of soaring birds at the Bosphorus. *Ibis* **110**(4), p. 520–536.

Potapov, E., Fox, N. C., Sumya, D., Gombobaatar, S., Launay, F., Combreau, O. & Eastham, C. (2001): Le Faucon sacre de Mongolie: migrateur, nomade ou sédentaire? The Mongolian Saker Falcon: migratory, nomadic or sedentary? *Argos Newsletter* **58**, p. 10–11, 16.

Potapov, E., Fox, N. C., Sumya, D. & Gombobaatar, S. (2002): Migration studies of the saker falcon. *Falco* **19**, p. 3–4.

Premuda, G. (2012): La migrazione dei rapaci sulle Alpi Apuane (LU): campo autunno 2012. *Infomigrans* **30**, p. 7.

Premuda, G., Gustin, M., Pandolfi, M., Sonet, L. & Cento, M. (2008): Spring raptor migration along the Adriatic coast (Italy): a comparative study over three sites. *Avocetta* **32**, p. 13–20.

Prommer, M. & Bagyura, J. (2009): Dangerous journeys of Sakers of the Carpathian Basin. In *Sielicki, J. & Mizera, T. (eds.):* Peregrine falcon populations. Status and perspectives in the 21st century. Turul & Poznań University of Life Sciences Press, Warsaw & Poznań, p. 768–778.

Prommer, M. & Bagyura, J. (2010): A 2007 és 2009 között Magyarországon jelölt fiatal kerecsensólymok mozgásai műholdas nyomkövetés alapján. *Heliaca* **7**, p. 34–48.
Ragyov, D. & Shishkova, V. (2006): Saker falcon in Bulgaria: past, present and future. Falco 27, p. 4–8.
Raine, A. & Vella, R. (2007): La migrazione autunnale nell'isola di Malta risultati del Campo Rapaci BirdLife Malta. *Infomigrans* **20**, p. 2–3.
Reeber, S. & le CHN (2011): Les oiseaux rares en France en 2010. 28e rapport du Comité d'Homologation National. *Ornithos* **18,** p. 325–367.
Ricciardi, D., Garavaglia, R., Ardizzone, D., Chiofalo, G., Flott, J. P., Vella, R., Adami, I., Cutini, S. & Giordano, A. (2009): Stretto di Messina (versante siciliano): 26° anno di attività 1 aprile – 27 maggio 2009. *Infomigrans* **23**, p. 2–3.
Sale, R. & Potapov, E. (2005): The gyrfalcon. Poyser, London, 288 p.
Sammut, M. & Bonavia, E. (2004): Autumn raptor migration over Buskett, Malta. *British Birds* **97**, p. 318–322.
Sargeant, D. E., Eriksen, H. & Eriksen, J. (eds) (2008): Birdwatching guide to Oman. Second edition. Al Roya Publishing, Muscat, 256 p.
Schmutz, J. K., Fyfe, R. W., Banasch, U. & Armbruster, H. (1991): Routes and timing of migration of falcons banded in Canada. *The Wilson Bulletin* **103,** p. 44–58.
Schröpfer, L. (2008): Raroh velký. *Falco cherrug*. Sokol rároh. Saker Falcon. In *Cepák, J., Klvaňa, P., Škopek, J., Schröpfer, L., Jelínek, M., Hořák, D., Formánek, J. & Zárybnický, J. (eds.)*: Atlas migrace ptáků České a Slovenské republiky. Czech and Slovak bird migration atlas. Aventinum, Praha, p. 291–292.
Serra, G., Abdallah, M. S., Assaed, A. K., Al Qaim, G. & Abdallah, A. K. (2005a): A long-term bird survey in the central Syrian desert (2000–2004): Part 1. *Sandgrouse* **27**(1), p. 9–23.
Serra, G., Al Qaim, G., Abdallah, M. S., Kanani, A. & Assaed, A. K. (2005b): A long-term bird survey in the central Syrian desert (2000–2004): Part 2–a provisional annotated checklist. *Sandgrouse* **27**(2), p. 104–125.
Shirihai, H. (1996): The birds of Israel. *Academic Press*, London, 692 p.
Shirihai, H., Yosef, R., Alon, D., Kirwan, G. & Spaar, R. (2000): Raptor migration in Israel and the Middle East: a summary of 30 years of field research. International Birdwatching Centre, Eilat, 191 p.
Sielicki, J., Prommer, M., Gamauf, A. & Kata, M. (2009): Saker falcon *Falco cherrug* in Poland (2008–2009). In *Wiącek, J., Polak, M., Kucharczyk, M., Grzywaczewski, G. &, Jerzak L. (eds.):* Ptaki – Środowisko – Zagrożenia – Ochrona. Wybrane aspekty ekologii ptaków. LTO, Lublin, p. 273–285.
Sonet, L., Amatiello, V., Pandolfi, M. & Balsamo, M. (2009): La migrazione primaverile nel Parco Naturale del Monte San Bartolo (PS). *Infomigrans* **23**, p. 7.
Sonet, L., Amatiello, V., Pandolfi, M. & Balsamo, M. (2010): La migrazione primaverile nel Parco Naturale del Monte San Bartolo (PS). *Infomigrans* **25**, p. 7.
Steenhof, K., Bates, K. K., Fuller, M. R., Kochert, M. N., Mckinley, J. O. & Lukacs, P. M. (2006): Effects of radiomarking on prairie falcons: attachment failures provide insights about survival. *Wildlife Society Bulletin* **34**(1), p. 116–126.
Sumya, D., Gombobaatar, S., Shagdarsuren, O., Potapov, E. & Fox, N. (2001): Wintering of saker falcon in Mongolia. Research and conservation. In *Potapov, E., Banzragch, S., Fox, N. & Barton, N. (eds.):* Proceedings of the 2nd International Conference of the Middle East Falcon Research Group on Saker Falcon and Houbara Bustard. Ulanbaatar, 1–4 July 2000. p. 138–143.
Sutherland, W. J. & Brooks, D. J. (1981): The autumn migration of raptors, storks, pelicans and spoonbills at the Belen Pass, southern Turkey. *Sandgrouse* **2**, p. 1–21.
Thiollay, J.-M. (1977): Importance des populations de rapaces migrateurs au Méditerranée occidentale. *Alauda* **45**, p. 115–121.

Thiollay, J.-M. (1989): Distribution and ecology of Palearctic birds of prey wintering in West and Central Africa. In *Meyburg, B.-U. & Chancellor, R. D. (eds.):* Raptors in the modern world. Proceedings of the III World Conference on Birds of Prey and Owls. World Working Group on Birds of Prey, Berlin, London & Paris, p. 95–107.

Uhrin, M. & Chavko, J. (2008): Mení sa obraz poznatkov o migrácii sokolov rárohov? *Dravce a sovy* **4**(2), p. 12–14.

Üner, Ö., Boyla, K. A., Bacak, E., Birel, E., Çelikoba, I., Dalyan, C., Tabur, E. & Yardim, Ü. (2010): Spring migration of soaring birds over the Bosphorus, Turkey, in 2006. *Sandgrouse* **32**(1), p. 20–33.

Váczi M. & Prommer M. (2010): A Mosonszolnok-Levéli szélerőműpark területén végzett madártani viszgálatokról. *Heliaca* **7**, p. 78–85.

Verhelst, B., Jansen, J. & Vansteelant, W. (2011): South West Georgia: an important bottleneck for raptor migration during autumn. *Ardea* **99**(2), p. 137–146.

Welch, G. & Welch, H. (1989): Autumn migration across the Bab-el-Mandeb Straits. In *Meyburg, B.-U. & Chancellor, R. D. (eds.):* Raptors in the modern world. Proceedings of the III World Conference on Birds of Prey and Owls. World Working Group on Birds of Prey, Berlin, London & Paris, p. 123–126.

Appendix 1. Review of migration of Saker Falcon data related to its Central and Eastern European populations (data from regular and long-term monitoring programmes were included to the table; the Eastern Mediterranean region includes the Balkan countries also, n.d. = no data available)

Country	Site	Date / *Period*	No. of raptors	No. of Sakers	Reference
Middle East					
Georgia	Batumi	Autumn 2002	n.d.	31	*Balmer & Betton (2003)*
		Autumn 2008–2009	1 658 170	6	*Verhelst et al. (2011)*
	southern Caucasus	26 Aug.–29 Oct. 1997	120 000	11	*Galushin & Moseikin (2000)*
Israel	"Northern Valleys Survey"	1990–1999	n.d.	4	*Alon et al. (2004)*
	Eilat	1969–1980	n.d.	1	*Christensen et al. (1982)*
	Haifa	7 Apr 1987	n.d.	2	*Géroudet & Juillard (1990)*
Russia	Kislovodsk	12 and Sep. 1998	n.d.	3	*Galushin & Moseikin (2000)*
Syria		Sep.–Nov. 2000–2003	n.d.	6 (trapped)	*Serra et al. (2005a, 2005b)*
Turkey	Belen Pass	Autumn 1976	n.d.	1	*Acar et al. (1975)*
	Bosporus	13 Sep.–1 Oct 1956, Autumn 1957, 20 Aug.–8 Oct. 1966	n.d.	23	*Porter & Willis (1968)*
		18 Mar.–31 May 2006	n.d.	1	*Üner et al. (2010)*
Yemen	Bab-el-Mandeb Straits	15 Oct..–1 Nov. 1985	n.d.	3	*Welch & Welch (1989)*
	Mafraq al Mukha	4 Nov. 1985	n.d.	1	*Porter & Christensen (1987)*
Eastern Mediterranean region					
Bulgaria	Bourgas (Burgas)	Autumn 1979–2003	770 674	151	*Michev et al. (2011)*
	NE & S Bulgaria, Bourgas (Burgas)	Sep.–Oct. 2007	n.d.	6	*D. Ragyov (pers.comm.), www.netfugl.dk (leg. P.E. Pedersen)*
Cyprus	Akrotiri Peninsula	Sep.–Nov. 2006	n.d.	7	*M. Miltiadous* (pers.comm.)
		Autumn 2004–2007	n.d.	individuals	*M. Miltiadous* (pers.comm.)
Greece	Antikythira	Autumn 2007–2009	4 106	2	*Lucia et al. (2011)*
		Spring 2007–2008	797	0	*Lucia et al. (2011)*
Romania	Măcin	Autumn 2002–2007	66 952	17	*Milvus (2008)*
Western Mediterranean region					
France		1901–2012	n.d.	5	*Mission Migration Project (www.migraction.net)*
Italy	Apuan Alps (Alpi Apuane)	1–30 Sep. 2012	2 400	1	*Premuda (2012)*
	Monte Conero	20 Mar.–20 May 2004; Spring 2009; 15 Apr.–31 May 2012	18 957	3	*Premuda et al. (2008), Borioni & Baldoni (2009), Fusari (2012)*
	Monte San Bartolo	23 Apr.–7 May 2005; 10 Mar.–31 May 2009; 14 Mar.–31 May 2010	6 286	3	*Premuda et al. (2008), Sonet et al. (2009, 2010)*
	Panarea	20 Apr.–20 May 2005; 20 Apr.–20 May 2007	4 809	2	*Gustin (2005, 2007)*
	Strait of Messina (Stretto di Messina)	Apr.–May 1986–2006	n.d.	20	*Giordano (1991)*
		Spring 1996–2000; 14 Apr.–21 May 2006; 2 Apr. – 27 May 2008; 1 Apr.–27 May 2009; 27 Mar.–26 May 2012	266 020	17	*Corso (2001), Chiofalo et al. (2006), Cutini et al. (2008), Ricciardi et al. (2009), Giordano et al. (2012)*
Malta	Buskett	2001	n.d.	3	*Sammut & Bonavia (2004)*
	Buskett	8–23 Sep 2007, 25 Aug–26 Oct 2012	6 309	3	*Raine & Vella (2007); Galea & Vella (2012)*
		1908–2007	n.d.	49	*R. Vella (pers.comm.)*
Northern Africa & Sahel					
Tunisia	Cape Bon	Mar.–Apr. 1974; 1–20 May 1975; Mar.–May 1977	n.d.	35	*Thiollay (1977), De Jong et al. (2009)*
Ethiopia	Awash area	Nov. 2004	n.d.	27	*Dixon (2005)*
Sudan	Lake Nasser area	Autumn 1986	n.d.	1–2	*Ash & Nikolaus (1992)*

We express our sincere thanks to the following persons who, in parallel with various members of the editorial board provided their help by peer reviewing the manuscripts submitted to *Aquila: Nigel Collar, Szilárd Daróczi, Ricard Gutierrez, Zoltán Hegyi, Márton Horváth, Giovanni Leonardi, Mike J. McGrady, Maurizio Sará, András Schmidt, Enikő Tamás, Zsolt Végvári, Michael Wink*.

Index alphabeticus avium

Index of authors – A szerzők mutatója