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SAKER
FALCON
NETWORK

SAKER FALCON *Falco cherrug* REINTRODUCTION IN BULGARIA

FEASIBILITY STUDY

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Saker Falcon fledglings on their nest in Western Balkan Mountains in 1980s. © T. Michev

CONTENTS

INTRODUCTION

The purposes of this document are: i) to make an assessment of whether or not reintroduction is a suitable and feasible conservation management option for restoring the Saker Falcon as a breeding bird in Bulgaria; ii) to outline the strategies of a potential reintroduction, following the best practices in similar conservation projects and the IUCN criteria for reintroductions; iii) to serve as a tool in preparation and implementation of any Saker reintroduction projects and other conservation activities.

The document is broken down into 8 sections:

The first section provides a broad overview of the distribution, population and conservation status of the Saker Falcon. The European Union holds less than 2% of the global Saker Falcon breeding population, but the species has a high conservation profile with its own EU Single Species Action Plan (Nagy & Demeter, 2006). In recent years the species has been the focus of two EU LIFE projects; one in Hungary and Slovakia (5-year project initiated in 2006) and the other, on Sakers and Imperial Eagles, in Bulgaria (5-year project initiated in 2009). These activities serve to highlight the high conservation value placed on the Saker Falcon in the European Union.

The second section provides information on the past and present status of breeding Saker Falcons in Bulgaria; evaluate the factors that could have caused their decline and assess the possibilities for natural recolonisation.

The third section makes an overview of the Saker Falcon, its basic biology and habitat requirements. This provides a basis for the following (fourth) section, which assesses 15 specific areas of Bulgaria in relation to their suitability for breeding Saker Falcons. These 15 areas exemplify parts of the wider countryside in Bulgaria that the species could potentially occupy. Some of these areas are also assessed in relation to their suitability as potential release areas for Saker Falcons in a reintroduction project.

The fifth section examines reintroduction as potential conservation management strategy for Saker Falcon in Bulgaria and this is followed by a review of our current knowledge on the variation between Sakers in different geographical regions (sixth section). We then introduce some population models to assess the impact of harvesting juvenile Sakers for translocation and a model for population re-establishment following reintroduction (seventh section). Finally, we end with criteria that can be used to judge the success of a potential reintroduction project (eighth section).

Former Saker Falcon breeding areas in Balkan Mountains. © D. Ragyov

DISTRIBUTION AND POPULATION STATUS

Saker Falcons occur across a wide area of the Palearctic region from eastern Europe to east Asia, breeding in Afghanistan, Austria, Bulgaria, China, Croatia, Czech Republic, Georgia, Hungary, Iran, Iraq, Kazakhstan, Kyrgyzstan, Moldova, Mongolia, Poland, Romania, Russia, Serbia, Slovakia, Ukraine, Uzbekistan, Tajikistan, Turkey, Turkmenistan, and possibly India (Ladakh) and Pakistan, with wintering or passage populations regularly in Italy, Malta, Cyprus, Israel, Jordan, Egypt, Libya, Sudan, Tunisia, Ethiopia, Kenya, Saudi Arabia, Yemen, Oman, UAE, Bahrain, Kuwait, Pakistan, Iran, India, Nepal, Afghanistan and Azerbaijan, with much smaller numbers or vagrants reaching many other countries (MEFRG, 2009; Dixon, 2009; BirdLife International, 2009; Figure 1).

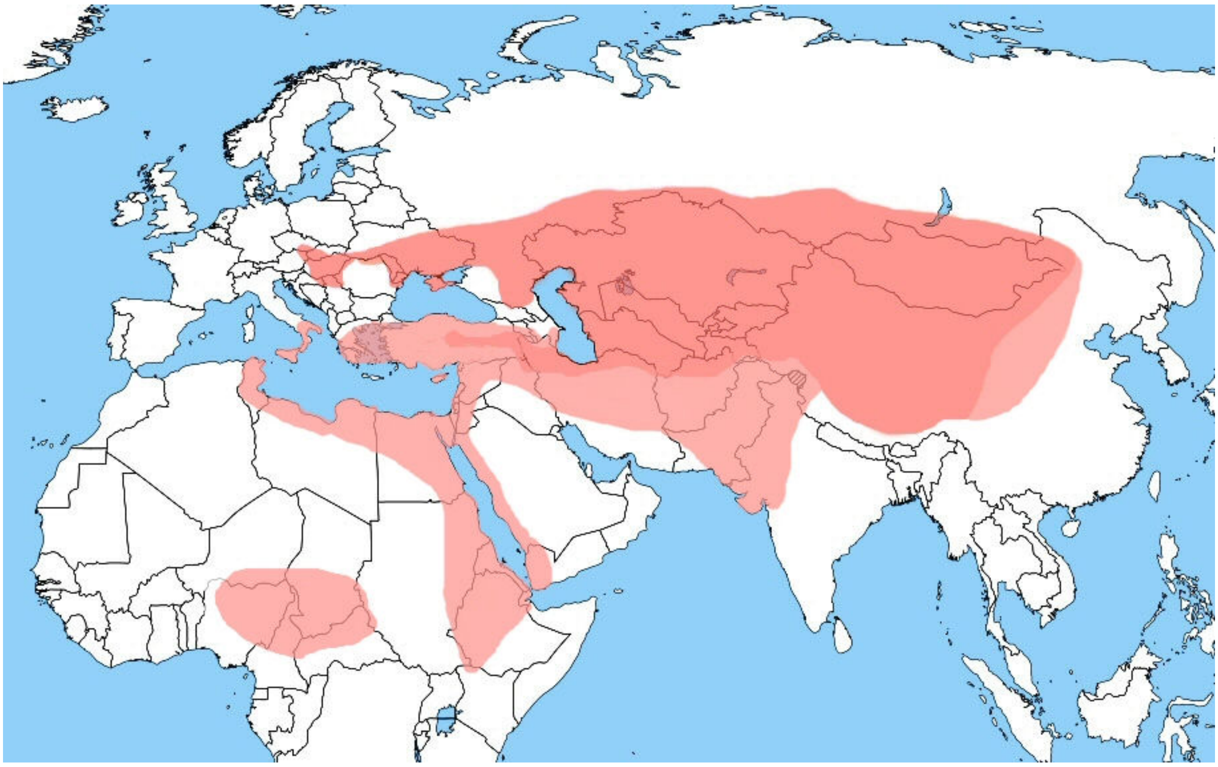

Figure 1. Breeding (dark shading) and wintering (light shading) areas of Saker Falcons. Reproduced from MEFRG (2009)

Population data is scanty for much of the Asian part of the breeding range, but the most recent estimate of the global population is between 9,400-17,700 breeding pairs (Dixon, 2007; 2009). In some parts of the range regional populations are increasing, yet in others it is stable or declining. The overall global population is believed to be declining, primarily because of reductions in large Asian populations in Russia, Kazakhstan, Central Asian states and China.

The Saker Falcon is now widely regarded as being either polytypic with two sub-species, the nominate western *cherrug* and the eastern *milvipes* races (Vaurie, 1959) or monotypic showing clinal variation and a high degree of individual polymorphism (Eastham, 2001). Genetic analysis using mitochondrial and microsatellite markers did not detect any significant population substructuring across the Palearctic breeding range of the Saker Falcon (Nittinger *et al.,* 2007).

In the Western Palearctic region (as defined by Cramp *et al.*, 1980) the breeding population is estimated at 713-842 pairs (Table 1). This estimate excludes the provinces in Iraq, Iran and Kazakhstan that are within the Western Palearctic and for which no data exists. The current breeding distribution of the Saker Falcon in the Western Palearctic is presented in Figure 1. The Western Palearctic is at the western end of the global distribution range and holds less than 10% of the global breeding population.

Table 1. Recent Saker Falcon population estimates in the Western Palearctic (WP)

Country	Population Estimate	Date of Estimate	Source of Information	15 year Trend (Dixon, 2007; MEFRG, 2009)
Austria	20-25 bp	2004	Mebs & Schmidt, 2006	Slight increase
Bulgaria	0-3 bp	2009	This study	Declining/Extinct
Croatia	3-5 bp	2009	D. Glica	Unknown
Czech Republic	15-16 bp	2008	D. Horal	Stable
Georgia	3-5 bp	2000-2003	Nagy & Demeter, 2006	Unknown
Hungary	214-230 bp	2009	I. Balazs	Increasing
Iraq (WP)	Unknown	NA	NA	Unknown
Iran (WP)	Unknown	NA	NA	Unknown
Kazakhstan (WP)	Unknown	NA	Wassink & Oreel, 2007	Unknown
Moldova	10-12 bp	2005-2006	V. Vetrov, Y. Milobog	Unknown
Poland	0-2 bp	1998	Augst, 1998	Unknown
Romania	2-12 bp	2006	Z. Domahidi	Stable
Russia (WP)	40-45 bp	2007	Karyakin, 2008	Declining
Serbia	55-60 bp	2008	M. Tucakov	Increasing
Slovakia	31-32 bp	2008	L. Deutschova per I. Balasz	Increasing
Turkey	50 bp	2007	Dixon *et al.,* 2009	Unknown
Ukraine	270-345 bp	2005-2007	V. Vetrov, Y. Milobog	Increasing
Western Palearctic	**713-842**			

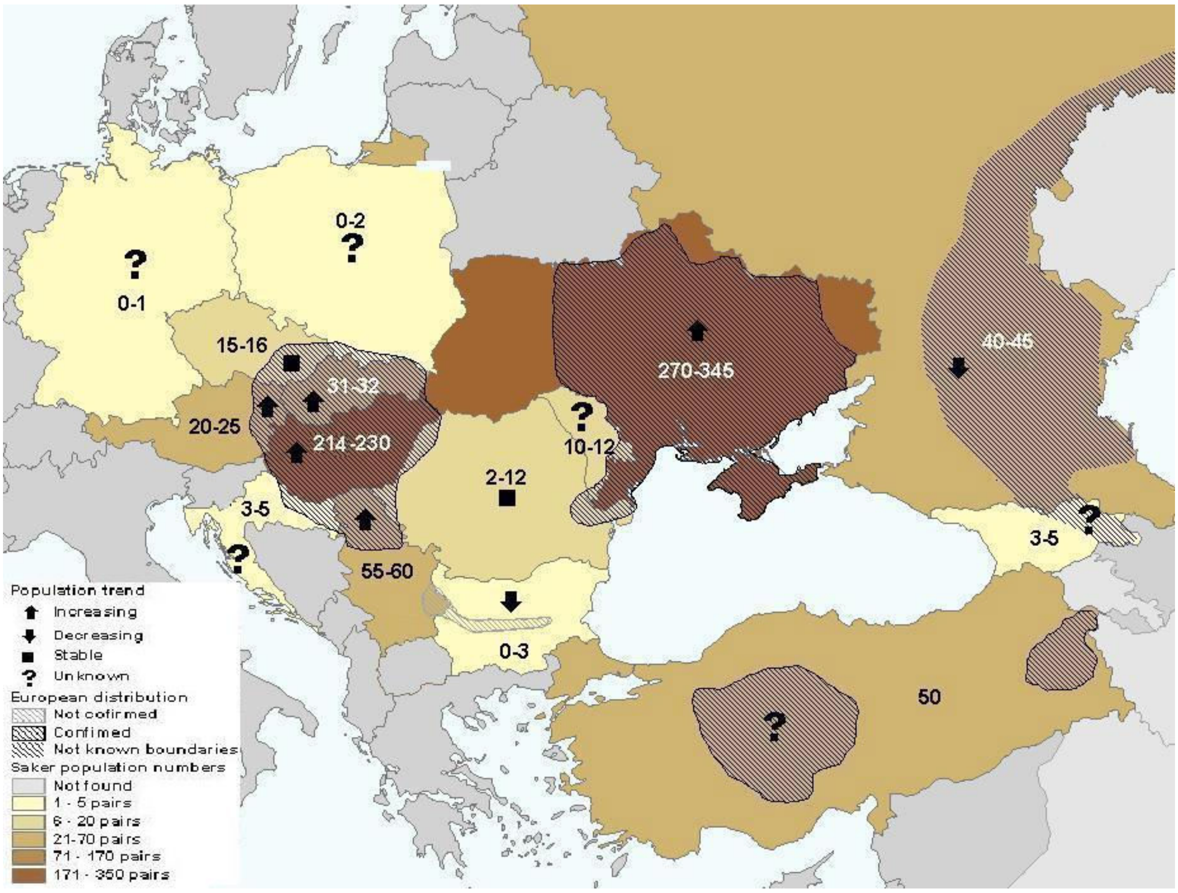

Figure 2. Current Saker Falcon breeding range, numbers and population trends in the Western Palearctic region (excluding Iraq, Iran and Kazakhstan)

CONSERVATION STATUS

The Saker Falcon is listed as "Endangered" (EN) in the IUCN Red List (IUCN, 2009), though this global listing status is currently under review. At a national level, the Saker Falcon is listed in the Bulgarian Red Data Book (Michev, 1985) as "Endangered" and it is to be uplisted in the new edition as "Critically Endangered" (Domuschiev *et al.*, in prep.). The species is also included in the appendices/annexes of the following International Conventions, ratified by Bulgaria:

- The Convention of European Wildlife and Natural Habitats (Bern Convention)
- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)

- The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)

EU Directives

Bulgaria joined European Union in 2007. An obligation of the country under the EC Birds (79/409/EEC) and Habitat Directives (92/43/EEC) is “to ensure that protected species (and habitats) are maintained in, or restored to, favorable conservation status”.

Convention on Biological Diversity

Bulgaria has been a Party to the Convention on Biological Diversity since 2003. Article 9 (c) states: “Each Contracting Party shall, as far as possible and as appropriate, and predominantly for the purpose of complementing in-situ measures adopt measures for the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions”

Bulgarian Biodiversity Law

Saker Falcon is listed in Annexes 2 and 3 of the Biodiversity Act (2004). Reintroduction and restocking is one of the sixth tools for conservation of extinct or threatened species from wild flora and fauna in their native habitats (under Article 35).

The Hunting and Game Protection Act

Article 65, Section 12 of the Act bans the use of falcons and other birds of prey, regardless their species and origin, as means for hunting.

STATUS OF THE SAKER FALCON IN BULGARIA

- Former status

Prior to the 1930's Saker Falcons were common and widely distributed in Bulgaria, especially in open hilly areas and Danube River valley (reviewed by Ragyov & Shishkova, 2006). Based on three decades ornithological research, Arabdzhiev (1962) stated that "*the species is extremely rare in Bulgaria*", indicating a significant decline after the 1920's. In the latter half of the 20th century the breeding population was believed to be less than 50 pairs (population assessments are summarized in Table 2). Further decline was noted by the late 1990's (Stoyanov & Kouzmanov, 1998) and the population was estimated at 2-6 breeding pairs (BirdLife International, 2004).

Table 2. Saker Falcon population trends in Bulgaria

PERIOD	*STATUS*	*REFERENCE*
Late 19th – early 20th cent.	"Widespread, Common, Abundant"	Farman, 1868; Elwes & Buckley, 1870; Sintenis, 1877; Reiser, 1894; Floericke, 1918
1930's – 1950's	"Extremely rare"	Arabadzhiev, 1962
1960's – 1970's	30 – 50 pairs	Baumgart, 1977, 1978, 1991
1980's – 1990's	15 – 50 pairs	Michev, 1985; Michev & Petrov 1985; Nankinov *et al.*, 1991; Kostadinova, 1997; Stoyanov & Kouzmanov, 1998; Boev, 1991

- Current status

The current situation in the 21st century is characterized by the continuing decline of the breeding population that started in late 1990's, though reporting of the status of Bulgarian Sakers is complicated by differing assessments. Since 2000 population estimates vary between 2 and 15 breeding pairs / breeding territories. Most of them were produced by the Bulgarian Society for the Protection of Birds (BSPB) - summarized in Table 3. The accuracy of these assessments is unknown but they reflect an increased survey effort and better coverage of the country than previously. Details of many of these records are unclear i.e. there is no reference to the observer, no information on the location and date of the observation, nor any reference to the description or behavior of the birds. The recording units used by BSPB are inconsistent and refer to breeding territories and breeding pairs, without explanation as to how these have been defined from sight records of birds; no nests have been found. In order to protect sites from disturbance, BSPB maintain a policy of strict secrecy in relation to their Saker Falcon observation records. This secrecy, which extends beyond simply suppressing the geographical location of the Saker Falcon records, combined with the production of several different population estimates, even for the same year (Table 3) means that it is impossible to verify the claims made by BSPB.

The last documented successful breeding attempt of Saker Falcons in Bulgaria was in 1997. The last documented active nest was in 1998 - a pair successfully hatched chicks, but lately the brood disappeared (Domuschiev *in litt.*). After this date there are three records that we have classified as evidence of 'confirmed breeding'. All of them relate to sightings of one or two adults flying with a young bird in July-August, indicating that these young birds had hatched locally in 1998, 1999 and 2005 (I. Angelov; D. Gradinarov; V. Kojchev). Most recently, BSPB have claimed that there are at least nine breeding pairs of Saker Falcons in Bulgaria (Gradinarov & Iankov, 2009). Whilst at the same time, for the period 2006-09, they report that they have evidence of only two breeding attempts, though no active nests were recorded.

Independent data apart from that produced by the BSPB is also available. Survey teams from the Central Laboratory of General Ecology (CLGE) with cooperation of other organizations (Green Balkans Federation, Birds of Prey Protection Society /BPPS/, Fund for Wild Flora & Fauna /FWFF/ and Institute of Zoology) implemented a four-year Saker survey from 2006-09. The survey was targeted at localities where Saker Falcons had previously been recorded in Bulgaria. Potentially suitable habitats were also explored. Total size of the surveyed territories comprises more than 10% of Bulgarian territory (> 11,000 km²). Records from the past were categorized by their priority – *High* and *Low Priority.* High Priority records comprised confirmed and probable breeding records where the habitat had not drastically changed whilst the Low Priority records comprised (i) all possible breeding records, (ii) confirmed and probable records where habitat was altered to the extent that it no longer supported other birds of prey and (iii) records in areas that had been intensively surveyed in the previous 10 years but where Sakers had not been recorded during the breeding season. The methods used to classify Saker Falcon records in terms of 'confirmed', 'probable' and 'possible' breeding are given in Appendix I. All of the *High Priority* records were explored, together with most of the *Low Priority* records but no breeding pairs were recorded, nor were any single birds observed.

There are several Saker Falcon breeding-season (March-July inclusive) records from Bulgaria during the period 2006-09, which were reported incidentally to GLGE by researchers undertaking various field expeditions. Over the period 2006-09 we obtained 29 records from 26 different localities i.e., 2006: 10 records from 8 localities, 2007: 7 records from 6 localities, 2008: 5 records from 5 localities and 2009: 7 records from 7 localities. Only one record referred to a pair of birds, at coastal location in June 2008, whilst the remainder referred to singletons (five of which were positively identified as adults and one as an immature). The incidental records suggest that the Saker Falcons found in Bulgaria during the breeding season are mainly single birds (either non-breeding or roaming birds from elsewhere). Since 1998, no Saker Falcon nests have been documented in Bulgaria and confirmed breeding was not recorded despite the intensive surveys in 2006-09. Therefore, based on the survey results and incidental reports, the current breeding population is believed to be very small if not extinct.

Table 3. Recent estimates of the Saker Falcon population in Bulgaria (bp = breeding pairs; bt = occupied territories). No Saker Falcon nests have been recorded in Bulgaria since 1998.

PERIOD	*STATUS*	*REFERENCE*
2002	5 bp	Kostadinova & Mihaylov, 2002
2004	8-12 bp	Nankinov *et al*., 2004
	4-10 bp	Nagy & Demeter, 2006
<2005	”All traditional breeding sites in Bulgaria have been desolated”	Iankov, 2005
2005	≤ 5 bt	Domuschiev, *in litt*..
	10-15 bp	Iankov, 2007
2006	Min 6 bt	Ruskov, 2007
	About 6 bt	Iankov, 2007
2007	Min 4 bt (≥5) bt	Ruskov, 2007
	Min 2 bp (6-7 bt)	BSPB, 2008a
	Min 7 bt or 5-6 bp	Iankov & Ruskov, 2009
2008	Min 2 bt	BSPB, 2008a
	5-6 bp	BSPB, 2008b
	6-7 bp	P. Iankov; BSPB, 2008c
	3-7 bp	D. Gradinarov, P. Iankov BSPB
2009	9 bp	P. Iankov BSPB
	6-9 bp	BSPB, 2009
	Min 9 bp	Gradinarov & Iankov, 2009
	Min 6-9 bp	Gradinarov & Iankov, 2009

- Reasons for decline and extinction

In the early part of 20th century persecution of birds of prey seems had a great impact on their populations. There were government sponsored programmes to eradicate birds of prey from the environment (Arabadzhiev, 1962; Spiridonov, 1977). Persecution continued well into the middle of the century with official data from the National Hunting Society showing that 70,000 raptors were killed in 1957 alone (Arabadzhiev, 1962).

Additionally, habitat loss contributed to the large-scale decline of the Saker Falcon in Bulgaria from the middle of the 20th century. Massive changes in agricultural practices dramatically altered the Bulgarian landscape. Habitat loss occurred through abandonment of lowland grazing or conversion to arable crops, which in turn contributed to the decline of important prey species for Sakers such as the European Souslik *Spermophilus citellus* and various grassland birds. In addition, drainage of native wetlands contributed to decline of waterbirds – another Saker Falcon food resource. Persecution and habitat loss were the main reasons for the decline of the Saker in the 20th century and consequently a diminished population of 30-50 breeding pairs was restricted mainly to upland areas in the Balkan Mountains by the 1970s (Baumgart, 1978).

The impact of organochlorine pesticides on Saker Falcons is not well documented, but population declines were noted for Peregrines in Eastern Europe from the mid 1950's through to the 1970's. In Bulgaria, the Peregrine population only started showing signs of recovery from the mid 1980's (Stoynov *et al*., 2007; Ragyov *et al*., 2009). DDT was used in the 1950's but its use declined in the following decade with the introduction of Aldrin, Dieldrin and Heptaclor. These chemicals were imported and used in Bulgaria from the early 1960s. Most of these chemicals, which were implicated in the population crash of the Peregrine, were used in large quantities until they were eventually banned in 1969, but the Heptaclor was used up to 1991 (MoEW, 2006). It is likely that organochlorine pesticides had some detrimental impact on Saker Falcon populations in Bulgaria, and may have significantly contributed to their disappearance in lowland agricultural regions.

In the 1970's there was a resurgence in the interest of falconry in western Europe, which was accompanied by an increased demand for falcons. Falcons were needed not just for falconry but to stock the newly established breeding centres that were being created to meet the demand for falcons from European falconers. The 1970's and 1980's saw Saker Falcons and Peregrines being taken from many nests in central and eastern Europe, reducing the breeding success of wild populations that had already been badly affected by pesticides. Scheglman (1983) reported that ten groups of falcon poachers operated on the Balkan Peninsula (cited in Michev & Petrov, 1985).

In the 1990's major politic and social changes took place in Bulgaria which lead to a period of economic instability combined with lax enforcement of conservation legislation. This situation enabled criminal gangs, intent on taking wild falcons for commercial gain, to act with relative impunity. By the 1990's the number and/or activities of such gangs increased, as did the frequency of reported nest robberies and trapping. This increase in the illegal, commercial exploitation of wild Saker Falcons coincided with the beginning of the final crash of their population in Bulgaria (Ragyov & Shishkova, 2006; Iankov, 2007). Nest robbery, in an already diminished Saker population, may have been sufficient to reduce the level of recruitment into the breeding population to the extent where it did not compensate for adult mortality rates. Any trapping of breeding Saker Falcons would effectively increase adult 'mortality' by removing the birds from the Bulgarian breeding population.

Young Saker Falcon taken from its nest by poachers in 1997. After a police action the bird was returned to its nest. Later on the bird and its sibling successfully dispersed from the breeding territory. © D. Domuschiev

As with the earlier period, persecution was not the only factor implication in the final population crash, habitat changes probably played a role too. The socio-economic changes of the 1990's saw yet more areas of pasture abandoned or turned-over to cultivation and development for construction. These changes continue into the 21st century with impacts on favoured prey species such as the European Souslik. Over the period 2004-08 Koshev (2008) investigated 90 European Souslik colonies in three regions of Bulgaria; approximately 30% of the colonies had disappeared, 28% were vulnerable to extinction and only 42% were stable compared with the period 1950-1989.

The surge in illegal commercial exploitation of wild falcons in the 1990's has abated and the Bulgarian Peregrine population continues to increase. While in 1980s and 1990s the small number Bulgarian falconers were using wild taken birds, nowadays they tend to use legally imported birds from European breeding facilities. Furthermore, the commercial market for illegally taken chicks in European breeding facilities has also greatly diminished. Protection efforts and enforcement of conservation legislation has improved since the 1990's and Bulgaria's accession to the European Union has increased the profile and level of financial support for conservation activities. The series of recently implemented Saker Falcon conservation projects has increased public awareness of the problem. Consequently, illegal nest robbery and trapping, a major factor in the final extinction of the Saker in Bulgaria, has been minimized if not totally removed. However, major habitat changes continue to take place in the wider Bulgarian countryside, most of which make the agricultural landscape of the lowlands less suitable for Saker Falcons by reducing prey abundance. Nevertheless, the network of protected areas in Bulgaria provide some refuge where Saker Falcons could still potentially exist in numbers comparable to that found in the middle of the 20th century.

- Possibilities for natural recolonisation

The western end of Saker Falcon breeding range in the Palearctic is fragmented, with three main population centres located in the Pannonian Basin (Central Europe), steppe areas and agricultural areas of Eastern Europe and the Anatolian Plateau of Turkey.

The Saker population of Central Europe has been steadily increasing over the last couple of decades (Bagyura *et al.,* 2004). Long-term data from ringing recoveries of Hungarian Sakers indicates a relatively high degree of natal philopatry in this population; the distance between the place of hatching and the place of subsequent breeding ranges between 10 - 130 km (M. Prommer) whilst the same ringing data indicates that juvenile movements are pronounced. This has been verified by recent satellite telemetry of juvenile Sakers (MME, 2009). In 2007-09 43 juvenile Sakers from central Europe (Hungary and Slovakia) were fitted with satellite transmitters. Four of them flew over the Carpathian Mountains to reach Bulgaria (MME, 2009). Despite large dispersive movements in the post-fledging period there is little evidence that these birds settle to breed in areas far removed from their natal origin in Central Europe.

To the east of Bulgaria Saker Falcons breed in steppe and agricultural habitats from Romania to West Kazakhstan, this East European population is larger than that in Central Europe and, unlike the latter, there are no major "geographical barriers" separating it from Bulgaria. However, little is known about the dispersal movements and natal philopatry of East European Sakers. Sakers are rare but regular passage visitors to Bulgaria along the Via Pontica migratory route used by many East European migrants (Michev & Profirorov, *in litt.*).

To the south the Saker breeding population in Turkey, once contiguous with the Bulgarian population is now much diminished and isolated (Dixon *et al.,* 2009; Ragyov *et al.,* 2008).

Long-distance settlement in breeding areas far removed from the area of natal origin has never been recorded in the Saker Falcon and is extremely unlikely to occur in areas without an existing breeding population (as it would require the settlement in a novel area by at least two individuals, male and female, of breeding age). Based on the limited extent of range expansion over the 15 years in Central and Eastern Europe, despite increasing population trends it may be concluded that natural recolonisation of Bulgaria is unlikely within the next couple of decades.

- Concluding remarks

There is no doubt that the Saker Falcon demise in Bulgaria has been caused by direct human activity i.e., habitat change and persecution. Therefore, there are moral obligations to implement proper measures for species restoration. The Saker Falcon is a candidate as a ‘flagship’ species for developing public awareness of conservation issues related to direct human persecution and wider landscape changes. The species fits the criteria for “umbrella species” that could help/induce the protection of other species such as the European Souslik and specific habitats e.g. mountain steppe/pastures and stimulate wildlife friendly agricultural land use. It is well suited to promote protected sites within the NATURA 2000 network. The reintroduction in Bulgaria also has international merits as Bulgaria lies between the Saker population centres in Central Europe, Eastern Europe and Turkey, where a reintroduced population could increase connectivity and gene flow between these fragmented populations. The objectives of a Saker Falcon reintroduction project in Bulgaria are to establish a self-sustaining breeding population of Saker Falcons in Bulgaria in order to:

1. Restore the Saker Falcon as a component of ecosystem biodiversity in Bulgaria

2. Promote conservation awareness, thus protecting other wildlife and habitats

3. Increase the capacities of Bulgarian nature conservation organisations via transfer of skills and applications for other threatened species

HABITAT REQUIREMENTS OF SAKER FALCONS

- General description

Saker Falcon is one of the group of closely related taxa termed the hierofalcons (comprising Saker Falcon, Gyrfalcon *Falco rusticolus,* Lanner Falcon *Falco biarmicus* and Lagger Falcon *Falco jugger*). The Saker Falcon combines rapid acceleration with high maneuverability to hunt small mammals and birds in open landscapes. Saker Falcons are partial migrants; within a population some individuals are sedentary and remain in the vicinity of their breeding sites, whilst others (including all juveniles) either make dispersal movements or long-distance migrations away from their nest sites.

The Saker is essentially a species of open landscapes such as steppe, open plains or montane plateaus. In the continental, middle latitudes of the Western Palearctic they breed mainly in agricultural and steppe landscapes, with varying amounts of woodland, and in mountain foothills, often bordering or overlapping into forests.

Unlike other large falcons, Sakers frequently feed on small mammals, although birds are also important prey; a very wide range of prey species are taken, depending on local availability. Detailed dietary studies have demonstrated that the prey spectrum taken by breeding Sakers can vary temporally and spatially, both from year to year and between areas within a year depending on prey availability. Mammalian prey ranges in size from small voles, through to larger mammals like sousliks, rabbits and hares. The type of bird species taken range from small passerines up to species as large as herons and bustards.

In common with other species in the order *Falco*, Sakers do not build their own nests; they typically occupy old nests or else usurp nests of other large species such as Raven *Corvus corax*, Common Buzzard *Buteo buteo*, Long-legged buzzard *Buteo rufinus* etc. This feature of its biology means that the Saker is sensitive to nest site availability, which can be a limiting factor in some regions. Nest sites are normally located in tall trees, cliffs or on human artifacts such as electricity pylons.

- Habitat use in Bulgaria

A review of available Saker Falcon records since the 1860's showed changes in habitat use over the course of time. Up to the 1950's Sakers were recorded mostly at altitudes below 600 m a.s.l. during the breeding season. These areas include: (i) open areas with scattered old single trees (Sofia Plain and Dobrudzha Plateau); (ii) open areas and wetlands along big rivers where gallery river forests provided nesting sites (Danube River valley) and (iii) open areas mixed with old mature forest (Dobrudzha and Ludogorie Plateaus, Thrace Lowland). Grasslands such as pastures and shrubby communities were most probably the main hunting habitat for Sakers. Since pastoralism was the main livelihood in the country, huge areas of Bulgaria were used as pastures. These pastures provided Sakers with abundant small mammal prey. The numerous wetlands (bogs, marshes and temporary flooded areas) with their concentration of water birds were also favorable hunting places. Although some cliff nesting Sakers were recorded in that period (in the Thrace Lowlands, Ludogorie and Dobrudzha Plateaus) the available information suggest that Sakers used trees more frequently than cliffs.

During the 1960's to 1990's Saker Falcons were recorded breeding at higher altitude. One third of the available records were in places above 600 m. i.e., the foothills and alpine zone of the Balkan, Rhodopes, Pirin, Krajshte and Rila Mountains. All these areas are characterized by extensively grazed pastures and alpine grasslands bordering mountain slopes, with numerous nesting sites. However, two thirds of the records from this period still referred to the lowlands of the country. From the available documentary evidence Sakers appeared to be widely distributed but rare in the country during the period 1960-90. Most of the breeding records refer to, or suggest, cliff-nesting, with only exceptional records of tree-nesting. This change in habitat use and nest site choice was probably connected with the massive agriculture intensification and change in traditional land use over the period, which resulted in a marked population decline particularly in lowland habitats. However, it is not clear whether the species shifted from the lowlands to the mountains or if Sakers always occurred in the mountains but were largely under-recorded; probably the latter.

During the last decade (2000-09) there have been no documented active nests, so it is not possible to discuss the current habitat selection of breeding Saker Falcons in Bulgaria. However, sight records of Saker Falcons have mainly come from the Balkan Mountain range, Maritime Dobrudzha and the Western Thrace lowlands where extensive areas of natural or semi-natural grassland remain.

Host species that have been recorded providing nests for Saker Falcons in Bulgaria include: White-tailed Eagle *Haliaeetus albicilla*, Grey Heron *Ardea cinerea*, Rooks *Corvus frugilegus,* Hooded Crow *Corvus cornix,* Common Buzzard *Buteo buteo*, Goshawk *Accipiter gentilis*, Black Vulture *Aegypius monachus*, Eagles *Aquila sp.* Raven and Long-legged Buzzard (Stoyanov & Kouzmanov, 1994; Undjian & Braun, 1984; Michev & Petrov, 1985; Sintenis, 1877; Lorenz-Liburnau, 1893; M. Paspaleva). Nests on bare ledges of rock faces have also been recorded (T. Michev). Saker Falcon nests on human artifacts (e.g. pylons of electric transmission power-lines) have never been reported in Bulgaria, in contrast to central and eastern European populations where it is a common phenomenon.

European Souslik. © Yordan Koshev

- Current habitat use in the Western Palearctic

In the late 20th century changes in habitat occupancy were noticed in European populations; most of the central European Sakers disappeared from riparian forests, dry forests and mountain foothills and populations increased in agricultural plains in Hungary (Bagyura *et al.*, 2006) and Serbia (S. Puzovic), whilst in eastern Europe the species declined markedly in the forest steppe/agricultural zone but remained (or even increased) in the more southerly steppe zone (V. Vetrov, Y. Milobog). A corollary of this change in habitat use has seen a change in nest site selection and prey species.

Most Sakers in both central and eastern Europe now use poles and pylons of high voltage electricity power lines for nesting instead of trees and cliffs (V. Vetrov, Y. Miolobog; Bagyura *et al.,* 2004). Power lines provide secure nesting sites, protected from disturbance and persecution. Artificial nest boxes on pylons and in trees have been used extensively in central Europe and these have been readily adopted by Saker Falcons. The main breeding season prey in central Europe (e.g. Hungary) is birds, especially Domestic Pigeons *Columba livia* (Bagyura *et al.,* 2006) but also voles. Mammals (especially Sousliks) are still the predominant prey in eastern Europe (Moldova and Ukraine) and Turkey (Dixon *et al.*, 2009). Systematic diet studies have not been conducted on the east European population but existing data suggests that sousliks are the most important prey, followed by birds (e.g. gulls, crows and larks). It is clear that agricultural areas with power lines are now the stronghold of Saker Falcons in central and eastern Europe.

Mountain Habitat in Ukraine

Agriculture habitat in Ukraine

Coastal habitat in Ukraine

Hungarian "Pusta" habitat

Agriculture habitat in Serbia

© D. Ragyov

Saker nest in Moldova

AREA ASSESSMENTS

Whilst undertaking Saker Falcon breeding surveys in 2006-09 our survey work covered landscapes and land cover types considered broadly suitable for breeding Saker Falcons. From the survey 15 areas, comprising *ca*. 7% of Bulgarian territory, were identified and studied in detail to assess their suitability for breeding Saker Falcons (Table 4; Figure 3). The aim of this assessment was to determine whether or not there was potential for Saker Falcons to breed in a variety of widely dispersed areas across Bulgaria. The larger areas included in this assessment that showed best suitability characteristics were identified as potential Release Areas (pRAs) for Saker reintroduction.

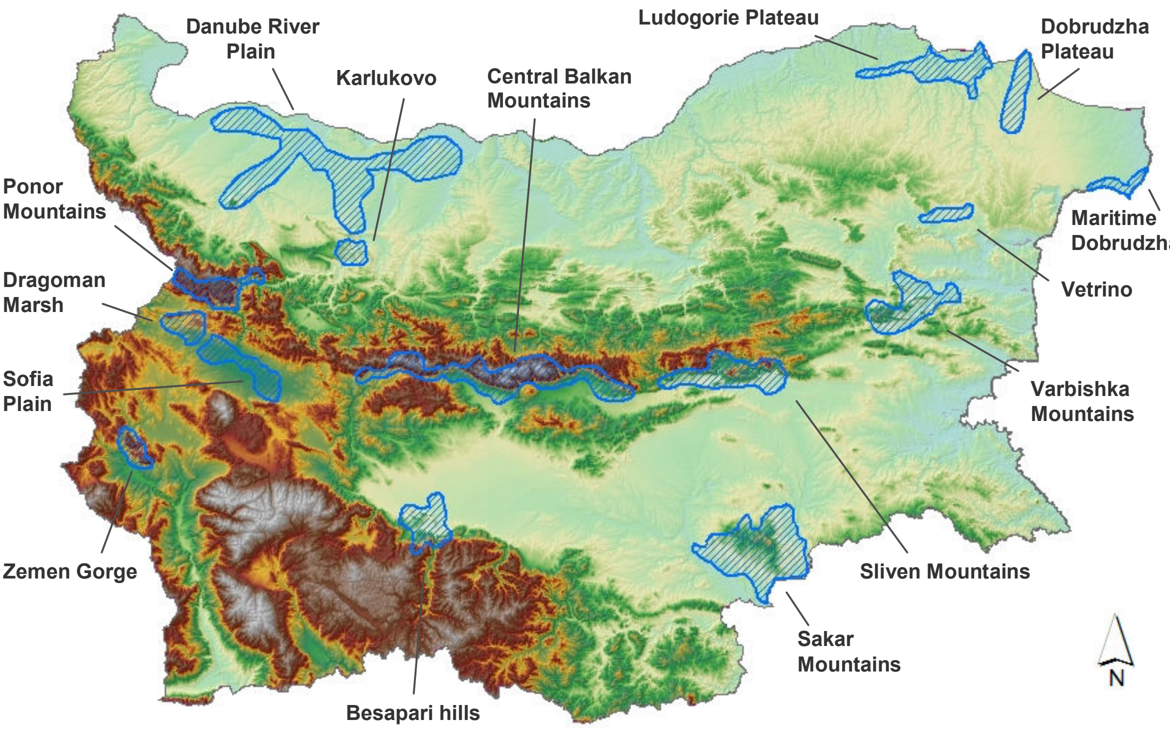

Figure 3. Map of areas that were assesses in terms of their suitability for Saker Falcons

- Potential Release Area (pRA) size

A significant criterion in assessing the pRAs is the size of the site, as larger areas could potentially support a bigger population of re-established Saker Falcons. Breeding Sakers occupy territories and usually their breeding range size exceeds 310 km^2 (Brown & Amadon, 1968), though pairs normally only defend an exclusive area much closer to their nest site, and can nest as close as 0.5 km apart (Solomatin, 1974, cited in Cramp *et al.*, 1980). Range size is dependent of food supply, with larger ranges used in regions with lower prey availability. In Mongolia, in areas with a high food supply and unlimited nesting sites, Sakers can breed at very high density (17 bp/100km^2) and occupy small individual home ranges of 7-30 km^2 (A. Dixon, unpublished data). There is little published information on regional or local breeding densities of Saker Falcons in Europe, but regional population densities of Long-legged Buzzard and Peregrine in our survey areas reach 5.6 bp/100km^2 and 1.3 bp/100km^2 respectively (Appendix 2; Table 10); with average density of 1.2 bp/100km^2. The surveyed areas varied in size from 124 to 2064 km^2. Thus the smallest and largest pRAs could potentially support 1 and 25 breeding pairs of Saker Falcons respectively, if regional densities of 1.2 bp/100km^2 could be established (Table 4). For the purposes of reintroduction we want to establish a core breeding population within a five-year time frame. Our population models indicate that we could potentially establish 5-8 breeding pairs within five years (Figure 9), thus our potential release area must be capable of supporting a minimum of five breeding pairs.

Table 4. **Size (km²) and description of the 15 surveyed areas and the hypothetical population of breeding Saker Falcons that could be supported with a breeding density of 1.0 to 1.4 bp/100 km². Areas highlighted in red are judged to be able to support a minimum of four breeding pairs of Saker Falcons and were assesses as potential Release Areas for reintroduction.**

Area Name	Total Area (km^2)	Landscape Description	Hypothetical Saker Population with density of 1.2 bp/100 km^2
Besapari hills	391	Foothills and lowlands with agriculture and pastures.	5
Central Balkans	1207	Forested foothills, upland pastures, and lowland agricultural land with pastures and abandoned land.	14
Danube Plain	2064	Lowland, predominantly modified agricultural land.	25
Dobrudzha Plateau	301	Lowland, predominantly modified agricultural land.	4
Dragoman Marsh	220	Foothills and lowland agricultural land with marshes, wet meadows and pastures.	3
Karlukovo	141	Uplands with river gorge bordering agricultural land, open pastures and abandoned land.	2
Ludgorie Plateau	522	Lowland, predominantly agricultural land with pastures.	6
Maritime Dobrudzha	124	Lowland, predominantly modified agricultural land.	1
Ponor Mountains	377	Upland, predominantly open pastures.	5
Sakar Mountains	1233	Forested foothills and lowlands with agricultural lands, pastures and abandoned land.	15
Sliven Mountains	636	Foothills and lowlands with agriculture and pastures.	8
Sofia Plain	380	Lowland, predominantly modified agricultural land	5
Varbiska Mountains	582	Foothills with agricultural lands, forests and pastures.	7
Vetrino	130	Lowland, predominantly agricultural land with uncultivated valleys.	2
Zemen	181	Upland, predominantly open pasture and abandoned land.	2

In order to assess the relative suitability of these 15 areas for Saker Falcons, we evaluated several site characteristics. Firstly, we identified two basic requirements of Saker Falcons i.e., food supply and nest site availability. Lastly, we assessed the sites in terms of their protected status.

- Food supply

Four indicators were used to assess potential food supply for breeding Saker Falcons:

i. European Souslik availability,
ii. Common Vole *Microtus arvalis* availability,
iii. Avian prey availability,
iv. Presence of other raptor species (i.e. Long-legged Buzzard, Peregrine, Imperial Eagle).

The methods used to quantify and compare food availability across the different sites are given in Appendix II.

Table 5. Evaluation of the 15 study areas in terms of the food supply.

Study Area	Index of Availability			Raptor Index	Food Supply Index	Ranking
	Souslik	Vole	Bird			
Besapari hills	**3**	**2**	**2**	**3**	**2,50**	**1**
Maritime Dobrudzha	**2**	**3**	**2**	**3**	**2,50**	**1**
Sliven Mountains	**3**	**2**	**3**	**1**	**2,25**	**3**
Danube Plain	**2**	**3**	**2**	**1**	**2,00**	**4**
Central Balkans	**3**	**1**	**1**	**2**	**1,75**	**5**
Ponor Mountains	**2**	**1**	**1**	**3**	**1,75**	**5**
Sofia Plain	**1**	**2**	**3**	**1**	**1,75**	**5**
Vetrino	**1**	**2**	**1**	**3**	**1,75**	**5**
Dobrudzha Plateau	1	3	1	1	1,50	9
Karlukovo	1	2	1	2	1,50	9
Ludgorie Plateau	1	2	1	2	1,50	9
Sakar Mountains	1	1	1	3	1,50	9
Zemen	1	2	1	2	1,50	9
Dragoman Marsh	1	2	1	1	1,25	14
Varbiska Mountains	1	1	1	1	1,00	15

- Nest site availability

To estimate nest-site availability for Saker Falcons, we recorded the number and density (per 100 km²) of nests (active and inactive) built by nest-building species (i.e., Raven, Long-legged Buzzard, Golden Eagle *Aquila chrysaetos*, Black Stork *Ciconia nigra* and Egyptian Vulture *Neophron percopteus*) in each of the areas surveyed. The method used to rank each study area in terms of nest-site availability is given in Appendix II.

Table 6. Evaluation of the 15 study areas in terms of the nest site availability.

Study Area	Nest Site Density (nests / 100km²)	Ranking
Ponor Mountains	**11.9**	**1**
Besapari hills	**10.5**	**2**
Dobrudzha Plateau	**10.3**	**3**
Zemen	**9.4**	**4**
Varbiska Mountains	**8.1**	**5**
Central Balkans	**8.0**	**6**
Karlukovo	7.1	7
Sakar Mountains	6.3	8
Maritime Dobrudzha	5.6	9
Ludgorie Plateau	5.0	10
Vetrino	4.6	11
Sliven Mountains	4.2	12
Dragoman Marsh	2.3	13
Danube Plain	0.8	14
Sofia Plain	0.8	14

- Protected Status

The long-term security of the area was assessed by considering their:

(i) Level of legal protection,

(ii) Level of direct protection,

(iii) Level of disturbance, estimated by the human population density (number of people per km²),

(iv) Level of general conservation activities undertaken by NGOs and government structures locally.

The method we used to rank each area in terms of its protected status is given in Appendix II.

Table 7. Evaluation of the 15 study areas in terms of the protected status.

Study Area	Security Index				Protected Status Index	Ranking
	Legal Protection	Direct Protection	Disturbance	Conservation Activities		
Central Balkans	**3**	**3**	**2**	**3**	**2,75**	**1**
Dragoman Marsh	**3**	**1**	**3**	**3**	**2,50**	**2**
Ponor Mountains	**3**	**1**	**3**	**3**	**2,50**	**2**
Sakar Mountains	**3**	**1**	**3**	**3**	**2,50**	**2**
Karlukovo	**3**	**1**	**3**	**2**	**2,25**	**5**
Ludgorie Plateau	**3**	**1**	**3**	**1**	**2,00**	**6**
Varbiska Mountains	**2**	**1**	**3**	**2**	**2,00**	**6**
Besapari hills	2	1	1	3	**1,75**	**8**
Danube Plain	1	1	3	2	**1,75**	**8**
Maritime Dobrudzha	2	1	2	2	**1,75**	**8**
Zemen	2	1	3	1	**1,75**	**8**
Dobrudzha Plateau	1	1	3	1	**1,50**	**12**
Sliven Mountains	1	1	1	3	**1,50**	**12**
Vetrino	1	1	3	1	**1,50**	**12**
Sofia Plain	1	1	1	1	**1,00**	**15**

- Evaluation

1. General suitability of surveyed areas for Saker Falcons

Eight areas were ranked highly in terms of prey availability (i.e., Besapari hills, Maritime Dobrudzha, Sliven Mountains, Danube Plain, Central Balkan, Ponor Mountans, Sofia Plain and Vetrino). Those areas are dispersed in the country's territory, indicating that food supply was generally good across Bulgaria. Our opinion that Saker Falcons have the potential to establish a widespread distribution in Bulgaria is reinforced when the current distribution of Peregrine, Long-legged Buzzard and Imperial Eagle is examined (Figure 4). These species have broadly similar habitat requirements to Saker Falcons and act as indicators for the potential distribution of Saker Falcons.

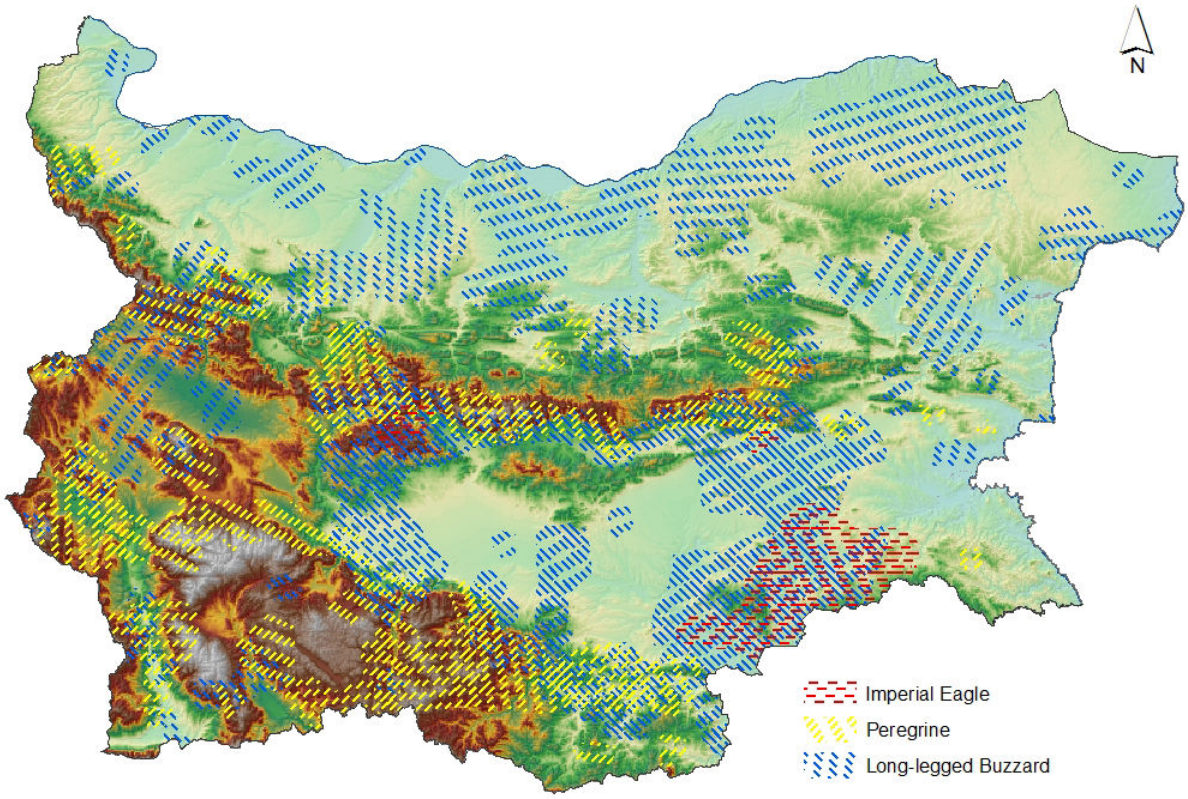

Figure 4. Breeding distribution ranges of Long-legged Buzzard, Peregrine and Imperial Eagle in Bulgaria as an indicator of the potential breeding distribution of Saker Falcons. The figure is reproduced from new edition of Bulgarian Red Data Book (in prep.) and Atlas of the Breeding Birds in Bulgaria (Iankov, 2007) by overlapping the distribution of the three species.

Three areas had a very low density of breeding raptors (< 0.3 bp/100km²) despite scoring highly in our assessment of prey availability (i.e., Danube Plain, Sofia Plain and Dobrudzha Plateau). It seems that some factor other than food supply limits the raptor breeding population in these areas, which are characterized by highly modified agricultural land.

The scarcity of breeding raptors in such modified lowland landscapes was reflected in our assessment of nest site availability for Sakers, where the Danube and Sofia Plains were ranked lowest. However, the Dobrudzha Plateau, scored much more highly because artificial nests have been installed on high-voltage power lines in the area by CLGE and BSPB. Consequently, the highest ranking areas in regard of nest site availability were the uplands of the Ponor Mountains, Central Balkans, Varbishka Mountains, Zemen and the lower-lying hills of Besapari together with the lowlands of Dobrudzha Plataeu where management has increased the availability of nesting sites.

2. Selection of Release Area

In selecting the most suitable site for reintroduction from this evaluation process we need to weigh the relative importance of the different factors we have assessed e.g., food availability is difficult to manipulate whereas nest site availability is relatively simple to modify using artificial nests. Consequently, food availability is a more important factor than nest site availability. The three sites ranked least in terms of food supply were eliminated from our selection (i.e., Varbiska Mountains, Ludogorie Plateau and Sakar Mountains). Consequently, available nest sites and protected status were important discriminating factors to evaluate the four remaining pRAs. Sofia and Danube Plains were ranked low in terms of both - nest site availability and protected status, consequently eliminated from the pRAs selection too. In this case the upland pRAs ranked highest, with the Central Balkan Mountains and Ponor Mountains scoring highly for these two characteristics.

The long-term survival of the Saker Falcon in Bulgaria is best assured if the species can be established over a wide area in both upland and lowland landscapes. The Balkan Mountain chain running across central Bulgaria contains three of our assessed areas (Ponor, Central Balkan and Sliven Mountains). It is also close to Besapari hills pRA which was highly ranked in terms of food supply and nest sites availability. Thus there is a degree of connectivity between the best sites. In conclusion, we believe that the largest, central area, the Central Balkan Mountains, is the most suitable Release Area for an initial reintroduction of Saker Falcons in Bulgaria.

- Central Balkan Mountains

The region covers *ca*. 1207 km^2 in central Bulgaria. It includes the alpine zone of the Central Balkan Mountains, its southern foothills and the plain between the Balkan Mountains and the Sredna Gora Mountains. The elevation of the area ranges from 400 to 2376 m a.s.l. Rocky ravines run down from the hills to the adjacent lowlands. The slopes of the foothills are covered by native deciduous forests and conifer plantations. The alpine meadows are used extensively as pastures in the summer. The upper limit of the tree line (beech forest) was cleared in the previous century to create open space for grazing. The lowland is occupied by pastures, abandoned pastures, recently developed areas of horticulture (e.g. rose plantations), orchards etc.

There is a good historical evidence of Sakers occupying the area, dating from 1964. The species was registered in ten different localities over the period 1964-99 (3 *possible*, 1 *probable* and 6 *confirmed* breeding locations; data from Baumgart, 1966; Donchev, 1977; Georgiev, 2004; Lamburov, 1984; Z. Spiridonov; G. Stoyanov; V. Kojchev; D. Domuschiev). The region was one of the strongholds of the species in Bulgaria after their lowland habitats had been altered. Sakers have been recorded at 10 locations during the period 2000-05 with mainly single birds records, but also 1 pair observed in 2002 and 2 adults and 1 juvenile observed in July-August 2005 (data from G. Stoyanov; D. Dobrinov & L. Krivoshieva; D. Domuschiev; D. Gradinarov; V. Kojchev; E. Stoynov; M. Kurtev; Z. Spiridonov). During the period 2006–09 three single birds were reported (V. Kojchev and Anonymous per P. Yankov). The Central Balkan Mountains have been subjected to intensive survey efforts in each season from 2006-09 but breeding was not recorded.

Trapping and shooting are believed to be the main factors lead to the extirpation of the species in the Central Balkan Mountains.

"Peeshtite skali" reserve. © D. Ragyov

Upland grasslands (former Saker site). © D. Ragyov

Mountain slope and lowland grasslands. © D. Ragyov

"Sokolna" Reserve (former Saker site). © D. Ragyov

Prey availability

During our surveys, 30 Souslik colonies were located. The total area covered by the colonies was 29.5 km² (representing 2.4% of the site area). High-mountain colonies (above 1000 m a.s.l.) had a measured density of 0.8 holes/0.1ha (Stefanov, 2005), and they extend over a large area of the mountain plateau. This relatively low density is typical for high-mountain Souslik habitats. Souslik colonies in the lowland supported higher densities than those in the uplands (Georgiev *et al.*, 2008).

According to Dekov (1997), the Central Balkan Mountains are within a zone with "no damage" from Common Voles, therefore the availability of this mammal is low (see Appendix 2 for details).

The minimum number of suitable prey-birds is 8431 bp with density of bird prey 137 bp/100km².

The area supports a large community of raptors. There were a minimum of 16 breeding pairs of Long-legged Buzzards (1.3 bp/100 km²). Analysis of the diet of Long-legged Buzzards in 2008 revealed that 68% of prey items identified from pellets were small mammals and 30% were reptiles; a good indicator that sufficient mammalian prey exists in the Central Balkan Mountains for Saker Falcons. Other raptor species included Ravens, with minimum of 19 breeding pairs (1.6 bp/100 km²); Golden Eagles, with a minimum of 17 breeding pairs (1.4 bp/100 km²); Peregrines, with an estimated 7 breeding pairs (0.6 bp/100 km²) and 1 breeding pair of Imperial Eagles (0.1 bp/100 km²). The density of indicatory raptors is 2 bp/100km².

Nest sites

Surveys recorded a minimum of 96 stick nests (i.e., 8.0 nests/100 km²) that were built by Long-legged Buzzards, Ravens, Golden Eagles, Black Storks and Imperial Eagle. Average nest height from the ground was 14 m and the nests were situated on cliffs with one exeption (the Imperial Eagle nest in a tree). Most nests were located in secure sites in steep valleys, with dense young forest or bushes which overgrow the foothills of the mountain additionally protecting the nesting sites.

Security

The site includes a large area that falls within the NATURA 2000 network i.e., 762 km² or 63.1% of the site. The territory is protected by 12 Nature Reserves and one National Park; the total size of these is 508 km² or 42.1% of the site. There is well coordinated team of rangers and policemen to protect the wildlife in the Park. It is considered to be the best working Directorate of National Parks in Bulgaria. Human population density is 136,391 people. General conservation efforts are represented by several projects: *Conservation, management and restoration of natural habitats and species habitats in the Central Balkan National Park* (CBNP); *Conservation of Imperial Eagle and Saker Falcon in key NATURA 2000 sites in Bulgaria* (BSPB, CBNP and FWFF); *Restoration of Griffon Vulture as a nesting species in Central Balkan* (BPPS) and *Compensation sheep herding as a tool for conservation of biodiversity and habitats in the Central Balkan National Park* (*BPPS*).

Survey work. © Veselina Shishkova

REINTRODUCTION STRATEGY

Various different strategies have been used for reintroduction of birds of prey. These strategies differ in (i) the source of birds used for release (i.e. wild or captive bred) and (ii) the method used for release into the wild.

The success of various bird of prey reintroduction projects implemented across the world have varied, reflecting the diversity of reintroduction strategies, the species and locations of these conservation programs. In general, juvenile birds that are released into the wild by the method of "hacking" tend to be the preferred method for the reintroduction of raptor species. A general description of the "hacking" is published by Sherrod *et al.* (1982). This method has been used for re-establishment of Peregrine Falcons in North America and Europe (well documented by Cade *et al*., 1988), Bald Eagle *Haliaeetus leucocephalus* in New York and California, White-tailed Eagle *Haliaeetus albicilla* in Europe (Cade, 1986), Aplomado Falcon *Falco femoralis* in North America (Brown *et al*., 2006), Mauritius Kestrels *Falco punctatus* (Nicoll *et al*., 2004), White-tailed Eagles, Ospreys and Red Kites *Milvus milvus* in the United Kingdom (Carter *et al*., 2008), White-tailed Eagles, Golden Eagles and Red Kites in Ireland (Mee, 2008; Carter *et al.*, 2008; Clarke, 2008), Griffon Vulture *Gyps fulvus* in Europe (Sarrazin *et al.,* 1995; Terrasse *et al.,* 2004) and Lammergeier *Gypaetus barbatus* in Europe (Zink & Frey, 2008).

- Captive-bred releases

The captive breeding of raptors has a long history. Fifteen species of raptors are recorded as having produced and rised young in captivity before 1950, and the total number had increased to 23 species by 1965 (Cade, 1988). Captive rearing of species for release to the wild is an important management technique used in attempts to save species from extinction (Martin, 1975; Temple, 1978; Carpenter & Derrickson, 1981; Scott & Carpenter, 1987). However, the technique has some limitations. There are high costs associated with establishing and maintaining a captive-breeding population, and it is very labour intensive and time consuming to produce sufficient stock for release. In order to maximise the genetic diversity of released stock it is necessary to carefully manage the captive-population and to maintain a sufficiently large unrelated founder stock. Potential problems associated with domestication and habituation to humans can be carefully managed in a well-run breeding programme but restricting production to parent-reared birds limits the number of young falcons that can be raised for release each year. The method has played an important role in reintroduction of Peregrines, especially in the USA but also in Europe (Sielicki & Sielicki, 2009; Lindberg & Sjoberg, 2009).

An additional advantage of captive breeding is that the technique could involve a variety of interest groups, for example zoos, falconers, aviculturalists and veterinarians. By increasing the range of stakeholders who have an interest in the success of a reintroduction project it may be possible to generate wider support, which could contribute to its ultimate success.

- International translocation of wild taken chicks

"*It is desirable that source animals come from wild populations*" (IUCN, 1998), but the use of wild birds is not always possible for logistic reasons (Carter *et al.*, 2008). Harvesting individuals of an endangered species could potentially have a deleterious impact on the population, thus they should only be removed from a wild population after the effects of translocation on the donor population have been assessed. Cade *et al.* (1996) described an approach used for Peregrines in the USA chicks were removed from eyries that consistently failed during fledging. In the case of Saker Falcons in Bulgaria a viable wild population is not available within the country and international translocation would be necessary. This requires coordination and cooperation between countries. Despite this, the translocation technique is still much cheaper and less time consuming than captive breeding.

- Release strategy

The method of release is an important component of a reintroduction strategy. The "hacking" method works well with other falcon species and birds of prey. The method has been used for many years in raptor conservation and it has been refined to ensure maximum success of reintroductions. Based on our review we conclude that "hacking" of young birds is the most suitable method for Saker Falcon releases in Bulgaria.

ASSESSMENT OF DONOR STOCK

Taxonomic history of the Saker Falcon

The Saker Falcon was first described by the British zoologist John Edward Gray in Hardwicke's *Illustrations of Indian Zoology* published in 1833-34. The description was based on an overwintering young falcon found in India and was given the name *Falco cherrug*.

The early 20th century was a period when the describing and naming of subspecies of birds proliferated, sometimes to an excessive degree based on a small sample of specimens and little knowledge of their geographical range; the Saker Falcon was no exception. There was an urgent need to collate and appraise this confused position and in the Palearctic region Ernst Hartert undertook a major review which was published as *Die Vögel der Paläarktishen Fauna* (1903-22). Hartert took the view that the Saker Falcon should be divided into two subspecies *cherrug* (synonym *cyanopus*) and *milvipes* (synonyms *hendersoni*, *saceroides* and *coatsi*). Nevertheless, new subspecies were subsequently described and other taxonomists further revised the systematics, such as Kleinschmidt (who coined the term *Hierofalcon* and lumped Saker Falcon, Altai Falcon and Gyrfalcon together as a single super-species) and Stegmann (who treated them as separate species).

The Russian revolution of 1917 and the subsequent division between 'eastern' and 'western' ornithologists has had a long lasting impact on the taxonomy and nomenclature of the Saker Falcon. In Russia Georgiy P. Dementiev reviewed the taxonomic position of the Saker Falcon and in the major work *Birds of the Soviet Union* (1951), six subspecies were recognised, whilst *altaicus* was considered to be a subspecies of the Gyrfalcon:

- European Saker Falcon *Falco cherrug danubialis*
- Common Saker Falcon *Falco cherrug cherrug*
- Siberian Saker Falcon *Falco cherrug saceroides*
- Turkestan Saker Facon *Falco cherrug coatsi*
- Mongolian Saker Falcon *Falco cherrug milvipes*

- Tibet Saker Falcon *Falco cherrug hendersoni*

- Altai Gyrfalcon *Falco gyrfalcon altaicus*

In the west, the American taxonomist Charles Vaurie undertook the mammoth task of reviewing the taxonomy of Palearctic birds, subsequently published in two volumes *The Birds of the Palearctic Fauna: a Systematic Reference* (1959). In his review of the Falconidae he felt that Dementiev's subdivision of the Saker falcon into six subspecies was unnecessary because the geographical variation previously described was clearly clinal in nature. However, despite having considered Dementiev's position regarding *altaicus*, Vaurie nonetheless retained it as a separate species:

- Saker Falcon *Falco cherrug cherrug*
- Saker Falcon *Falco cherrug milvipes*

- Altai Falcon *Falco altaicus*

By the latter half of the 20th century taxonomy and nomenclature had fallen out of vogue in ornithology and little detailed taxonomic work was undertaken for decades. The prevailing taxonomy of Vaurie became widely adopted by western ornithologists (though Altai Falcon was often subsumed within the Saker Falcon or Gyrfalcon either as a morph or subspecies by subsequent authors). The taxonomy of Dementiev was adopted by eastern ornithologists though Dementiev, working with the Mongolian Prof. Shagdasuren, later reappraised his assessment of the Atai Gyrfalcon and reassigned this taxon as a subspecies of the Saker Falcon *Falco cherrug altaicus* (Dementiev & Shagdasuren, 1964).

The late 20th century witnessed the collapse of the Soviet Union and the development of molecular techniques that have breathed new life into taxonomic studies. However, there is still no consensus on the systematics and taxonomy of the large falcons. Stepanyan (2003), in his summary of the ornithological fauna of the former USSR, recognised four subspecies of the Saker Falcon (*cherrug*, *milvipes*, *coatsi* and *hendersoni*) but made no mention of *altaicus*, whilst Koblik *et al*. (2006), in their checklist of Russian birds, only recognised two subspecies (*cherrug* and *milvipes*) and regarded *altaicus* as being either a full species or a subspecies of Gyrfalcon.

In the *Handbook of the Birds of the World* (1999) two subspecies of Saker Falcon (*cherrug* and *milvipes*) are recognised, as they are in Fergusson-Lees and Christie (2001), *Raptors of the World*, though the latter treat *altaicus* as a separate species, albeit cautiously.

A wide-ranging morphological review of the Saker Falcon and allied species was undertaken by Christopher Eastham (Eastham & Nicholls, 1999; Eastham, 2001; Eastham and Nicholls, 2002; Eastham *et al.*, 2002; Eastham & Nicholls, 2005). The conclusion of this review was that there was a significant degree of individual variation throughout the global breeding range of the Saker Falcon and that the species showed some clinal variation from the larger, dorsally barred *milvipes* form in the east to the smaller, dorsally plain brown *cherrug* form in the west.

Recently, molecular techniques have been applied to elucidate the phylogeny of the Hierofalcons by Franziska Nittinger and colleagues working at the Museum of Natural History in Vienna and the University of Heidelberg (Nittinger *et al.,* 2007; Nittinger *et al.,* 2005). However, the mitochondrial and nuclear DNA markers used in this study did not reveal any clear differentiation between the established species of Saker Falcon *F. cherrug*, Gyrfalcon *F. rusticolus*, Lagger Falcon *F. juggar* and Lanner Falcon *F. biarmicus*. Clearly, these taxa are closely related and it was concluded that the observed genetic similarities among these taxa was the result of incomplete lineage sorting from a common ancestor and/or hybridisation events (either historical or current). Further genetic analysis is required to differentiate these recognised species, such as that described by Dawnay *et al*. (2008) to distinguish Gyrfalcons and Saker Falcons. To date, no genetic sub-structuring has been identified across the global breeding population of the Saker Falcon.

Conclusions

Molecular evidence indicates that the Saker Falcon is very closely related to the Gyrfalcon, Lanner Falcon and Lagger Falcon and that these species probably diverged from a common ancestor 130 to 200 thousand years ago. Current morphological and genetic data shows that the Saker Falcon is polymorphic but that the species is essentially monotypic with clinal variation exhibited from west to east; these forms can be conveniently termed *cherrug* and *milvipes*. There is no evidence of any sub-species or regional differentiation between populations of Saker Falcons in the Western Palearctic.

Captive-bred birds

Raptors for captive breeding can be acquired from several sources. They can be taken from the wild or they can be acquired from existing captive stock.

Saker Falcons of European origin are not commonly held by falconers and breeders. Small numbers can be found scattered across a range of small-scale falcon breeding projects, animal rescue centers and zoos in Europe (for example Czech Republic, Croatia, Slovenia, Germany, Hungary, Russia, Serbia and Slovakia). If captive stock is to be used, it must be from a population which has been soundly managed both demographically and genetically (IUCN, 1998).

Wild birds

It is desirable that source animals come from wild populations. If there is a choice of wild populations to supply founder stock for translocation, the source population should ideally be closely related genetically to the original native stock and show similar ecological characteristics to the original sub-population. Removal of individuals for reintroduction must not endanger the wild source population. Individuals should only be removed from a wild population after the effects of translocation on the donor population have been assessed and after it is guaranteed that these effects will not be negative (IUCN, 1987; 1998).

POPULATION MODELS

- ## Model description

The model was developed using RAMAS GIS 4.0, RAMAS Metapop 4.0 program (Akçakaya *et al.*, 2002), which is a tool for constructing population viability analysis (PVA) models of different complexity levels, using build-in submodels. The purpose of the model was to:

1) Assess impact of harvesting juvenile individuals on potential donor populations by simulating expected changes in abundance and extinction risk.
2) Estimate the chances of establishing a new viable population.

To address these questions, we used models that described a single population that consists of individuals in different age and sex classes. The dynamics of this population were determined by age and sex class specific survival and fecundity rates and the initial number of individuals in each sex and age class. The simulations were conducted in yearly time steps for the time of 20 years.

- ## Model of the effects of harvesting potential donor populations

Population structure and dynamics

The models contained three age classes for both, males and females. We considered four different scenarios that were based on available information about populations breeding in Europe to determine the number of offspring, breeding success and survival rate of each stage (Table 8). These scenarios differed in juvenile survival rates and number of offspring per breeding pair. In all scenarios, we assumed a conservative value of breeding success (75%). Furthermore, we investigated the effect of different initial population sizes. For each scenario and each initial population size, we performed 1000 simulations to estimate the impact of harvesting on population sizes and extinction risks. In all simulations (Table 8) six juveniles (3 males and 3 females) were removed each year in the period of the first five years of the simulations.

Results

Our analysis showed that harvesting juveniles from increasing donor populations does not have a strong impact on population size and dynamics (Figures 5, 6 and 7). The only exceptions included populations with a growth rate below zero (scenario 1 in Table 8 in which we assumed a low juvenile survival rate and a small number of offspring per breeding pair). In these cases, harvesting could cause further decrease in population size. However we assume such populations would not be selected as suitable donor populations.

Taken together, these results show that even with conservative parameters values (e.g. scenario 2), chosen amount individuals and length of harvest does not affect the viability of population if the donor population growth rate is greater than 1.

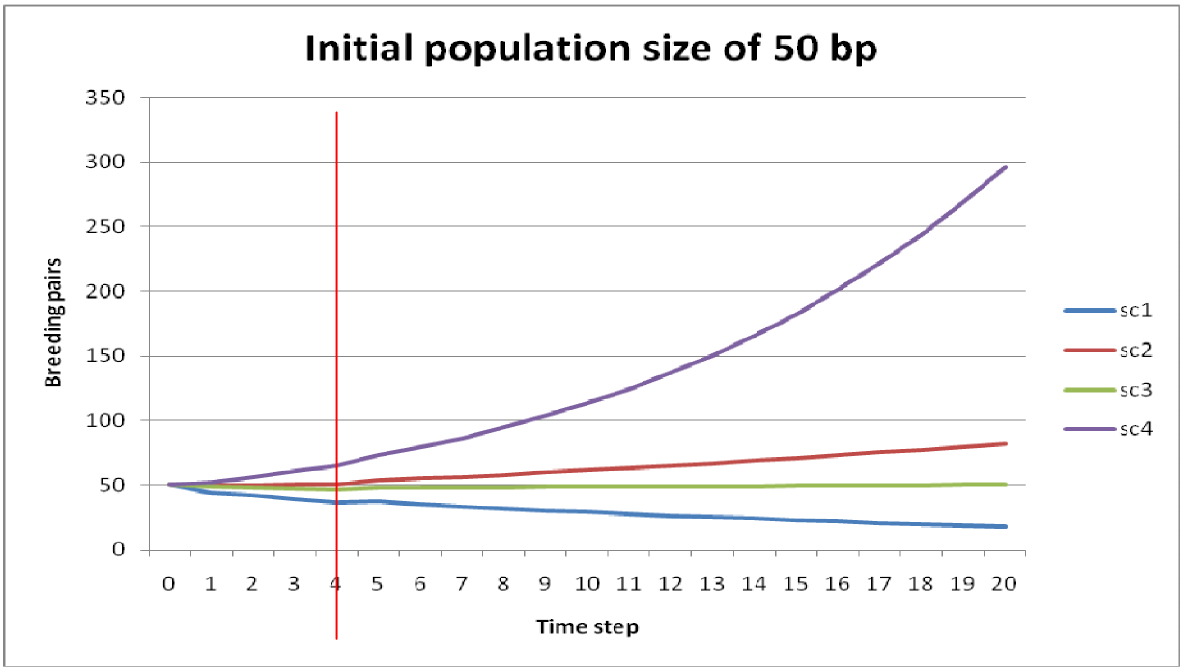

Figure 5. Mean population dynamics of four simulated scenarios (Table 8) that explore the effects of harvesting six juveniles each year on populations with an initial size of 50 breeding pairs. The red line indicates the end of the period in which juveniles are harvested.

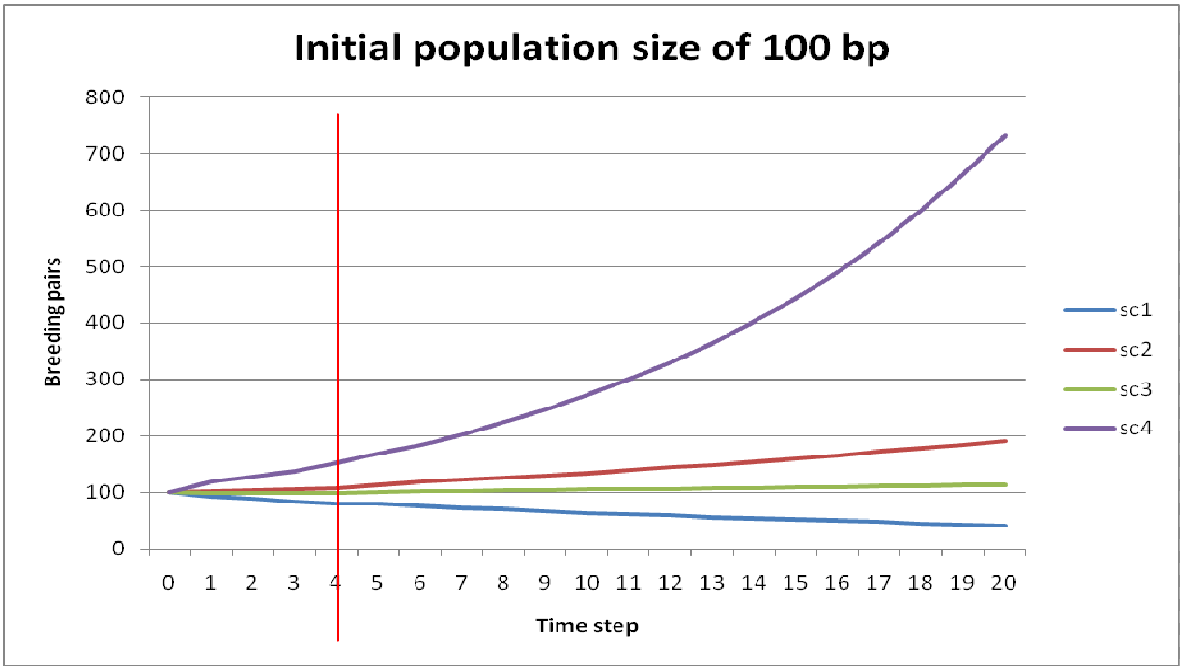

Figure 6. Mean population dynamics of four simulated scenarios (Table 8) that explore the effects of harvesting six juveniles each year on populations with an initial size of 100 breeding pairs. The red line indicates the end of the period in which juveniles are harvested.

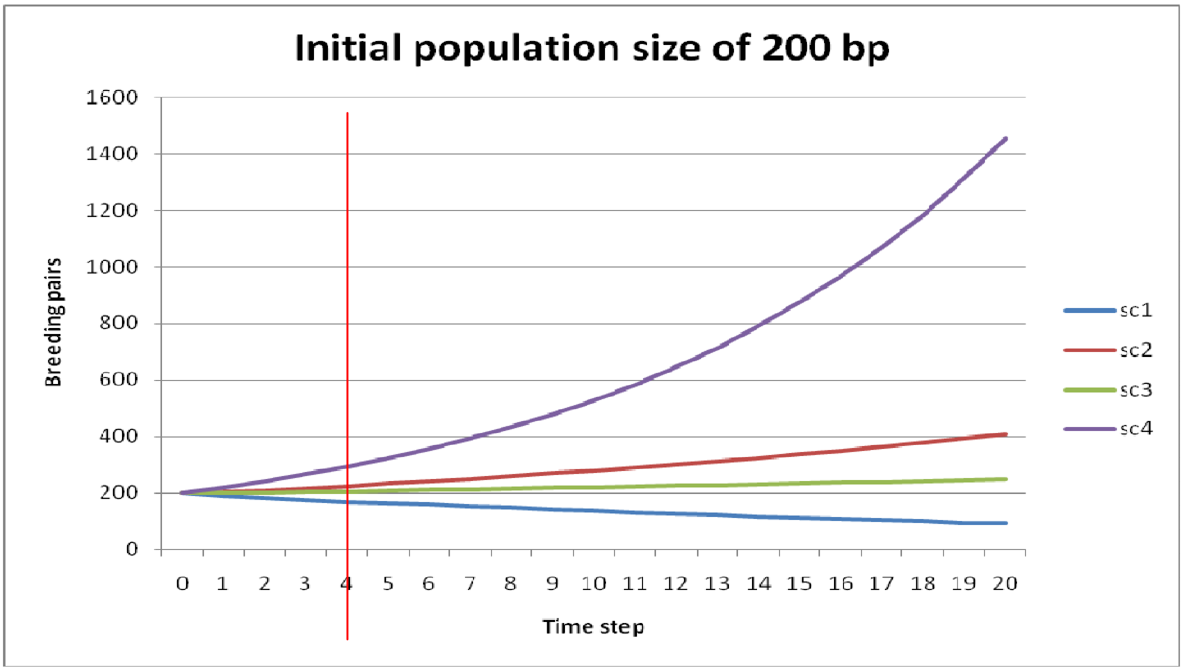

Figure 7. Mean population dynamics of four simulated scenarios (Table 8) that explore the effects of harvesting six juveniles each year on populations with an initial size of 200 breeding pairs. The red line indicates the end of the period in which juveniles are harvested.

Table 8. Parameters used to assess impact of harvesting on potential donor populations. Data was taken from Bagyura *et al*., 2006; Kenward *et al.*, 2007; Wink *et al*., 1999. Additional unpublished data was provided by V. Vetrov, S. Pusovic and D. Ragyov.

Scenarios	Number of offspring	Juvenile survival	Subadult survival	Adult survival	Growth rate
sc 1	2	0.23	0.82	0.82	0.970
sc 2	2	0.4	0.82	0.82	1.045
sc 3	2.9	0.23	0.82	0.82	1.020
sc 4	2.9	0.4	0.82	0.82	1.112

- Preliminary model of hypothetical new established population

We used the same age and sex-structured stochastic model as described above. However, we increased the number of life-stages to five to conservatively estimate the rate of recruitment of adult birds into the breeding population. The five life-stages are: juvenile non-breeding (< 1 year old), sub-adult non-breeding (1 year old), adult (2 years old), adult (3 years old) and adult (> 4 years old). For the model we have arbitrarily assumed that 50% of adults breed at 2 years old, 75% at three years old and 100% at 5 years old (we have not attempted to build-in any sex differences in breeding age for these preliminary models).

We estimated the number of offspring, breeding success and survival rate of each stage based on data from Table 9. Juvenile survival of 40% was provisionally taken from 10 Hungarian juveniles that were fitted with satellite transmitters in 2007 (M. Prommer) and sub-adult/adult survival of 82% from radio-tracking and DNA studies in Kazakhstan (Wink *et al*., 1999; Kenward *et al*., 2007). We initialized the simulations with no adult individuals and introduced only juveniles at a rate of 10 males and 10 females per annum.

Results

We tested several scenarios with different estimations of survival and breeding success parameters (given in Table 9). In all cases we observed positive population growth, which indicates the establishment of a viable population and, therefore, a successful reintroduction.

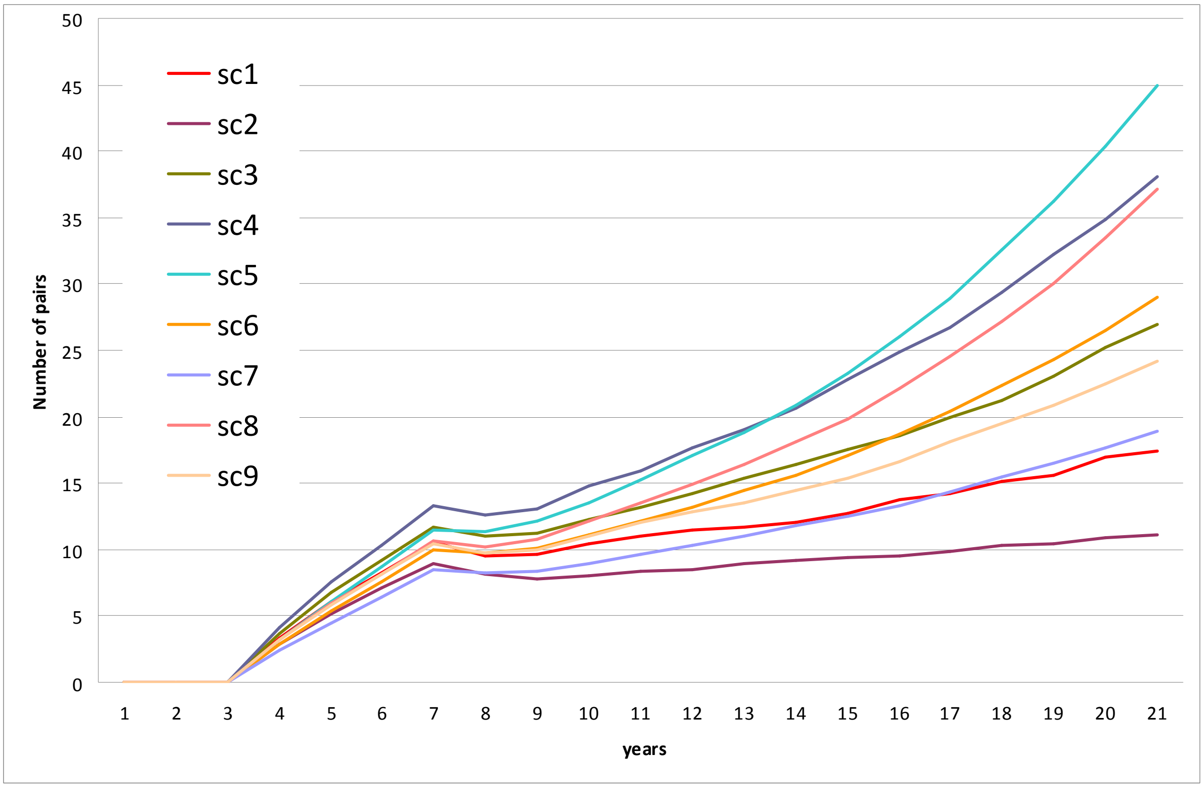

Figure 9. Possible scenarios of new population establishment (values of juvenile survival, subadult survival, adult survival and number of offspring respectively are presented in Table 9) .

Table 9. Parameters used to create a model of new established population. Data was taken from Bagyura *et al*., 2006; Kenward *et al*., 2007; Wink *et al*., 1999. Additional unpublished data was provided by V. Vetrov, S. Pusovic and D. Ragyov.

Scenarios	Number of offspring	Juvenile survival	Subadult survival	Adult survival
sc 1	2.16	0.4	0.82	0.82
sc 2	2.16	0.35	0.82	0.82
sc 3	2.16	0.45	0.82	0.82
sc 4	2.16	0.5	0.82	0.82
sc 5	2.16	0.4	0.8	0.9
sc 6	2.16	0.35	0.8	0.9
sc 7	2.16	0.3	0.8	0.9
sc 8	3	0.4	0.82	0.82
sc 9	2.5	0.4	0.82	0.82

CRITERIA TO JUDGE SUCCESS

The criteria to judge success are based on our population models. This model predicts that 10 years after initiating a reintroduction project (involving the release of 10 male and 10 female juveniles each year for five years) we would establish an increasing breeding population of between 8 to 15 breeding pairs in our selected release area.

During the reintroduction success criteria will be measured each year. In the first year success will be measured in terms of one-year survival of our released birds, which should be at least 30%. Individual survival rates will be measured by satellite tracking a sample of released birds and individually marking all released birds with patagial tags. In subsequent years, success will be measured in terms of annual survival of juveniles and older birds, which should be at least 30% and 80% respectively.

In the third, fourth and fifth years of release we will expect some pairs to settle and breed, such that by the end of the five-year release program 5-8 breeding pairs will have become established. Each of these milestones will need to be met and our release program can be adapted to take into account variations in survival (e.g., by increasing the number of birds released, changing the sex ratio of releases etc).

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Artificial nests are used where nest sites are limiting factor in order to improve the conditions for recolonisation of Bulgarian territory by Saker Falcons. © D. Ragyov

Appendix 1

CRITERIA USED TO CLASSIFY SAKER FALCON REPORTS AS "POSSIBLE", "PROBABLE" OR "CONFIRMED" BREEDING RECORDS.

All Saker Falcon records were classified according to breeding evidence scale widely used in breeding bird atlases e.g. The EBCC Atlas of European Breeding Birds (Hagemeuer & Blair, 1997) as follows:

Possible breeding:

1. Species observed in breeding season in suitable nesting habitat
2. Singing male present (or breeding calls heard) in breeding season in suitable breeding habitat

Probable breeding:

3. Pair observed in suitable nesting habitat in breeding season
4. Permanent territory presumed through registration of territorial behaviour (song etc) on at least two different days a week or more at the same place or many individuals on one day
5. Courtship and display
6. Visiting probable nest site
7. Agitated behaviour or anxiety calls from adults, suggesting probable presence of nest or young nearby
8. Brood patch on adult examined in the hand, suggesting incubation
9. Nest building or excavating nest-hole

Confirmed breeding:

10. Distraction-display or injury feigning
11. Used nest or eggshells found (occupied or laid within period of survey)
12. Recently fledged young (nidicolous species) or downy young (nidifugous species) *
13. Adults entering or leaving nest-site in circumstances indicating occupied nest (including high nests or nest holes, the contents of which can not be seen) or adults seen incubating
14. Adult carrying faecal sac or food for young
15. Nest containing eggs
16. Nest with young seen or heard

* Sightings of adult/s and juvenile/s in July–August inclusive were considered as confirmed breeding records in this study.

Appendix 2

METHODS AND RESULTS

This appendix describes the methods used to quantify and compare food availability, nest site availability and protected status across 15 study areas; and the results from the survey of specific site characteristics used to calculate values of the indicators for suitability.

1. Methods

1.1. Food supply

Four indicators were used for assessing the food supply:

i. European Souslik Availability

Population density of European Souslik populations largely varies within short period of time and therefore long term studies are needed to properly reveal it. At present, there are no uniform methods for estimation of European souslik density available in monitoring studies (Cepáková & Hulová, 2002; Katona *et al.*, 2002). We investigated the European Souslik Availability through the size of the colonies. It was measured on the field by GPS device, or by detailed map using ArcMap 9.3 (ESRI, 2008), in square kilometers. Sizes of all colonies in each site were summarized in order to obtain the total size of the area covered by colonies. The percentage of the area covered by souslik colonies was used for comparison between the sites.

ii. Common Vole Availability

Common Vole Availability was estimated using a study of Dekov (1997). In his work he divided Bulgaria into several zones describing the damage in agriculture caused by the Vole. The study covers 43-year period. These zones were established on the base of population density, size of colonized areas and frequency of calamites. There are four types of zones in Bulgaria: (a) zone with high damage; (b) zone with potential damage; (c) zone with limited damage; (d) zone with no damage. Each of our survey areas is part of one of those zones, representing the general characteristics of vole's population in Bulgaria (Table 10).

iii. Avian Prey Availability

Published sources were used for assessing the Avian Prey Availability. Horak (1998) summarized 3 dietary studies in Czech Republic, Hungary (Bagyura *et al*., 1994) and Slovakia (Obuch & Chavko, 1997). According to them the bulk of the birds consumed by Sakers are the following taxa: *Columba sp., Corvus corone, Larus ridibundus, Perdix perdix, Phasianus colchicus, Streptopelia sp., Sturnus vulgaris, Vanelus vanelus*. These species were used as indicator species for determining the relative avian prey abundance. Bird numbers in each study area were extracted from the recently published Atlas of the Breeding Birds in Bulgaria (Iankov, 2007). The density patterns of the species were presented by minimum and maximum number of breeding pairs in every UTM grid (10x10 km). The minimum number of birds was used for between-sites comparison. We overlapped our study areas with the Atlas maps showing the species numbers using ARC MAP 9.3 (ESRI, 2008). Every grid which fell into a study area (entirely or partially) was taken into consideration. When the grid was entirely included in a study area the minimum number was used. In case the grid was only partially included in the study area we took a minimum number of birds corresponding to the proportion of intersected area to the total size of the UTM. After summarizing the numbers of all indicator species in each partial or entire grid we obtained the minimum number of birds into the study areas. This number was used for calculation of bird-prey densities (bp/100 km^2). The densities were used for calculation of the index of Avian Prey Availability.

iv. Presence of other raptor species

Raptors presence (i.e. Long-legged Buzzard, Peregrine and Imperial Eagle) was used as an additional site characteristic because they share some of the basic habitat requirements with Sakers and can be found coexisting in various habitats elsewhere in Europe. Therefore the raptor density (bp/100 km^2) was used as an indicator for the suitability of the sites (Raptor Index). Raptor densities by species are presented in Table 10 and total raptor density is presented in Table 11.

1.2. Nest sites

Nest site availability was evaluated using the nest site density, representing number of nests per 100 km^2. The following host species were considered: Raven, Long-legged Buzzard, Golden Eagle, Black Stork and Egyptian Vulture. These are species whose nests Sakers often occupy in its current Global breeding range and occupied in Bulgaria in the past. Both active nests and not active nests were included in the analysis. Each study area was ranked as it is Table 6 according to the value of the nest site density presented in Table 11.

1.3. Protected status

Protected status of the sites was assessed considering four parameters (Security Indeces):

i. Level of Legal Protection, in terms of the proportion of the area covered by NATURA 2000 sites (Special Protected Areas and potential Sites of Community Interest) in percents;
ii. Level of Direct Protection (wardenning), estimated by the proportion of the area covered by National and/or Nature Parks in percents;
iii. Level of Disturbance, estimated by the human population density (number of people per km²), based on human population data in 2007 from the National Statistical Institute,
iv. Level of General Conservation Activities undertaken by NGOs and government structures locally. Three types of activities were considered: (a) no monitoring and no management activities; (b) regular monitoring is implemented but no direct conservation/management measures undertaken; (c) monitoring and wildlife conservation/management measures implemented.

1.4. Indexing and ranking

Three-index system was used to assess the indicators for suitability.

Common Vole Availability in each study area was indexed as follows: Index 1 = zone with limited damage *or* zone with no damage (*c or d*); Index 2 = zone with potential damage (*b*); 3 = zone with high damage (a).

General Conservation Activities were indexed as follows: Index 1 = no monitoring and no conservation or wildlife management activities (a); Index 2 = regular monitoring is implemented but no direct conservation measures undertaken (b); Index 3 = monitoring and conservation or wildlife management measures implemented (c).

The rest indicators i.e., Souslik Availability, Avian prey Availability, Raptors Presence, Legal Protection, Direct Protection and Disturbance were assessed using "between-site" comparison methodology. Every site has an exact value for each indicator (Table 11), and we transformed these values in percentage scale from 0 to 100 to compare the parameters. The site with lowest values received

0% while the site with the highest value received 100%. The rest of the sites received percents according to the place which their value take on the scale equal to the difference between the minimum (0%) and maximum (100%) value. Then each indicator received an index corresponding with its place on the percentage scale as follows: from 0% to 33.2% - Index 1; from 33.3% to 66.5% - Index 2; from 66.6% to 100% - Index 3. For clearance we present an example with one of the parameters – *Avian prey Availability*:

Example for calculation of indices:

Lowest Avian prey density exists in Ponor Mts. (X = 111 bp/100km²), and highest Avian prey density exists in Sofia Plain (Y = 738 bp/100km²) - see Table 11. The difference between them is Z = Y – X = 627. Therefore the scale for calculating the coefficient of this parameter in the rest of the sites is 0-627. Ponor Mts. as minimum density received 0% of this scale; Sofia Plain as maximum density received 100% of the scale. The percentage of every other site is:

$W_{1-15} = (V_{1-15} - X) / Z * 100$ (%), *where* V_{1-15} *is the Avian prey density in each site.*

Ones the percentage (W) is calculated every site received an index as follows: ***Index 1 – from 0% to 33.2%; Index 2 – from 33.3% to 66.5%; Index 3 – from 66.6% to 100%.***

The Food Supply Index (Column 6; Table 5) was calculated as an average value of the indices of each characteristic i.e., Souslik, Vole, Avian prey and Raptor Presence (Columns 2, 3, 4, 5; Table 5).

The Protected Status Index (Column 6; Table 7) was calculated as an average value of the indices of each characteristic i.e., Legal Protection, Direct Protection, Disturbance, Conservation Activities (Columns 2, 3, 4, 5; Table 7).

The study areas were finally ranked from 1st to 15th according to the values of Food Supply Index, Nest Site Density and Protected Status Index put in descending order (last columns of Table 5, 6 and 7).

2. Results

Results from studying of specific site characteristics (i.e. number and total size of souslik colonies; damage on agriculture caused by Common Vole; number of bird-prey; numbers and density of Long-legged Buzzard, Peregrine and Imperial Eagle; number of nest sites; size of NATURA 2000 areas; size of areas protected by parks and reserves; number of human population; type of general conservation efforts are presented in Table 10. This is the base for calculating of values of the indicators of the suitability of the potential release areas (Table 11).

Table 10. Characteristics of 15 study areas measured during the survey.

SITE CHARACTERISTIC	Besapari Hills	Central Balkan Mts.	Danube River Plain	Dobrudzha Plateau	Dragoman Marsh	Karlukovo	Ludogorie Plateau	Maritime Dobrudzha	Ponor Mts.	Sakar Mts.	Sliven Mts.	Sofia Plain	Varbishka Mts.	Vetrino	Zemen Gorge
Study areas size (km²)	391	1207	2064	301	220	141	522	124	377	1233	636	380	582	130	181
Size of Souslik colonies (km²)	7,4	29,5	18,6	1,4	1,2	0,4	3,7	1,3	5,1	1,5	11,9	0,1	1,1	0,7	0,8
N of colonies	14	30	15	3	6	1	8	8	12	15	11	1	4	2	2
Damage on agriculture caused by Common Vole (Dekov, 1997)	Potential	No	High	High	Potential	Potential	High	High	No	Limited	Potential	Potential	No	Potential	Potential
Min. number of avian bird-prey (bp)	1927	8431	4889	1759	277	1524	2969	772	852	594	1190	380	403	272	3850
LLB density (bp/100 km²)	4,1	1,3	0,1	0,0	0,9	2,1	3,6	5,6	3,4	3,7	1,3	0,0	0,2	3,8	1,1
LLB min. number (bp)	16	16	3	0	2	3	19	7	13	46	8	0	1	5	2
Peregrine density (bp/100 km²)	0,5	0,6	0,0	0,0	0,0	0,7	0,0	0,0	1,3	0,0	0,3	0,0	0,0	0,0	1,1
Peregine min. number (bp)	2	7	0	0	0	1	0	0	5	0	2	0	0	0	2
IE density (bp/100 km²)	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,2	0,0	0,0	0,0	0,0
IE min. number (bp)	0	1	0	0	0	0	0	0	0	8	1	0	0	0	0
Total raptor density (bp/100 km²)	4,6	2,0	0,3	0,0	0,9	2,8	3,6	5,6	4,8	4,4	1,7	0,0	0,2	3,8	2,2
Raptor min. number (bp)	18	24	7	0	2	4	19	7	18	54	11	0	1	5	4
Min. number nest site	41	96	17	31	5	10	26	7	45	78	27	3	47	6	17
NATURA 2000 size (km²)	167	762	338	17	170	118	334	73	356	1129	143	23	291	0	96
Parks & reserves size (km²)	1,7	508,3	0,0	0,0	0,0	0,0	0,0	5,3	44,9	0,0	71,9	0,0	0,0	0,0	0,0
Human population (N)	54740	136391	109392	3612	12320	2397	9396	13640	7163	17262	125292	66880	17460	1430	4706
Type of activities	Monit. and cons.	Monit. and cons.	Monitoring	No	Monit. and cons.	Monitoring	No	Monitoring	Monit. and cons.	Monit. and cons.	Monit. and cons.	No	Monitoring	No	No

Table 11. Indicators for suitability in 15 survey areas.

FACTOR	SITE INDICATOR	DIMENSION	Besapari Hills	Central Balkan Mts.	Danube River Plain	Dobrudzha Plateau	Dragoman Marsh	Karlukovo	Ludogorie Plateau	Maritime Dobrudzha	Ponor Mts.	Sakar Mts.	Sliven Mts.	Sofia Plain	Varbishka Mts.	Vetrino	Zemen Gorge
PREY AVAILABILITY	Souslik availability	colony size / site size (%)	1,89	2,44	0,90	0,47	0,55	0,28	0,71	1,05	1,35	0,12	1,87	0,03	0,19	0,54	0,44
	Common Vole availability	3 rank scale	Medium	Low	High	High	Medium	Medium	High	High	Low	Low	Medium	Medium	Low	Medium	Medium
	Avian prey availability	density (birds / 100 km²)	318	137	295	214	220	227	242	552	111	210	607	738	174	178	176
	Raptors presence	bp/100 km²	4,6	2,0	0,3	0,0	0,9	2,8	3,6	5,6	4,8	4,4	1,7	0,0	0,2	3,8	2,2
NEST SITES		nest site density (nests/100 km²)	10,5	8,0	0,8	10,3	2,3	7,1	5,0	5,6	11,9	6,3	4,2	0,8	8,1	4,6	9,4
PROTECTED STATUS	Legal protection	NATURA 2000 / total territory (%)	42,8	63,1	16,4	5,6	77,2	83,6	63,9	58,6	94,3	91,6	22,5	6,1	50,0	0,0	53,2
	Direct protection / wardening	parks and reserves / total territory (%)	0,4	42,1	0,0	0,0	0,0	0,0	0,0	4,3	11,9	0,0	11,3	0,0	0,0	0,0	0,0
	Disturbance	human population (N / km²)	140	113	53	12	56	17	18	110	19	14	197	176	30	11	26
	General cons. efforts	3 rank scale	High	High	Medium	Low	High	Medium	Low	Medium	High	High	High	Low	Medium	Low	Low