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Reintroductions of the European Ground Squirrel (*Spermophilus citellus*) in Central Europe (Rodentia: Sciuridae)

Reintrodukce sysla obecného (*Spermophilus citellus*) ve střední Evropě (Rodentia: Sciuridae)

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Abstract. We collected primary data on 13 European ground squirrel reintroduction projects carried out in the Czech Republic, Slovakia and Poland since 1989. During these projects more than 3,200 ground squirrels were reintroduced at 15 sites or used for reinforcement of 5 populations. Reintroductions can be considered successful at 7 sites where settlement and reproduction of the released individuals were observed. At other 7 sites reintroductions failed and the result of reintroduction is still unknown at one site. Proportion of long existing reintroduced colonies is even much lower. Results of reinforcements are unclear at all 5 sites. The main problems of reintroductions were the low number of released individuals, unsuitable methodology of releasing and inappropriate site management. For future reintroduction attempts we recommend to release a sufficient number of individuals and to use artificial burrows as well as temporary fencing of the site of release. Long-term management of the site and regular monitoring of the newly established population are also necessary.

Key words. Reintroduction, endangered species, European ground squirrel, *Spermophilus citellus*.

INTRODUCTION

The European ground squirrel, *Spermophilus citellus*, (Linnaeus, 1766) used to be a common species of the Central European agricultural landscape (e.g. Jacobi 1902, Werth 1932, Grulich 1960, Spitzenberger 2001). Population decline of the species started in the 1960s, probably due the changes of landscape and agricultural methods. The population of the European ground

squirrel (hereinafter EGS) covering the territory of the former Czechoslovakia gradually became fragmented into isolated islands. The last population of the EGS in Germany became extinct in 1968 (Feiler 1988) and in Poland in 1983 (Męczyński 1985). Since the late 1980s the EGS was referred to as an endangered species in Czechoslovakia (Trpák 1988, Baruš 1989), and a few projects aimed at EGS protection were started. Reintroductions (re-establishment of former occurrence) were relatively common but were not always successful. Information concerning these reintroduction attempts and their results was mostly mentioned only in local conference proceedings or was not published at all. However, such data can be very valuable for planning of future reintroductions or other conservation measures (Macnab 1983, Short et al. 1992).

The aim of this review is to summarize detailed information on reintroductions of the EGS in the Czech Republic, Slovakia and Poland since 1989, to provide critical comments on the methodology used and the results of these attempts, and to draw recommendations for future reintroduction projects.

LIST OF REPATRIATION PROJECTS

S l o v a k i a

Rescue transfer in the southern part of the Košice basin

In 1992 and 1993, project of repatriation of the EGS was implemented in the Košice basin in eastern Slovakia. The project was supported by the Slovak Environmental Agency in Prešov as a part of the project aimed at reinforcement of population of the saker falcon (*Falco cherrug*) (Budayová 1995).

EGSs were transferred from the colony inhabiting a pasture (9 ha in size) in the site called Grajciar (Košice-okolie district). It was a rescue transfer, since the Grajciar colony was threatened by planned ploughing of the locality. During the repatriation project, the abundance of the source colony did not exceed 1000 individuals (Budayová 1995). Target localities (Buzica, Milhosť and Perín-Chým in the Košice-okolie district) include several hundreds of hectares of pastures covered with thermophile vegetation. According to Mošanský (1992) and local reports, EGSs previously occurred at all of the target localities (Budayová 1995).

In both years catching and transfer was carried out in April. Traps (cylindrical cages 29 cm long, 8.5 cm in diameter with a backflow valve) were mounted on burrow entrances. Ground squirrels were expelled from the burrows by water and immediately after trapping were placed into a tempered car and left to dry. During the whole project 200 individuals were transferred, however, neither the number of individuals released on the particular locality nor sex ratio and other data on the transferred animals were recorded (Budayová 1995).

Ground squirrels were transported in cages to the target locality on the day of trapping and released individually to prepared hiding burrows (10–15 cm in diameter, 50 cm deep, 10 m in span). The next day, ground squirrels left the prepared burrows and started to build their own. In the following years, reproduction of transferred ground squirrels was observed at the Buzica and Milhosť localities and the colonies started to grow. The repatriation project was then considered as successful. In 1993, the transferred population at Perín-Chým was destroyed by cattle (Budayová 1995). In 2002, one of authors of this paper visited all target localities and found no proof of EGS occurrence. According to unverified reports, a few ground squirrels were observed near the Perín village at the end of the summer 2008.

Due to the absence of data on the development of the populations after 1995, we can suggest only some probable explanations of the present state. The repatriation seems not to be as success-

ful as expected and the transferred populations became gradually extinct or/and the established populations were affected by inadequate management of the target localities. The observations of ground squirrels near Perín in 2008 indicate that individuals probably migrated to different habitats. Combination of the above mentioned factors is also possible.

Repatriation project in the Ponitrie Protected Landscape Area

In 2003–2006, the State Nature Conservancy of the Slovak Republic organized the project of repatriation of the EGS in the Ponitrie Protected Landscape Area. Ground squirrels were captured in the colony inhabiting the Bratislava International Airport. At the time of implementation of the project, the area of the source colony was approx. 270 ha and its abundance was 1000–1500 individuals. With these parameters, the population at the Bratislava International Airport was considered to be the largest in Slovakia (Baláž et al., 2008). The target locality called Breziny is situated near the village of Klátová Nová Ves in the Tríbeč Mountains (Partizánske district) in the Ponitrie Protected Landscape Area. At the time of transfer, it was a 55 ha pasture for cattle, later for sheep and goats. EGSs were not previously reported on the target locality, however, ground squirrels were observed 5km from the target locality in 1994. The project was financed within the LIFE project "Conservation of the Imperial Eagle (*Aquila heliaca*) in the Carpathian fold" in 2004–2006.

There were three repatriation transfers: one in August 2003 and two in August 2006. Ground squirrels were caught by snares placed on burrow entrances and the age (adult, juvenile), sex, weight, and tail and foot length were recorded. The animals were kept in plastic boxes and transported individually to the target locality.

In the first transfer, 31 individuals (16 males, 15 females) were released to previously prepared burrows. After the release, ground squirrels moved to a different part of the locality. Due to the early onset of cold weather they immerged into hibernation already in mid September. The next spring, only few active burrows were found and no individuals were observed. During each of the two transfers in 2006, in total 16 individuals (9 males, 7 females) were released to previously prepared burrows on the target locality. The burrows were enclosed by two acclimatization fences (1m wide, 1m long and 0.5 m high) and ground squirrels were additionally fed with apples.

The locality was monitored continuously for two weeks. Ground squirrels escaped under the fences in several hours, but some of them came back for food and settled in the prepared burrows. Two weeks after the last transfer, 9 individuals were observed on the target locality. In October 2006, 5 burrows with plugged entrances were found, indicating that a part of the transferred group was hibernating on the target locality. The next spring no ground squirrels were observed on the locality, but an unverified observation of ground squirrels approx. 200 m SW from the site of the release was reported.

It seems that the project of EGS repatriation at Breziny failed due to the following facts: a small amount of transferred individuals, the time lapse between the first and second transfer was too long and the group from the second and third transfer could not successfully support the existing population. As the ground squirrels tended to leave the target locality, it seems that the site was not suitable for release, probably also due to predation pressure by birds of prey, weasels and cats.

Repatriation project in the Nízke Tatry National Park

The repatriation project which took place in 2005–2006 was initiated by the administration of the Nízke Tatry National Park. EGSs were transported from the Košice International Airport. At the time of transfer, the abundance of the source colony was around 1000 individuals and

the colony inhabited 220 ha of the grassy landing ground. The distance between the source and target locality was more than 150 km. The target locality called Jakub (Banská Bystrica district) is situated on the southwestern slope of the Nízke Tatry Mts. The locality was formerly used as a pasture and at the time of transfer was managed as a meadow with hay production. Former occurrence of ground squirrels was reported near the Selce village located 5 km east of the target locality (Cyprich 1986).

Transfers from the source colony were organized in April and July 2005 and in April 2006. Ground squirrels were caught by snares placed on burrow entrances and then were transported in wooden boxes. During the whole project, 74 individuals were transferred and the numbers of released males and females were recorded. In the first transfer, 31 individuals (21 males, 10 females) were released into previously prepared burrows. During the second transfer in July 2005, 20 individuals (15 males, 5 females) were released. Soon after the release, individuals dissipated to the surroundings and the next spring no ground squirrels were observed on the locality. In April 2006, 23 individuals (12 males, 11 females) were released at the site. Information on behaviour of the transferred animals and on management of the target locality after the transfer is not available. According to the reports by the staff of the Nízké Tatry National Park, no EGSs were observed on the locality at the end of the following season – in October 2007.

Regarding the insufficient documentation of this repatriation project, it is difficult to analyse its results. One possible reason of the repatriation failure could be an unbalanced sex ratio of the released individuals (only 35 % of females). Moreover, unsuitable management of the target locality cannot be excluded.

Repatriation project in the Muránska planina National Park

The project of EGS repatriation was implemented in the years 2000–2009 in the Muránska planina National Park. The project was originally focused on increasing food availability for the Saker Falcon (*Falco cherrug*) and organized by the National Park administration. Most of the transferred individuals came from the colony at the Košice International Airport (see above). Another source was a colony inhabiting a 40 ha pasture situated in the zone of protection of the Slovenský kras National Park (locality of a planned golf course called Drienovec in the Košice-okolie district). Five more individuals for repatriation were obtained from the colony on a pasture near the Turňa nad Bodvou castle (Košice-okolie district). An abundant population of EGSs used to live on the meadow and in steppe areas around the Turňa castle, but the 10 ha meadow was endangered by a planned transformation into arable land and the repatriation was thus a rescue transfer. Six more individuals were obtained as a result of the rescue transfer from a 6 ha pasture north of Moldava nad Bodvou (Košice-okolie district). The target locality was situated in the Muránska planina National Park, 3 km east-west of the Muráň village (Revúca district). The locality is around 40 ha in size, consisting of a few kilometer system of pastures called Biele vody, Spišské and Pod Cigánkou. This locality was chosen based on the following criteria: it is situated in the hunting grounds of the Saker Falcon (*Falco cherrug*), occurrence of EGSs was reported previously and at the beginning of the project, regular management of the locality was ensured by grazing. Later on, when grazing ceased, the locality was managed by mowing.

From 2000 till 2009, altogether 23 transfers were organized (for details see Table 1) and 1057 individuals were released. Ground squirrels were caught by snares placed on burrow entrances and from 2007 also using wire traps. After trapping, the age and sex of each individual and occasionally also body mass, tail length and hind foot length were recorded. Ground squirrels were housed individually in plastic boxes, which were also used during the transfer on the target

Table 1. Abundance and sex ratio of European ground squirrels transferred into the Biele vody, Muránska planina National Park, Slovakia. If not indexed in footnotes, the animals came from the source colony at the Košice International Airport

Tab. 2. Počet a poměr pohlaví syslů obecných vypuštěných na lokalitě Biele vody, Národní park Muránska planina. Pokud není uvedeno jinak, jedná se o jedince pocházející z kolonie na mezinárodním letišti v Košicích

Releasing periods / období vypouštění: **1** – 19–21 April 2000; **2** – 13 June 2000[a]; **3** – 26–28 July 2000; **4** – 22–24 April 2001; **5** – 28–29 April 2001; **6** – 4–6 May 2001; **7** – 11–13May 2001; **8** – 3–5 August 2001; **9** – 10–12 August 2001; **10** – 17–19 August 2001; **11** – 1–3 May 2002; **12** – 20–22 August 2002; **13** – 29–30 April 2003; **14** – 14–16 July 2003; **15** – 29 March – 2 April 2004[b]; **16** – 15–16 April 2004; **17** – 16–17 August 2004; **18** – 26–28 April 2006; **19** – 31 March – 2 April 2007; **20** – 31 July – 3 August 2007; **21** – 13–25 April 2008[c]; **22** – 25–28 July 2008; **23** – 14–16 April 2009

period	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	total
♀♀	6	1	6	1	6	9	11	19	13	6	40	32	30	36	6	15	13	18	38	64	72	67	13	515
♂♂	2	4	12	0	8	16	8	30	23	11	22	52	32	55	0	10	17	12	41	48	33	71	28	531
total	8	5	18	1	14	25	19	49	36	17	62	84	62	91	6	25	30	30	79	112	105	138	41	1057

[a]source lokality Turňa

[b]source locality Moldava nad Bodvou

[c]source lokality Drienovec

Table 2. Abundance and sex ratio of European ground squirrels transferred from the source colony at the Bratislava International Airport to the target locality Kuchyňa in the Malé Karpaty Protected Landscape Area, Slovakia

Tab. 2. Počet a poměr pohlaví syslů obecných z kolonie na mezinárodním letišti v Bratislavě, kteří byli vypuštěni na lokalitě Kuchyňa v Chráněné krajinné oblasti Malé Karpaty

Releasing periods / období vypouštění: **1** – 20–22 April 2004; **2** – 18–20 August 2004; **3** – 27–29 April 2005; **4** – 10–13 April 2006; **5** – 19–21 April 2006; **6** – 11–13 April 2007; **7** – 17–19 April 2007; **8** – 24–26 April 2007; **9** – 26–27 July 2007; **10** – 12–13 September 2007; **11** – 3–6 April 2008; **12** – 12–15 August 2008; **13** – 22–24 August 2008; **14** – 6–9 April 2009; **15** – 30 July – 9 August 2009; **16** – 8–10 April 2010

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	total
♀♀	32	17	53	39	20	10	25	16	19	10	48	50	16	54	43	14	466
♂♂	60	15	51	28	28	17	19	24	26	10	42	53	7	42	38	12	472
undet.	–	–	–	–	–	–	1	–	–	–	10	–	–	–	1	–	12
total	92	32	104	67	48	27	45	40	45	20	100	103	23	96	82	26	950

Fig. 1. Example of acclimatisation enclosure used for releasing European ground squirrels in Slovakia.
Obr. 1. Příklad voliéry používané pro vypouštění syslů obecných na Slovensku.

locality. Immediately after each catching session, the individuals were released into previously prepared artificial burrows, later into existing burrows or acclimatization fences (see Fig. 1). To observe behaviour of the released animals and to prevent predation, the target locality was continuously monitored for three days after each transfer.

Up to now, results of EGS repatriation on the Biele vody locality seems to be positive. In 2007, the estimated abundance of the colony was around 400 individuals and the annual population increment seemed to compensate for the loss caused by predation by birds of prey, foxes and badgers. However, the colony is still reinforced by the transfers and it is not clear how the situation develops when the transfers will be stopped. The geographic isolation of the locality may also impact the long-term existence of this population.

Repatriation in the Malé Karpaty Protected Landscape Area

The project of EGS repatriation in the Malé Karpaty Protected Landscape Area took place in 2004–2010. The animals came from the source colony inhabiting the Bratislava International Airport (for details see above). The target locality is found near the Kuchyňa village (approx. 30 km from the source locality) in the Malé Karpaty Protected Landscape Area. The site is several hundreds of hectares in size, situated at 250–330 m a. s. l. It has been extensively used as a year-round pasture for cattle and horses, providing appropriate management of vegetation. No previous reports of EGS occurrence are known. The repatriation was organized by the administration of the Ponitrie Protected Landscape Area and supported by two LIFE projects aimed at conservation of the Imperial Eagle (*Aquila heliaca*) in the Carpathian fold (2004–2006) and conservation of the Saker Falcon (*Falco cherrug*) in the Carpathian fold (2007–2010).

During the whole project, 16 transfers were organized and 950 individuals were moved (for details see Table 2). Ground squirrels were trapped by snares placed on burrow entrances and also using wire traps. Data on age, sex, body mass, tail and foot length of each individual were recorded and the animals were kept and transported individually in plastic boxes. In April 2004, 92 individuals were released on a one-hectare plot on the southwestern side of the hill in the target locality. The slope of the selected plot was 15–20°. Ground squirrels were released into previously prepared artificial burrows (45–60 cm deep). Most of the released individuals (approx. 80%) left these burrows during the next few days and tried to hide in the neighbourhood (under the bushes, rocks and fallen trees around the pasture). In autumn 2004, only six burrows were found at the site of release and few other burrows were found within the 250 m range. At this time, 32 more individuals were added on the locality.

In spring 2005, burrows at the original site of release were unoccupied, however, six new burrows were found in approx. 100 m distance. According to the reports of local people, several individuals were observed in a different part of the pasture. Another release of 219 individuals in 2005 and 2006 resulted in only 22 occupied burrows which were found in spring 2007. The occupancy of the Kuchyňa locality showed intra- as well as inter-seasonal variability. In 2007, the site of release was slightly changed according to preferences of the formerly transferred individuals. During 2007, 177 EGS individuals were released into previously prepared burrows as well as into EGS-made burrows on a plot situated about 200 m north of the site of former releases. During 2008 to 2010, altogether 430 other individuals were transferred to the Kuchyňa locality and released into EGS-made burrows.

The first reproduction of transferred EGSs was observed in 2007. In spite of this partial success, only 38 inhabited burrows were found on the monitored 50 ha area and the estimated abundance was between 15 and 45 individuals. Successful reproduction was confirmed in 2008, when the abundance of the colony slightly increased to 70–80 individuals, the number of burrows increased and ground squirrels started to colonize other parts of the pasture (Krivošik pers. comm.). Considering the large number of transferred individuals, this repatriation project does not seem to be very successful. The massive migration of transferred animals at the beginning of the project indicates that the place of release was not suitable. A positive finding is that the colony exhibits natural reproduction. However, abundance of the population is nearly 10% of the transferred amount, which may not be sufficient for a long-term existence of the colony.

Reinforcement of EGS population in the Slovenský kras National Park

The project was carried out in the period 2004–2008, with the aim to increase abundance of five EGS colonies in the Slovenský kras (Slovak Karst) National Park. Ground squirrels were transferred from the source colonies at the Košice International Airport, Turňa, Moldava nad Bodvou and Drienovec (see above). All target localities were situated in the Rožňava district in the Slovenský kras National Park. The localities of Bezvody, Nilaše, Silická ladnica (all near the Silica village) and Kečovské lúky (near Kečovo) are localized in the area called Silická planina (Silica plain) and exhibit the same landscape pattern. The whole area was formerly used for intensive pasturage of sheep, goats and cattle. EGS occurrence was previously reported from the whole area as well as from the sink-holes, however, at the beginning of the project, abundance of the colony living at Kečovské lúky was only a few individuals. The last target locality, Kružná, is a 70 hectare pasture situated on a hillside above the Kružná village. The occurrence of EGS on this locality was reported previously and at the time of transfer, the abundance of the colony was approx. 100 individuals. During 2004–2006, the transfer was supported by the LIFE project "Conservation of the Imperial Eagle (*Aquila heliaca*) in the Carpathian fold".

Table 3. List of transfers of European ground squirrels in the Slovenský kras National Park, Slovakia
Tab. 3. Přehled syslů obecných vypuštěných na lokalitách v Národním parku Slovenský kras za účelem posílení původních populací

target locality cílová lokalita	date of transfer datum přesunu	♂♂	♀♀	undet. neurčeno	total úhrnem
Bezvody	12–13 April 2004[a]	30	20	1	51
	20–22 July 2005[a]	32	22	–	55
	26–28 April 2007[a]	17	19	–	36
	9–12 April 2008[b]	24	36	–	60
Nilaše	16–18 August 2004[c]	18	15	–	33
	15–16 April 2004[a]	23	27	–	50
	26–28 April 2006[a]	12	3	–	15
	15–17 August 2006[a]	7	–	–	7
Silická ladnica	29 March – 2 April 2004[d]	43	57	–	100
	2–4 August 2004[a]	20	14	–	34
Kečovské lúky	9–12 April 2008[b]	11	9	–	20
Kružná	9–12 April 2008[b]	9	11	–	20

[a]source locality Košice International Airport; [b]source locality Drienovec; [c]source locality Turňa; [d]source locality Moldava nad Bodvou

Ground squirrels were trapped by snares placed on burrow entrances and using live traps. Sex of the trapped individuals was recorded and they were housed and transported individually in plastic boxes. During the whole project, 481 individuals were transferred (for details see Table 3). On the target localities, individuals were released into previously existing burrows. Despite the fact that the release was accompanied by aggressive behaviour of the previously resided ground squirrels, a part of the transferred animals has settled on the localities. According to reports of the Slovenský kras National Park administration, the transfer did not enhance the abundance of the colonies. It seems that the abundance of the populations rather randomly oscillates in time.

The result of the project cannot be classified as clearly positive or negative. Compared to establishing a new population during a standard repatriation project, the release of individuals on the already occupied locality seems to be more complicated. A large number of individuals released on the previously inhabited locality results in disturbance of social relations within the colony, causing strong social stress. Moreover, different EGS populations host different species or combination of species of the *Eimeria* parasite (Golemansky & Koshev 2007), the newly released individuals may thus spread new parasites and diseases within the previously settled population. The release of individuals from a geographically distant locality can also disturb the local gene pool and possibly cause an outbreed depression.

Czech Republic

Rescue of EGSs in the Český kras Protected Landscape Area

In the years 1988–1992, administration of the Protected Landscape Area organized rescue of EGS in Český kras. It was the first EGS repatriation project in the country. Abundance of EGS in Český kras used to be high and at the time of transfer ground squirrels still occurred at a few

places. In the Protected Landscape Area it was possible to control the appropriate management of the sites of release and continuously analyse the results of the project (Jansová 1992). The source colony was situated in the western part of the Czech Republic at the Olšová Vrata golf course (Karlovy Vary district). According to the reports of the golf course staff, the abundance of the source colony was several hundreds of individuals at the time of transfer. In 1988, a suitable site of release was chosen in the Zlatý kůň National Natural Monument (Beroun district) (Jansová 1992). The target locality was 37 hectares in size, however, meadows and pastures cover only a part of the whole area. At the time of repatriation, the area served as a pasture for sheep and pasturage should also ensure management of the locality in the future (Hulová 2005).

During 1989–1990, 41 individuals were transferred from the source locality (24 individuals in 1989, 17 individuals in 1990). Neither the method of capture nor the age and sex ratio of the transferred animals were reported. EGSs were released on the locality and the area was monitored for one week. Germinated wheat was supplied as additional food on the site, however, ground squirrels migrated to the surroundings soon after the release. Two individuals were found run-over on the road next to the target locality (Jansová 1992). It seems that the number of released individuals was not sufficient for reproduction and establishing of a sustainable colony.

In 1991, 3 individuals (2 males, 1 female) were trapped on the source locality. This group was bred in captivity and in 1992 numbered 10 individuals. Seven of them together with 10 individuals from the source colony were then transferred to the Zlatý kůň locality. Ground squirrels were released into a wire cage with artificial subterranean hiding places. The sides of the cage were laid underground to prevent the animals from escaping. This method seems to be successful, as the individuals stayed on the site of release even after the cage was removed. In 1993, no additional transfer was organized and only few individuals were observed on the locality. In the following years, the population as well as the breed of ground squirrels in captivity died out (Hulová 2005).

In spite of the absence of basic information on the time of the transfer, age and sex ratio of the transferred animals, this first repatriation project brought many new findings. The most useful of them is the release of animals into the cages with temporary hiding places (Hulová 2005). Hulová (2005) also reported that the individuals which were raised in captivity lacked natural alertness and became prey of predators more often than the wild ones. The repatriation project failed due to the loss of transferred individuals by migration and predation.

Repatriation project in the Křivoklátsko Protected Landscape Area

The aim of the project implemented in 1994–1998 was to renew the EGS population at a site of previous occurrence in the Křivoklátsko Protected Landscape Area. Ground squirrels were transferred from the Trhovky locality (Příbram district), where they inhabit a system of campsites and meadows with the total area of 16 ha. The estimated abundance of the source colony was several hundreds of individuals. The administration of the Protected Landscape Area chose the locality called Novina (near the Zbečno village, Rakovník district) as the target site for repatriation. The place of release was situated on a pasture on the south-oriented slope. Management of the locality was provided by the pasturage of sheep.

During the whole project, 39 individuals were released at Novina; however, details on the method of trapping are not available. The first transfer was organized in May 1994. Six individuals (2 males, 4 females) were released on the target locality and few more individuals were taken for breeding in captivity. In 1995, four more individuals (2 males, 2 females) were released on the locality. In August 1995, 9 individuals were transferred from the source colony at Trhovky and released together with 4 juveniles from the breed. There were no transfers organized in

1996 and 1997 and during this time, only 2 individuals and 10 active burrow entrances were observed. During the last transfer organized in 1998, 14 juveniles from the breed and 2 adults from Trhovky were released at Novina. The last observation of ground squirrels at Novina was reported in autumn 1998. The project was stopped when no individuals survived the subsequent hibernation on the locality and the population in captivity was destroyed by ectoparasites.

The project of EGS repatriation in the Křivoklátsko Protected Landscape Area did not succeed probably due to a small number of individuals released and long time lapses between the transfers. It would have been beneficial to reinforce the population also in 1995 and 1996. However, since detailed information on the project (such as the method of release or the physical condition of individuals) is not available, we are not able to determine more causes of the failure.

Repatriation project in the Slavkovský les Protected Landscape Area

The aim of the repatriation project, which took place in 2000 and 2001, was to renew the population of EGS on the Vítkův vrch locality (near Olšová Vrata, Karlovy Vary district). Last occurrence of EGS at this site was reported in September 1993 (Vacík 1996). However, the remnants of old burrows were still detectable at the time of the repatriation project. The animals for repatriation were transferred from the colony living only 2.5 km northeast of the target locality, at the golf course in Olšová Vrata (near Karlovy Vary in western Bohemia). In 2000 and 2001, the estimated abundance of the source colony was about 300 individuals. The site of release (total area 2 ha) was a meadow on the south-oriented slope and the adjacent campsite. Grass on the site of release was managed by mowing; however, the campsite was not run at the time of release. This repatriation project was supported and organized by the administration of the Slavkovský les Protected Landscape Area.

During the whole repatriation project, 60 individuals were transferred to the target locality. Ground squirrels were trapped by snares placed on burrow entrances and transported in linen bags. Age, sex and body mass of each individual were recorded. At the day of trapping, the animals were released on the target locality into a wire enclosure (3×8 m) with temporal shelters (boxes) and old burrows. To prevent the released individuals from escaping, the fence was laid approx. 30 cm underground and additional food (oat) was provided (Matějů 2004).

During the first transfer (30 August – 1 September 2000), 26 individuals (9 males, 17 females) were released at the target locality. The first day after the release, ground squirrels started to build their own burrows. After three days, they went under and left the enclosure. They dispersed over the whole campsite area during the next week and preferred to build their burrows under the grounds of the camp houses. During the second transfer (19–21 August 2001), the same method was used and 34 individuals (14 male, 20 females) were released on the target locality. Monitoring of the locality in 2002 revealed an inappropriate management of the locality with grass approx. 50 cm high on some places. The maximum number of individuals observed at the same time on the locality was five. In 2003, only one ground squirrel was observed and the abundance was estimated at approx. 3 individuals. Since 2004, no ground squirrels have been observed and it seems that the repatriation project was not successful.

However, in 2003, two individuals were observed at the Karlovy Vary International Airport, approx. 350 m from the site of release (Matějů et al., 2008). Ground squirrel occurrence was previously reported from this locality, but when the repatriation project took place, no EGS were found (Cepáková & Hulová 2002). Since migration from the colony at the Olšová Vrata golf course is limited by spatial constraints (road, village, wet grasslands) within the golf course and airport, it seems that the individuals observed at the airport came from the Vítkův vrch locality. Since its discovery, the EGS population at the Karlovy Vary International Airport has

Table 4. Estimated abundance (EA) of the European ground squirrel population at the Karlovy Vary International Airport, Czech Republic (Matějů et al. 2008, Matějů & Schnitzerová unpublished data)
Tab. 4. Odhadovaná početnost (EA) populace sysla obecného na mezinárodním letišti Karlovy Vary (Matějů et al. 2008, Matějů & Schnitzerová nepublikovaná data)

Year	2003	2004	2005	2006	2007	2008	2009	2010
EA (no. individuals)	10	10	10	30	50	40	25	30

been monitored. The occupied area and abundance of the colony is estimated each year and the airport provides adequate management of the locality. The population at the airport exhibits active reproduction and seems to be sustainable, however, the number of individuals is still low (Table 4) and the colony requires thorough monitoring and protection.

Results of the repatriation project cannot be classified as clearly positive or negative. Individuals migrate from the site of release to the area providing better conditions, especially regular management of the grass. It seems that individuals which left Vítkův vrch probably moved to the international airport nearby. This presumption that the new population at the Karlovy Vary International Airport is a result of the repatriation project was presently confirmed by DNA analysis (Hulva ad verb.).

Repatriation project in the Strakonice district

A repatriation project, aimed at renewing EGS population at the site of its former occurrence in the Strakonice district (southern Bohemia), was organized by amateurs in 1989 and 1990. Ground squirrels were transferred from the colony at the Strakonice airport. During the repatriation project, the abundance of the source colony was quite high. The target locality Řepické rybníky (Strakonice district) is situated approx. 5 km northeast of the airport and EGS occurrence was reported there as late as in the 1970s (Hulová 2005). Details on the management of the target locality are not available.

Each year, trapping was organized at the turn of July and August. The animals were expelled from their burrows by water. No further data on the trapped individuals (age, sex, etc.) were recorded. In 1989, 10 individuals were released on the target locality. In 1990, 20 individuals were released into prepared burrows with the entrances covered by boxes. During the following weeks, ground squirrels modified their burrows. Five occupied burrows were found in spring 1991, however in 1992, no signs of presence of EGS were observed at the target locality, the reintroduction thus was not successful (Hulová 2005).

Due to the lack of detailed information, it is not easy to determine the reasons why the repatriation was not successful. Obviously, the small amount of transferred individuals and an unsuitable method of the first release contributed to the failure of the action.

Reintroduction of EGSs at the Velká Dobrá airfield

This reintroduction attempt was carried out by amateurs and its aim was to establish EGS population at the Velká Dobrá airfield (Kladno district, central part of the Czech Republic). The animals were taken from the colony at the Bořitov airfield (Blansko district), whose abundance at that time was estimated at about 170 individuals. At the turn of July and August 2007, ten EGSs were released into an enclosure on the target locality. Management of the locality which consisted of mowing was probably sufficient. No further data concerning the reintroduction (e.g. how the animals were trapped, their age, sex ratio, etc.) are known.

In summer 2008 and 2009, juveniles were observed on the target locality and the population was estimated about 15 individuals (Matějů et al. 2008, Matějů & Schnitzerová unpub. data). Despite a very low number of released animals the reintroduction can be considered successful, however, long-term survival of the small established colony is unlikely. It should be mentioned that the information on this reintroduction is based only on personal communication with the airport staff and could not be easily verified. The only possibility is to carry out a genetic analysis of the new colony and compare it with the reported source population; nevertheless, this could not document the number of introduced individuals and other important facts.

Transfer of EGS to the Písečný vrch u Milé Natural Monument

In 1992, the authorities of the Most district organized transfer of four EGS individuals. The source colony, situated at Benedikt u Vtelna (Most district, northern Bohemia) was endangered by destruction (Franěk pers. comm.). Contrary to the reports of Tichý (2003), previous occurrence of EGS on the target locality Písečný vrch (hill) was not observed (Franěk pers. comm.). Ground squirrels were released on the target locality without any subsequent monitoring or management. The locality got overgrown with ruderal vegetation and the repatriation failed.

Concerning all mentioned information there is no doubt that the failure was caused by the combination of few transferred individuals, inappropriate method of the release and absence of management.

P o l a n d

Although the last reports on EGS occurrence in Poland were published in the 1970s (Męczyński 1985), a reintroduction project was launched in 2000. Its aim was to create stable population on the sites of previous occurrence. The repatriation project was supported and organized by the Polish Society for Nature Conservation "Salamandra".

The target locality was a 30 ha area of meadows between two villages – Kamień Śląski and Kamionek (Opolskie district), where an abundant EGS colony was reported in 1973 (Męczyński 1985). At the time of reintroduction, the meadows were used for hay production and mowed twice a year. Moreover, management of adjacent areas enabled future expansion of the colony.

For the purpose of the project, almost 180 EGS from Hungary (from two localities: Budakeszi grassy airport and Budapest International Airport) and Slovakia (Bratislava International Airport) were imported to the Poznań Zoo. In addition, nine individuals came from the breeding colony in the Bern Zoo (Switzerland). EGS were bred in three separate open enclosures, each of them 100 square meters in size. Both adults and their offspring were released at the target site.

Four transfers of EGS were organized between 2005 and 2008. In this period, altogether 306 individuals were released on the target locality. Each individual was labelled by a subcutaneous microchip. Ground squirrels were then released into several acclimatization enclosures (see Fig. 2) with prepared burrows, 30 cm deep. To prevent the released individuals from escaping, each side of the fence was laid approx. 30 cm underground. The animals were provided with vegetables, fruit and wheat for one week after the release.

During the first transfer at the turn of July and August 2005, 79 individuals (33 males, 46 females) were released on the target locality. In May 2006, altogether 90 burrows (single or grouped by 2–3) were found. At the same time, a group of 16 males was released on the target locality. In late July 2006, the number of occupied burrows reached 390. Soon afterwards 84 individuals (32 males, 52 females) were released on the locality. Monitoring of the locality in 2007 revealed 220 occupied burrows in mid May and 240 in mid July. The decrease of the number of inhabited

Fig. 2. Portable enclosure used for releasing European ground squirrels in Poland.
Obr. 2. Mobilní voliéra používaná pro vypouštění syslů obecných v Polsku.

burrows might have been caused by the lack of good view due to high grass and rests of hay. In July 2007, the last group consisting of 67 individuals (28 males, 36 females, 3 undet.) was released at the site. The estimated abundance of the colony in 2007 was 200–250 individuals. Monitoring of the locality in late July 2008 revealed 230 inhabited burrows and the abundance of the population was estimated at 150–200. Juvenile ground squirrels indicating reproduction of the colony have been observed from 2006.

We are currently not able to analyse the results of the repatriation project at Kamień Śląski, as it is still in process. However, although reproduction in the EGS population occurs regularly, the low abundance does not yet ensure long-term survival of the colony. Moreover, low frequency of management results in the presence of 40–50 cm high vegetation on the target locality. A positive result of the project is regular monitoring of the locality. The number of occupied burrows can be counted easily and helps to better estimate the abundance and map its temporal changes.

Another repatriation project was started near the Głębowice village (Dolnośląskie district) in 2008. The target locality with sandy sub-soil and thermophilous vegetation is situated approx. 1.5 km northwest of the village and is owned by a non-governmental organization, the Polish Society of Friends of Nature "ProNatura". This organization also provides regular management of the locality. The animals for repatriation came from the breed in the Poznań Zoo and the above mentioned method was used for the release. The first group of 60 individuals

(36 males, 24 females) was released in early August 2008, thus the results of the transfer are not yet available.

CONCLUSIONS

We collected all available information on 13 EGS reintroduction projects implemented in Central Europe since 1989. During this period more than 3,200 ground squirrels were reintroduced at 15 different sites or used for reinforcement of 5 populations (see Fig. 3). At 7 of these sites, settlement and reproduction of the released individuals has been observed and the reintroduction can be considered successful. On the other hand, reintroduction failed at other 7 sites and the result of reintroduction is still unknown at one site. The ratio of long-term existing reintroduced colonies is even much lower. The results of reinforcements are unclear at all 5 sites.

The weakest point of reintroductions seems to be the low number of released individuals. In only three cases, more than one hundred individuals were released and all these projects

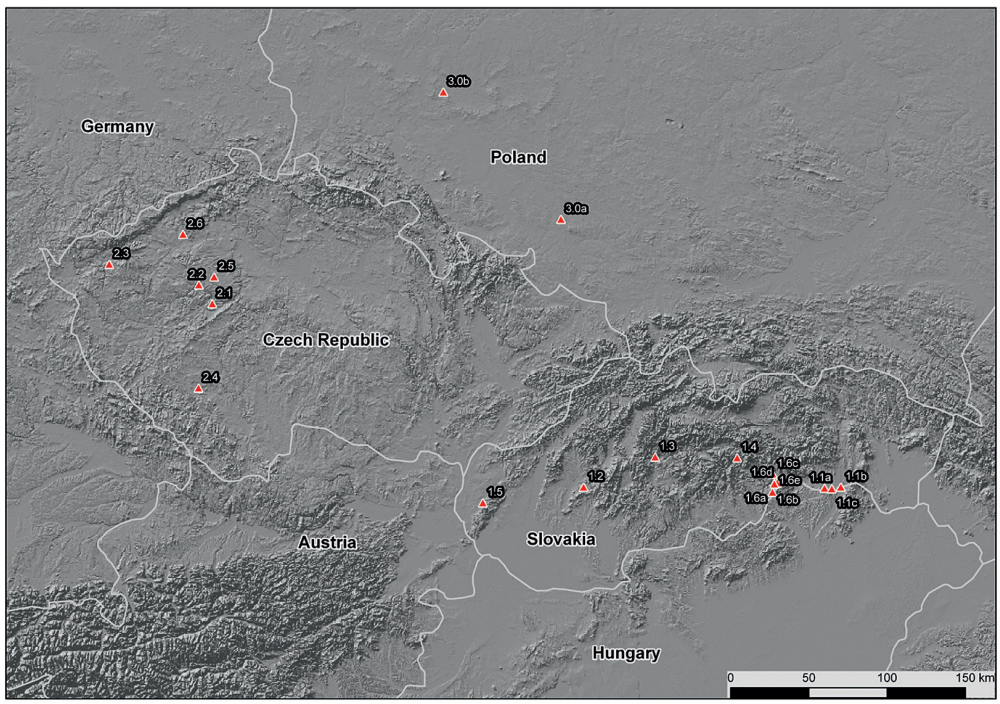

Fig. 3. List of sites in Central Europe where European ground squirrels were released in 1989–2010
Obr. 3. Přehled lokalit, na kterých v letech 1989 až 2010 probíhalo vypouštění syslů obecných.
Legend / Vysvětlivky: **Slovakia** / **Slovensko**: 1.1a Buzica, 1.1b Milhosť, 1.1c Perín-Chým, 1.2 Breziny, 1.3 Jakub, 1.4 Biele vody, 1.5 Kuchyňa, 1.6a Bezvody, 1.6b Kečovské lúky, 1.6c Kružná, 1.6d Nilaše, 1.6e Silická ladnica; **Czech Republic** / **Česko**: 2.1 Zlatý kůň, 2.2 Novina, 2.3 Vítkův vrch, 2.4 Řepické rybníky, 2.5 Velká Dobrá, 2.6 Písečný vrch; **Poland** / **Polsko**: 3.0a Kamień Śląski, 3.0b Głębowice.

were evaluated as successful. According to Hapl et al. (2006), about one hundred individuals should be used for reintroduction at one site. Another problem was the method of releasing. Especially during the first attempts, the individuals were released freely without providing any shelter (artificial burrow) or fence (enclosure) which would prevent the immediate escape from the site of release. This method never led to successful reintroduction.

Additional problems are connected with selection and management of target localities. The selection of sites for reintroductions was usually based on former EGS occurrence, regardless of the reason of their disappearance. Consequently, the animals were released on the site that was no more suitable for their existence (e.g. high groundwater level). Insufficient management at the locality (absence of regular mowing or pasture) is another common problem. It usually appears later when the reintroduction is "finished" and the concern of wildlife managers becomes lower. Position of the site in landscape is a fundamental question. This fact was not considered in any of the above reintroduction projects, so the newly established EGS colonies became isolated without possible connections between them or with any other existing colony. In this context, migration of animals between the populations is unlikely and potential decrease of population abundance could not be compensated by immigrants. The long-term existence of such a population is less probable than its existence within a metapopulation (Allendorf & Luikart 2007).

All above-mentioned facts should be considered in future reintroduction projects. Our recommendations are as follows: new colonies should be established particularly in the neighbourhood of already existing colonies with the potential to establish a metapopulation pattern of populations. A sufficient number of individuals should be released and artificial burrows as well as temporary fencing of the site of release can help in adaptation of the released individuals. It is also recommended to provide proper management of the site (mowing or pasture) on a long-term basis. Last but not least, detailed documentation of the reintroduction methods and regular monitoring of the established population are of high importance.

SOUHRN

Shromáždili jsme zde veškeré dostupné informace o třinácti reintrodukčních projektech sysla obecného, které se uskutečnily ve střední Evropě od roku 1989. Během tohoto období bylo více než 3200 jedinců sysla vypuštěno na 15 různých míst za účelem reintrodukce. Na pěti dalších místech byla část těchto jedinců použita pro posílení původních populací (obr. 3). V sedmi případech bylo zaznamenáno osídlení lokality sysli a reprodukce vypuštěných jedinců, což považujeme za úspěšnou reintrodukci. Počet dlouhodobě existujících reintrodukovaných populací je však ještě nižší. Na sedmi lokalitách reintrodukce selhala a u jedné je výsledek stále neznámý. Na pěti místech, kde byla zvířata použita pro posílení populací, je výsledek nejasný.

Nejslabším bodem všech realizovaných reintrodukcí se zdá být nízký počet vypouštěných jedinců. Jenom ve třech případech, které zároveň patří mezi úspěšné, bylo na lokalitu vypuštěno více než sto jedinců. Dle zkušeností Hapla et al. (2006) je sto jedinců optimální počet vhodný pro reintrodukci na jedné lokalitě. Další úskalím je metoda vypouštění. Při prvních pokusech o reintrodukci sysla, byli jedinci vypuštěni na lokalitě bez zajištění jakéhokoliv úkrytu (uměle vytvořené nory) nebo ohrazení, které by jim zabránilo v okamžitém opuštění místa. Taková metoda vypouštění nikdy nevedla k úspěšné reintrodukci.

Některé problémy byly spojeny i s výběrem a managementem lokality. Výběr lokality pro reintrodukci byl převážně založen na doložené dřívější přítomnosti tohoto druhu, ale bez ohledu zjištění příčiny jeho vymizení. Následně se stalo, že byla zvířata vypuštěna na lokalitě, která již nebyla vhodná k jejich existenci (např. vysoká hladina spodní vody). Nedostatečný management lokality (absence pravidelného kosení nebo spásání) byl další častý problém. To se obvykle se stalo v době, kdy byla "samotná" reintrodukce

ukončena a zájem realizátorů o nově vzniklou kolonii syslů poklesl. Velmi důležitou otázkou je umístění vybrané lokality v krajině. Tento fakt nebyl nikdy zvažován. Nově vzniklé syslí kolonie jsou bohužel izolované, bez možnosti vzájemného kontaktu nebo kontaktu s jinými existujícími koloniemi. Za těchto podmínek je migrace zvířat mezi populacemi nepravděpodobná a potenciální úbytek v početnosti populace nemůže být kompenzovaný imigranty. Dlouhodobá existence takových populací je méně pravděpodobná než existence populací v rámci metapopulace (Allendorf & Luikart 2007).

Všechna výše zmíněná fakta by měla být zvažována v příštích reintrodukčních projektech. Nové kolonie by měly být zakládány v blízkosti již existujících kolonií s možností vytvořit funkční metapopulační systém. Dále je nutné provádět reintrodukce pouze s dostatečným počtem jedinců a pro vypouštění použít uměle vytvořené nory společně s dočasným oplocením, které napomůže adaptaci jedinců na lokalitě. Je nezbytně nutné, aby byl dlouhodobě zajištěn vhodný management lokality (kosení nebo spásání). Poslední, ale neméně důležité doporučení, je vedení detailní dokumentace reintrodukčních metod a pravidelný monitoring nově založených populací.

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