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Translocations of European ground squirrel (*Spermophilus citellus*) along altitudinal gradient in Bulgaria – an overview

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Abstract

The European ground squirrel (*Spermophilus citellus*) is a vulnerable species (IUCN) living in open habitats of Central and South-eastern Europe. Translocations (introductions, reintroductions and reinforcements) are commonly used as part of the European ground squirrel (EGS) conservation. There are numerous publications for such activities carried out in Central Europe, but data from South-eastern Europe, where translocations have also been implemented, are still scarce.

The present study summarises the methodologies used in the translocations in Bulgaria and analyses the factors impacting their success. Eight translocations of more than 1730 individuals were performed in the period 2010 to 2018. These included 4 reinforcements, 3 reintroductions and 1 introduction. Two of the translocations are still ongoing. Five of the completed six (83%) translocations were successful, although in two cases the number of individuals was critically low. The relatively higher success in Bulgaria than in Central Europe is probably due to using the gained experience. Most of the translocations (6) used a soft release approach. In 6 cases, the animals settled 100 to 720 metres away from the release site, implying management and protection of suitable habitat beyond the translocation area. In 7 of the translocations, the altitude between the donor colony and the release site varied from 470 to 1320 m which could have a hindering effect on the adaptation of animals due to the specific conditions in the mountains. The main reasons for failure are probably poorly selected and maintained habitats and bad climatic conditions (rainy and cool weather) during the translocation action. European funds are of critical importance for translocations, with only two translocations funded by other sources. Based on the gathered data, the current paper also gives some recommendations for improvement in translocation activities.

Keywords
repatriation, reintroduction, reinforcement, *Spermophilus citellus*, european souslik, high altitude, mountain

Introduction

The European ground squirrel (*Spermophilus citellus*, also known as souslik), hereafter EGS, is a diurnal rodent living in colonies in the open habitats of Central and South-eastern Europe. Its distribution and population numbers are decreasing significantly throughout all of its range (Coroiu et al. 2008), including throughout Bulgaria (Koshev 2008, Stefanov 2015). It is listed in the European Community Directive 92/43 Appendix II and IV, the IUCN Red List (Coroiu et al. 2008) and the Bulgarian Red Data Book (Stefanov 2015) as "Vulnerable". This population status and trend has prompted a variety of conservation activities. In many countries, the species is protected and its habitats are conserved and maintained through mowing, grazing and cutting bushes and trees. Along with these activities, translocations (or repatriations) have often been implemented in order to save EGS from habitat destruction or to re-establish extinct colonies. In the last 30 years, those have taken place in Czech Republic, Slovakia, Poland and Hungary (Balaz et al. 2008, Matějů et al. 2010, 2012, Gedeon et al. 2011, 2012, Lobbová and Hapl 2014). In total, 15 repatriations have been accomplished in Central Europe (Czech Republic, Slovakia and Poland), relocating more than 3200 individuals (Matějů et al. 2010, 2012). Different methods have been used in these translocations and, in general, they can be separated into "hard" and "soft", according to the method of release (Beck et al. 1994, Matějů et al. 2012). During hard release, animals were released directly on the field, in some cases in artificial burrows, but with poorly closed holes, for example with grass. During soft release, animals are released into enclosures, in abandoned or artificial burrows with a retention cap (grass, bottle or stone) with a food supply.

All these activities were conducted in the north-western part of the species' range. The south-eastern part of the range, particularly Bulgaria, presents some unique ecological challenges and conservation opportunities. It is separated from the north-western part of the species' range by the Carpathians and the Djerdap Canyon of the Danube river (Ramos-Lara et al. 2014). The EGS population within the territory of Bulgaria has the highest genetic variability and is most likely to be the centre of the ancestral range (Říčanová et al. 2013, Chassovnikarova et al. 2015). The country's territory of 110.993 km^2 is unevenly distributed along the altitudinal gradient: 72% of the area is low elevation (0–600 m) and 27% is in the range 600–2925 m (Kopralev et al. 2002). This topography reduces the opportunities for selection and transfer of individuals in mountainous habitats, where the main protected areas are located. The EGS habitats in the mountainous regions are threatened by the reduction of grazing and pasture succession of shrubs, juniper and high grass vegetation (Koshev 2008). Conservation measures, such as pastures maintenance, have been implemented, especially after the accession of Bulgaria to the European Union in 2007. Eight EGS translocations were

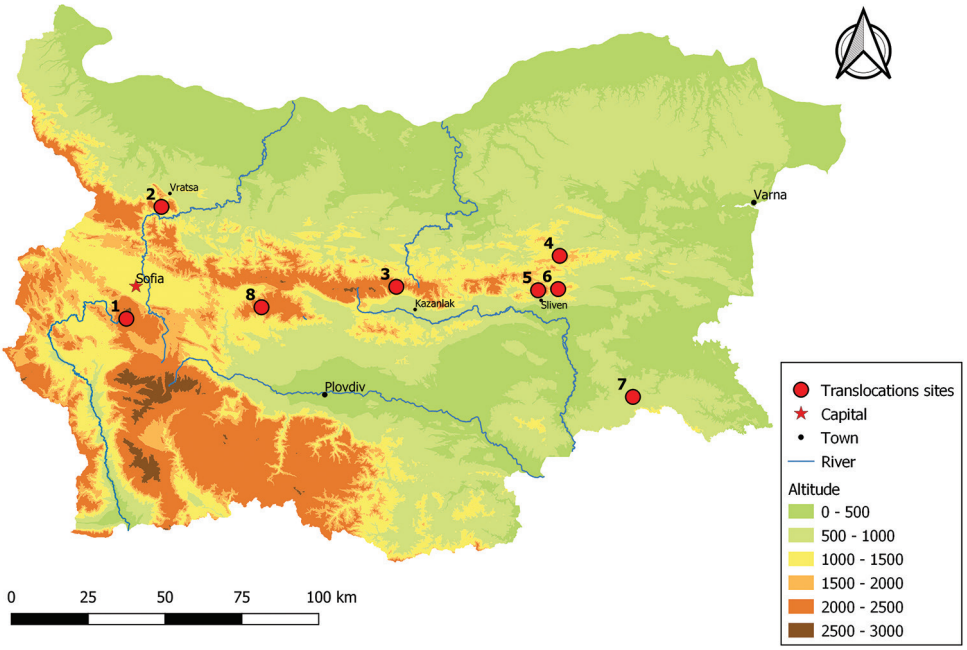

Figure 1. Map of the translocation sites of European ground squirrel in Bulgaria Legend: **1.** Vitosha NP; **2.** Vrachanski Balkan NP; **3.** Bulgarka NP; **4.** Kotlenska planina protected site; **5**. Sinite Kamani NP (Karakyutyuk and Karierata); **6.** Sinite Kamani NP (Golyamata chuka and Lokvata); **7.** Western Strandzha protected site; **8.** Luda Yana dam.

launched between 2010 and 2018. Not all the methods used have been published nor have their outcomes been analysed. The effectiveness of the translocations has not been systematically monitored.

The purpose of this article is to summarise existing information on EGS translocations in Bulgaria and to provide critical comments on the field methods and results. Four categories of information sources were used: 1) scientific publications and reports (Stoynov et al. 2013, Stefanov et al. 2016, Stoeva et al. 2016, Zidarova et al. 2018); 2) news from official websites; 3) personal data of the field crews (two sites in Sinite Kamani Natural Park (NP), one protected site in Kotlenska planina and Luda Yana dam translocations); 4) unpublished data of the authors for Vitosha NP, Vrachanski Balkan NP, Bulgarka NP and Western Strandzha protected site translocations. The unpublished data included description of the field methods and the results from 2-day field visits of 6 of the sites (without Western Strandzha and Luda Yana) in May-June 2017. The field data included burrows mapping and counting, observations and trapping. In 2018 Vrachanski Balkan NP, Vitosha NP and Luda Yana dam were visited.

An overview of the 8 translocations is presented in Table 1 and their locations are mapped in Figure 1.

Table 1. Translocations of the European ground squirrel in Bulgaria.

Location	NP Vitosha	NP Vrachanski Balkan	NP Bulgarka	Kotlenska planina protected zone	NP Sinite Kamani – Karakyutyuk and Karierata	NP Sinite Kamani – Golyama Chuka and Lokvata	Western Strandzha	Luda Yana dam
Natura 2000	Vitosha SCI&SPA[1] BG0000113	Vrachanski Balkan SCI BG0000166, SPA BG0002053	Bulgarka SCI&SPA BG0000399	Kotlenska planina SCI BG0000117, SPA BG0002029	SCI Sinite Kamani BG0000164, Sinite kamani – Grebenets SPA BG0002058	SCI Sinite Kamani BG0000164, Sinite kamani – Grebenets SPA BG0002058	Western Strandzha SPA BG0002066, Derventski vazvisheniya – 2 SCI BG0000219	Sredna Gora SCI BG0001389 SPA BG0002054
Type	Reinforcement	Reintroduction	Reintroduction	Reintroduction	Reinforcement	Introduction	Reinforcement	Rescue translocation, reinforcement
Finance source	OP[2] Environment 2007–2013	OP Environment 2007–2013	OP Environment 2007–2013	NGO own funds	OP Environment 2007–2013 project (Karakyutyuk); Life+ EU programme (Karierata)	OP Environment 2007–2013 project	Life+ EU programme	MRDPW[3]
Responsible organization	NPD[4] Vitosha	NPD Vrachanski Balkan	NPD Bulgarka	Wild Flora and Fauna Fund	NPD Sinite Kamani	NPD Sinite Kamani	Bulgarian Society for protection of Birds	IBER-BAS[5]
Duration	2011–2014	2013–2016	2013–2015	2011–2016, ongoing	2010–2014	2013–2014	2017–2019	2018
Number of locations	1	1	1	more in one area	2	2	1	1
Number of animals released	100	132	149	309	292 in Karakyutyuk 57 in Karierata	206 in Golyamata Chuka, 222 in Lokvata	167 (to be continued in 2019)	96
Method of release	Soft – in adaptation cages	Soft – in adaptation cages	Soft – in adaptation cages	Hard – in artificial burrows closed with dry hay or stone	Hard – in artificial burrows closed with dry hay or stone	Soft – in adaptation cage	Soft – in individual adaptation cages	Soft – in individual adaptation cages
Months of release	April–August	July – August	May - August	July	July–August	July–August	June–July	July
Altitude	1550 m	1420 m	1420 m	660 m	920 m	830 m	300 m	1380 m

Location	NP Vitosha	NP Vrachanski Balkan	NP Bulgarka	Kotlenska planina protected zone	NP Sinite Kamani – Karakyutyuk and Karierata	NP Sinite Kamani – Golyama Chuka and Lokvata	Western Strandzha	Luda Yana dam
Land property	State public	Municipality public and private	State-owned private and private	Municipality public and municipality-owned private, private	State public	State public	BSPB (NGO)	Mainly municipality public
Distance to the source population	36 km	44 km	13 km	27 km (to Topolchane village) 32 km (to Rechitsa and golf course)	13 km (to Topolchane village) 11 km (to Rechitsa and golf course)	13 km (to Topolchane village) 11 km (to Rechitsa and golf course)	75 km	10 km
Difference in the altitude to the source population	850 m	1320 m	970 m	470m	730m	630 m	110 m	780 m
Success in 2017/2018	Yes	Yes	Yes	Yes	Yes	No	Yes	–
Habitat preparation activities	Burrow digging with grass mowing	Burrow digging with grass mowing	Burrow digging	Burrow digging	Burrow digging	Shrubs clearing, grass mowing and burrow digging	Burrow digging	Burrow digging
Habitat maintenance activities	Grass mowing	Extensive horses grazing	Cattle grazing	Bushes removal and extensive livestock grazing	extensive sheep grazing	Shrubs clearing, sheep grazing until 2014	Extensive caws and sheep grazing	Grazing
Food provision	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Animal marking	Yes, transponders	Yes, transponders	Yes, transponders	Yes, toe-cutting in the more recent releases	Yes, with transponders and a hair dye	Yes, with transporters	Yes, with transponders	Yes, with hair dye
Guarding of release sites	Yes, for 30 days	Yes, for 3 days	Yes, for 30 days	No	Yes	Yes	Yes, for 10 days	Yes
Main threats and limiting factors	Lack of habitat maintenance	Unfavourable meteorological conditions	Unfavourable meteorological conditions	Decline in extensive grazing	Increased predators presence	Lack of habitat maintenece	Diseases of livestock	–

[1]Sites of Community Importance and Special Protection Areas in the Natura 2000 protected areas network (https://www.eea.europa.eu/themes/biodiversity/natura-2000/the-natura-2000-protected-areas-network#tab-data-visualisations) [2]Operational Programme [3]Ministry of Regional Development and Public Works [4]Nature Park Directorate [5]Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences

Field methods used in Vitosha NP, Vrachanski Balkan NP, Bulgarka NP and Western Strandzha protected site

All Vitosha NP, Vrachanski Balkan NP, Bulgarka NP and Western Strandzha protected site translocations were implemented following one common methodology. The methodology and the results have not been published before and that is the reason why they are described here. The animals were captured with "donski" type traps – perforated (holes of 5 × 5 mm) cylindrical metal box. Trap length was 300 mm and the diameter – 53–55 mm. The rear end of the trap was closed with a lid and, at the front, there was a backflow valve (Figure 2). The traps were placed at the burrow entrance. After being caught, the animals were placed in a dark, cool and airy place until they calmed down.

Standard body measurements were taken (length of ear, tail, head and hind foot) with a vernier caliper with 1 mm accuracy. The weight was measured with portable electronic scales TH-1000A with a maximum load of 1000 g and accuracy 0.5 g. In the Western Strandzha, the animals were measured with scales Joycare JC-405B / P / JC-445 with a maximum load of 5000 g and accuracy 1 g. All the locations in the survey were recorded with the Garmin Dakota 10 GPS device.

There are no requirements and recommendations in literature regarding the age and size of the animals used for reintroductions/reinforcements. The following trapped animals were not used in the reviewed translocations and, if trapped, were released back to the donor colony: animals less than 120 g, visibly sick animals (with external injuries and/or highly infected with ectoparasites such as fleas and ticks) and nursing females. The animals, suitable for translocation, were marked with individual transponders (Datamars 12/2 mm for Vitosha NP, Vrachanski Balkan NP, Bulgarka NP and Animal Microchip Syringe encased in 12/2 mm biodegradable glass for Western Strandzha protected site), injected subcutaneously between the two shoulders. Antiseptics were applied to the area with 70% ethanol prior the manipulation. The Datamars Micromax reader was used to read the transponders. The animals were transported in cylindrical boxes made of PVC tube with a length of 400 mm and a diameter 63 mm. On each box, there are 36 openings, 10 mm in diameter, arranged in 3 rows of 12 holes on each side. The transportation boxes were specially designed to ensure that the animals were not injured (Figure 3).

All trapped animals were released in pre-prepared holes at the translocation sites on the evening after the capture day. The minimum number of holes designated to a released individual was 5. They were located at 3 to 5 metre distance from each other. The holes, made with a motorised drill (Figure 4) were 60–100 mm in diameter, 695–700 mm long and at an angle of 45 degrees. After the animals' release, the holes were covered with grass or other material to calm down the animals in the burrow and prevent them from escaping.

Animals were released into adaptation enclosures, whose design and size varied amongst the translocation projects (Figure 4, more detailed description below). The goal of using adaptive enclosures, artificial holes and additional feeding is to reduce

Figure 2. A ground squirrel captured in the "donski" type trap.

Figure 3. Transportation boxes.

stress in the first days after animals are released, to avoid the panic displacement of individuals in inappropriate areas (forests, shrub complexes, urbanised territories etc.) and to reduce the risk of predation. Typically, a few days after the transfer, the ground squirrels found a way to leave the enclosures and settle nearby.

In Vitosha NP, Vrachanski Balkan NP, Bulgarka NP and Western Strandzha protected site, activities were implemented in accordance with the ethical recommendations and Guidelines for Reintroductions and Other Conservation Translocations IUCN / SSC (2013 and earlier) (IUCN / SSC 2013). Detailed information about the field practices is provided in the text.

Figure 4. Installation of adaptation enclosure in Vrachanski Balkan NP.

List of translocation projects

Reinforcement in Vitosha Nature Park

Vitosha Nature Park is located south of Bulgaria's capital – Sofia. The park covers the mountain Vitosha with an area of 270.79 km^2 and with an average altitude of 1317 m. The southern slopes of the park are predominantly pastures and meadows.

Prior to the translocation, a feasibility study was carried out by assessing the possible release areas and donor colonies. Four EGS colonies had historically been documented in the park, but the existence of only three of them has recently been confirmed (Koshev 2013). Over the years, there has been a decline in the distribution of the species on the park's territory. One of the densest colonies (near the village of Zheleznitsa) disappeared in 2004–2005, most likely due to lack of connection with other colonies, although the habitats were maintained in good condition by intensive cattle grazing (Stefanov and Markova 2009, Koshev 2008, Koshev 2013). According to Koshev (2013), the EGS population in the park's territory exists as small colonies (about 20–30 individuals) isolated from each other by geographic barriers (forests, gullies).

The activities for moving individuals started in 2011 under the leadership of the Vitosha NP Directorate (DNP). Animals were trapped in a colony near Kremikovtsi, city of Sofia (42.7918N; 23.4935E, 680 m a.s.l.), threatened by reduced grazing intensity, ploughing and covering with soil from the nearby mine. One of the highest densities in the country was previously calculated at this site, based on the number of holes: 15–120 individuals/ha (Stefanov and Markova 2009). The donor colony is

Figure 5. Adaptation enclosure in Vitosha NP (2011–2014).

36 km away from the release site and belongs to the same gene pool (Říčanová et al. 2013). The selected site is located southwest from Kupena peak (42.5185N; 23.2611E, 1530 m a.s.l.). A total of 5–15 ha of the site is maintained by the park through annual mowing with a self-propelled lawn mower (the area varies over the years).

The nearby game station "Vitoshko-Studena" contributes to the stable population of European roe deer (*Capreolus capreolus*) and red deer (*Cervus elaphus*) which graze in the release area. The deer are additionally attracted to the area by rock salt regularly placed by the park authorities.

A 150 m^2 adaptation enclosure was built to prevent attacks by predators (Figure 5). It had a reinforced base (inserted into the grass), walls of metal wire-net and a top of plastic mesh. Artificial burrows were created inside and around the enclosure. One hundred individuals were released inside the enclosure in the period 2011–2014 (Table 2). The sex ratio was 1:1.45 in favour of females. One-year-olds were 60% of all catches (data for 2012 were not available at the time of writing this article, but the proportions were similar).

The animals were released in several sessions with a maximum of 20 in the enclosure per session. The sessions occurred at intervals of 5 to 25 days. This allowed the previous group of animals to adapt and spread in the vicinity. After their release, the animals were observed daily for one month in order to prevent predator and human interactions and to collect data for their initial behaviour and adaptation. Sunflower seeds, wheat and apples were provided as supplementary food.

Reinforcement can be considered successful. In the first year (2012), the animals survived the winter and settled in the new place. In 2012, two individuals were seen at the release site. In 2013, 13 holes and several individuals were reported, with holes

Table 2. Sex and age ratio of the EGS, translocated in Vitosha NP.

Year	Period of realising	Female	Male	Juveniles and subadults	Adults	total
2011	8–9.08.	12	8	13	7	20
2012	25.04.–30.05.	*	*	*	*	40
2013	6–14.07.	11	9	9	11	20
2014	9–10.8.	12	8	15	5	20
Total		**35**	**25**	**37**	**23**	**100**

* data not available

found in a new location. In June 2017, the colony had moved about 150 metres away from the release site, 52 burrows were recorded and 4–5 individuals were observed. A one-year-old unmarked male was trapped. Thirteen holes were counted in 2018. The habitat is a humid meadow with naturally low vegetation and there was no evidence of grazing by livestock or mowing. The observed density was very low and the future survival of the colony is uncertain without further reinforcement and habitat maintenance.

Reintroduction in Vrachanski Balkan Nature Park

The Vrachanski Balkan Nature Park is located south of the regional centre Vratsa in the western Stara Planina mountain. The park has an area of 288.03 km^2 and an average altitude 700 m (Bechev and Georgiev 2016). There are historical data of the species' presence near the release site (Parshevitsa hut), but the species disappeared at the end of the 1950s due to a ban on transhumance (G. Stoyanov – unpubl. record, Nedyalkov and Koshev 2016). Vrachanski Balkan NPD started EGS reintroduction activities in 2013.

The release site (43.1379N; 23.4855E, 1420 m a.s.l.) had previously been maintained through mowing, horse grazing and rarely sheep grazing (Figure 6). Other favourable factors for the site selection were the limestone rock base, good soil permeability and southern exposure. Four adaptation enclosures were installed, each measuring 5 × 7 m or a total area of 560 m^2. They were covered with plastic mesh and their walls of metal wire-net were inserted into the grass. Artificial burrows were dug.

The closest mountainous EGS colonies are in Ponor Mountain and colonies have gradually been decreasing from 2008 to 2011 (Koshev 2014). Therefore, they were found to be inappropriate for donor colonies. In 2013, four individuals were transferred from the colony near the village of Chiren, but future captures were discontinued due the low density of the colony. A new donor colony was identified near the village of Kobilyak (43.5215N; 23.443E) which was situated 36 km away from the release site. This donor colony covered a large area and had a good density of 30–40 ind/ha. A total of 132 animals were captured and translocated during the 4 years of the project (Table 3). Five to seven animals (1 adult male, 1–2 adult females and several juvenile and sub-adults) were released in each enclosure. Oats and sunflower seeds were provided as supplementary food. An increased aggregation of predators (red fox

Figure 6. Picture of 2 of the 4 adaptation enclosures in Vrachanski Balkan NP.

Table 3. Sex and age ratio of the individuals, translocated in Vrachanski Balkan NP.

Year	Period of releasing	Females	Males	Juveniles and Subadults	Adults	Total
2013	4–15.07.	25	15	17	23	40
2014	13.06–12.08.	28	23	34	17	51
2015	19.07.	6	8	11	3	14
2016	30.07.	16	11	19	8	27
Total		**75**	**57**	**81**	**51**	**132**

(*Vulpes vulpes*), common buzzard (*Buteo buteo*), common ravens (*Corvus corax*) and common kestrels (*Falco tinnunculus*)) was observed around the enclosures.

The monitoring showed 2 adult and 1 juvenile animals in 2014, 4 animals in 2015 and 4 animals in 2016. In 2017, it was found that part of the colony had established 190–390 m away from the release site. A total of 58 holes were detected, 10 individuals were observed, 2 individuals were captured – one juvenile female and one adult male previously marked in 2015. In 2018, one individual was observed and 40 holes were counted. In the same year, the park's authorities reported observing ground squirrels 600 m away from the release site (Klyuchni dol locality). This information was not confirmed upon field checking.

The establishment of a colony and the juveniles observed/captured indicate that the translocation was successful. On the other hand, the number of observed individuals is too small and it can have a negative impact over a longer period of time.

Reintroduction in Bulgarka Nature Park

Bulgarka Nature Park is situated on the northern slopes of the Central Stara Planina mountain with an area of 236.9 km^2 and an average altitude of 870 m. A total of 89% of the park area is covered by forests. EGS colonies were previously documented in the area of Uzana hut (V. Popov – personal data for 2003), Karamandra locality, "St. Nikola" (Shipka) and Budzludzha peaks, all situated on the borders of the park (Koshev 2013).

A donor colony was selected near the village of Kran (42.6788N; 25.3770E, 480 m a.s.l.) – 12–13 km away from the release site. Location near the border of the park named Karamandra (42.7410N; 25.2510E, 1410 m a.s.l.) was selected for a release site. It has been inhabited by EGS in the past, according to the local people. The low (10–15 cm) grass vegetation is maintained by about 100 cows. The water source for the animals is located at a nearby hut built by the park authorities.

Four adaptation enclosures were built (5 m × 7 m or a total area of 560 m^2) (Figure 7). They were covered with plastic mesh (to prevent attacks by predators) and their walls of metal wire-net were inserted into the grass. Artificial burrows were dug. For the period 2013–2015, 149 individuals were released (Table 4). The sex ratio was in favour of females (1:1.48). The adult animals were 52%. Five to seven animals (1 adult male, 1–2 adult females and several juvenile and sub-adults) were released in each enclosure. Additional feeding (sunflower seeds, apple) was provided. The area had a permanent guard for one month. Predation by a young imperial eagle (*A. heliaca*), red fox (*V. vulpes*), common buzzard (*B. buteo*), common ravens (*C. corax*) and common kestrels (*F. tinnunculus*) has been observed.

In the period 2013–2014, the animals were released by less experienced externally hired experts. In 2015, the park's authorities independently organised releases on 10 July and 31 August (S. Staykov – unpubl. records). The later release date is close to the start of the hibernation for the species, which poses a threat to their successful adaptation.

In 2014, two individuals were observed and 11 holes counted. The grass was high, owning to the bad weather which forced local shepherds to move livestock to the mountains at a later date. In 2015, several animals were observed before the new release. In 2016, the park's authorities reported observing individuals, but this was not confirmed by the regular monitoring.

No signs of ground squirrels' presence were found at the release site in 2017. The colony was discovered on the southern slopes of Ispolin peak (42.7334N; 25.2520E) which is 720 m (suitable habitat path) away from the original release site at the same altitude (1420 m a.s.l.). Forty seven holes were counted, a minimum of 15 animals were observed and a juvenile female was captured. The habitat is in good condition with high plant diversity and sufficient grazing. The translocation could be considered successful, as the animals formed a colony and there were signs of reproduction. However, the colony's future is uncertain due to ongoing and expected new disturbances. The site is regularly visited by motor vehicles for sightseeing and is being researched for installing wind turbines.

Figure 7. Four adaptation enclosures built in the Bulgarka Nature Park (2013–2015).

Table 4. Sex and age ratio of the animals, translocated in Bulgarka Nature Park.

Year	Period of releasing	Females	Males	Juveniles and Sub-adults	Adults	Total
2013	22–23.06; 9–10.07.	23	17	19	21	40
2014	23.05; 14–28.06; 21–22.07.	21	20	23	18	41
2015	12–24.07; 10–31.08.	45	23	29	39	68
Total		**89**	**60**	**71**	**78**	**149**

Reintroduction in Kotlenska Planina Natura 2000 Site

Kotlenska Planina is a Natura 2000 protected site in Eastern Stara Planina mountain near the town of Kotel, with an area of 690.58 km^2 and highest peak Razboina (1128 m a.s.l.). The main habitat types are deciduous forests and secondary steppe habitats, maintained by livestock grazing (Stoynov et al. 2013).

The 2007 and 2008 assessment of the site's suitability for EGS translocation showed a shallow soil horizon, dense soil and rocky terrain (Y. Koshev – unpubl. records). The closest EGS colony is 25 km away (Stoynov et al. 2013), separated by severely intersected mountainous terrain which greatly hinders the natural exchange of individuals. According to Stefanov et al. (2016), EGS had been considered extinct in the region of Kotel since 1990 due to the decline of the extensive livestock-grazing. However, the historic presence of the species in this area is questionable because the four specimens from the Kotel Natural History Museum were from locations outside the target area (Y. Koshev, D. Ragyov – unpubl. records).

In 2011, the Fund for Wild Flora and Fauna started an EGS reintroduction project in the area Urushki Skaly (42.922N; 26.4617E, 660 m a.s.l.), where the organisation had been protecting and restoring semi-natural grassland habitats through traditional methods of cattle grazing since 2000 (Stoynov et al. 2013). The source colony inhabited a golf course near the town of Sliven (42.6386N; 26.2914E) where the species was unwanted. In 2014, the golf course failed, consequently the colony disappeared and a new source colony was designed (near Topolchane and Kaloyanovo villages, Sliven district, 42.666N; 26.441E, 180 m a.s.l.).

The animals were released in 6 sites that were not geographically isolated and were close to one another. Areas with weak slope, soil layer depth 60–80 cm and grass cover with height under 15–20 cm and projective cover below 80% were accepted as appropriate habitats (Stoynov et al. 2013; Stefanov et al. 2016). The animals were released in artificial burrows with tunnel length of 60–100 cm and a diameter of 5 cm. The translocation took place after the juveniles had attained independence and before the start of their hibernation (Stefanov et al. 2016). The initial releases in 2011 and 2012 were in two sites, 200 m apart from each other. In total, 309 individuals are released. The increase in the number of livestock due to the favourable conditions in 2011–2015 encouraged a new round of translocations in 2015 and 2016 (Stefanov et al. 2016). The number, the sex and the age ratio of the released animals are presented in Table 5 (according Stefanov et al. 2016, V. Stefanov – unpubl. records).

According to the official overview in 2013, 80 burrows were found (Stoynov et al. 2013). The area used is about 10 ha and the animals are concentrated in three distinct plots.

In 2014, there were 300 sheep of the Karakachan breed, 4 cows and about 20 goats in the region and about 30 inhabited holes were found in the area. Only a few holes have been found in some of the areas. Due to the rocky terrain, only in small, separate areas (with a sufficiently deep soil layer) have the animals managed to settle and dig their shelters.

In 2014, two colonies were observed within an area of 0.5 and 2.4 ha. The number of holes remained the same and the density was estimated at 5–10 animals/ha (Stefanov et al. 2016).

In May 2017, all the release sites were visited and interviews with the involved professionals were held. On the 2012, 2015 and on one of the 2016 release sites, fresh burrows were found and animals were observed. Neither holes nor animals were found on the 2011 release site and the second 2016 release site (more remote and dry). The overall habitat condition was very good: the grass height was less than 10 cm and was maintained by the local livestock which numbered about 300 cows, 300 sheep as well as goats and buffaloes.

Predation of ground squirrels in the area was confirmed several times: domestic cat (*Felis catus*), domestic dog (*Canis familiaris*) and common buzzard (*B. buteo*) (Stoynov et al. 2013).

This project involved one of the highest numbers of translocated animals in Bulgaria (Table 1). Due to the fact that new holes were found and juveniles observed, reintroduction can be considered successful. The hard release method is used as there

Table 5. Sex and age of the animals, translocated in Kotlenska planina (Stoynov et al. 2013, Stefanov et al. 2016, V. Stefanov – unpubl. records).

Year	Period of releasing	Females	Males	Juveniles	Adults	Total
2011	July	36	28	43	21	64 (57*)
2012	July	27	29	37	19	56
2015	–	25	19	39	5	44
2016	–	**	**	**	**	145**
Total		**88**	**76**	**119**	**45**	**309**

Note: * the authors give different data on released individuals in 2011 – according to Stoynov et al. (2013), there were 57 and according to Stefanov et al. (2016) – 64, the differences being at the expense of young male and female individuals; ** only the total number was available (V. Stefanov – unpubl. data).

is no evidence of: monitoring the populations from which the animals were caught; no use of enclosures; no data on weather conditions at release; not all individuals were marked; transport boxes were not used; the animals were not guarded from predators; no selection of individuals was performed on the basis of their individual weight, infestation with external parasites, physiological and health status. Under these conditions, it is easy to explain the observations by Stoynov et al. (2013) and Stefanov et al. (2016) that the animals dispersed and rarely inhabited the artificially-made burrows.

Sinite Kamani Nature Park – two main translocations

Sinite Kamani NP, with an area of 113.80 km^2, is located in Eastern Stara planina mountain, north of the town of Sliven. Its altitude is between 300 m and 1181 m. The EGS conservation status became unfavourable on the park's territory in the late 1980s and early 1990s due to the abandonment of extensive farming and pastures (Koshev 2013, Stoeva et al. 2016). This status encouraged a reinforcement project, which started in 2010 and was led by NPD Sinite Kamani.

Prior to the start of the translocation, a study of the potential donor colonies was carried out in the lowland in a perimeter of about 30 km around the town of Sliven. The main donor colonies selected were: the golf course in Rechitsa district (Sliven) (12 km away) and the pastures of the villages of Topolchane and Kaloyanovo (7–12 km away). These populations belong to the same genetic line (Říčanová et al. 2013) and provide appropriate source colonies. Their density has been studied and threats to the colonies have been evaluated. Both colonies are at risk. The animals in the golf course were purposefully killed by the owners and later, when the course stopped functioning in 2013, habitat succession restarted. The pastures around the villages of Topolchane and Kaloyanovo are ploughed for farming and there is a high mortality rate from the nearby busy road Sliven–Burgas.

For the purpose of translocation, the animals were trapped in the golf course until 2014 and near Topolchane village after that. "Donski" type traps and rat traps with apple bait were used. The individuals were marked with standard Felixcan microchip transponders. They were placed in transport boxes and transported to the release sites

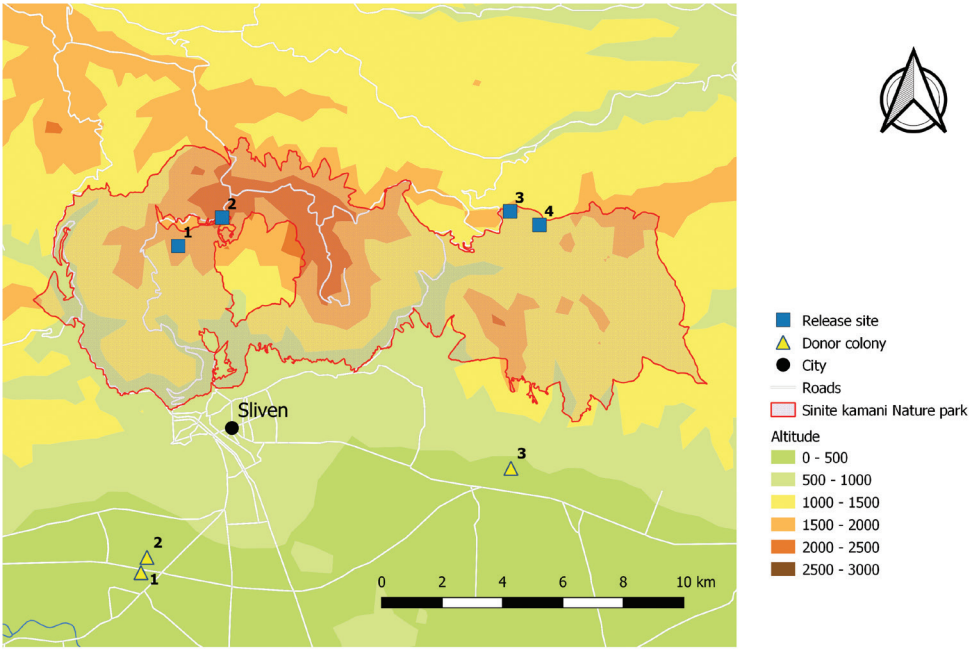

Figure 8. The translocation sites and main donor colonies in Sinite Kamani Nature Park. Legend: Translocations (squares): Reinforcement in the sites Karakyutyuk (**1**) and Karierata (**2**); Introduction in sites Golyamata chuka (**3**) and Lokvata (**4**). Main donor colonies (triangles): (**1**) Rechitsa district, (**2**) golf course, (**3**) villages of Topolchane and Kaloyanovo.

on the day they were caught. All related activities and manipulations were performed in the presence of a veterinarian. Juveniles, underweight individuals and visually unhealthy animals were not translocated (Stoeva et al. 2016).

In the region of "Sinite Kamani" NP, two different type of translocations (reinforcement and introduction) were implemented at four locations (Figure 8). As the release sites were separated by landscape barriers such as forests and gullies and adaptation fences were used on some but not others, they were considered distinct translocations, despite all being on the park's territory.

Reinforcement in the Karakyutyuk and Karierata sites

Karakyutyuk site (42.7375N; 26.3049E, 930 m a.s.l.), has an area of 34.56 ha and harbours a small EGS population of almost critically low abundance (about 20 individuals). In order to increase the habitat quality, the shrub and tree vegetation was cleared and the site was managed through extensive sheep grazing and mechanical maintenance. Additional food was provided. There was a spreading of clover seeds to improve the vegetation. Artificial burrows (80 cm deep at 45°) were dug. The animals were released in the evening after being trapped. The holes are plugged with a large tuft of grass. The

Table 6. Sex and age ratio of the animals, translocated in Karakyutyuk site (Sinite Kamani Nature Park) (Stoeva et al. 2016).

Year	Periods of releasing	Female	Male	Juveniles	Juveniles/ 1st year	Adults/ 1st year	Adults	Total
2010	7–22.07.	27	30	23	9	3	22	57
2011	30.06.–23.08.	67	52	68	8		43	119
2012	25.06.–25.07.	35	31	41	–	–	25	66
2013	19.08.	5	5	–	6	–	4	10
2014	28.6.–22.7.	22	18	–	25	–	15	40
Total		**156**	**136**	**132**	**48**	**3**	**109**	**292**

activities continued annually from 2010 to 2014. The exact periods of release, number, sex and age of the repatriated animals are presented in Table 6 (Stoeva et al. 2016).

The estimation of the sex index for the entire period shows that females prevailed, accounting for 53.4% of the individuals, compared to males – 46.6%. Most of the released individuals were juveniles (45.2%), while the adults comprised 37.3% (Stoeva et al. 2016). The post release guarding was implemented though camera-traps in key locations and supplementary feeding to divert the predators. Guards were also present to monitor the behaviour of the individuals and chase away predators.

A remarkable success was reported in 2014, the number of holes increasing by 520% compared to 2010. With the active holes providing a more precise picture of the relevant population abundance of the species, there was an impressive increase by 1352% compared to the numbers recorded in 2010 prior to the release of the first individuals (Stoeva et al. 2016).

In June 2017, 62 holes were counted through the transect method. Several animals were seen. The habitat was in good condition, with low grass cover. Although the site is rocky, which is generally considered unsuitable for the ground squirrel, there was no apparent preference observed for the less rocky areas. Many burrows were dug directly under the stones and some were even dug under the fence's poles fixed in cement. A possible explanation is that the fence provides a defence against raptors by hindering their flight. The raptors are abundant in the area and a couple of booted eagles (*Hieraaetus pennatus*) were reported feeding regularly on the colony. European wildcats (*Felis silvestris*), golden eagle (*Aquila chrysaetos*), golden jackals (*Canis aureus*), hawks (*Accipiter* sp.) and foxes (*V. vulpes*) were also observed. The increased predator pressure could also be due to the proximity of a vulture feeding site (although a camera trap showed EGS feeding there). Human presence and livestock grazing in the area are prominent. Two hundred sheep are owned by the NGO and they plan to increase this number to 500. This will assure the habitat maintenance.

In conclusion, the reinforcement in the Karakyutyuk region has been successful. An increase in both the area and the number of holes was recorded. The following success factors were identified: initial presence of animals, preparation of the habitat, existence of sustainable grazing, maintenance of the habitat and sufficient number of individuals, properly selected for release, nourished and secured.

Karierata site (42.7417N; 26.3217E, 1070 m a.s.l.) is located at the foot of the highest peak (Bulgarka) in the Natural Park Sinite Kamani, 1.3 km away from the Karakyutyuk. In May 2011, a small EGS colony was found. This colony was near a stone quarry at the foot of the peak. It is connected with the Karakyutyuk site through suitable habitats and maybe the two colonies were part of single colony split after a drop in the population number (E. Stoeva, I. Ivanov – unpubl. records). There were 38 holes in 2011, of which 29 were active. One individual was observed and two others were heard. Researchers suggested that this colony was on the verge of extinction and, therefore, proceeded with its reinforcement in 2016 and 2017 (Table 7), which is still ongoing (E. Stoeva, I. Ivanov – unpubl. records).

Table 7. Sex and age ratio of the animals, translocated in Karierata site (Sinite amani NP).

Year	Period of releasing	Females	Males	Juveniles	Subadults	Adults	Total
2016	8–21.07.2016	15	17	4	–	28	32
2017	–	11	14	8	–	17	25
Total		**26**	**31**	**12**	**–**	**45**	**57**

In 2017, the habitat seemed appropriate – there was a natural low grass cover – although it was stony and near a road. Fresh holes and excrement were found, but no animals were observed. Fifteen holes with faeces were counted. The reinforcement continues, so it is still not possible to evaluate the success of the activities.

Introduction in the Golyamata chuka and Lokvata sites

The places for introduction are selected by the NPD Sinite Kamani without preliminary research. There is no historical data on the EGS presence there. The area consists of several open habitats surrounded by forests with a total area of 45 ha.

Golyamata chuka locality (42.7446N; 26.4396E, 830 m a.s.l.) has an area of 6.8 ha. Initially, part of it (1.36 ha) was cleared in 2013, then the entire area was cleared in 2014, leaving single trees and shrubs (5% of the area). The nearest EGS colonies are 10 km (Karierata) and 12 km (Karakyutyuk) away. A fence, enclosing an area of about 500 $m^{2,}$ was built in 2013 and this was doubled in 2014 to reach an enclosed area of 1000 m^2 (Figure 9). The wire-net was buried 10 cm in the ground. Artificial burrows (40 cm deep, 7 cm in diameter) were dug at an angle of 45° inside and around the enclosed area. Security cameras and signs were installed. The animals were fed with wheat and guarded for 1 month. Sheep grazing by a local farmer was implemented in the summer of 2014 and 2015 and high vegetation was cleared 2 times (E. Stoeva, I. Ivanov – unpubl. records).

A total of 207 individuals were released at that site – 101 in 2013 (caught on a golf course near Sliven) and 106 in 2014 (caught in Topolchane colony and golf course) (E. Stoeva, I. Ivanov – unpubl. records) (Table 8). The estimated survival after the first year of the translocation was 10%. Only 7–8 animals were found in 2015. The population kept decreasing and no signs of ground squirrels' presence were found on the site in 2017.

Figure 9. The adaptation enclosure in Golyamata chuka locality in 2014 (**a**) and 2017 (**b**).

Table 8. Sex and age ratio of the animals, translocated in Golyamata chuka site (Sinite Kamani NP).

Year	Period of releasing	Males	Females	Juv	Subadults	Adults	Total
2013	–	–	–	–	–	–	101
2014	10.06–17.07	52	54	44	–	62	106
Total							**207**

Table 9. Sex and age ratio of the animals, translocated in Lokvata site (Sinite Kamani NP).

Year	Period of releasing	Females	Males	Juveniles	Subadults	Adults	Total
2010	21–22.07	33	18	25	10	16	51
2011	–	59	62	73	7	41	121
2013	August	–	–	–	–	–	10
2014	21–27.07.	–	–	–	–	–	40
Total							**222**

In **Lokvata** locality (42.7394N; 26.4516E, 780 m a.s.l.), with a total area of 2.65 ha, is a former pasture heavily overgrown with shrubs. The release area of 0.74 ha was cleared for the translocation. The area is 1 km away from Golyamata Chuka, 10 km from Karierata and 12 km from Karakyutyuk. It is separated from the former two sites by forests and gullies. In total, 222 individuals were released (E. Stoeva, I. Ivanov – unpubl. records) (Table 9).

The monitoring of Lokvata's activities shows a modest initial success – 12 active holes were mapped in early June of 2013, 66 holes were counted in 2014 and 84 holes again in 2014 after releasing the new animals (E. Stoeva, I. Ivanov – unpubl. records). According to the project staff, the success of the introduction was hindered by the succession of pastures and the lack of remnant colony. The 2017 monitoring showed no presence of EGS and shrubs cover of more than 40%. The cottage and the photo-shelter built on the site were abandoned.

In conclusion, the Golyamata chuka and Lokvata translocation activities could be considered unsuccessful as no sign of ground squirrels was found in 2017. The most likely causes are the rainy and cold weather in 2014 (see Discussion), as well as the lack of data for the EGS presence in the past, the small and fragmented habitats and insufficient habitat maintenance (Figure 9).

Reinforcement in Western Strandzha Natura 2000 Site

The Natura 2000 site Western Strandzha (BG0002066) is situated in a hilly area in south-eastern Bulgaria near the border with Turkey. The EGS populations in the region are declining (Koshev 2013, Y. Koshev, D. Demerdzhiev – unpubl. records) because of pasture abandonment. A reinforcement of the colony near the village of Momina Tsarkva (42.1513N; 27.0061E, 300 m a.s.l) was started in 2017 by the Bulgarian Society for Protection of Birds (BSPB) in partnerships with local farmers. The activities' core area (1.65 ha) is owned by the same non-government organisation. The surrounding area (around 10 km^2) is constantly grazed by sheep and cows. Thirty seven individual cylindrical adaptation cages (51 cm high, 45 cm in diameter) were built to reduce the stress (Figure 10). Each of them was placed above an artificial burrow. Ninety six animals were translocated from the Topolchane and Kaloyanovo colony in 2017 and an additional 71 in 2018 (Table 10). This donor population was chosen because of its size, demography and genetic similarity (Říčanová et al. 2013). Apple, carrots and sunflower

Table 10. Sex and age ratio of the animals, translocated in Western Strandzha.

Year	Period of releasing	Females	Males	Juveniles	Subadults	Adults	Total
2017	6–19.07	54	42	49	14	33	96
2018	21.06–19.07	35	36	34	8	29	71
Total		**89**	**78**	**83**	**22**	**62**	**167**

Figure 10. A ground squirrel released in the individual cage for initial adaptation in Western Strandzha protected site.

seeds were provided as supplementary food. The animals' adaptation progress in the new environment was documented by recording their behaviour through radio-tracking and direct observations. Samples were taken for stress hormones and endoparasites.

Rescue transfer (reinforcement) of EGS from the bottom of "Luda Yana" dam

In 2016, the Ministry of Regional Development and Public Works (MRDPW) resumed the construction of Luda Yana Dam near the town of Panagyurishte and overflowing was planned for 2018. An EGS colony had been reported to exist in the flood-threatened zone in 1997–2018 (S. Lazarov, Y. Koshev, S. Uzunov - unpubl. records). The colony occupied an area of 0.420 km^2 (42.5229N; 24.2044E) at 550–600 m a.s.l. A total of 90% of it was destroyed during the construction of the dam by removal of the humus soil layer, pouring of earth masses into the EGS habitat, disturbance from the construction machinery and other construction-related activities (Figure 11). A small, core part of the colony occupying an area of 0.04 km^2 survived near the river before the flooding of the dam. In June 2018, the colony was estimated to have about 70–150 active holes or about 50–60 adults. Juveniles were observed at that time.

In the period 24.06–20.07.2018, the first EGS rescue translocation in Bulgaria began. About 90 artificial burrows were dug at the release site. They were 60–80 cm deep

Figure 11. EGS colony in the future bed of the Luda Yana dam, June 2018.

and have a 45° slope. Ninety six animals (of which 68 were juveniles) were trapped and temporarily marked with hair dying. They were transferred 10 km away to the Belotrup area (42.6095N; 24.2561E, 1380 m a.s.l.). Individual adaptation cages were placed over the artificial burrows. Additional feeding (seeds, carrots and apples) was provided (World Bank news, Zidarova et al. 2018).

The Belotrup area was inhabited by a viable colony prior to the translocation. The habitat was a maintained pasture with an active hut and artificial ponds (Koshev 2013, Y. Koshev, D. Ragyov – unpubl. records). The population for the whole protected site was estimated at 0.73 burrows/100 m transects (n = 71) (SD = 1.38) and the conservation status was unfavourable-bad (Koshev 2013). There is no evidence that the specific population in Belotrup has been subjected to anthropogenic pressure, negative factors or risk of extinction.

Shortly after the translocation, the release site experienced severe disturbance: an annual gathering involving more than 130 high passable off-road vehicles took place on 5–10 July 2018. The event included building of temporary camps, tents and feeding places, as well as fires and loud music. Historical events were recreated with gunshots and pistols (Srednogorie website, P. Tsvetkov – personal communication). All these activities likely impacted the adaptation and acclimatisation of the animals. In addition, the months of June and July 2018 were extremely rainy. The target area is located on a mountain ridge where rainfall is more frequent and more abundant (NIMH-BAS 2018). The results of this first rescue and EGS repatriation in Bulgaria are yet to be assessed in the coming years.

Discussion

Assessing the success of translocations in Bulgaria

A total of 1730 EGS individuals were translocated in Bulgaria between 2010 and 2018. The success of the activities was assessed according to three criteria: survival (phase I), settlement (phase II) and reproduction of the released animals (phase III) (Letty et al. 2003, Teixeira et al. 2007, Matějů et al. 2012). Therefore 5 out of 6 accomplished translocations (83%) where reproduction was detected can be considered successful. In other parts of Europe (Matějů et al. 2010, 2012), only half of the relocations were successful. The relatively higher success in Bulgaria is probably due to the accumulated experience from Central Europe shared in numerous articles (Adamec et al. 2006, Balaz et al. 2008, Ambros 2008, Matějů et al. 2010, 2012, Tokaj et al. 2012, Lobbová and Hapl 2014), guidelines (Hapl et al. 2006), experimental studies (Gedeon et al. 2011, 2012) and others. Failure is probably due to poor preparation of the new site, lack of further habitat maintenance and/or poor weather conditions.

In some cases, even if the repatriation is reported successful, the number of individuals in the newly formed populations is low, which can lead to inbreeding or population density reduction when catastrophic events occur (heavy spring snowfall or

torrential rains). That is why the populations in Vrachanski Balkan NP and Bulgarka NP should be strengthened with more individuals.

Our analysis shows that choosing the right release site is crucial for rescue transfers. In the case of Luda Yana dam, the release site was inhabited by a stable known population, well connected with other populations. There were no data to indicate that it was decreasing or at risk (Koshev 2013). Bringing more individuals to it was expected to lead to a temporary increase in the population size. Then, once the capacity of the environment was reached, the number of the individuals should drop to the pre-release level. Uncertainty remains whether such rescue actions have only short-term positive effects and do not contribute to the species' conservation in the long-term. Although the genetic diversity is expected to increase in the reinforced colony, there is an increased risk of introducing parasites (Golemansky and Koshev 2009) and diseases to a healthy population.

Target areas, funding sources and sustainability

Translocations were conducted in two types of protected areas: Nature Parks and Natura 2000 sites. The Nature Parks are preferred for several reasons. First, the land there is often owned by the state or municipalities. Another advantage is that the park administration manages the grazing and mowing, gain extra funding (OPE), guard the areas etc. A possible drawback is that NPDs tend to prepare similar project proposals for reintroductions/reinforcements without implementing preliminary research or consultation with a specialist, which leads to difficulties with the choice of release place, donor colony etc.

Translocations in Natura 2000 sites include Kotlenska Planina Mountain, Western Strandzha and Sredna Gora (Luda Yana Dam). The Natura 2000 network also could be suitable for such activities – some funding opportunities exist. The main problem is the ineffective protection that only exists "on paper" (Duprey 2014). Examples are the EGS colonies on the pastures of the villages of Topolchane and Kaloyanovo (Figure 12) or Besaparski ridove that are being ploughed despite their conservation status (Nedyalkov and Koshev 2014).

In Kotlenska Planina, the ownership of the land in the release site is not mentioned by the authors (Stoynov et al. 2013, Stefanov et al. 2016), but the organisation leading the activities (Fund for Wild Flora and Fauna) has managed the habitat through sheep herding for several years. In Western Strandzha, the activities have been implemented on land owned by another non-government organisation, the BSPB and the management of the habitats has been undertaken jointly with the farmers – partners of a LIFE project.

Sometimes, the planned and the actual dispersal of released animals differ. For example, the target area in Bulgarka NP is on the border of the park as this was the only suitable habitat with available data for the species' presence in the past. However, the new colonies have settled outside its borders of Bulgarka NP in the Natura 2000

Figure 12. Source colony of Topolchane and Kaloyanovo EGS habitat freshly ploughed (2018).

protected site "Central Balkan – buffer" on land owned by the state where grazing is still subsidised, but a new threat from wind turbines has recently emerged.

Most of the translocations described (6) are financed under the Operational Programme Environment (OPE) of the European Union and one translocation (in the Western Strandzha) is financed under the EU's Life + program. The rescue action is financed by the MRDPW, which is a precedent for Bulgaria. One translocation (that in the Kotlenska Mountains) had no specified funding and was probably undertaken with the responsible NGO's own resources. The main donor – OP Environment – does impose some restrictions, such as the impossibility to postpone the activity for another year in the presence of unfavourable climatic conditions, as those observed in 2014. That lack of flexibility could lead to increased mortality amongst the translocated animals.

EU funds are crucial for conservation activities, such as EGS translocations, because national funding is lacking. Since all funding is project-based, with funds covering only the translocation activities, it is difficult to conduct systematic monitoring that reliably assesses the conservation effect. The same applies to the site management (mowing, grazing that also requires special regular funding). In the cases where such management is necessary, the end of the funding project could also be the end of the habitat maintenance activities (Figure 9b). When the agricultural activities maintaining the habitats in the target areas are stimulated by EU subsidies, changes in EU's

common agricultural policy could have huge consequences for the newly established colonies. One possible solution for implementation in the Western Strandzha translocation is to choose an area owned by the organisation implementing the project. Even in that case, there is a certain degree of dependence on the surrounding conditions as the grazing is provided by local farm animals. Another possible solution is practised by the NGO Green Balkans, which has its own livestock permanently based in the area (Sinite Kamani NP).

Choice of source colony, genetic diversity and risks

In 4 translocations (Sinite Kamani NP (2 cases), Kotlenska planina and Western Strandzha) the main donor colony was in the pastures near the villages of Topolchane and Kaloyanovo (Sliven region). This is the Bulgarian EGS population with the highest genetic diversity (Říčanová et al. 2013). It is only partially protected, with a small part being included in the Natura 2000 protected site, designed according to the Birds Directive, but not protected by the Habitats Directive. The estimated density in 2016 is 12.95 holes / 0.05 ha. One of the highest densities of EGS in the country is believed to be here.

Part of the area is recorded as agricultural land in the registers, although it has been used for over 20 years as pasture. Landowners, stimulated by the EU subsidy policy, are taking steps to plough the pastures (Figure 12). Since it is impossible to predict which section will be ploughed next, we consider the translocations to be rescue actions.

The choice of the other donor colonies was mostly driven by the available options. Since the activities are implemented in mountainous areas (on the territories of Vitosha NP, Vrachanski Balkan NP, Bulgarka NP) where no suitable source colonies existed, the donor colonies were from relatively distant regions.

A very important feature of the donor colony is that it should be from the same genetic pool as the area of release or the colony that is amplified. According to Kryštufek et al. (2009), the planning of EGS conservation and translocation activities in Bulgaria should be particularly careful due to the presence of the two genetic lines on the territory of the country.

Difference in altitude between donor colonies and release sites

In Bulgaria, EGS is distributed from the sea level to more than 2500 m. The highest altitude records are for 2593 m in Rila Mountain (Y. Koshev, V. Milushev - unpubl. records). The species also occupies high altitudes in Vitosha Mts, Rodopi Mts, Sredna Gora Mts, Central and Western Stara Planina Mts (Koshev 2008). Most of the countries' conservation areas, such as nature parks, are situated in the mountains. Yet, few suitable donor colonies are available there. For this reason, the altitudinal difference between donor and release sites in seven of the analysed translocations ranged from 470 to 1320 m. Even when high flexibility existed regarding the translocation area

(Luda Yana dam), the animals were still transferred to an area located about 800 m higher than where the initial colony was.

The difference in altitude has several negative effects:

– With every 100 metres increase in elevation, there is a decrease in temperature by 1 °C. Increasing altitude also increases the wind speed. Weather in the mountains is rainier and windier, i.e. less favourable than in the lowlands (Kopralev et al. 2002). In these conditions, the daily activity period of the EGS is reduced (Katona et al. 2002, Koshev and Kocheva 2008).
– Translocations are carried out on the mountain ridges where the open alpine area is usually the suitable habitat. In these areas, the rainfall and the wind speed are especially high.
– EGS has a pronounced life cycle dominated by hibernation. Due to different mountain conditions, the difference in hibernation period may reach up to 2 months (Y. Koshev – unpubl. records).

These altitude differences lead to numerous related problems. When EGS in the lowlands are in a period of growing and the juveniles need to be moved to a higher altitude, the warm season has not yet started there; temperatures are low, especially during night and morning hours. The vegetation is not yet well-developed, the grasses give seeds later in the season etc. The type of habitat and hence the food resources differ. Ružić (1950) found that females from mountain areas in Serbia have more embryos (average 6.1) than females from lowland (average 4.7). Additionally, the reproduction season in mountain populations is shorter (5–12 days) in comparison with lowland populations (about 30 days). Therefore, newly released individuals encounter a number of difficulties that may lead to reduced adaptability, frostbite, higher mortality etc., in addition to the stress related to the transfer itself. The active period in the mountains is shorter and the EGS have less time to accumulate body fat and build suitable burrows.

Attempts have been made to solve these issues by moving the animals earlier (in April, May, June) and avoiding transferring pregnant or nursing females and young animals. This strategy has shown initial positive effects in Vitosha NP and Bulgarka NP (Koshev, Arangelov – unpubl. records).

Climate conditions in the year of release

The weather conditions in two years (2014 and 2018) of the period reviewed (2010–2018) were particularly extreme. All the translocations, with the exception of that in Kotlenska planina, involved activities in one of these years.

For the whole territory of Bulgaria, the monthly precipitation amount in 2014 was above the normal in April, June and September. For the whole period of April to July, rainfall was above normal. Increased rainfall leads to a positive accumulation of water in the soil. In the same two years, temperatures were exceptionally high in February and the temperature anomaly in the spring and summer was negative. The 2014 win-

ter season started with high temperatures, which helped to make the snow melt faster while the summer was relatively cold, which is a prerequisite for the slower soil drying and its several months of water saturation (Tepsizova 2017). Similar climatic conditions were observed in the summer of 2018 (NIMH-BAS 2018).

In 2014, extreme rainfall was recorded in the area of Vrachanski Balkan NP on 15–20.04.2014, 30–31.07.2014 and 2–7.09.2014. There was local intense rainfall and high soil moisture, which led to flooding in surrounding villages. In the area of Bulgarka NP, extreme rainfall and flooding was registered on 28–31.05.2014 (Stoycheva et al. 2015).

The abundant rains flood the holes, cause drowning and hypothermia. EGS are scattering mammals that spend much of their lives underground, making them particularly vulnerable. Numerous cases of mass death caused by floods and rains (Hoffmann et al. 2003) resulted in translocation actions (Lobbová et al. 2012). In Bulgaria, Stoyanov (2001) reported hundreds of drowned EGS in the Ponor Mountains at 1200 m a.s.l. (Western Stara Planina) after heavy rains. This could be especially valid after translocation in artificial burrows which initially have simple structure and cannot yet provide the protection of the animal-made ones. Increased rainfall also causes higher grass cover, which has negative impact for EGS.

Independent resettlement away from the release site

It is notable that, on 4 occasions, the animals settled several hundred metres away from the release site. This has been observed during the translocations in Central Europe, but the distances observed in Vrachanski Balkan NP and Bulgarka NP are the largest reported (Table 11).

Table 11. Distance (m) from the release site to the resettlement point reported in literature compared with the data of the current article.

Translocation	State	Distance from the release site (m)	Reference
Pod Okrúhlou skalou (Tisovec)	Slovakia	30	Lobbová, Hapl 2014
Ponitrie Protected Landscape Area	Slovakia	200	Matějů et al. 2010, 2012
Malé Karpaty Protected Landscape Area	Slovakia	250	Matějů et al. 2010, 2012
Malé Karpaty Protected Landscape Area	Slovakia	100	Matějů et al. 2010, 2012
Malé Karpaty Protected Landscape Area	Slovakia	200	Matějů et al. 2010, 2012
Slavkovský les Protected Landscape Area	Czech Republic	350	Matějů et al. 2010, 2012
Kotlenska Planina Natura 2000 Site	Bulgaria	500	Stefanov et al. 2016
Kotlenska Planina Natura 2000 Site	Bulgaria	100	Stefanov et al. 2016
Vitosha Nature Park	Bulgaria	150	current study
Vrachanski Balkan Nature Park	Bulgaria	290	current study
Vrachanski Balkan Nature Park	Bulgaria	600	current study
Bulgarka Nature Park	Bulgaria	720	current study
Average		290.8	
Min		30	
Max		720	
n		12	

This could be explained by the microhabitat conditions where the slope, the wind, the soil type and depth and the vegetation vary widely and are hard to assess at first sight. In that case, the exact data about the species' occurrence in the past could be precious, but was not present in the investigated cases. This resettlement indicates that the animals' perception of habitat suitability could differ from conservationists' opinion and project restrictions. Thus, the possibility for moving and the conditions in the surrounding territories (300 to 720 m around) should be considered during the process for selection of the release area. For example, the resettlement in the Bulgarka NP led to the current colony being situated outside the park's boundaries and is now threatened by wind power plants. In Vrachanski Balkan NP, after its movement, the colony is partly on private land so its protection is not guaranteed.

Conclusions

1. Between 2010 and 2018, 8 translocations of more than 1730 individuals were performed in Bulgaria for different purposes: 4 for reinforcement of old colonies, 3 for reintroductions and 1 for introduction. Currently two translocations are ongoing.
2. Five or 83% of the translocations were successful, but two had a critically low number of established individuals – Vrachanski Balkan NP and Bulgarka NP.
3. Six translocations used soft release methods and two translocations – hard release. In six cases, released individuals settled from 100 to 720 m away from the place of release, which imposes management and protection of larger areas.
4. In seven cases, there was a difference in altitude between the donor colony and the release site of 470 to 1320 m a.s.l., which could have a hindering effect on the adaptation of animals due to the specific conditions in the mountains and the preparation for hibernation.
5. The main reasons for failure were probably related to poorly selected and maintained habitats, as well as poor climatic conditions (rainy and cold weather).
6. European funds are of critical importance with only two translocations funded by other sources.

Recommendations for the future

1. The IUCN / SSC (2013) recommendations for translocation of individuals and the recommendations of Matějů et al. (2010, 2012) should be followed, for example to undertake a preliminary study to check whether the donor colonies and the translocation sites meet the requirements.
2. Soft release methods should be used (using enclosures, guarding, artificial holes, additional feeding).
3. The number of individuals should be consistent with the initial success [the three phases of Letty et al. (2003), Teixeira et al. (2007), Mateju et al. (2012)], post-

release-monitoring to be a mandatory part of projects. Rules for interruption of the translocation should be adopted when it fails – for example no surviving individuals and breeding.

4. Maintaining the habitat and even the populations, if needed, should continue after the project's end. The funding sources should be diverse so that there is flexibility in the implementation of the activities. Translocation activities should not be undertaken during a given year in the case of unacceptable factors, such as bad meteorological conditions.
5. Larger areas around the translocation sites should be designed and maintained taking into account the migration (movement) of the individuals described in the current article. The releasing sites should be far from the protected areas' edges so that individuals remain under protection despite their dispersal.
6. Moving individuals from low to high altitudes should be avoided, if not necessary. If case it is inevitable, undertake translocation activities only under appropriate meteorological conditions and in a season consistent with the active cycle of individuals, carefully selecting the age, sex and physiological state of the animals.
7. A scientific database should be created hosting detailed information about past, current and future activities related to translocation of EGS (including reintroduction, restocking, translocation, repatriation, restoration, recolonisation etc.) aiming for standardisation and harmonisation of the activities. This need is due to the constantly increasing number of translocations of EGS that, if not planned carefully, could hinder the unique genetic diversity of the species in Bulgaria.

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Supplementary material 1

Translocations of European ground squirrel (*Spermophilus citellus*) along altitudinal gradient in Bulgaria – an overview

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