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Population Boost of the Griffon Vulture *Gyps fulvus* (Hablizl, 1783) (Accipitridae) in Bulgaria Based on Reintroductions

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Abstract: The griffon vulture was considered to be extinct as a breeding bird in Bulgaria by the end of the 1960s. In 1978, the species was rediscovered in the Eastern Rhodopes with one breeding pair and less than 30 immature individuals. Despite the success of the immediately initiated and later intensified conservation measures the species increased very slowly and in next three decades the breeding area remained relatively small, ranging 20 to 30 km along Arda River. To boost the recovery of the species along the country, by means of acclimatization aviaries, releases of captive bred and translocated birds from Spain and France, has started in 2010. For seven years, more than 275 individuals were freed in five reintroduction sites – four along Balkan Mountains and one in the Kresna Gorge. In 2016, the first successful fledging of 11 chicks and total number of 25 breeding pairs marked the successful reintroduction of the species in three new sites, as follows: Vrachanski Balkan Nature Park – 10 pairs and 4 fledglings; Eastern Balkan Mountains – 8 pairs and 5 fledglings; the Kresna Gorge – 7 pairs and 2 fledglings. This led to further increase of the national population of the species with some 20%. Together with the on-going increase of the autochthonous population in the Eastern Rhodopes (75-80 pairs), the total national griffon vulture population reached 100 pairs in 13 colonies and the range has tripled from 3,220 km^2 to more than 10,500 km^2.

Key words: re-introduction, vulture restaurants, vulture safe areas, Balkan Mountains, Kresna Gorge, Vrachanski Balkan

Introduction

The griffon vulture *Gyps fulvus* (Hablizl, 1783) used to be numerous and widespread breeding species in Bulgaria up to 1940s (Patev 1950, Demerdzhiev et al. 2007). After the middle of the last century, the species was more rarely observed in various parts of the country and probably extinct as a breeder around 1970 (Baumgart 1974, Demerdzhiev et al. 2007). In 1978, in the Eastern Rhodopes a new breeding locality of the species was discovered with one nesting pair (Mitchev et al. 1980) or 1-4 breeding pairs (Yankov & Profirov 1991); most probably, this was a colony re-established by young birds. Based on complex conservation measures, the species recovered slowly to 10 breeding pairs in 1987 and to about 70 breeding pairs in 2014 (Demerdzhiev et al. 2014, Dobrev & Stoychev 2014). Despite the increase in the number of breeding pairs, the area of occupancy remained on the cliffs within a 20 to 30 km along Arda River (UTM, LG71 and MG01) and the foraging area extended to about 3,000-4,000 km^2

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in Bulgaria and some 3,000-4,000 km² beyond the border in the Greek part of the Eastern Rhodopes. This was the only area in Bulgaria, where the species was breeding until the first decade of the XXI Century (Fig. 1).

In 2010, reintroduction projects and releases of griffon vultures began at four sites along the Balkan Mountains: Vrachanski Balkan Nature Park (UTM, FN99), Central Balkan National Park (UTM, LH32), Sinite Kamani Nature Park (UTM, MH43) and Kotlenska Planina (UTM, MH65; a few birds were released already in 2009) (Stoyanov et al. 2016, Stoev et al. 2016, Yankov et al. 2016) and in the Kresna Gorge (UTM, FM73) (Peshev et al. 2015, Stoynov et al. 2016). The purpose was to secure the long-term survival of the species population in the country with increasing its number and range, through strategic re-establishment of colonies, where the griffon vulture historically occurred. The facts proving that an action was needed at the planning stage of the programme were as follows:

The species increased in number in Eastern Rhodopes (35 times) but very slowly enlarged its range, remaining always in the same valley.

The direction of potential spreading was towards Greece, where in the meantime the last griffon vulture colonies on mainland vanished due to hardly controlled illegal use of poisoned baits. Through reintroduction to the north (Balkan Mountains), it was considered that the national population will be secured as well as birds from Eastern Rhodopes will be attracted there and kept away (at least for some periods of time) from Greece (Demerdzhiev et al. 2014), while persisting in the newly established Vulture Safe Areas (Grozdanov et al. 2017).

It was considered that the griffon vulture in Southwest Bulgaria would recover naturally from the Former Yugoslav Republic of Macedonia (FYROM) but, for the period 2003-2010, the species had undergone a continuous decline there, too. This was the reason to start releases in the Kresna Gorge, once to restore the Bulgarian population in this area but also to support the survival and recovery of the species beyond the border in FYROM.

The griffon vulture was considered as proxy species for future re-establishment, either natural or assisted, to the other three more threatened Egyptian (*Neophron percnopterus*), Eurasian Black (*Aegypius monachus*) and Bearded (*Gypaetus barbatus*) vultures in some or all of the five chosen sites.

After some ten years of preparation and planning within an international initiative called Balkan Vultures Action Plan (Tewes et al. 2004), in 2010 captive bred and rehabilitated griffon vulture individuals were imported from Spain, France and zoos from different European countries. They were kept in provisionally built aviaries and releases were planned according to the acclimatization aviary method, well developed and applied in 1980s in Massif Central in France (Terrasse & Choisy 2007). Since 2010, releases took place at four sites along Balkan Mountains and one in the Kresna Gorge (Fig. 1); until 2015, 275 birds were released (Table 1).

In the present study, we collected data, carried out analyses and report on the griffon vulture population changes in number of individuals, colonies, pairs, occupied range and territories in Bulgaria in 2010-2016, when the species was an object of intensive reintroduction actions in some historical breeding sites (Table 1).

Materials and Methods

The griffon vulture breeding performance was monitored weekly for the period since 2010, after the first releases, until the end of 2016 in Vrachanski Balkan Nature Park, Sinite Kamani Nature Park, Kotlenska Planina and the Kresna Gorge in Bulgaria.

All of the discovered griffon vulture nests were located on cliffs. All suitable cliffs in the areas of release and reasonable vicinity of them were surveyed for occupied nests. The monitoring was implemented each year during January – August, with a minimum a weekly visits to each cliff. All observations were made with good visibility at distance of 300 to 1300 m from the particular cliff in order to avoid disturbance. Viewing scopes with a magnification of 30X and 20-60X were used for the observations. In accordance with Demerdzhiev et al. (2014), a cliff was considered as a griffon vulture colony when it was occupied by at least two pairs, at a distance of at least one kilometre from the neighbouring occupied cliff. For every nest, a record of the participating birds (almost all identified through their markings – wing-tags and colour rings), nest location and time of occupation, activity (nest building, mating, laying, chick rearing, etc.) were recorded. Other parameters recorded were: 1. number of occupied nests (all nests occupied by breeding and non-breeding pairs); 2. number of breeding pairs (pairs that were observed incubating); 3. breeding success (fledged juveniles per incubating pairs); 4. productivity (fledged juveniles per occupied nest); and 5. hatching success (hatchlings per incubating pair). In accordance with Demerdzhiev et al. (2014), the criteria for counting non-breeding pairs (pairs that did not lay eggs) was an observation that both birds in the pair were attached to a particular niche (ledge) of

Fig. 1. Map of the griffon vulture range in Bulgaria and adjacent territories prior to 2010 (Eastern Rhodopes and FYROM – autochthonous) and in 2016 (also Eastern Balkan Mountain – Kotlenska Planina – Sinite kamani; Vrachanski Balkan and Kresna Gorge – reintroduced). The numbers of birds, breeding pairs and fledged young per site are for 2016.

Table 1. Number of released griffon vultures *Gyps fulvus* (Hablizl, 1783) by reintroduction site in Bulgaria, 2009-2015.

Year	Vrachanski Balkan UTM FN99	Central Balkan UTM LH32	Eastern Balkan Mts.		Kresna Gorge UTM FM73	Total
			Sinite kamani UTM MH43	Kotlenska Planina UTM MH65		
2009	0	0	0	5	0	**5**
2010	8	8	7	7	19	**49**
2011	7	0	12	11	7	**37**
2012	5	15	19	7	12	**58**
2013	8	10	8	0	14	**40**
2014	12	19	16	10	4	**61**
2015	4	7	3	4	7	**25**
Total	**44**	**59**	**65**	**44**	**63**	**275**

the cliff suitable for breeding where nest may or may not be present, and engaged in at least two of the following behaviour types: courtship flights, mutual preening, copulation, nest building, and defence of the immediate vicinity of the chosen nest site from conspecifics. A juvenile was considered fledgling if it was aged at least 125 days old (Cramp & Simmons 1980) and, for the marked ones, when seen perched out of the nest or flying in the area.

According to Demerdzhiev et al. (2014), the range of the griffon vulture in Bulgaria is covering the Eastern Rhodopes and extends south across the border in Greece. Based on data from 15 tracked with GPS/GPRS devices griffon vultures, with methodology and analyzes described in detail by Peshev et al. (2017), we made an extra calculation of ranges used by the species before 2010 and in 2016 in each of the sites permanently occupied in Bulgaria in order to estimate the range expansion. The range of the species in Eastern Rhodopes was roughly calculated and presented in the studies by Demerdzhiev et al. (2007, 2014) and it was proved and in detail mapped in the study by Peshev et al. (2017), based on four birds movements tracked with GPS/GPRS transmitters in the period 2012-2016. Based on these three sources and additional own data, we considered that

the home-range of the griffon vulture in Eastern Rhodopes prior to the reintroductions start in the new sites in Bulgaria in 2010 was 3,220 km².

Data from seven birds tracked in the Kresna Gorge, two in Kotlenska Planina – Sinite Kamani and four in Vrachanski Balkan was used to establish the local home-ranges of the species and to calculate the national range (adding the four from Eastern Rhodopes).

Results

The first breeding attempts were recorded in 2011 in the Kresna Gorge and 2012 in Balkan Mountains but they were unsuccessful until 2015 when the first and the only at that time chick fledged successfully in Vrachanski Balkan. However, in 2016, with the first released vultures' groups reaching maturity, 25 pairs were formed, 14 eggs laid and 11 chicks fledged (Table 2).

In 2016, in total 6 new colonies were formed in Balkan Mountains and the Kresna Gorge as follows: two colonies were formed in Kotlenska Planina (Kotel Mountain) – Terzievi Porti and Urushki Skali; two colonies in the Kresna Gorge – Tsarvenata Skala (above the petrol station in the middle of the Gorge) and Chervenata Skala (above the Kresnensko Hanche); and two colonies in Vrachanski Balkan Nature Park – Kotlya and Vrachanski Karst Reserve.

The range of the griffon vulture in Bulgaria increased by factor of 2.27, and from 3,220 km² in 2010 reached 10,531 km² in 2016 (Table 3).

Discussion

Continuing the positive trend reported by Demerdzhiev et al. (2014), the increase of the griffon vulture continued throughout the studied period and the number of pairs in the autochthonous population in Eastern Rhodopes reached 75-80 (rewildingeurope.com, BSPB 2015 and 2016), which summed with our results from the reintroduced colonies (25 pairs) made the total population of the species in Bulgaria to reach and pass the psychological threshold of 100 pairs.

In total, 13 colonies of griffon vultures now exist in Bulgaria – seven in the Eastern Rhodopes reported by Demerdzhiev et al. (2014) and six new ones as result of the reintroductions, counting for a nearly double increase. The national population of the species in the country in 2016 increased with more than 20% as a result of the re-introductions and numbers 100-105 pairs breeding in four distinct vulture areas – Eastern Rhodopes, Kotlenska Planina – Sinite Kamani, Vrachanski Balkan and the Kresna Gorge.

Table 2. Breeding performance of the reintroduced colonies of griffon vulture *Gyps fulvus* (Hablizl, 1783) in Bulgaria in the period 2010-2016. Years with successful reproduction given in bold.

Site	Year	Colonies	Breeding pairs (b)	Productive pairs (c)	Fledglings (d)	Breeding success (d/b)	Fledging rate (d/c)
Vrachanski Balkan UTM, FN99	2014	1	2	0	0	0	0
	2015	**1**	**5**	**2**	**1**	**0.20**	**0.50**
	2016	**2**	**8**	**6**	**4**	**0.5**	**0.67**
Eastern Balkan UTM, MH65	2012	1	1	1	0	0	0
	2013	1	1	1	0	0	0
	2014	1	2	2	0	0	0
	2015	1	3	2	0	0	0
	2016	**2**	**10**	**6**	**5**	**0.50**	**0.83**
Kresna Gorge UTM, FM73	2010	1	2	0	0	0	0
	2011	1	2	1	0	0	0
	2012	1	0	0	0	0	0
	2013	1	2	0	0	0	0
	2014	1	3	0	0	0	0
	2015	1	3	1	0	0	0
	2016	**2**	**7**	**2**	**2**	**0.29**	**1.00**
Total	2010	1	2	0	0	0	0
	2011	1	2	1	0	0	0
	2012	2	1	1	0	0	0
	2013	2	3	1	0	0	0
	2014	3	7	2	0	0	0
	2015	**3**	**11**	**5**	1	0.09	0.20
	2016	6	25	14	11	0.44	0.78

The breeding success of the new colonies is still relatively low: 0.29 in the Kresna Gorge, 0.5 in Kotlenska Planina – Sinite Kamani and Vrachanski Balkan, compared to the mean breeding success of the Eastern Rhodopean colonies of 0.77 (Demerdzhiev et al. 2014). It was however close to that in the early stages of other reintroduced populations elsewhere, e.g. 0.57 in Massif Central in France (Sarrazin et al. 1996). This might be attributed to the young age of most of the reproducing birds and related lower breeding performance (Forslund & Part 1995, Sanchez-Zapata et al. 2000). It is known that immatures have lower breeding potential owing to their lower frequency to start breeding and tendency to produce smaller clutches and broods (Margalida et al. 2008). It is expected with the time the breeding

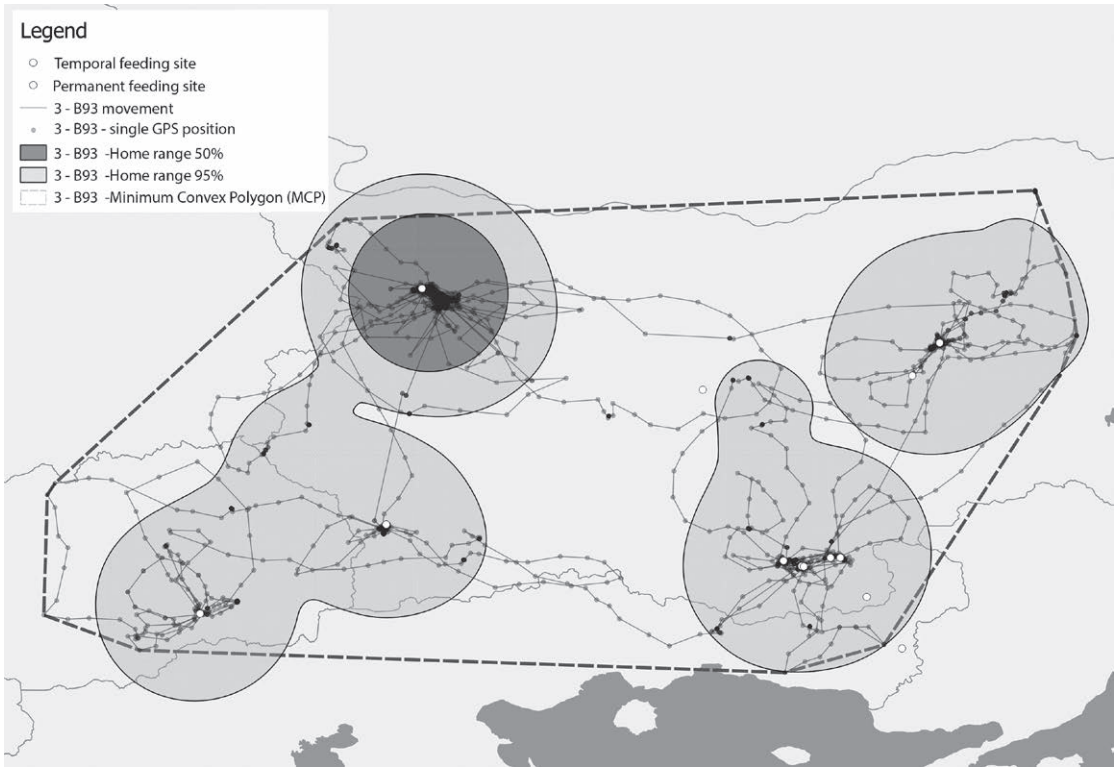

Fig. 2. Map of movements and sojourn of a wild, native to Balkans, immature griffon vulture (captured and marked in Kresna Gorge with ring B93-3 and named Svarog) from 26.06.2014 to 06.10.2015, in which time it moved between and kept staying exclusively in the existing colonies (the autochthonous ones – Eastern Rhodopes and FYR Macedonia and reintroduced ones – Kresna Gorge, Vrachanski Balkan and Kotlenska Planina – Sinite kamani).

Table 3. Home Range 95% kernels of the griffon vulture population in Bulgaria and related extensions in neighbouring countries by sites in the period before 2010 and in 2016.

Period/site	Site	Home Range 95% per site km² Bulgaria and related extensions in neighbouring countries	Home Range 95% per site km², only Bulgarian part
Prior to 2010 in Bulgaria	Eastern Rhodopes (+ Greece)	7,239.6	3,220
New territories in 2010-2016 by site	Kresna Gorge (+ FYROM)	3,159.5	2,014
	Vrachanski Balkan (+ Serbia)	5,058.4	4,957
	Kotlenska Planina – Sinite kamani	-	340
Total new territories	Vrachanski Balkan, Kresna Gorge, Kotlenska Planina – Sinite kamani + Serbia + FYROM	8,557.9	7,311
Total in Bulgaria 2016	**-**	**15,797.5**	**10,531**

success to increase as it has been observed in Massif Central in France and French Alps (Terrasse 2006), reaching the average for the species.

The other positive development is the increase of the range of the species in the country from 3,220 km² to 10,531 km². This facilitates more intensive interactions and exchange of individuals among the colonies of the species in Bulgaria (Fig. 2). This has become possible as the flying vultures on site attract their conspecifics that pass nearby during their roaming and migration movements. The attracted migrants temporarily use the feeding and roosting sites with the local birds. Some of the "guests" spent few days to months in the area or even permanently settle in the new colony. Between three and seven marked elsewhere and non-marked (thus, surely exogenous) birds originating from other colonies have settled permanently in the reintroduced colonies. Some birds were marked in Israel (3) (usually native to Balkans, but marked in Israel during wintering there), Greece (1) and Serbia (2). Temporary presence of more than 80 non-released at the site birds has been reported for the Kresna Gorge (Peshev et al. 2015) but similar presence has also been noticed in Vrachanski Balkan and Kotlenska Planina – Sinite Kamani.

The established feeding sites in the areas of release of the griffon vultures are supplied on a regular basis (minimum two times a week, but in most cases more frequently) and form a coherent network (Fig. 2) (unpublished data), which is of benefit not only to the Bulgarian griffon vulture population but also to the Balkans' one, and where Croatian, Serbian and Macedonian birds are now finding safe food and areas to stay during their migrations and sojourn along Balkans (Peshev et al. 2015, Stoyanov et al. 2016, Stoev et al. 2016, Yankov et al. 2016). Not least, these newly created, so called "Vulture Safe Areas" (Grozdanov et al. 2017), are characterized by intensive control of poison use and counteraction, safeguarding of power lines, public awareness raising and presence of local team with long-term engagement to apply adaptive management, etc. Such sites are now also of benefit to the entire native Balkans scavenging birds' guild and support the conservation of other threatened species. The *endangered* (BirdLife International 2017) Egyptian Vulture, the *near-threatened* Eurasian Black Vulture, the *vulnerable* Eastern Imperial Eagle (*Aquila heliaca*) and the White-tailed Sea Eagle (*Haliaeetus albicilla*) appear more and more frequently and spend longer periods in the release sites of the griffon vulture, and tend to permanently reoccupy these sites, where they have been missing for decades.

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