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## *Past and Present State of the Griffon Vulture *Gyps fulvus* in Rila and Pirin National Parks and Rilski Manastir Nature Park*

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**Abstract.** Widespread in the past, the Griffon Vulture (*Gyps fulvus*) has disappeared in most of Europe (including Bulgaria) in the 20th century. Although this species was reported from Southwestern Bulgaria in the area of Rila and Pirin it became locally extinct. In the end of 20th century it was breeding only in Eastern Rhodopes. With the local reintroduction of the species in Kresna Gorge since 2010, the high mountain pastures and cliffs regained their role of refuge for the Griffon Vulture mainly in summer. Here, we report and analyze the home range and seasonal presence of the species in Rila National Park, Pirin National Park and Rilski Manastir Nature Park. Home range analysis was based on data received from 8 birds tracked by GPS/GSM transmitters in Southwestern Bulgaria. The obtained results (Max. Daily distance =  $195.3 \pm 51.1$  km; Home-range 95% kernel =  $238 \pm 207.5$  km<sup>2</sup> and core area 50% kernel =  $6.5 \pm 5.4$  km<sup>2</sup>) indicated that these birds almost exclusively roost and feed in the already established Griffon Vulture colonies or join the seasonal gatherings of conspecifics, which are usually found within a zone of 15 km radius from a complex of feeding site or abundant easy accessible food in close proximity to suitable roosting places. Strategically placed and permanently supplied vulture feeding stations in close proximity of roosting sites, may concentrate large numbers of Griffon Vultures in relatively small and controlled areas. This, in combination with implementation of site based conservation activities such as the creation of Vulture Safe Areas, the impact of any, otherwise, hardly controlled and large-scale threats, such as poisoning and electrocution can be buffered. Rila and Pirin National Parks as well as Rilski Manastir Nature Park are recommended for management, adapted to the Vulture Safe Areas concept.

**Key words:** local extinction, reintroduction, conservation, *Gyps fulvus*, summer pastures, Vulture Safe Areas.

### **Introduction**

The distribution of the Griffon Vulture (*Gyps fulvus*) in Bulgaria was wide during 19th century, and, although declining, the species was still present until the first half of 20<sup>th</sup> century (CRAMP & SIMMONS 1980; DEMERDZHIEV *et al.*, 2007; 2014). The same

authors compiled numerous observations and information reported in other studies authored by Bulgarian and foreign ornithologists since the end of the 19<sup>th</sup> century about the presence of the species, including in the current studied sites – Rila and Pirin Mountains.

In the 1960s the Griffon Vulture disappeared in most of the country, mainly due to the widespread poisoning campaigns against large predators and was considered extinct until 1978, when a small group of birds was discovered in the Eastern Rhodopes (MICHEV *et al.*, 1980; DEMERDZHIIEV *et al.*, 2014). In the following period, some birds were rarely observed in Southwestern Bulgaria and were classified as wandering individuals (YANKOV & PROFIROV, 1991).

Since 2010, the Griffon Vulture is a subject of reintroduction efforts in the area of Kresna Gorge, with wide range of related activities, including the release of more than 80 individuals, imported from Western Europe, until the end of 2018. The first breeding attempts with successfully fledged chicks were registered in 2016 (PESHEV *et al.*, 2015; 2017; STOYNOV *et al.*, 2018). The newly formed colony in the Gorge attracted birds from other parts of the Balkans, a fact confirmed with numerous observations of marked vultures. A maximum number of 63 individuals was recorded in November 2016 (PESHEV *et al.*, 2017), with a continuous tendency for increasing in the following years.

During the reintroduction activities, a vulture feeding station was constructed and supplied with 3 to 10 tons of carcass monthly. The dead livestock was delivered to the feeding station from a specialized project team and was obtained by local farmers in variable quantities, due to the different mortality levels during the seasons.

Yet since the summer of 2012, but more profoundly in 2013, the vultures started to migrate vertically to the higher parts of Pirin and, more rarely, Rila Mountains. The birds were obviously attracted by the livestock herds, located there in the summer, and the abundant fresh water sources. In the period 2013-2018, the vultures were observed to use these areas in July-October, and were absent or only rarely used the feeding station in Kresna gorge during that period.

The present study aims to provide new insight for the presence of the Griffon

Vulture in Rila National Park (UTM, GM17), Rilski Manastir Nature Park (UTM, FM96) and Pirin National Park (UTM, GM02), which cover most of the Rila and Pirin Mountains and have the statute of protected areas with appointed management administrations and plans. These sites completely overlap with the same named Special protected areas (SPA) from the Natura 2000 network (MOEW, 2013) and the Griffon Vulture is so far not included in the standard Natura 2000 forms of Rila SPA (BG0000495), Rilski Manastir SPA (BG0000496) and its presence in Pirin SPA (BG0000209) is of one individual, according to the related publications (MOEW, 2013).

We, herewith, systematized the data on movements of the equipped with GPS/GSM transmitters Griffon Vultures in the Southwestern Bulgaria and based on most actual data proposing the inclusion and update of the species population parameters in the Standard Natura 2000 forms for the researched here sites. The last is important for the evaluation of importance of the Rila and Pirin National Parks and Rilski Manastir Nature Park as areas in use by the Griffon Vultures and for including of the species in future related strategic documents and for the development and application of certain measures for its conservation including further local population restorations.

The detailed information about the Griffon Vulture's territorial and seasonal movements in the researched area is of significant importance to understand and neutralize major threats for the species like the use of poison baits and the unsecured power lines used for perching, and for management of important factors like the food sources management, breeding and roosting sites protection etc.

### **Material and Methods**

The presented information was obtained through mounting of GPS/GSM transmitters on some of the reintroduced Griffon vultures (*Gyps fulvus*). Eight immature birds, equipped in the period 2012-2017, remained

in the area long enough, to allow detailed analysis of their movements.

Vultures were tagged in the adaptation aviary near the Rakitna Village (Kresna Gorge, UTM, FM73) before their releasing. The transmitter weight was 33 g., or 0,3% of the body mass (<3% is recommended for flying birds) and it was also used to hold the wing-tag, mounted on the *patagium* of the vultures to assist the visual recognition. The transmitter was equipped with solar panel and was designed with a weak point in the attachment pin, in order to fall off the bird after few years.

The data download and the reprogramming of transmitters were executed remotely through internet. We estimated the number of days with bird presence in Southwestern Bulgaria, by taking into account all coordinates, closed in the area south from 42°20' N and west from 23°60' E, and by the national borders to the west with North Macedonia and Serbia and to the south with Greece. The days spent in the Rila and Pirin National Parks and Rilski Manastir Nature Park were calculated. The daily distance covered by all tracked vultures were calculated as the average of summed straight-line distances between successive locations on the same day.

We calculated the 50% (core area) and 95% home-range (FIEBERG, 2007) of the vultures by using the classical kernel method (kernelUD, points, extent=0.1) (CALENGE, 2006).

We excluded all coordinate locations acquired between 20:00 and 06:00h local time and they were used only for defining the nocturnal roosting places. The analysis was made using QGIS 3.8.0 (QGIS Development Team, 2009), OpenJUMP HoRAE toolbox (STEINIGER & HUNTER, 2012) for OpenJUMP GIS 1.7.1 (The JUMP Pilot Project, 2008), the package adehabitat for the R software, R package version 3.4.0 (MAECHLER *et al.*, 2013). We estimated the 95% and 50% kernel of all points during birds movement (speed >5km/h),

eliminating the impact of the points, where the vultures were resting or roosting, which helped for better understanding of the dynamic parts of their behavior.

We calculated 95% and 50% kernels of the coordinates in the summer months (July – September), when the birds were mainly in the territory of the national parks, and the percent of overlapping of kernel area with the national parks territories was estimated.

To establish the numbers of the Griffon Vultures visiting the Rila and Pirin National Parks and Rilski Manastir Nature Park, we used direct observations either done by our team or reported from other observers in occasional visits. The last were included for analyzing here only if the provided information possessed all required attributes (exact date, place and observer) and was within the scope of the estimated home-range acquired by the GPS/GSM transmitters and/or the observation was proven by photographic evidence.

## Results

The seven transmitters sent a total of 80277 GPS coordinate locations (excluding nocturnal and erroneous) in Southwestern Bulgaria. The average number of coordinates sent by a transmitter was  $10034.6 \pm 6979.4$  (range 2448 – 22211). The tracking period for the birds on average was  $152.3 \pm 116.4$  days (range 23 – 373). The average number of coordinates per day is  $71.8 \pm 17.7$  (range 61 – 106.4).

In total the vultures flew over 47081.1 km, mean for vulture  $5885.1 \pm 4810.9$  km (range 1575 – 14737.7) (Table 1).

### Daily movement

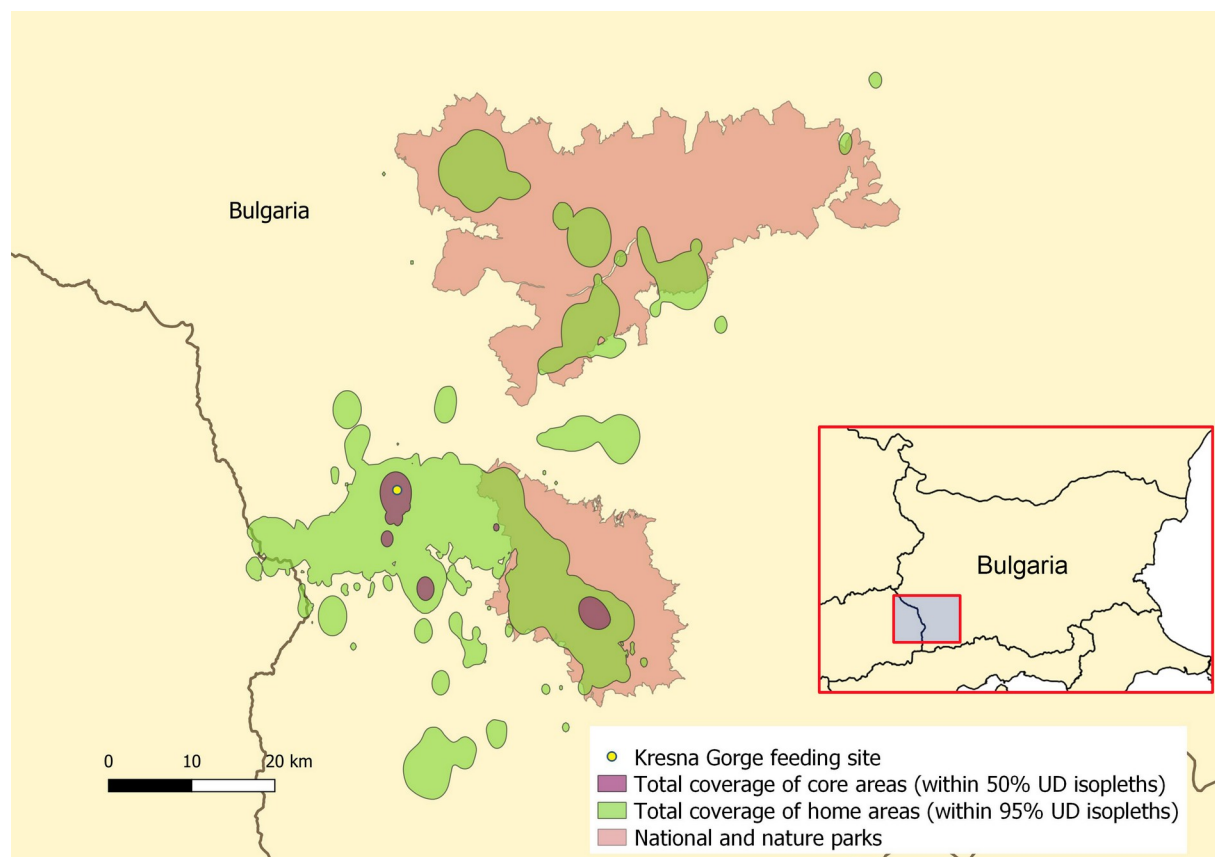
The average distance of the daily flights was  $55.7 \pm 36$  km (range 22.5 – 143.2), where the maximum distance covered in a single day was  $195.3 \pm 51.1$  km (range 98.1 – 268.4).

### Home Ranges Estimation

For all of the tagged birds the total area covered by 95% kernel was 920.3 km<sup>2</sup>, and for 50% kernel was 36.2 km<sup>2</sup> (Fig. 1).

**Table 1.** Results from GPS tracking of eight Griffon Vultures (*Gyps fulvus*) in SW Bulgaria.

Tag	Total tracking days in SW Bulgaria	Days with coordinates in the Parks	Start - End date	Received GPS coordinates	Coordinates per day	Distance traveled, km	Daily distance, mean $\pm$ standard deviation	Median daily distance, km	Daily distance (min - max), km
56	280	48	13.07.2017 - 01.05.2018	17651	63.0	14737.70	52.6 $\pm$ 47.7	34.60	2.2-231.7
v8	373	33	03.05.2018 - 07.05.2019	22211	59.5	11848.50	32.4 $\pm$ 31.0	21.20	0.7-207.8
v3	180	28	24.04.2018 - 24.04.2018	14389	79.9	5324.40	29.6 $\pm$ 31.2	18.60	1.8-176.4
k9u	23	12	03.08.2017 - 31.03.2018	2448	106.4	1575.00	68.5 $\pm$ 57.7	44.30	0.9-238.7
k2m	179	23	03.08.2017 - 01.02.2018	10919	61.0	7489.25	41.8 $\pm$ 43.6	23.2	1-195.1
89	53	35	15.07.2016 - 12.09.2016	2455	46.3	1191.03	22.5 $\pm$ 26.7	12.00	0-98.1
b70	59	21	18.07.2017 - 14.09.2017	5184	87.7	1002.10	143.2 $\pm$ 61.4	111.80	86-268.4
b71	71	27	03.08.2017 - 14.10.2017	5020	70.7	3913.20	55.1 $\pm$ 43.4	46.50	0.1-146.4



**Fig. 1.** Total area coverage of home range (95% kernel) and core area (50% kernel) for the eight tracked Griffon Vultures. The generalized map (right) shows the study area location.



Mean area of the home range (95% kernel) and core area (50% kernel) was  $238 \pm 207.5 \text{ km}^2$  (range 43.7 – 749) and  $6.5 \pm 5.4 \text{ km}^2$  (range 2 – 15.9), respectively.

For all vultures, 32% of the 95% kernel overlaps parts of Rila and Pirin National parks, and for the 50% kernel, the percent is 9. (Table 2).

*Kernels for coordinates with speed over 5 km/h.*

Mean area of the home range (95% kernel) and core area (50% kernel) was  $882.2 \pm 573.5 \text{ km}^2$  (range 158.1 – 2219.6) and  $57.8 \pm 46.2 \text{ km}^2$  (range 18 – 135.8), respectively.

*Summer coordinates home range estimation.*

Mean area of the home range (95% kernel) and core area (50% kernel) was  $315.9 \pm 189.5 \text{ km}^2$  (range 156.3– 749.4) and  $9.7 \pm 4.6 \text{ km}^2$  (range 2.1 – 15.5), respectively.

*Direct observations of Griffon Vultures reported for Rila and Pirin National Parks and Rilski Manastir Nature Park.*

In total 24 observations of Griffon Vultures were collected and analyzed in this study from 2013 until the end of 2018, although some more for the period 2012–2018 were provided in the technical reports by STOYANOV & PESHEV (2013) and PESHEV *et al.* (2017; 2018; 2019). The last were not included in the current study due to insufficient precision in data collection and

provision. However, this additional data increased the knowledge about the frequency of the presence of Griffon Vulture in high mountains of Southwestern Bulgaria. All reported observations of the species in the target areas were obtained in the period July–October, except one in April 2016. The maximum number of observed together individuals was 32 in Pirin National Park. The maximum seen at once in Rila National Park were 10 individuals, which is the same in Rilski Manastir Nature Park, because the very same observation was in the two sites in the same time (Table 3).

## Discussion

The Griffon Vulture was extinct in Southwestern Bulgaria around mid 20<sup>th</sup> Century (DEMERDZHIJEV *et al.*, 2007) and thus was not listed as species of conservation concern in the Rila and Pirin National Parks and Rilski Manastir Nature Park, which were established in their current shape in 1990s (YANKOV & PROFIROV, 1991; MOEW, 2013). The species is not listed in the Standard Natura 2000 forms for Rila National Park and Rilski Manastir Nature Park (MOEW, 2013) and its presence is obviously underestimated in Pirin National Park, where the minimum and maximum population is presented with 1 individual.

**Table 2.** Home-ranges including Core area - 50% kernel and home-range 95%, Kernels for coordinates with speed over 5 km/h and summer coordinates home range estimation.

Tag	Core areas (within 50% UD isopleths), km <sup>2</sup>	Home range area (within 95% UD isopleths), km <sup>2</sup>	Speed >5km/h Core areas (within 50% UD isopleths), km <sup>2</sup>	Speed >5km/h Home range area (within 95% UD isopleths), km <sup>2</sup>	Summer Core areas (within 50% UD isopleths), km <sup>2</sup>	Summer Home range area (within 95% UD isopleths), km <sup>2</sup>
56	3.23	226.6	15.1	674.4	10.1	448.9
v8	2.00	56.7	18.0	856.6	8.0	163.3
v3	4.50	43.7	25.8	580.0	12.4	156.3
k9u	15.90	749.0	135.8	2219.6	16.1	749.4
k2m	4.00	158.1	15.8	158.1	8.6	341.9
89	15.50	214.2	98.6	750.2	15.5	214.2
b70	4.50	280.7	111.6	1195.6	4.5	280.7
b71	2.60	175.3	42.0	622.9	2.1	172.3

**Table 3.** Observations of Griffon Vultures (*Gyps fulvus*) in Pirin and Rila National Parks and Rilski Manastir Nature Park for the period 2013-2016.

No	Date	Number of Griffon Vultures observed	National/ Nature Park	Specific site	Observer
1.	20.09.2013	12	Pirin	Spano Pole	Pirin NP ranger
2.	22.09.2014	14	Pirin	Orlite	Todor Georgiev, Pirin NP
3.	23.08.2014	11	Pirin	Koncheto	Margarita Valkova
4.	28.07.2015	7	Pirin	Todorka	Own observation
5.	19.08.2015	6	Pirin	Vihren	Own observation
6.	21.09.2015	16	Pirin	Orlite	Todor Georgiev, Pirin NP
7.	28.04.2016	1	Pirin	Todorka peak	Pepi Sakariev
8.	05.07.2016	5	Pirin	Gorno	Ivaylo Nikolov
				Vlahinsko ezero	
9.	08.07.2016	1	Pirin	Sinanishka porta	Maya Petkova
10.	22.07.2016	5	Pirin	Karaulite	Yordan Pulev
11.	23.07.2016	4	Pirin	Spano pole	Ivaylo Madjarov
12.	23.07.2016	10	Rila & Rilski Manstir	Malyovitsa peak	Vera Peltekova
13.	23.07.2016	28	Pirin	Bashliiska reka	Lyudmil Petrov
14.	30.07.2016	17	Pirin	Chairski ezera	Yordan Kutsarov
15.	11.08.2016	1	Pirin	Tipitsite peaks	Petko Boyadjiev
16.	11.08.2016	32	Pirin	Bashliiska reka	Own observation
17.	12.08.2016	2	Pirin	Banderishka porta	Own observation
18.	17.08.2016	3	Pirin	Razloshki suhodol	Elena Smilkova
19.	21.08.2016	3	Pirin	Banderishki chukar, Muratov and Karaulite	Nikolay Dautov
20.	28.08.2016	3	Pirin	Todorka peak	Vladimir Milushev
21.	29.08.2016	2	Pirin	Vihren peak	Vladimir Milushev
22.	05.10.2016	1	Rila	Ibar reserve	Yordan Hristov
23.	07.10.2016	7	Pirin	Tevno ezero	Pepi Sakariev
24.	26.08.2018	4	Rilski Manastir	Kirilova polyana	Nikolay Petkov



**Fig. 2 (left), Fig. 3 (right).** Griffon Vultures in high altitude ~2400 m mountain habitat in Pirin National Park (Photo by Hristo Peshev, 11 August 2016).



**Fig. 4.** The remains of a dead cow eaten by the Griffon Vultures in high altitude ~2200 m mountain pastures in Pirin National Park (note the Griffon Vulture's secondary feather in front) (Photo by Hristo Peshev, 11 August 2016).

The current study provides new insight of Griffon Vultures' movements and whereabouts in Southwestern Bulgaria and some specific data about their seasonal presence and numbers in the targeted Parks' territories.

While the feeding station in Kresna Gorge is definitely the focal point and the center of the core area for the relatively newly formed colony of the species in the study region (Stoynov *et al.*, 2018), the summer movements of the birds to the



higher parts of Rila and Pirin mountains are clearly visible.

For roosting, vultures were using mainly few traditional sites as referred in the study of PESHEV *et al.* (2018), and feeding events outside the specialized feeding stations in Kresna Gorge, Macedonia or Greece were rarely registered, with the exclusion of the regular summer visits to Pirin National Park, where the vultures were feeding on carcasses of free ranging cattle in the period July – October.

Analysis of the points where birds are on the move shows that 95% kernel fully cover Kresna Gorge, about half of the Pirin National Park, parts of Maleshevska Mountain, Rila National Park and Rilski Manastir Nature Park. This falls within the c.15 km radius area around Kresna Gorge, which is perimeter also confirmed in other studies (XIROUCHAKIS & ANDREOU, 2009; GARCÍA-RIPOLES *et al.*, 2011). The 50% kernel for all tracked birds include the feeding station, favorite roosting places in the Kresna Gorge and area of 2-5 km around them. Similar second core that was used exclusively in the summer was observed in Pirin National Park in the areas of Spano pole and Bashliiska reka with the surrounding peaks, where feeding of vultures and roosting sites were registered not only by the GPS/GSM transmitters, but also through direct observations.

Based on the results of the current study we suggest a summering to be included as a seasonal pattern of presence of the Griffon Vulture in certain Natura 2000 sites which should be listed in the Standard Natura 2000 form for the respective SPAs as follows:

- Pirin National Park (BG0000209) – present in summer, min. 10 ind. – max. 32 individuals (instead of min. 1 and max. 1 individual as it is now).
- Rila National Park (BG0000495) – present in summer, min. 4 ind. – max. 10 individuals (instead of none as it is now).
- Rilski Manastir Nature Park (BG0000496) – present in summer, min. 4 ind. – max. 10 individuals (instead of none as it is now).

## Conclusions

The results showed that the Griffon Vulture is seasonally present in Rila and Pirin National Parks and Rilski Manastir Nature Park, where the birds are spending the summer months. These territories should be maintained in ways, which could provide safe environment for the vultures – preventively addressing threats such as poisoning and electrocution/collision with power lines. The establishment and maintenance of seasonally operated feeding stations, which concentrate the vultures in safe environment in the protected areas in the high mountains should be shortly foreseen and implemented by each of the current study's target Parks' administrations. Also any future management of the livestock grazing and husbandry in the area should acknowledge the vultures' presence and needs. Specific measures for the Griffon Vulture should be incorporated in any future management plans development for the Rila and Pirin National Parks and Rilski Manastir Nature Park. Also the species should be listed accordingly and updated in the Standard Natura 2000 forms.

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