

Thesis Abstracts

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ARKUMAREV, V. (2021). *Movement pattern and home range of Griffon Vultures (Gyps fulvus) from Bulgaria*. PhD thesis, Plovdiv University "Paisii Hilendarski", Plovdiv, Bulgaria. 143 pp. Correspondence: volen.arkumarev@bspb.org

Animal movements and bird migration have always fascinated humans. With the fast technology advancement in the past 20 years new systems and methods were developed allowing animals to be tracked for longer periods and significant amount of data to be collected, stored and analysed. Vultures are obligate scavengers which consume up to 90% of the carcasses in some ecosystems providing significant ecosystem services. By efficiently disposing the carcasses they prevent the spread of diseases and save costs from transportation and incineration of animal carcasses. However, vulture populations are experiencing dramatic declines worldwide and their conservation is a priority in many areas. Due to their conservation status and role in the ecosystems more studies on vulture movements and ecology are needed to inform efficient conservation strategies.

The recent study was conducted on the autochthonous Griffon Vulture population in the Eastern Rhodopes, Bulgaria. In the period 2016-2019 we equipped with solar-powered GSM-GPS and Argos-GPS transmitters adult ($n = 10$), immature ($n = 8$) and juvenile ($n = 7$) Griffon Vultures in order to study their home range, movements, foraging behaviour and migration pattern. The foraging home range of the species was $2,958.4 \text{ km}^2$ (95% KDE) with core area of 231.6 km^2 (50% KDE). Foraging home range size was maximal in summer and minimal in winter ($3,166.2 \text{ km}^2$ and $1,327.7 \text{ km}^2$ respectively). Adult vultures had significantly smaller core areas compared to immatures ($Z = -2.15$, $p = 0.03$). The daily travel distance with all seasons and all individuals pooled was $79.1 \pm 64.9 \text{ km}$ while displacement was $21.4 \pm 20.5 \text{ km}$. The longest daily distance was recorded on 7 May when an immature vulture travelled 364.4 km within the Eastern Rhodopes. Successful breeders travelled longer daily distances than the adults which were not breeding or failed at different stages of their breeding attempt ($89.5 \pm 71.9 \text{ km}$ and $65.7 \pm 65.9 \text{ km}$ respectively, $t = 4.37$, $p < 0.05$). The mean daily distance travelled by the immature vultures was $85 \pm 66.06 \text{ km}$ while adults travelled $76.82 \pm 64.5 \text{ km}$ ($t = -6.05$, $p < 0.01$). The difference between the two age classes was most prominent during winter and autumn when immatures travelled $45.8 \pm 41.7 \text{ km}$ and $51 \pm 44 \text{ km}$ respectively while adults had significantly shorter daily distances $29.9 \pm 31.3 \text{ km}$ and $36.6 \pm 42.8 \text{ km}$ ($t = -5.37$, $p < 0.01$; $t = -5.45$, $p < 0.01$).

Griffon Vultures were roosting mostly on cliffs (85.62%, $n = 8120$), in 14.05% of the cases they were roosting on trees and twice ground roosts were recorded. In the Bulgarian part of the Eastern Rhodopes vultures were roosting on cliffs in $94.6 \pm 3.9\%$ of the cases while in the Greek part of the mountain they were roosting mostly on trees, $78.7 \pm 24.4\%$. Our results indicated high variance in the preferences of roosting cliffs according to the season. In autumn and winter vultures were roosting on cliffs with breeding pairs in $80.1 \pm 24.2\%$ and $88 \pm 24.8\%$ of the cases respectively while this percentage dropped significantly in spring and summer when vultures preferred to roost on cliffs with no breeding pairs ($59.4 \pm 25.3\%$ and $45.8 \pm 24.8\%$).

The recent study showed that 71.5% of the juvenile Griffon Vultures migrate south in their first autumn while only 14% of the immatures started migration and none of the tracked adults. We followed eight

vultures during autumn migration and five during the spring migration. Autumn migration started in the period 19 September-29 October. The average distance travelled on migration was $3,602 \pm 1,137$ km, covered for 38 ± 12 days with an average migration speed 100.7 ± 32 km/day. The longest daily distances travelled on migration was 374 km on 30 October when the juvenile vulture 6G crossed the Bosphorus and reached the region of Gerede in Turkey. Spring migration started in the period 22 March-7 May. The mean distance travelled was $2,340 \pm 737$ km and migration took on average 13 ± 6 days with an average migration speed 176.3 ± 61.8 km/day. Griffon vultures had greater migration speed during the spring than the autumn ($t = 2.50$, $p < 0.05$). During autumn migration vultures used different stopover sites along the flyway where they spent between 3 and 50 days. The majority of the stopover sites were in Turkey, one was in Iraq and one on the border area between Iraq and Iran. All vultures followed the Eastern Mediterranean flyway through Turkey and Middle East. The most important bottlenecks for the juvenile and immature Griffon Vultures were the Bosphorus and Iskenderun in Turkey.

The main wintering areas were in central and north Saudi Arabia, Israel. One juvenile vulture reached South Sudan which is the first record of the species for the country and one of the southernmost records in Africa. The home range in the wintering areas was $18,933 \pm 13,314$ km² (95% KDE) and the size of the core area was $1,876 \pm 2,001.4$ km² (50% KDE). The size of the home range varied among the individuals and the years. In the wintering grounds 78.07% of the area inhabited by the vultures had no vegetation e.g. deserts and rocky mountains. Only 10.05% were covered by sparse vegetation and 8.39% were natural grasslands or arable lands.

Griffon Vultures were feeding at natural carcasses found in the wild in the Eastern Rhodopes in 77.4% ($n = 1036$) of the recorded cases. In winter 56.5% of the feedings were at the vulture feeding stations while in the summer 80.2% of the feeding events were on occasional carcasses found in the wild. The breeding Griffon Vultures were feeding at the vulture restaurants mostly during the pre-breeding and incubation period (54% and 46.6% respectively). During the post-breeding period 81.6% of the feedings were in the wild. Vultures were landing on the feeding stations on average 53.2 h after carcass disposal. In summer and autumn this period was prolonged up to 10-12 days. Griffon Vultures were feeding in 42.8% of the days in the month. In the summer they were feeding on average once per 1.6 days and in winter once per 4.1 days. One vulture can visit up to four feeding locations per day.

The recent study revealed that Griffon Vultures travel significantly longer distances in days when they were feeding on carcasses found in the wild compared to days when feeding at vulture restaurants ($t = -11.6$ $p < 0.001$). In addition, they have less straight flight and reach lower displacement when feeding on occasional carcasses ($t = 5.9$, $p < 0.001$; $t = -7.33$, $p < 0.001$). The average daily distances travelled were 80.3 ± 53.3 km in days when vultures were feeding and only 69.8 ± 58.4 km in days when they did not manage to find food. Our model showed that the season and the age of the vultures determine the most their success in finding food. The other factors which showed correlation were the daily travelled distance, daily displacement, temperature, daily precipitation and wind speed.

In 47% of the cases ($n = 305$) vultures were feeding on cattle carcasses in the wild. In 28% sheep or goats were used for food and wild ungulates were found in 11.5% of the cases. Other species consumed by the vultures were fox, jackal, dog, wild boar, hare, horse and donkey. In 4.6% of the cases vultures were feeding at places where offal from slaughter houses was illegally dumped. The most common reason for the death of the animals consumed by the vultures was carnivore attack (60.2%) while in 37.6% of the cases animals died due to natural causes. However, on two occasions death was attributed to poaching.

Peer-reviewed research derived from the thesis:

- Arkumarev, V., Dobrev, D. & Stamenov, A. 2019. First record of Eurasian Griffon Vulture (*Gyps fulvus*) from the Balkans migrating to South Sudan revealed by GPS tracking. *Scopus* 39: 27-35.
- Arkumarev, V., Dobrev, D., Stamenov, A., Terziev, N., Delchev, A. & Stoychev, S. 2021. Seasonal dynamics in the exploitation of natural carcasses and supplementary feeding stations by a top avian scavenger. *Journal of Ornithology* 162: 723–735.
- Arkumarev, V., Dobrev, D., Stamenov, A., Terziev, N., Delchev, A. & Stoychev, S. 2021. Using GPS and accelerometry data to study the diet of a top avian scavenger. *Bird Study* 67: 300-310.
- Arkumarev, V., Dobrev, D., Stamenov, A., Delchev, A., Stouchev, S. 2021. Seasonal and age-specific dynamics of the Griffon Vulture's home range and movements in the Eastern Rhodopes. *Ornis Hungarica* 29: 81-92.

Note from the editor:

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