

HABITAT OF THE EGYPTIAN VULTURE (*NEOPHRON PERCNOPTERUS*) IN BULGARIA AND GREECE (2003-2014)

TECHNICAL REPORT UNDER ACTION A5

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ABOUT THE PROJECT

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SUMMARY

Vultures are declining throughout the world because of a large number of threats such as poisoning, electrocution, collision with man-made structures, direct persecution, changes in habitat and food availability. However, quantifying which of these factors has the greatest influence on demographic parameters such as territory occupancy and breeding success is challenging. The species with the most precarious conservation status in Europe is the Egyptian Vulture *Neophron percnopterus*, and we collated territory and nest monitoring data from Bulgaria and Greece to understand the relative influence of various environmental factors on population declines.

We monitored occupancy in a total of 87 different territories and breeding performance of 376 territorial pairs between 2003 – 2014, with an overall territory occupancy rate of 69% and a mean productivity of 0.80 fledglings per occupied territory. We examined which of 48 different environmental variables were most influential in explaining variation in territory occupancy and breeding success using algorithmic random forest models. Territory occupancy was best explained by food availability, geographic structure, and nesting opportunities, while breeding success was best explained by the number of adjacent villages, topography, and nesting opportunities.

Both models had reasonably good discriminative ability (AUC for territory occupancy = 0.852, AUC for breeding success = 0.737). Territory occupancy and breeding success were affected by a wide range of environmental variables, each of which had a small effect.

Additionally, in several buffer zones (1 km, 5 km and 30 km) the physical characteristics of 110 nests in 84 Egyptian vulture territories in Bulgaria and Greece were investigated, and a GIS tools were used to describe the landscape features and composition in Egyptian vulture territories. We found that 74% of the Egyptian vulture nests are situated in caves while only 26% are situated on cliff ledges, and the majority of the nests are up to 10 m in height. The mean height of the cliffs that the species occupy is 32.05m and can range between 6m and 340m in height. Additionally the length of the breeding cliffs vary from 5m to 5300 m with a mean length of 371.09 m. The landscape composition consists of variety of habitats but mostly forests, arable lands and pastures, both in Bulgaria and Greece.

We recommend a complex management aiming at adoption of large-scale landscape conservation programs that retain or restore historical small-scale farming practices which may benefit vultures and other biodiversity.

LIST OF ABBREVIATIONS

AUC - Receiver-operated characteristic curve

BG - Bulgaria

CLC – Corine Land Cover

EV – Egyptian vulture

GIS - Geographic information system

GR - Greece

NDVI - Normalised Difference Vegetation Index

PPI - Primary productivity index

INTRODUCTION

Many raptor species around the world are declining, and avian scavengers like vultures are among the most threatened raptor species (Thiollay 2006, Virani et al. 2011, Chaudhary et al. 2012, Ogada et al. 2012). Many different threats exist for vultures around the world, ranging from poisoning by the veterinary drug Diclofenac (Green et al. 2004, Oaks et al. 2004, Galligan et al. 2014), poison bait targeted at livestock predators (Hernández and Margalida 2008, 2009, Mateo-Tomás et al. 2012, Skartsi et al. 2014), electrocution at electrical infrastructure (Donazar et al. 2002, Boshoff et al. 2011, Angelov et al. 2013), collision with man-made structures (Carrete et al. 2009; de Lucas et al. 2012), to direct persecution (Thiollay 2006; Margalida et al. 2008). In addition to threats causing direct mortality of birds, changes in agricultural practices, landscape composition, and sanitary regulations are known to have more subtle effects on vulture populations, for example by altering food availability and thus leading to lower reproductive output or lower survival probability (Carrete et al. 2007, Donazar et al. 2010, Margalida et al. 2014). Understanding the relative influence of these threats on declining populations is important to develop effective conservation management actions.

Among the four vulture species that breed in Europe, the EV (*Neophron percnopterus*) is the smallest species with the most precarious conservation status. While a few local populations in western Europe are currently stable or increasing (García-Ripollés et al. 2006, Lieury et al. 2015), the EV population in Eastern Europe has been declining at a rate of ~7% per year for several decades (Velevski et al. 2015). Territory abandonment and declines in productivity in Spain have been related to changes in diet availability and diversity (Margalida et al. 2012), poison use, and a complex mixture of various landscape factors affecting habitat suitability (Carrete et al. 2007, Hernández and Margalida 2009, Olea and Mateo-Tomás 2011). For the Balkan population, however, the causes of population declines are still speculative and considerable uncertainty exists as to which conservation management actions might be effective to halt population declines (Grubač et al. 2014, Velevski et al. 2014). While several potential causes leading to population declines are known (Skartsi et al. 2014, Velevski et al. 2015), there has been no comprehensive study to date to understand the factors affecting which territories are abandoned and how productivity is affected that could be used for conservation management. A very general habitat description for BG and GR exists and it covers grassland, rocky and forest habitats (Kurtev et al. 2008, Iankov 2007, Xiroutachis et al. in prep), but so far there is no explicit description and analysis of the habitats in the breeding areas.

For the Balkan population of EV, several sources of mortality have been identified, for example electrocution and natural mortality on migration (Angelov et al. 2013, Opperl et al. 2015), direct persecution on wintering areas (Arkumarev et al. 2014, Opperl et al. 2015), poisoning on breeding areas (Skartsi et al. 2014, Kret et al. 2016, Saravia et al. 2016), and the collection of adult birds and eggs by poachers (Kurtev et al. 2008). In addition, considerable changes in land use, livestock, animal and waste disposal practices have occurred in BG and GR over the past decades following the abandonment of socialist farming structures and the adoption of EU regulations, and it is plausible that such changes may have affected the suitability of areas for breeding vultures (Carrete et al. 2007, Kurtev et al. 2008, Carrete et al. 2009, Kamp et al. 2011, Xirouchakis in prep.) or affected available diet with consequences for productivity (Margalida et al. 2012). Although changes in diet over the past seven years were small and unlikely to have had a major influence on population dynamics (Velevski et al. 2014, Dobrev et al. 2016), a robust assessment of all factors influencing territory occupancy and productivity is needed to inform conservation management.

Because of the large number of potential direct and indirect threats that may affect vulture presence and productivity, previous analyses of territory occupancy had to resort to various multivariate analytical procedures (Carrete et al. 2007, Krüger et al. 2015), many of which are known to be suboptimal and may potentially yield biased inference regarding the actual importance of certain variables (Grömping 2009, Fernández-Delgado et al. 2014, Galipaud et al. 2014). Indeed, previous landscape analyses of the factors affecting territory abandonment and breeding success in vultures had relatively low predictive capability (Carrete et al. 2007, Olea and Mateo-Tomás 2011, Krüger et al. 2015). Here we used a powerful machine-learning algorithm that can evaluate the relative importance of many predictor variables simultaneously to explore whether any of a wide range of landscape variables has a sufficiently large effect on territory

occupancy or breeding success to warrant conservation management in BG and GR. This study is the first comprehensive analysis of a large number of potential factors affecting the conservation status of EV in Eastern Europe, and provides a thorough assessment of the generality of the analytical models on which inference and management recommendations will be based. Moreover, it provides an explicit description of the nest-sites and landscape composition in the breeding territories in BG and GR, which can be further used for effective conservation of the species in these two countries, holding about 60% of the EV population in the Balkans.

Although Arkumarev (2014) provides a robust analyse of the nest site exposition and nest type preferences of the species in BG, still nothing is known for GR. On the other hand a description and composition analyse of the main land cover types in the EV territories on the Balkans does not exists except for some general habitat descriptions for BG (Iankov 2007, Kurtev et al. 2008). Increased knowledge on the nest site preferences and on the landscape features and composition would help to better understanding and identifying variety of factors affecting the survival and the persistence of the species in the breeding grounds and thus building an appropriate conservation strategy towards the species (Carrete et al. 2007).

METHODS

Nest monitoring

All known EV nests in BG were monitored every year in the period 2003 – 2014, and in GR between 2010 – 2014. Each breeding territory was visited multiple times per breeding season to confirm if the territory was occupied, and to count the number of raised fledglings (Velevski et al. 2015, Dobrev et al. 2016). A territory was considered occupied if a pair or a single bird was observed with territorial or nest building behaviour at the beginning of the breeding season (March/April). All territories were visited again in May to confirm which of the pairs were breeding, in June and July to confirm the number of hatchlings and in August to confirm the number of fledged juveniles. Survey efforts were generally many hours in duration, and because multiple surveys were carried out in each territory in each year we do not account for imperfect detection because the probability of missing an occupied territory would have been extremely small (Olea and Mateo-Tomás 2011).

Because pairs can use different nest sites within the same territory in different years (Kurtev et al. 2008), we considered the territory as the unit of replication in all analyses, rather than individual nest sites, to avoid pseudo-replication. EV can lay 1-3 eggs but generally raises up to two fledglings. However, the processes determining whether a pair raises one or two fledglings may be fundamentally different from the processes determining whether a pair raises any fledglings or none, and preliminary explorations indicated that none of our environmental variables were able to accurately differentiate between pairs raising one or two fledglings. Hence, for the purpose of this analysis the data on the number of fledglings was reduced to 'breeding success', which considered pairs successful if they raised any fledglings, and unsuccessful if not. The breeding success was measured as the proportion of all territories occupied by two adult birds that resulted in at least one fledgling, which accounts for incomplete breeding propensity.

Nest site and breeding cliff characteristics

Microhabitat characteristics such as nest type, exposition, nest height, height of the cliff, height from the nest to the top of the cliff, cliff exposition and length were defined in order to reveal the preferences of the species towards the microhabitat. We used data for the EV nests between 2005 – 2014 for BG and between 2003 – 2014 for GR. Descriptive statistics were calculated (StatSoft 2004).

For each EV nest the exposition towards the four cardinal points and the four secondary points were identified. A radar graphic was used to identify preferred nest expositions (Fisher 1995). For the purpose of the analyse

nests with eastern and southeastern exposition were grouped; nests with northern and northwestern exposition were grouped; nests with western, southwestern and southern exposition were grouped.

Breeding niches were grouped in 2 – caves and ledges. Caves include deep and shallow holes in the cliffs and ledges include open rocky ledges.

Additionally to identify the preferences towards the height and the position of the nests on the breeding cliffs, all nests were grouped as follows:

- nest situated up to 10 m height
- nest situated between 11 and 20 m height
- nest situated between 21 and 30 m height
- nest situated over 31 m height

The same groups were created to identify the preferences of the species towards the height of the cliff:

- nest situated on small sized cliffs –up to 10 m height
- nest situated on middle sized cliffs - between 11 and 20 m in height
- nest situated on big sized cliffs – between 21 and 30 m in height
- nest situated on very big sized cliffs - over 31 m in height

Landscape characteristics around the nests

To build detailed descriptive statistics of landscape composition and configuration around EV nests, we implemented GIS analysis within 1 km, 5 km and within 30 km buffer around each nests occupied in the period 2006-2014 for BG and within 30 km buffer for GR in the period 2010-2014. This analysis was performed with ArcGIS 10.2 (ESRI 2014) based on Land Parcels Identification System for BG (MAF 2015) and GR (Hellenic Mapping and Cadastral Organization). Due to the less number of territories of the species in GR and the shorter study period we only calculated the landscape composition in a larger scale for GR. The polygons (patches) within the buffers were dissolved to aggregate bordering polygons for each buffer range (1 km, 5 km and 30 km) over all territories. Then polygons were converted from single part to multi part to calculate the total number of patches for a given landscape feature. A descriptive statistic was calculated. Additionally 2 clusters were created for BG – Northern BG and Southern BG following the same steps in order to compare differences in the territories on a regional level. All GIS procedures were performed for 1 km and 5 km buffer and descriptive statistics were calculated.



Nest and productivity monitoring in BG and GR.

Environmental variables affecting territory occupancy and breeding success

We collected information on variables influencing the physical environment, food availability, human disturbance, and intra- and interspecific biological interactions for each territory from a variety of remote sensing and local resources (Annex 1). To characterise the environmental conditions of EV territories, we used a 5 km radius around the nest, and we refer to this circular area as ‘territory’ for the purpose of this analysis. A larger radius, which may have been warranted given that EV can travel >20 km during foraging excursions and can have fairly large home-ranges (Carrete et al. 2007, López-López et al. 2014), was considered impractical for our study due to the large overlap in territories and the effort required in obtaining relevant data (Annex 1) across such spatial scales.

We first measured several physical variables that have been associated with territory occupancy or nest success in past studies (Liberatori and Penteriani 2001, Carrete et al. 2007, Olea and Mateo-Tomás 2011), such as cliff height, aspect, and the precise location of the nest on the cliff (Annex 1). Cliff height was measured using a tape measure attached to a rope connecting the top and the bottom of the cliff in a straight line. The location of all reliable food sources, such as slaughterhouses, rubbish dumps, vulture restaurants, chicken farms, and other places with regular food available for vultures were mapped using handheld GPS devices or satellite images. Because wind turbines can cause mortality of adults and lead to nest or territory abandonment (Carrete et al. 2009), the location of all wind turbines in the study area was recorded. Then, a GIS (ArcGIS 10.6, ESRI, Redlands, California) was used to measure the distance from vulture nests to food sources and count the number of food sources and wind turbines within each territory.

Monitoring data of EV and other raptors were used to create indicator variables reflecting the potential

for intra-and interspecific interactions. Specifically, monitoring data were used to assess the number of alternative nesting sites in the same territory as an index of territory quality. We also determined whether an active Griffon Vulture *Gyps fulvus*, Peregrine Falcon *Falco peregrinus*, Eagle Owl *Bubo bubo* or Raven *Corax corax* nest existed within the territory. These species were chosen because they are known to interact with EV and may affect occupancy or breeding success (Margalida et al. 2003, Bertran and Margalida 2004, Brambilla et al. 2004).

Relief variables such as elevation, slope, and ruggedness of the landscape (expressed as the standard deviation of elevation over the territory) were derived from a digital elevation model with 25 m resolution for BG (EEA 2013) and 30 m for GR (Hellenic Mapping and Cadastral Organization).

Land use was expressed as the proportion of the territory that was covered in major land use categories, such as grassland, agricultural areas, forest, and water (Annex 1). The land use coverage was calculated from global remote sensing products (GlobCover 2009) that ascertained consistence across the geographic regions in our analysis (Arino et al. 2012). In addition to the proportional coverage of certain land use types, we also used the GlobCover2009 data to calculate metrics characterising the patchiness of the landscape, such as the number of distinct land use patches, the total length of habitat edges, and a habitat diversity index based on the number and extent of different habitat patches (Rotenberry and Wiens 1980, Nikolov 2010, Cord and Rodder 2011). We further considered the PPI, a metric that uses the maximum monthly values of NDVI within each territory to assess the primary productivity of an area as a general metric that may reflect food availability for opportunistic raptors (Seoane et al. 2003; Carrete et al. 2007). This index was derived from monthly averages of NDVI obtained from remote sensing (TERRA-MODIS, <http://reverb.echo.nasa.gov>) at a spatial resolution of 1192 m. Basic geographic variables such as the length of the road network were extracted from standard topographic maps (Annex 1).

We also contacted relevant authorities to obtain variables relating to food availability and human pressures within each territory. The number of livestock as a measure of food abundance was obtained from official records from the Bulgarian Ministry of Agriculture and Foods and the Greek Payment Authority of Common Agricultural Policy Aid Schemes (OPEKEPE in Greek) supervised by the Hellenic Ministry of Rural Development and Foods (Annex 1). The number of human inhabitants and human settlements was provided by the National Statistics Institute of Bulgaria and the Hellenic Statistical Authority to evaluate human disturbance, an important factor in the distribution of vultures (Grubb and King 1991, Richardson and Miller 1997, Krüger et al. 2015). Since poisoning is a potentially important driver of population declines in the Balkans (Velevski et al. 2015), we obtained official records of all poisoning incidents in the last 10 years in the study area (Skartsi et al. 2014).

Model construction and assessment of variable importance

We analysed the influence of environmental variables on three demographic processes that are relevant for conservation: (1) whether formerly occupied EV territories were abandoned at any time and were no longer occupied in 2013 and 2014 (hereafter referred to as territory abandonment); (2) whether territories were occupied on an annual basis (hereafter referred to as occupancy); and (3) whether pairs bred successfully given that a pair occupied a territory (hereafter referred to as breeding success). Our measure of breeding success encompasses pairs that may not have initiated a nesting attempt, and is therefore an overall metric that accounts for incomplete breeding propensity.

Previous landscape analyses of the factors affecting territory abandonment and breeding success in vultures used a variety of different statistical models to predict occupancy or abandonment, but most models had relatively low predictive capability (Carrete et al. 2007, Olea and Mateo-Tomás 2011, Krüger et al. 2015). Here we used a powerful random forest algorithm to relate occupancy and breeding success to the landscape and nest variables to identify which variables had the greatest influence and determine the direction and size of effects. A random forest is a machine learning algorithm based on classification or regression trees

that can accommodate a large number of predictor variables and yields highly accurate predictions (Breiman 2001, Cutler et al. 2007, Hochachka et al. 2007). We used a random forest model based on a conditional inference framework to account for correlated predictors and for missing data (Hothorn et al. 2006b, Strobl et al. 2008, Hapfelmeier et al. 2012). We fitted this model in a regression framework with the R package 'party' (Hothorn et al. 2006a) and evaluated the discriminatory ability of the model using the area under the AUC calculated with the package 'PresenceAbsence' (Freeman and Moisen 2008) in R 3.1.1 (R Development Core Team 2014).

To assess which variables had the greatest influence on our response variables, we used a permutation procedure that assesses the loss in predictive accuracy (based on AUC) of the random forest model after randomly permuting a given variable (Strobl et al. 2007, Janitza et al. 2013, Hapfelmeier et al. 2014). We implemented this assessment using the R function 'varimpAUC' with 100 permutations per variable and present results as relative variable importance, with the most important variable (greatest reduction in AUC after permutation) assigned a value of 100%.

Because a random forest is a non-parametric algorithm, the direction and size of effects by given variables cannot be expressed with numeric parameter estimates. For the most important variables we therefore produced partial dependence plots which show the direction and magnitude of the effect of an environmental variable on territory abandonment, annual occupancy, and breeding success after accounting for the effects of all other variables in the model (Cutler et al. 2007, Strobl et al. 2008).

RESULTS

Egyptian vulture nest site and breeding cliff characteristics

The physical characteristics of 110 nests in 84 EV territories in BG and GR were investigated. Most (74%) of the EV nests were situated in caves while 26% were situated on cliff ledges. Of all nest which exposition was identified (n=99), those with southwest exposition represent 26.3%, followed by those with west exposition (17.2%) and with south and east exposition (16.2%). Nests with southeast exposition represent 10.1%. The north and the northwest exposition are at the bottom of the list with 7.1% (Fig. 1).

The nest height on the breeding cliff was measured in 98 nests and most of them (53%) were situated up to 10 m height, 30% - between 11 and 20 m, 12% - between 21 and 30 m, and 5% - over 31 m (Fig. 2).



Figure 1. Expositions of EV nests in BG and GR between 2003 and 2014. N – north, E – east, S – south, W – west.

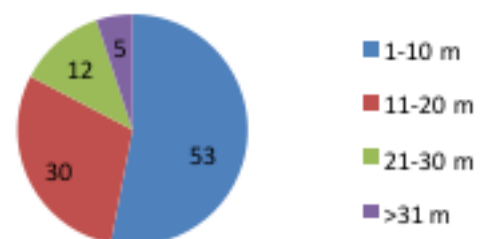


Figure 2. EV nest height (numbers are in %) in BG and GR between 2003 and 2014 (n=98).

According to the height of the breeding cliff, 30% of all nest (n=98) were located in cliffs with height between 21 and 30 m, followed by cliffs with height over 31 m (29%) and cliffs with height between 11 and 20 m (27%). The least occupied cliffs were with height between 1 and 10 m (Fig. 3).

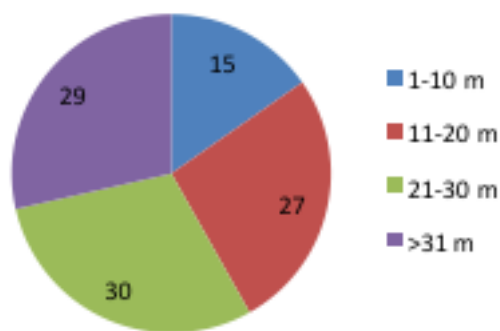


Figure 3. EV nesting cliff height (numbers are in %) in BG and GR between 2003 and 2014 (n = 98).

The mean height of the nests of the EV in BG and GR was 16.45 m (ranging from 2.5 m to 315 m). The mean height of the cliffs that the species occupy was 32.05m (ranging between 6 m and 340m) and the length of the breeding cliffs varied from 5m to 5300 m with a mean length of 371.09 m (Tab. 1).

Table 1. Descriptive statistics for EV nests and breeding cliffs in BG and GR between 2003 and 2014.

Variable	Mean	Minimum	Maximum	St.Dev.
Height_nest	16.4543	2.500000	315.000	32.2846
Height_cliff_above_nest	13.9726	0.900000	70.000	13.2374
Height_cliff	32.0477	6.000000	340.000	38.3508
Length_cliff	371.0909	5.000000	5300.000	780.3501

Landscape features and composition around Egyptian vulture nests

Bulgaria

- **1 km buffer zone around the nest**

A total of 31 land cover classes are identified in 1 km radius around EV nests in BG (n = 67 nests; Annex 2.1). Out of them, with the highest cover were forests (62%), shrubs and grasses (9.8%), and arable lands (6.7%) (Fig. 4). In terms of landscape configuration, shrubs and grasses were the most fragmented land cover class represented by 20% of all patches (n = 1,958 patches), followed by pastures and meadows (15%) and forests (11%) (Annex 2.1).

The number of land cover classes around EV nests in southern (n = 44 nests) and northern BG (n = 23 nests) was similar: 25 land cover classes in northern part of the country versus 26 in the south (Annex 2.5). In both regions the largest areas were covered by forests (68.7% in the south and 50.7% in the north), followed shrubs and grasses (7%) and pastures and meadows (5.8% in the south, and arable lands (15.6%) and shrubs and grasses (14.4%) in the north (Fig. 5 & 6).

In both northern and southern BG, the most fragmented land cover class is the shrub and grassland territories with 20% and 21% of the patches respectively, followed by the pastures and meadows (16%) in the south and forests (14%) in the north (Annex 2.5).

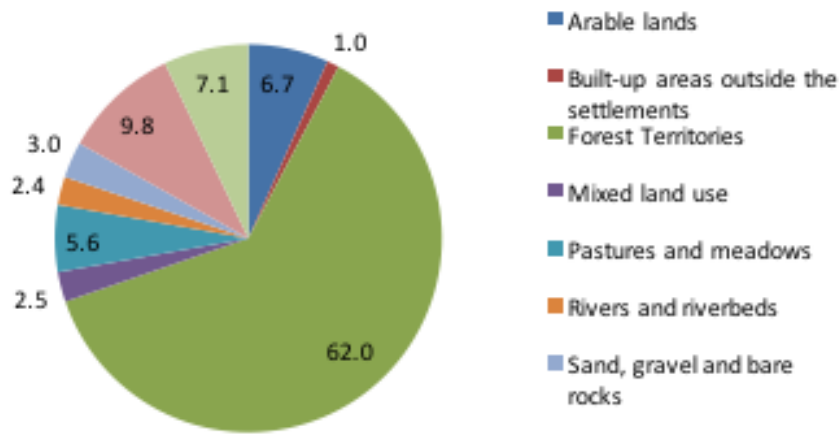


Figure 4. Landscape composition (in %) within 1 km radius around EV nests in BG.

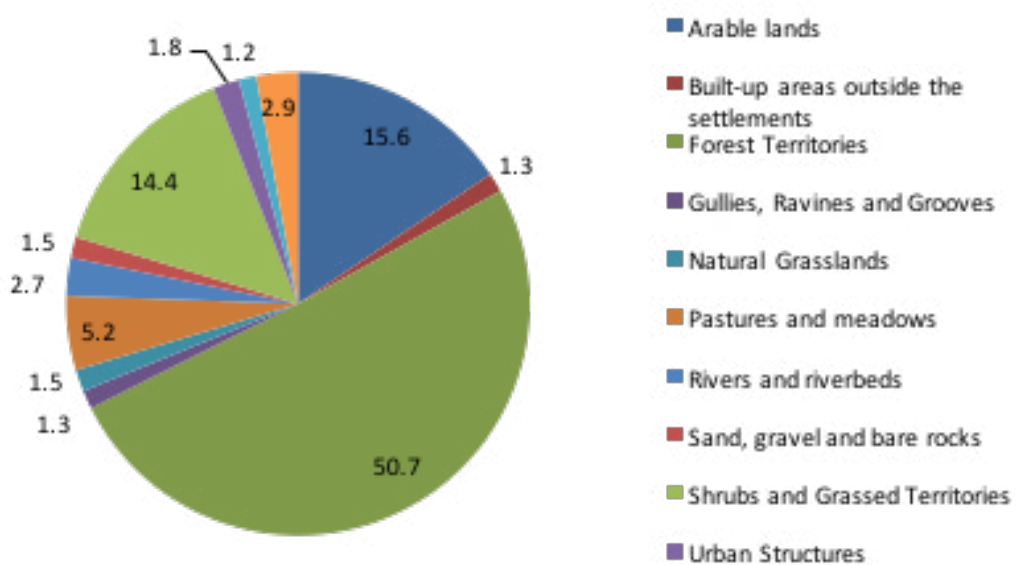


Figure 5. Landscape composition (in %) within 1 km radius around EV nests in northern BG.

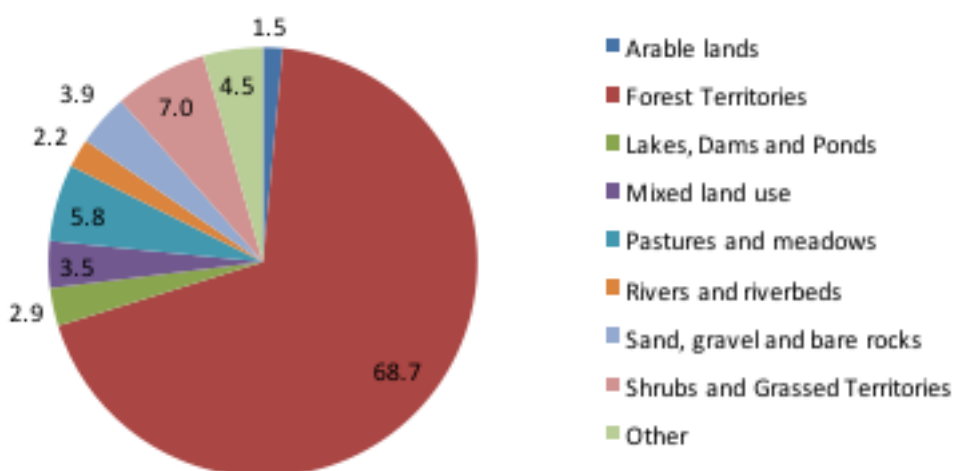


Figure 6. Landscape composition (in %) within 1 km radius, southern BG.

- **5 km buffer around the nest**

A total of 36 land cover classes were identified within 5 km radius around EV nests in BG (n = 67 nests, Annex 2.2). Out of them forested areas were with the largest cover (48.9%), followed by arable lands (16.7%) and shrubs and grassland territories (9%) (Fig. 7). Even with small cover, the built up areas outside settlements were the most fragmented landscape class representing 27% of all patches (n = 29,719 patches), followed by shrubs and grasslands (17%), pastures and meadows (14%), and arable lands (7%)(Annex 2.2).

In both southern and northern BG the number of the land cover classes within 5 km radius around EV nests was similar: 32 versus 36 land cover classes respectively in southern and northern part of the country (Annex 2.6). In the two regions the largest areas were occupied by forrests (61.6% in the south and 33.7% in the north), followed by shrubs and grasslands, and the pastures and meadows (8.4% each) in the south, and arable lands (33.4%) and shrubs and grasslands (9.6%) in the north (Fig. 8 & 9).

In the south BG the most fragmented land cover classes were shrub and grasslands, and pastures and meadows, each represented with 19 % of all patches (n = 16,409) (Annex 2.6). In the north, the most fragmented land cover classes were the shrubs and grasslands (14 % of all patches; n = 13,310) and the arable lands (11%).

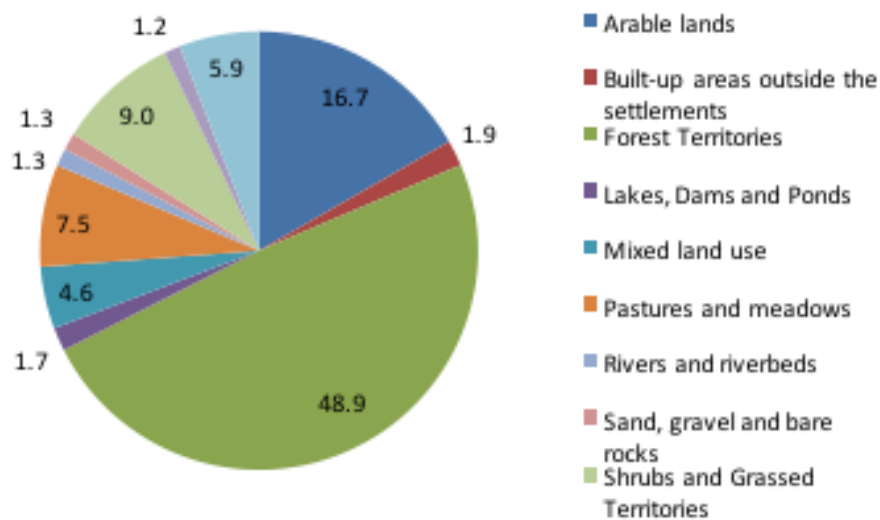


Figure 7. Landscape composition (in %) within 5 km radius, BG.

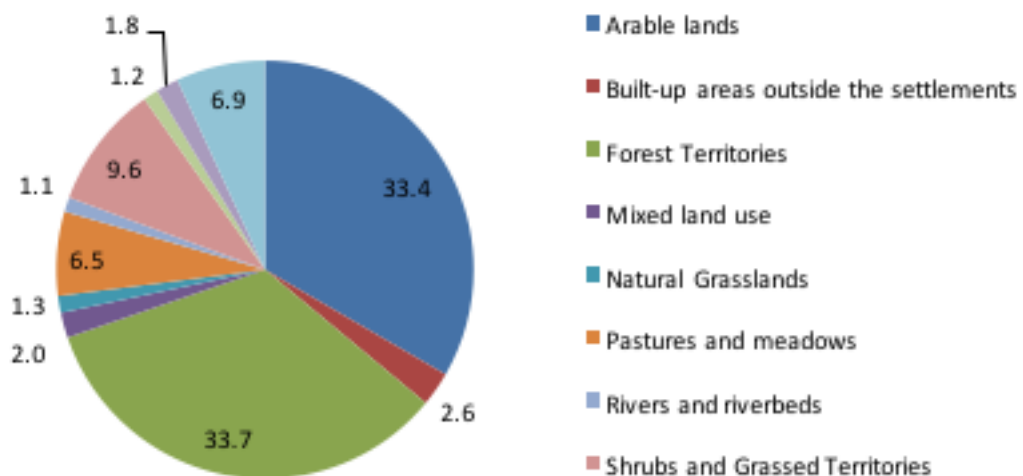


Figure 8. Landscape composition (in %) within 5 km radius, northern BG.

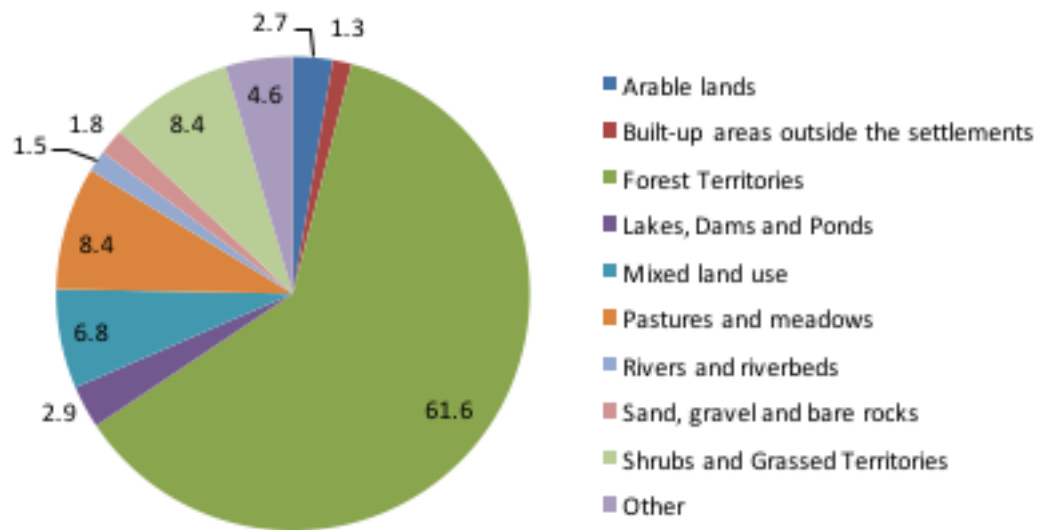


Figure 9. Landscape composition (in %) within 5 km radius, southern BG.

- **30 km buffer around the nest**

A total of 40 land cover classes were identified within 30 km radius around EV nests in BG (n = 67 nests, Annex 2.3). Forests covered the largest area (39.2%; n = 30,754 km²), followed by arable lands (28%). Other important land covers were pastures and meadows (7.4%), shrubs and grasslands (7.3%) and territories with mixed land use (4.8%) (Fig. 10). Of the largest land covers, pastures and meadows, and shrub and grassland territories were the most fragmented, represented respectively with 10% and 15% of all patches (Annex 2.3).

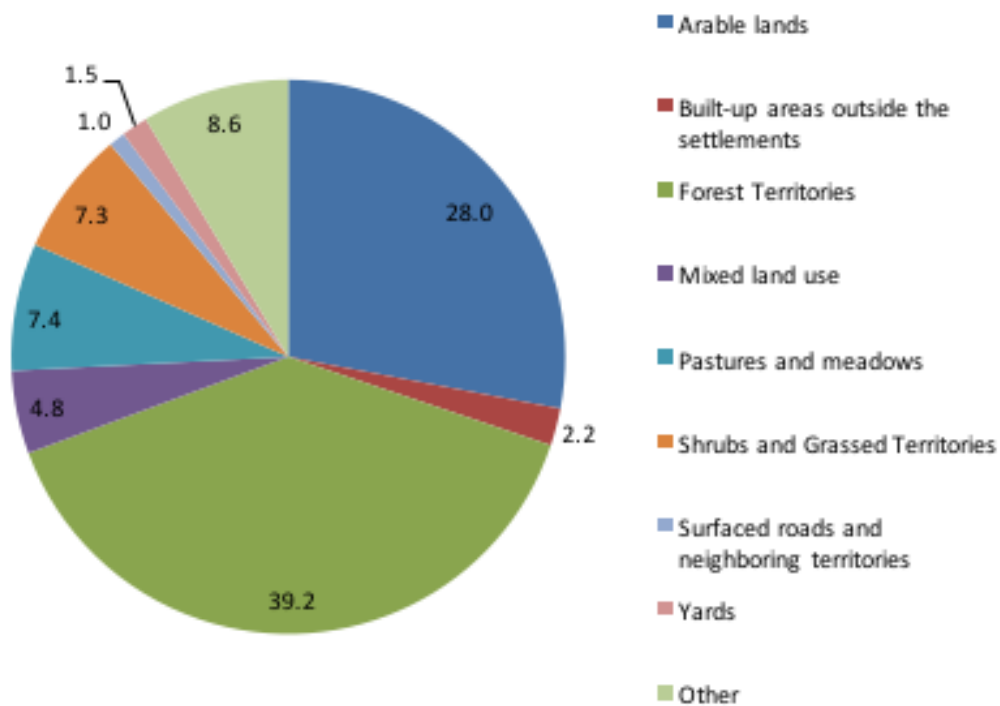


Figure 10. Coverage of landscape features (in %) in 30 km radius, BG.

Greece

• 30 km buffer around the nest

A total of 19 land cover classes were identified within 30 km radius around EV nests in GR (Annex 2.4). Arable lands covered the largest area (31.5%; $n = 6,066 \text{ km}^2$), followed by forests (25.7%) and forage land cover (20.8%) (Fig. 11). Arable lands were the most fragmented land cover class, with 47% of all patches, followed by the other large landscape features – forage land with 12% and forestry with 10% of all patches. (Annex 2.4).

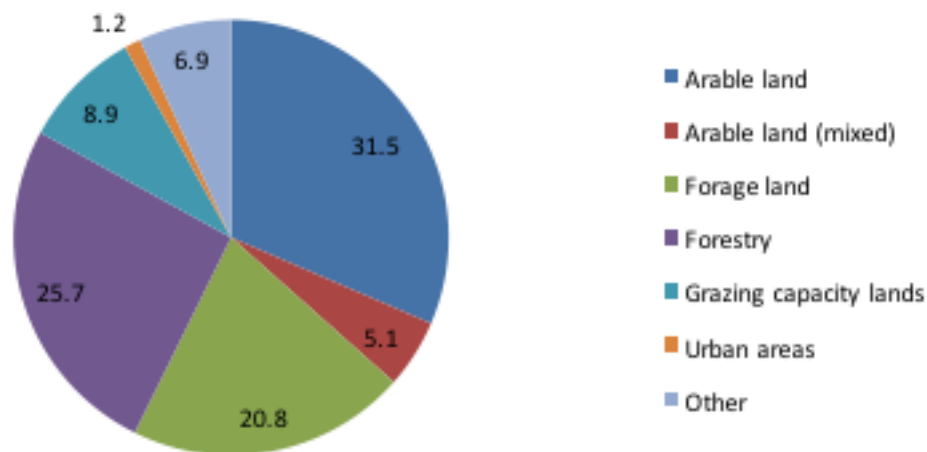


Figure 11. Coverage of landscape features (in %) in 30 km radius, GR.

Relationship between territory occupancy and environmental factors

We used data from 87 different territories that were monitored in up to 12 years between 2003 and 2014, resulting in 766 territory-year combinations for which reliable information on the occupancy status was available. Because not all monitoring efforts were sufficiently intensive to assess reproductive output, our assessment of factors influencing breeding success was based on 373 territory-year combinations occupied by a pair from 66 territories.

Of the 87 originally occupied territories that were monitored during our study, 43 had been abandoned by 2014 (49%). The model examining the influence of environmental variables on territory abandonment had reasonable discriminative ability ($AUC = 0.710 \pm 0.056$), and indicated that territories that were closer to a reliable food source, within the core distribution region, and at lower elevation were more likely to have persisted until 2014 (Figs. 12 and 13). Territories were also more likely to have persisted if they had a larger number of villages within a 5 km radius around the nest (Fig. 12).

Annual occupancy ranged from 100% of all monitored territories in 2003 ($n = 17$) to 47% of all monitored territories in 2014 ($n = 71$). Of the 766 territories monitored during the study period, 529 (69%) were occupied by at least one bird, and 497 (64.9%) were occupied by two birds. The model examining the influence of environmental variables on annual occupancy had good discriminative ability ($AUC = 0.867 \pm 0.008$), and indicated that variables relating to food availability, geographic structure, and nesting opportunities were the most influential in distinguishing between occupied and unoccupied territories (Fig. 14). Ten variables achieved a relative variable importance of $>25\%$, but no single variable reduced the discriminative ability of the model by >0.03 AUC units when randomly permuted (Annex 1). Consequently, the change in predicted probability of occupancy was relatively small across the scale of even the most important variables (Fig. 15)

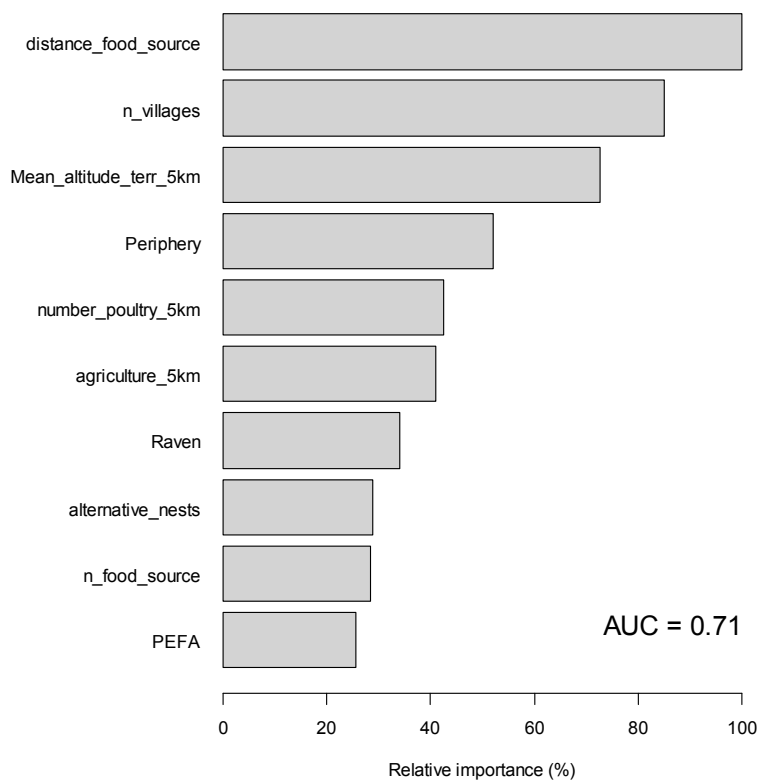


Figure 12. Relative variable importance of the 10 most important predictor variables influencing whether EV territories on the Balkan Peninsula were abandoned between 2003 – 2014. Variable importance was derived from a permutation procedure quantifying the reduction in discriminative ability of a random forest model

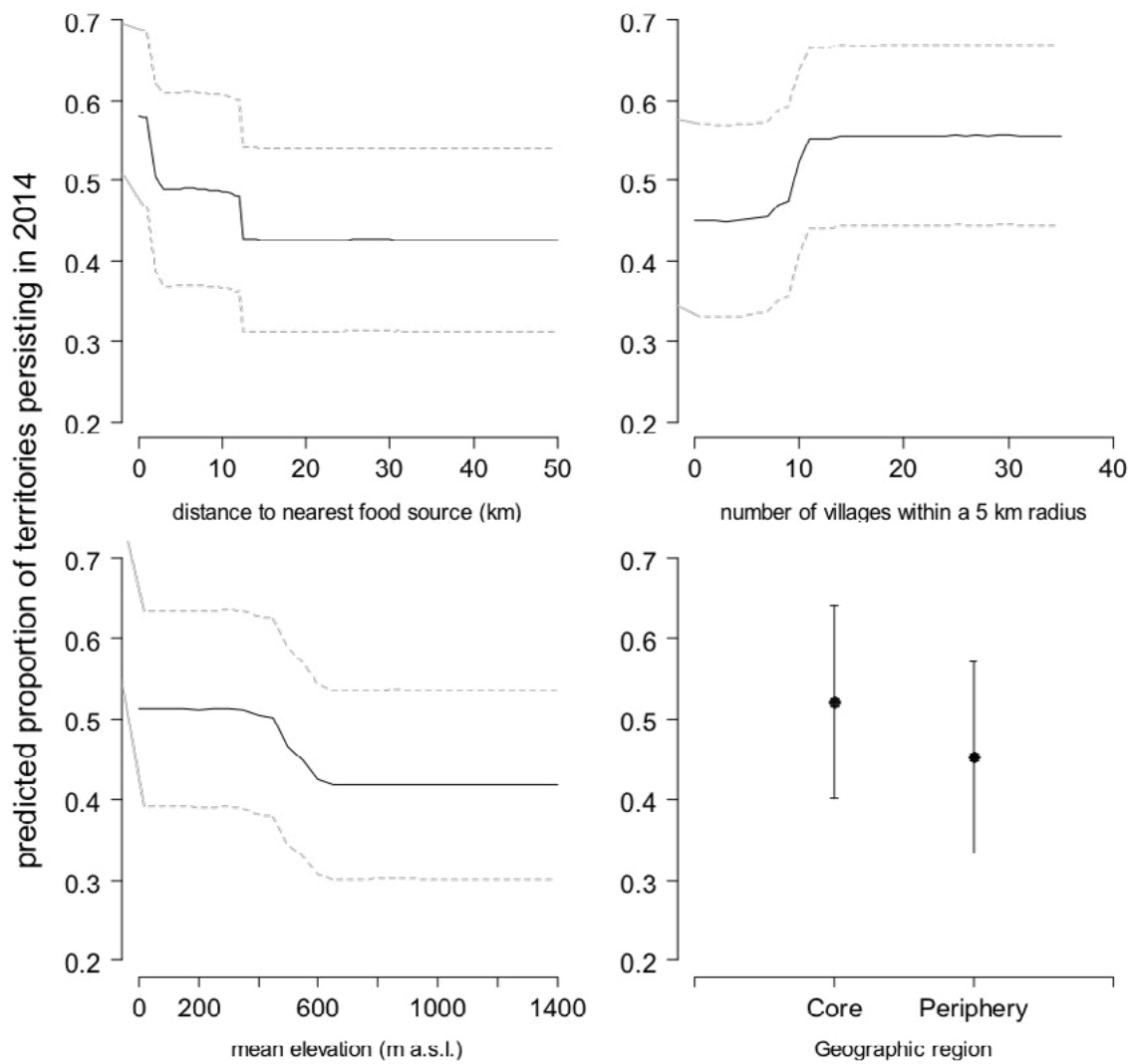


Figure 13. Predicted relationships between the 4 most influential environmental variables and the proportion of territories that were predicted to persist until 2014 if all other variables were held at their actual values.

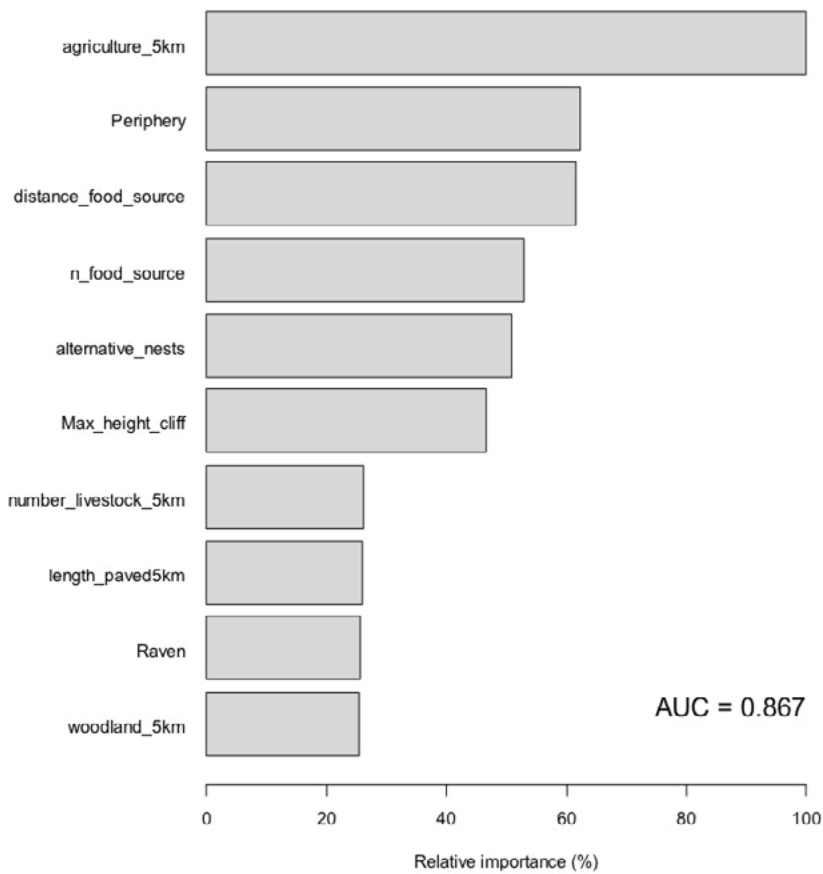


Figure 14. Relative variable importance of the 10 most important predictor variables influencing the annual occupancy of EV territories on the Balkan Peninsula between 2003 – 2014. Variable importance was derived from a permutation procedure quantifying the reduction in discriminative ability of a random forest model.

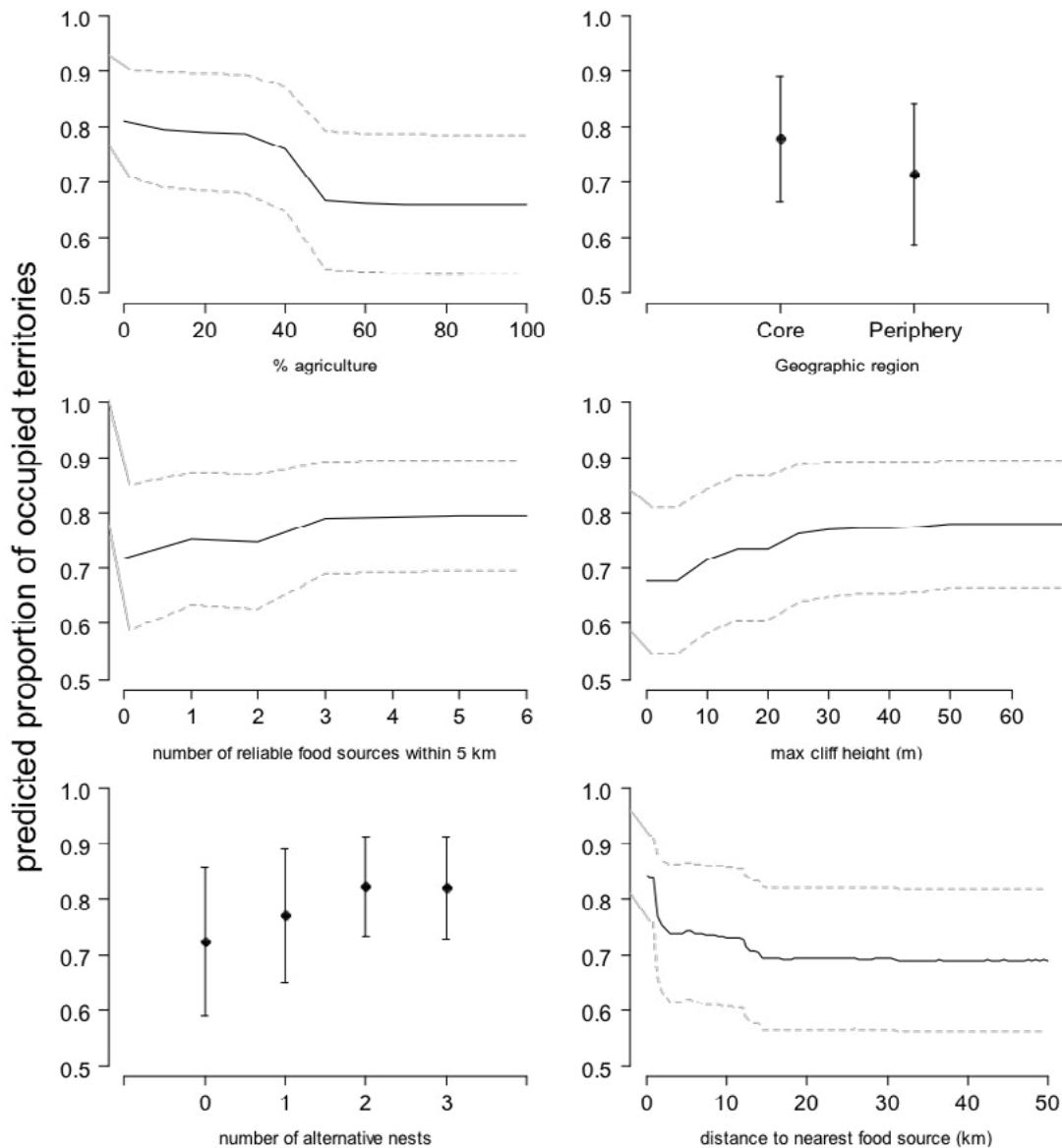


Figure 15. Predicted relationships between the 6 most influential environmental variables and the proportion of territories that were predicted to be occupied if all other variables were held at their actual values.

Relationship between breeding success and environmental factors

Of 399 territory-year combinations for which occupancy and breeding status information was available, 23 (5.8%) were only occupied by a single bird and in three further territories the final outcome could not be determined, and these territories were therefore excluded from calculations of breeding success. No breeding attempt was discovered in 89 occupied territories (23.7%, Table 2), and breeding success ranged from a minimum of 46.5% (in 2005) to a maximum of 76.5% (in 2008). Overall productivity (number of fledglings per occupied territory) was $0.79 (\pm 0.73 \text{ s.d.})$, and the average number of fledglings per successful pair was $1.30 (\pm 0.46 \text{ s.d.})$ and ranged from 1.19 (in 2010) to 1.50 (in 2006; Table 2). The model examining the influence of environmental variables on breeding success had a reasonable discriminative ability ($\text{AUC} = 0.737 \pm 0.026$). The variables with the greatest explanatory power related to disturbance, topography, and nesting opportunities (Fig. 16, Annex 1). Similar to the model describing occupancy, seven variables achieved a relative variable importance of $>50\%$, but no single variable reduced the discriminative ability of the model by >0.02 AUC units when randomly permuted (Annex 1). Consequently, the increase in predicted breeding success was relatively small across the scale of even the most important variables (Fig. 17)

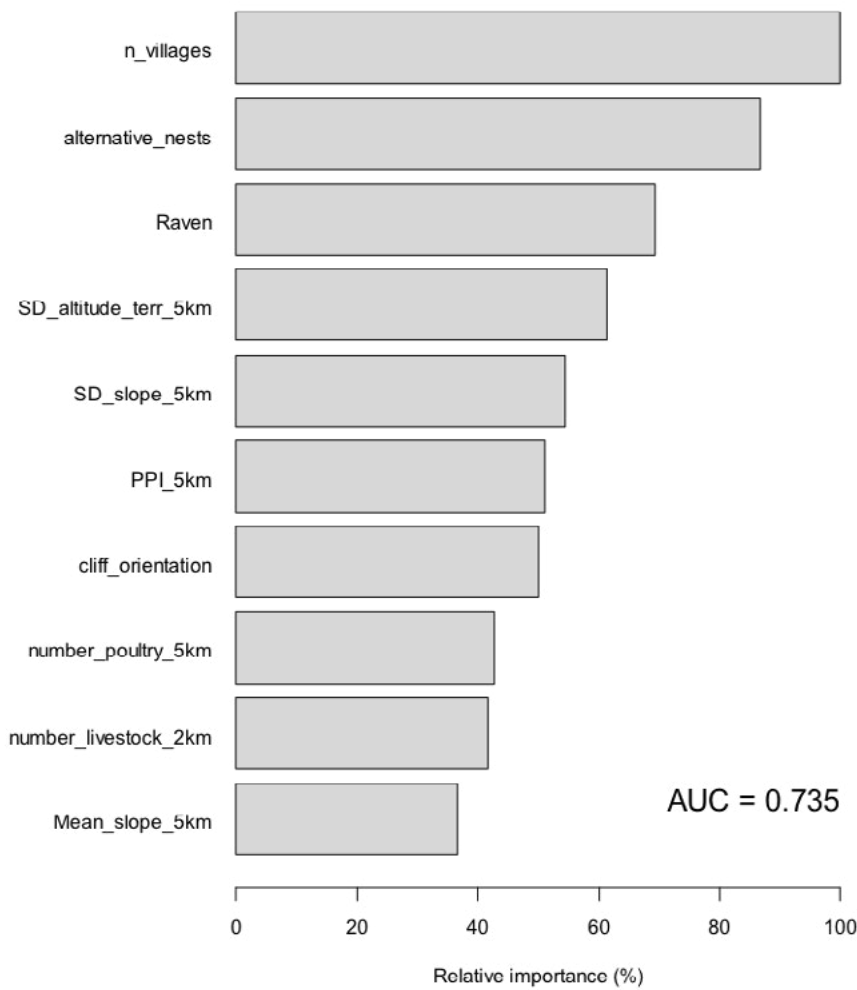


Figure 16. Relative variable importance of the 10 most important predictor variables influencing the breeding success of EV on the Balkan Peninsula between 2003 – 2014. Variable importance was derived from a permutation procedure quantifying the reduction in discriminative ability of a random forest model.

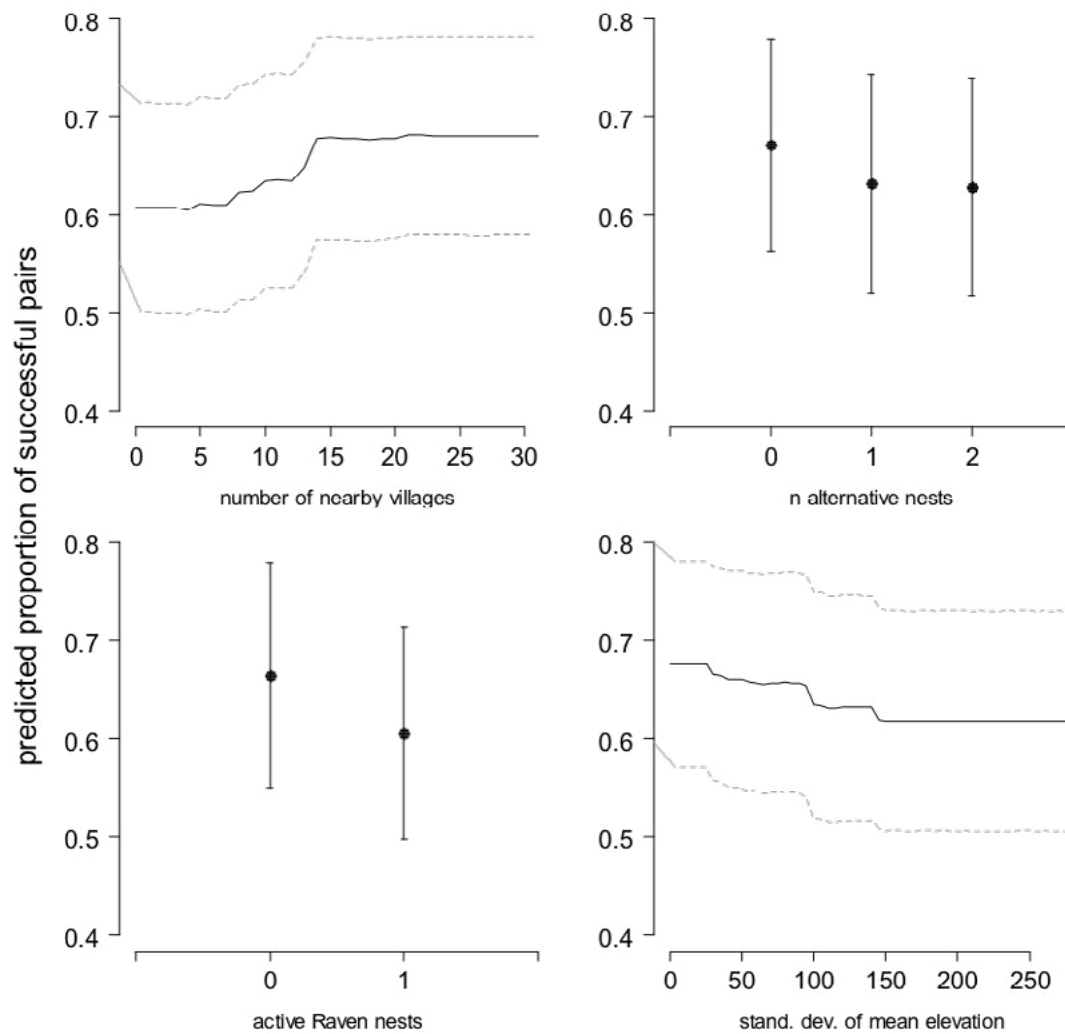


Figure 17. Predicted relationships between the four most influential environmental variables and the proportion of pairs that were predicted to successfully raise at least one fledgling if all other variables were held at their actual values.

Table 2. Summary of reproductive performance of EV in BG and GR between 2003 – 2014. ‘pairs breeding’ is the number of territories occupied by two adult birds that initiated a breeding attempt; ‘successful pairs’ is the number of breeding pairs that raised at least one fledgling; ‘productivity’ is the average number of fledglings produced across all territories occupied by two birds; ‘fledging rate’ is the average number of fledglings produced by successfully breeding pairs.

Country	Bulgaria		Greece	
	n	%	n	%
n territories monitored	340		59	
n territories occupied by two adults	324	95.3%	52	88.1%
n pairs breeding	243	75.0%	44	84.6%
n successful pairs	205	84.4%	25	56.8%
n pairs raising two young	61	29.8%	7	28.0%
Productivity	0.82 (n = 324)		0.65 (n = 41)	
Fledging rate	1.30 (n = 205)		1.28 (n = 25)	

DISCUSSION

Egyptian vulture nest site and breeding cliff characteristics

The EV is a typical cliff nesting species and occupies caves, holes or cliff ledges (Ferguson-Lees & Christie 2006). We found that the majority of the nests that we studied are built in caves. This is in accordance to another study in northeastern GR where 71% of the pairs occupy caves and 29% occupy ledges (Vlachos et al. 1998). Caves and deep holes are more protected than the cliff ledges and may favor the incubation during bad weather conditions too. It is known that in the Griffon vulture the breeding success is influenced by the position of the nest on the breeding cliff and those on open ledges are the least successful (Lopez-Lopez et al. 2004).

Our results show that nests with southwestern exposition are the most preferred, followed by nests with western, southern and eastern exposition showing almost similar results. A study from BG shows that EV breeding in nests with eastern and southeastern exposition are most likely to raise chicks (Arkumarev 2014). At the same time results from our study support the results from other studies across the range of the species, and confirm that the Balkan population of the species has no different preferences towards the exposition and the type of the nest. Hence, there is no difference between the Balkan and other populations of the species on this aspect of the breeding biology (Abuladze & Shergalin 1998; Liberatori & Penteriani 2001; Sara & Di Vittorio 2003). Most probably the preferences of the species towards “warm” expositions is due to a specific microhabitat and climatic conditions such as temperature, humidity, sunlight, etc. Nest with southwestern and southern expositions are warmer than the other and most probably favor the incubation, especially in cases of food shortage and worse weather conditions. In such cases sometimes both birds are foraging to restore the energy loss and thus eggs or chicks could be left longer without attendance.

The majority of the EV nests are chosen and built up to 10 m height, and almost all of the nests of the species in BG and GR can be found at no more than 30 m height. At the same time the nests are distributed more or less equally on cliffs with different size and height. Most probably building nests in the lower part of the cliffs, no matter the size, helps the species to avoid competition with other cliff nesting species, and on the other hand to protect its territory successfully towards intruders. The EV is disturbed and has lower breeding success when shares the breeding cliff with Griffon vultures (Carlson 1998). Except for the griffons, the raven is also a great competitor of the EV especially in the breeding cliffs. A study in the Eastern Rhodopes proves the raven as the main competitor of the species and most probably could compromise the breeding success (Dobrev 2010). Its foraging ability are suspected to cause breeding failures in the Bearded vulture in the Pyrenees (Margalida et al. 2003).

The EV on the Balkans is rapidly declining and it is exposed to many limiting factors with either natural or human induced origin (Velevski et al. 2015). And while some natural drivers of decreased breeding performance and/or mortality in the EV are difficult to be measured and controlled, human induced factors such as disturbance or/ and direct persecution, infrastructure and other activities can be solved. The disturbance in the vicinity of the nest of the EV is proved to have a negative impact on the breeding performance reducing the breeding success of the species especially in cases where the nest is more accessible and closer to a human settlement or area with intensive human activities (Carrete et al. 2007, Zuberogoitia et al. 2008, Inigo et al. 2009, Zuberogoitia et al. 2014). Different conservation approaches exist and have been tested in different species to mitigate human impact especially in sensitive species such as the EV and the Imperial Eagle (Demerdzhiev et al. 2014, Zuberogoitia et al. 2014, Dobrev et al. 2016, 2016).

In small populations such as the Balkan population of the EV (Velevski et al. 2015) conservation measures to mitigate limiting factors could play a positive role for the breeding success and the survival rate of the individuals, and because of the small population size, they can be individually orientated.

A conservation management strategies on a territory level can be the first step, summarizing threats and suggesting decisions, especially on issues such as disturbance and lack of food. On the second hand, those nests which are more exposed to human disturbance can be guarded and artificially fed. Additionally a video

surveillance and prohibition of activities such as climbing, para gliding, other extreme sports and any human activities, can be applied simultaneously (Demerdzhiev et al. 2014, Zuberogoitia et al. 2014, Dobrev et al. 2016, 2016).

Egyptian vulture habitat in Bulgaria and Greece

Over most of its' range, the species nests in montane open country, lowlands with canyons or plateaus, often in arid and mountainous regions, but also along beaches, river sand-banks and wetland edges, and frequently near human habitations: thus desert edge, the African Sahel, high rocky plains and ravines, steppe and other grasslands, open savannah (but not closed woodland), cultivation, rubbish dumps, harbors and villages (Ferguson-Lees & Christie 2001). Results from our study on the landscape features and composition in 1 km, 5 km and 30 km radius around EV nests in BG and GR show that there is no difference in the composition and the structure of the landscape features in the EV territories on a macro and micro level. A typical cliff nesting species the EV in BG and GR usually breeds along river valleys in mountainous regions which can explain the high percentage of forests in the Egyptian vulture habitat. More over especially in BG most of the nests are found in protected areas and natural parks with preserved forest habitats (Kurtev et al. 2007). The high proportion of natural habitats such as the shrubs and pastures is directly linked with the food availability of the species and that type of habitats are closely related to the diet of the species and the territory occupancy. Moreover the EV is an opportunistic scavenger and except for the carcasses, the species feed on small prey, usually abundant in shrub and grassland habitats (Dobrev et al. 2016). The high proportion of the arable lands is a consequence of the anthropogenic pressure, the lack of natural habitats, high habitat fragmentation and reduced habitat diversity, and where food availability seems to be low and the illegal use of poison to control predators is a common practice (Carrete et al. 2007, Skartsi et al. 2014). This is especially valid for the north of BG where the proportion of the arable lands is higher than in the Rhodopes and only several pairs of the species persist.

Our results show that heterogeneity of the landscape features in southern BG is greater than in the north even though the most fragmented features both in the north and in the south are the natural habitats – shrubs and grasslands. This is a main difference between the two surviving clusters of the species in BG – the core area in the south, and the periphery in the north of BG (Velevski et al. 2014). In northern BG in contrast to the south, most of the habitats are homogenous arable lands, hereafter a lesser diversity of habitats and a decreased area of natural habitats important for the EV as a foraging area. The decreased food availability due to habitat loss could induce a greater mortality in the EV. Birds will be forced to cover a greater distances to find food or to use alternatives such as dump sites, road kills or preys in agricultural landscape where the probability of poisoning is higher (Skartsi et al. 2014). Hence, the habitat in the EV territories is linked with the quality of the territory and the heterogeneous habitats usually offers better breeding and foraging opportunities. In addition, higher-quality territories are usually occupied more consistently than those of poorer quality (Carrete et al. 2007), and will therefore attract conspecific recruits in their vicinity. The persistence and attraction of high-quality territories is the possible underlying mechanism behind the cluster formation in EV territories in the Balkans (Velevski et al. 2015). This is the case with the core area in the south of BG and the periphery of the population in northern BG. EV are known for their high natal philopatry (Carrete et al. 2007 , Grande et al. 2009), which may explain the persistence of remote territories. However, increasingly isolated clusters in the periphery with few pairs face higher extinction probability in comparison to the pairs in the core area due to demographic, environmental, and potentially genetic stochasticity (Velevski et al. 2015).

The EV in BG and GR survives in areas where natural habitats such as shrubs and grasslands dominate together with a greater diversity of habitats and heterogeneity. A key factor for conservation of the species in the remaining clusters in the Balkans is the sustainment of the natural habitats important for the species – pastures, shrubs and grasslands where the availability of food is higher. Forest habitats are the dominant landscape feature in the EV territories in BG and GR. In most of the cases the territories of the species in both countries are covered by protected areas where the conservation of the habitat is a baseline in the

management plan of the protected area. This is the case with the majority of the territories in GR and BG. In most of these protected areas forest habitats are a priority for conservation and were the reason to establish the protected area itself. So generally the forests coverage in EV territories have helped for the establishment of protected areas around . More conservation efforts can be addressed to help development of conservation management plans for protected areas and IBAs where the species occur . And since forest habitats cover large area in EV territories more cooperation with Forest agencies should be enforced, especially in areas where nests of the species are outside protected areas. This is especially valid if nests are close to forests under intensive forestry management and where forestry activities can cause disturbance of the nest or/and destruction of the habitat in the vicinity of the nest. An agri-environmental measure for the EV in BG exists aiming conversion of arable lands into pastures in order to ensure favorable habitat for the species. Together with the agri-environmental measure, another tool applied to support the species' survival is subsidizing livestock breeders. There is a direct link between the livestock breeders and the EV, and the sustainment of the natural habitats on the other hand.

Territory occupancy and breeding success are affected by a wide range of environmental variables

Territory occupancy and breeding success of EV on the Balkan Peninsula are affected by a wide range of environmental variables relating to topography, nest and food availability, and disturbance, each of which has a small effect that may not be the same across political boundaries. As a consequence, simple approaches to modify habitats or manage resources based on a small number of environmental variables are unlikely to be effective conservation management approaches that will considerably slow the decline of the species.

During the 12 years of monitoring covered here, almost 50% of EV territories were abandoned, despite reproductive output being generally similar to other western Palaearctic populations (Liberatori and Penteriani 2001, Donázar et al. 2002, García-Ripollés et al. 2006, Lieury et al. 2015). We found that territory abandonment was only partially predictable, and that territories closer to the core population centre and within close proximity to a reliable food source were the most likely territories to persist. The most influential variables are all consistent with the conditions in the Eastern Rhodopes, which is the remaining stronghold of the species on the Balkan Peninsula (Velevski et al. 2015). The lack of very strong drivers that can plausibly explain territory abandonment may indicate that population declines could be partly caused by adult and juvenile mortality away from breeding grounds. EV may suffer considerable mortality during migration (Grande et al. 2009, Angelov et al. 2013, Oppel et al. 2015), and some territory abandonment could be a consequence of random mortality outside the breeding season. Alternatively, territory abandonment could also result from mortality during the breeding season that is poorly captured by the environmental variables available for our analysis, for example the illegal use of poison (Skartsi et al. 2014), the direct persecution of raptors, or accidental mortality in wind turbines (Carrete et al. 2009).

Territory abandonment in EV has previously been described as a consequence of various landscape factors (Carrete et al. 2007, Hernández and Margalida 2009, Olea and Mateo-Tomás 2011), and our analysis supports these findings. We found that the most influential variables affecting annual occupancy related to food availability and the availability of suitable nesting sites. Probability of occupancy was higher if the surrounding landscape had fewer areas dedicated to agriculture, which is consistent with the pattern observed in Spain (Carrete et al. 2007). This apparent negative effect of agriculture might be a consequence of the relatively low abundance of suitable prey items found in agricultural areas (Nikolov 2010; Dobrev et al. 2016), regular disturbance by agricultural activities, or the widespread use and misuse of agro-chemicals that could lead to secondary poisoning (Gradinarov and Difova 2014; Skartsi et al. 2014). Similarly, the number of reliable food sources within a 5 km radius and the distance to the nearest reliable food source both had a positive influence on occupancy, because they increase availability and accessibility of food and may thus favour the selection of territories (López-López et al. 2014). Territories were also more likely to be occupied if they contained higher cliffs with a larger number of alternative nest sites, which reflects the availability of suitable nesting substrate for individual birds to select (Liberatori and Penteriani 2001, Donázar et al. 2002, Mateo-

Tomás et al. 2010).

Effect of disturbance

Human disturbance has been recognised as a prominent factor for territory abandonment of vultures (Carrete et al. 2007, Zuberogoitia et al. 2014, Krüger et al. 2015). We found little evidence that factors associated with human pressure influenced the occupancy of territories, and found that both territory persistence and breeding success actually increased with an increasing number of villages in a 5 km radius around the nest. Although the number of settlements and human disturbance have been shown to explain territory abandonment of vultures in South Africa (Krüger et al. 2015) and decrease breeding success in Spain (Zuberogoitia et al. 2014), a larger number of villages may be reflective of traditional rural landscapes with many small livestock farms that are a more suitable cultural landscape than larger and increasingly urbanised human population centres. Because many small villages have been abandoned in BG, the attraction of remaining small livestock herds which can act as local food sources may be stronger than the repelling nature of human disturbance. EV are frequently observed feeding on scraps in small farm yards, and the remains of small-scale livestock farming in rural villages can likely be used by vultures to feed chicks and therefore increase breeding success. However, we found some evidence that disturbance by another cliff-nesting species, the Common Raven, may reduce breeding success of EV. Ravens are known for their aggressive and klepto-parasitic abilities, and can reduce breeding success of raptors (Bertran and Margalida 2004, Brambilla et al. 2004). Because neither of the most important variables explaining breeding success had a very strong effect, and neither is amenable to management, designing efficient conservation management to increase the productivity of EVs on the Balkan peninsula will be challenging (Opiel et al. 2016).

Conclusions

In conclusion, EV in BG and GR are affected by a broad suite of landscape variables that influence the availability of food and nesting sites, but the complex interaction between a large number of different factors renders it unlikely that targeted action to manage certain aspects of the landscape will have immediate and substantial success in reverting population declines. We recommend a thorough evaluation of existing management techniques, and advocate for the conservation of traditional rural farming landscapes with many small livestock holders, relatively few areas devoted to agriculture, and many small feeding stations where animal carcasses are regularly disposed of to replicate the historical patchy spatio-temporal distribution of prey.

On a territory level the EV generally suffers anthropogenic pressure linked mostly with disturbance and direct persecution. However a combination of individually targeted conservation actions can potentially have a positive effect on the breeding parameters and the survival rates of the species in the breeding grounds. On the other hand, a management plan and agrienvironmental measures to support the main habitats of the species would help the conservation of the habitats and the persistence of the high-quality territories of the EV on the Balkans.

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ANNEXES

Annex 1. List and description of 48 environmental predictor variables used to explain variation in EV territory occupancy and breeding success in BG and GR between 2003 and 2014. Relative importance and AUC reduction after permutation are derived from a conditional inference random forest model.

Variable	Source	Description	Importance for territory occupancy	AUC reduction territory occupancy	Importance for breeding success	AUC reduction breeding success
active_nests_5km	Field data	number of active Egyptian Vulture nests in a 5 km radius	16.0	0.0062	21.1	0.0039
agriculture_5km	GlobCover2009	% cover of agriculture within a 5 km radius around the nest	100.0	0.0390	16.8	0.0031
alternative_nests	Field data	total number of alternative nest sites used by an Egyptian Vulture in the same territory in other years	50.9	0.0199	81.6	0.0151
Cliff_length	Field data	horizontal length of the cliff in which the nest is located (m)	21.7	0.0085	12.2	0.0023
cliff_orientation	Field data	compass direction into which the cliff faces	12.2	0.0048	48.4	0.0090
distance_food_source	Field data	distance (km) to the nearest reliable food source	61.5	0.0240	29.7	0.0055
EAOW	Field data	presence of an active Eagle Owl nest within a 5 km radius	10.0	0.0039	4.9	0.0009
edge_length_5km	GlobCover2009	total length of habitat edges within a 5 km radius around the nest	7.7	0.0030	16.3	0.0030
GlobCover_classes_5km	GlobCover2009	number of different GlobCover habitat classes within a 5 km radius around the nest	13.4	0.0052	18.8	0.0035

grasslands_5km	GlobCover2009	% cover of grasslands within a 5 km radius around the nest	12.0	0.0047	11.8	0.0022
Griffon	Field data	presence of an active Griffon Vulture nest within a 5 km radius	7.5	0.0029	31.0	0.0057
Habitat_diversity_5km	GlobCover2009	Shannon-Wiener index of habitat diversity within a 5 km radius around the nest	9.3	0.0036	25.2	0.0047
habitat_patches_5km	GlobCover2009	total number of habitat patches within a 5 km radius around the nest	13.1	0.0051	23.4	0.0043
Height_cliff_above_nest	Field data	vertical distance from the nest to the top of the cliff (m)	NA	NA	15.6	0.0029
Height_nest	Field data	vertical distance from the base of the cliff to the nest (m)	NA	NA	28.2	0.0052
Latitude	Field data	Latitude of the nest	6.4	0.0025	14.8	0.0027
length_paved5km	Topo maps	total length of paved roads within a 5 km radius around the nest	25.9	0.0101	38.0	0.0070
length_unpaved5km	Topo maps	total length of unpaved roads within a 5 km radius around the nest	8.1	0.0032	13.8	0.0025
length_water5km	Topo maps	total length of water courses within a 5 km radius around the nest	8.2	0.0032	17.3	0.0032
Longitude	Field data	Longitude of the nest	7.6	0.0030	13.7	0.0025

Max_height_cliff	Field data	maximum height of the nesting cliff (m)	46.5	0.0182	18.4	0.0034
Mean_altitude_terr_5km	Digital elevation model	mean elevation of the territory (m above sea level)	11.6	0.0045	30.3	0.0056
Mean_slope_5km	Digital elevation model	mean slope of the terrain across the territory	17.1	0.0067	32.1	0.0059
n_food_source	Field data	number of reliable food sources in a 5 km radius	52.9	0.0207	26.3	0.0049
n_livestock_owner	Authorities	number of livestock owners in a 5 km radius	11.5	0.0045	-1.0	-0.0002
n_villages	GIS layers	number of villages within a 5 km radius around the nest	21.6	0.0084	100.0	0.0185
n_wind_turb	Field data	number of wind turbines in a 20 km radius	11.1	0.0043	5.1	0.0009
Nest_orientation	Field data	compass direction into which the nest entrance faces	NA	NA	18.2	0.0034
Nest_type	Field data	nest type: cave, ledge,	NA	NA	13.7	0.0025
number_livestock_2km	Authorities	number of livestock animals in a 2 km radius	22.7	0.0089	39.7	0.0073
number_livestock_5km	Authorities	number of livestock animals in a 5 km radius	26.1	0.0102	16.3	0.0030

Number_of_people_in_nearest_village	Authorities	number of human inhabitants in the nearest village	10.6	0.0041	10.7	0.0020
number_poultry_2km	Authorities	number of poultry animals in a 2 km radius	1.5	0.0006	5.7	0.0010
number_poultry_5km	Authorities	number of poultry animals in a 5 km radius	1.0	0.0004	41.4	0.0077
open_ground_5km	GlobCover2009	% cover of unvegetated soil within a 5 km radius around the nest	19.4	0.0076	33.4	0.0062
PEFA	Field data	presence of an active Peregrine Falcon nest within a 5 km radius	14.2	0.0055	27.0	0.0050
Periphery	Velevski et al. 2015	whether the nest was located in the population core (Eastern Rhodopes) or in the periphery (elsewhere in BG or GR).	62.2	0.0243	8.1	0.0015
Poisoning_5km	Skartsi et al. 2014	number of known poisoning incidents reported in the past 10 years within a 5 km radius	8.0	0.0031	1.9	0.0004
PPI_5km	GlobCover 2009	primary productivity index derived from the normalised difference vegetation index within a 5 km radius	17.7	0.0069	51.3	0.0095
Raven	Field data	presence of an active Eagle Owl nest within a 5 km radius	25.6	0.0100	67.8	0.0125
SD_altitude_terr_5km	Digital elevation model	topographical ruggedness expressed as standard deviation of mean elevation in the territory	16.9	0.0066	61.5	0.0114
SD_slope_5km	Digital elevation model	topographical ruggedness expressed as standard deviation of mean slope of the territory	18.1	0.0071	58.6	0.0108

shrubland_5km	GlobCover2009	% cover of shrub and intermediate succession vegetation within a 5 km radius around the nest	14.9	0.0058	21.8	0.0040
Total_people_5km	Authorities	total number of human inhabitants within a 5 km radius around the nest	8.7	0.0034	13.7	0.0025
type_food_source	Field data	type of the nearest reliable food source (e.g. slaughterhouse, feeding station, rubbish dump etc.)	17.6	0.0069	18.0	0.0033
urban_5km	GlobCover2009	% cover of urban habitats within a 5 km radius around the nest	5.4	0.0021	18.5	0.0034
water_5km	GlobCover2009	% cover of open water bodies within a 5 km radius around the nest	5.2	0.0020	21.2	0.0039
woodland_5km	GlobCover2009	% cover of forest and tree plantations within a 5 km radius around the nest	25.4	0.0099	29.0	0.0054

Annex 2. Land cover features and composition around Egyptian vulture nests, Bulgaria and Greece in 1 km, 5 km and 30 km radius. The polygons within the buffers were dissolved to aggregate bordering polygons for each buffer range over all territories. Then polygons were converted from single part to multi part to calculate the total number of patches for a given landscape feature.

Annex 2.1. Land cover features and composition in 1 km buffer around Egyptian vulture nests, Bulgaria

Landscape features	Number of patches	Patches coverage in %	Area size in ha	Area size in %	Average area size, ha	Minimal area size, ha	Maximal area size, ha	Standard deviation
Arable lands	109	6	1184.9	6.7	10.9	0.0	99.5	18.3
Areas for Sport and Recreation	1	0	2.3	0.0	2.3	2.3	2.3	0.0
Areas with other / non agricultural / purpose	2	0	13.1	0.1	6.6	6.6	12.3	8.1
Areas with Poor Vegetation	11	1	60.2	0.3	5.5	0.2	25.6	7.8
Built-up areas outside the settlements	367	19	179.1	1.0	0.5	0.0	13.6	1.3
Channels	1	0	0.1	0.0	0.1	0.1	0.1	0.0
Field roads, livestock treks and openings	53	3	36.4	0.2	0.7	0.0	6.2	1.1
Forest Meadows and Pastures	20	1	133.1	0.8	6.7	0.0	61.6	14.8
Forest Territories	215	11	10943.5	62.0	50.9	0.0	909.8	105.3
Gullies, Ravines and Grooves	26	1	113.8	0.6	4.4	0.0	66.3	12.9
Lakes, Dams and Ponds	22	1	320.6	1.8	14.6	0.0	146.9	35.4
Landfill and Tailings	1	0	0.9	0.0	0.9	0.9	0.9	0.0
Mixed land use	80	4	442.0	2.5	5.5	0.0	44.8	8.4
Naked and eroded terrain	1	0	0.4	0.0	0.4	0.4	0.4	0.0
Natural Grasslands	25	1	125.2	0.7	5.0	0.0	35.6	8.8
Near Urban areas	1	0	1.2	0.0	1.2	1.2	1.2	0.0
Orchards	1	0	1.9	0.0	1.9	1.9	1.9	0.0
Pastures and meadows	292	15	982.9	5.6	3.4	0.0	56.4	6.1
Perennials (perennial crops)	3	0	2.9	0.0	1.0	0.7	1.2	0.2
Quarries, open pits and Landslip	2	0	4.6	0.0	2.3	2.0	2.6	0.4
Railway lines and adjacent territories	6	0	19.5	0.1	3.3	1.4	5.1	1.5
Rivers and riverbeds	33	2	415.2	2.4	12.6	0.0	54.0	12.2
Sand, gravel and bare rocks	89	5	531.0	3.0	6.0	0.0	54.3	9.5
Shrubs and Grassed Territories	396	20	1723.3	9.8	4.4	0.0	140.6	12.8
Small-scale non-agricultural areas	18	1	0.6	0.0	0.0	0.0	0.1	0.0
Surfaced roads and neighboring territories	53	3	96.6	0.5	1.8	0.0	9.4	1.9
Transport Infrastructure	4	0	0.5	0.0	0.1	0.1	0.3	0.1
Urban Structures	8	0	125.7	0.7	15.7	0.1	49.4	20.3
Vines	11	1	23.5	0.1	2.1	0.1	7.3	2.2
Wetlands	1	0	8.0	0.0	8.0	8.0	8.0	0.0
Yards	106	5	153.4	0.9	1.4	0.0	19.6	2.8

Annex 2.2. Land cover features and composition in 5 km buffer around Egyptian vulture nests, Bulgaria

Landscapes features	Number of patches	Patches coverage	Area size in ha	Area size in %	Average area size	ha	Minimal area size	Maximal area size	Standard deviation
Arable lands	30704	9	860886.3	28.0	28.0	0.0	3711.4	83.2	
Areas for Sport and Recreation	418	0	2199.7	0.1	5.3	0.0	221.3	18.9	
Areas with other / non agricultural / purpose	202	0	4751.1	0.2	23.5	0.0	1262.0	96.6	
Areas with Poor Vegetation	1378	0	12937.2	0.4	9.4	0.0	327.1	23.4	
Border water areas	9	0	416.6	0.0	46.3	0.4	314.9	102.2	
Brownfields	27	0	144.6	0.0	5.4	0.2	36.1	9.5	
Built-up areas outside the settlements	111846	32	67055.5	2.2	0.6	0.0	789.9	4.7	
Channels	2221	1	7006.7	0.2	3.2	0.0	69.4	5.4	
Field roads, livestock treks and openings	12757	4	13840.1	0.5	1.1	0.0	54.8	2.2	
Forest Meadows and Pastures	617	0	3430.9	0.1	5.6	0.1	1052.0	45.5	
Forest Territories	11227	3	1204816.5	39.2	107.3	0.0	85056.0	1115.7	
Group Line Objects (Gorge)	280	0	2337.4	0.1	8.3	0.1	149.5	16.9	
Gullies, Ravines and Grooves	4844	1	24454.9	0.8	5.0	0.0	153.3	8.6	
Lakes, Dams and Ponds	3985	1	25777.2	0.8	6.5	0.0	2083.7	63.4	
Landfill and Tailings	500	0	2369.2	0.1	4.7	0.0	209.0	15.8	
Mixed land use	16800	5	149075.4	4.8	8.9	0.0	519.0	17.5	
Naked and eroded terrain	284	0	3889.4	0.1	13.7	0.0	1593.6	96.8	
Natural Grasslands	1811	1	16633.6	0.5	9.2	0.1	292.7	18.6	
Near Urban areas	1920	1	10363.8	0.3	5.4	0.0	334.5	16.7	
Orchards	2140	1	9135.2	0.3	4.3	0.0	93.1	8.4	
Other perennials	475	0	1730.1	0.1	3.6	0.0	40.9	5.4	
Other Territories	3	0	9.1	0.0	3.0	0.1	8.7	4.9	
Pastures and meadows	35921	10	228714.4	7.4	6.4	0.0	4769.7	31.4	
Perennials (perennial crops)	3694	1	12654.7	0.4	3.4	0.0	126.8	8.1	
Quarries, open pits and Landslip	279	0	3233.4	0.1	11.6	0.0	224.1	20.5	
Railway lines and adjacent territories	200	0	3976.9	0.1	19.9	0.0	282.2	30.6	
Rivers and riverbeds	1343	0	27916.1	0.9	20.8	0.0	991.7	52.3	
Sand, gravel and bare rocks	1775	1	22923.6	0.7	12.9	0.0	10449.9	248.5	
Settlements (family gardens)	24	0	37.6	0.0	1.6	0.2	12.8	2.5	
Shrubs and Grassed Territories	54072	15	223514.6	7.3	4.1	0.0	708.1	14.0	
Small-scale non-agricultural areas	8188	2	314.2	0.0	0.0	0.0	1.3	0.1	
Surfaced roads and neighboring territories	1840	1	29376.9	1.0	16.0	0.0	6743.9	221.8	
Transport Infrastructure	336	0	85.9	0.0	0.3	0.0	9.4	0.7	
Uncultivated Areas	26	0	180.3	0.0	6.9	0.2	65.0	13.2	
Urban Structures	2193	1	23816.4	0.8	10.9	0.0	2496.1	72.2	
Urbanized Territories	1	0	0.8	0.0	0.8	0.8	0.8	0.0	
Vines	3890	1	25889.7	0.8	6.7	0.0	230.8	14.1	
Water areas and wetlands	90	0	296.8	0.0	3.3	0.0	30.9	5.9	
Wetlands	387	0	1911.0	0.1	4.9	0.0	116.9	10.5	
Yards	32665	9	47307.5	1.5	1.4	0.0	159.0	2.4	

Annex 2.3. Land cover features and composition in 30 km buffer around Egyptian vulture nests, Bulgaria

Landscapes features	Number of patches	Patches coverage in %	Area size in ha	Area size in %	Average area size_ha	Minimal area size_ha	Maximal area size_ha	Standart deviation
Arable lands	2150	7	44191.2	16.7	20.6	844.9	0.0	56.2
Areas for Sport and Recreation	31	0	53.3	0.0	1.7	6.0	0.1	1.4
Areas with other / non agricultural / purpose	16	0	428.0	0.2	26.7	123.8	0.4	38.7
Areas with Poor Vegetation	151	1	1120.0	0.4	7.4	138.6	0.1	15.3
Brownfields	4	0	20.9	0.0	5.2	18.3	0.1	8.7
Built-up areas outside the settlements	8122	27	5038.6	1.9	0.6	336.6	0.0	4.2
Channels	63	0	163.9	0.1	2.6	30.3	0.0	4.6
Field roads, livestock treks and openings	1040	3	962.8	0.4	0.9	24.4	0.0	1.8
Forest Meadows and Pastures	96	0	321.9	0.1	3.4	80.2	0.0	9.3
Forest Territories	1217	4	129305.8	48.9	106.2	6054.5	0.0	471.8
Group Line Objects (Gorge)	13	0	397.8	0.2	30.6	119.9	0.5	38.4
Gullies, Ravines and Grooves	452	2	1899.4	0.7	4.2	86.1	0.0	8.3
Lakes, Dams and Ponds	458	2	4604.2	1.7	10.1	1462.6	0.0	87.0
Landfill and Tailings	20	0	510.3	0.2	25.5	168.5	0.2	46.0
Mixed land use	1798	6	12101.5	4.6	6.7	148.1	0.0	10.6
Naked and eroded terrain	19	0	130.1	0.0	6.8	47.3	0.3	12.8
Natural Grasslands	237	1	1925.0	0.7	8.1	211.9	0.0	17.2
Near Urban areas	18	0	219.6	0.1	12.2	46.3	0.4	17.9
Orchards	120	0	478.8	0.2	4.0	48.9	0.1	6.7
Other perennials	17	0	81.2	0.0	4.8	24.2	0.2	6.9
Pastures and meadows	4114	14	19942.3	7.5	4.8	251.3	0.0	11.8
Perennials (perennial crops)	158	1	763.3	0.3	4.8	79.3	0.0	11.1
Quarries, open pits and Landslip	29	0	366.0	0.1	12.6	102.5	0.6	20.8
Railway lines and adjacent territories	47	0	432.2	0.2	9.2	37.7	0.1	9.4
Rivers and riverbeds	139	0	3454.2	1.3	24.9	461.8	0.1	53.2
Sand, gravel and bare rocks	388	1	3348.9	1.3	8.6	196.1	0.0	21.5
Shrubs and Grassed Territories	4966	17	23706.7	9.0	4.8	534.1	0.0	16.5
Small-scale non-agricultural areas	686	2	24.7	0.0	0.0	0.3	0.0	0.0
Surfaced roads and neighboring territories	246	1	2378.8	0.9	9.7	164.7	0.0	22.4
Transport Infrastructure	34	0	6.5	0.0	0.2	0.7	0.0	0.2
Urban Structures	153	1	1153.3	0.4	7.5	279.6	0.0	27.1
Urbanized Territories	1	0	0.8	0.0	0.8	0.8	0.8	0.0
Vines	275	1	1395.9	0.5	5.1	76.7	0.0	11.1
Water areas and wetlands	6	0	58.5	0.0	9.7	30.9	3.0	10.9
Wetlands	25	0	269.7	0.1	10.8	61.4	0.1	17.2
Yards	2410	8	3175.5	1.2	1.3	71.2	0.0	2.3

Annex 2.4. Land cover features and composition in 30 km buffer around Egyptian vulture nests, Greece

Landscapes feautures	Number of patches	Patches coverage in %	Area size in ha	Area size in %	Average area size ha	Minimal area size ha	Maximal area size ha	Standart deviation
Arable land	19448	47	190918.1	31.5	9.8	0.0	946.1	32.6
Arable land (mixed)	3389	8	30941.8	5.1	9.1	0.0	101.7	10.2
Forage land	4849	12	125896.6	20.8	26.0	0.0	967.7	64.0
Forage land (mixed)	280	1	3207.4	0.5	11.5	0.0	135.5	14.2
Forestry	4021	10	155917.5	25.7	39.3	0.0	930.7	96.3
Forestry (mixed)	4	0	38.2	0.0	9.5	3.2	20.9	8.1
Grazing capacity lands	1148	3	53979.9	8.9	47.4	0.0	958.0	85.6
Not Eligible Areas (PEF)	254	1	4443.8	0.7	17.6	0.1	257.5	32.1
Olive cultivations	689	2	1672.3	0.3	2.4	0.0	66.8	5.1
Olive cultivations (mixed)	560	1	3015.0	0.5	5.4	0.2	31.1	4.9
Other	2695	7	14742.5	2.4	5.5	0.0	459.6	18.0
Permanent cultivations	572	1	1460.1	0.2	2.6	0.0	105.0	6.0
Permanent cultivations (mixed)	410	1	2698.2	0.4	6.6	0.1	98.0	9.6
Roads - Water bodies	764	2	4374.9	0.7	5.7	0.0	724.9	35.7
Urban areas	1678	4	7335.6	1.2	4.4	0.0	159.6	8.3
Urban areas (mixed)	71	0	341.2	0.1	4.8	0.0	21.9	3.8
Vineyards	217	1	367.8	0.1	1.7	0.0	55.0	4.2
Vineyards (mixed)	106	0	395.1	0.1	3.7	0.0	28.8	4.1
Wastelands	123	0	625.9	0.1	5.1	0.1	71.6	8.6

Annex 2.5. Land cover features and composition in 1 km buffer around Egyptian vulture nests, Northern versus Southern Bulgaria

Northern Bulgaria landscape features	Number of patches	Patches coverage in %	Area size in ha	Area size in %	Average area size_ha	Minimal area size_ha	Maximal area size_ha	Standard deviation
Arable lands	69	14	1020.64	15.6	14.79	0.03	99.53	21.54
Areas with other / non agricultural / purpose	2	0	13.15	0.2	6.57	0.83	12.31	8.12
Built-up areas outside the settlements	53	11	87.93	1.3	1.66	0.01	13.62	2.72
Channels	1	0	0.08	0.0	0.08	0.08	0.08	0.00
Field roads, livestock treks and openings	18	4	9.17	0.1	0.51	0.02	2.92	0.79
Forest Meadows and Pastures	5	1	39.57	0.6	7.91	0.92	32.34	13.71
Forest Territories	71	14	3322.94	50.7	46.80	0.01	302.41	77.03
Gullies, Ravines and Grooves	5	1	84.75	1.3	16.95	0.10	66.30	27.94
Lakes, Dams and Ponds	2	0	3.19	0.0	1.60	0.19	3.00	1.99
Mixed land use	7	1	51.04	0.8	7.29	0.05	23.26	9.25
Naked and eroded terrain	1	0	0.41	0.0	0.41	0.41	0.41	0.00
Natural Grasslands	11	2	100.36	1.5	9.12	0.01	35.60	11.38
Orchards	1	0	1.86	0.0	1.86	1.86	1.86	0.00
Pastures and meadows	61	12	339.09	5.2	5.56	0.01	56.44	9.21
Perennials (perennial crops)	3	1	2.87	0.0	0.96	0.71	1.15	0.23
Quarries, open pits and Landslip	1	0	2.01	0.0	2.01	2.01	2.01	0.00
Railway lines and adjacent territories	5	1	17.55	0.3	3.51	1.38	5.11	1.54
Rivers and riverbeds	17	3	173.80	2.7	10.22	0.01	26.64	9.79
Sand, gravel and bare rocks	11	2	95.59	1.5	8.69	0.66	22.82	7.50
Shrubs and Grassed Territories	106	21	945.02	14.4	8.92	0.01	140.58	22.80
Small-scale non-agricultural areas	1	0	0.06	0.0	0.06	0.06	0.06	0.00
Surfaced roads and neighboring territories	20	4	45.16	0.7	2.26	0.01	9.38	2.03
Transport Infrastructure	4	1	0.50	0.0	0.12	0.07	0.25	0.09
Urban Structures	4	1	120.31	1.8	30.08	2.17	49.36	20.24
Vines	2	0	0.29	0.0	0.15	0.09	0.21	0.08
Yards	21	4	78.82	1.2	3.75	0.01	19.61	5.73

Southern Bulgaria landscape features	Number of patches	Patches coverage in %	Area size in ha	Area size in %	Average area size_ha	Minimal area size_ha	Maximal area size_ha	Standart deviation
Arable lands	40	3	164.25	1.5	4.11	0.02	34.19	6.86
Areas for Sport and Recreation	1	0	2.26	0.0	2.26	2.26	2.26	0.00
Areas with Poor Vegetation	11	1	60.19	0.5	5.47	0.21	25.60	7.84
Built-up areas outside the settlements	314	22	91.14	0.8	0.29	0.01	3.93	0.59
Field roads, livestock treks and openings	35	2	27.26	0.2	0.78	0.01	6.22	1.27
Forest Meadows and Pastures	15	1	93.54	0.8	6.24	0.01	61.59	15.56
Forest Territories	144	10	7620.60	68.7	52.92	0.01	909.78	116.99
Gullies, Ravines and Grooves	21	1	29.09	0.3	1.39	0.01	7.81	1.98
Lakes, Dams and Ponds	20	1	317.39	2.9	15.87	0.03	146.91	36.91
Landfill and Tailings	1	0	0.94	0.0	0.94	0.94	0.94	0.00
Mixed land use	73	5	390.95	3.5	5.36	0.01	44.83	8.37
Natural Grasslands	14	1	24.80	0.2	1.77	0.01	15.64	4.08
Near Urban areas	1	0	1.24	0.0	1.24	1.24	1.24	0.00
Pastures and meadows	231	16	643.77	5.8	2.79	0.01	36.66	4.77
Quarries, open pits and Landslip	1	0	2.64	0.0	2.64	2.64	2.64	0.00
Railway lines and adjacent territories	1	0	1.95	0.0	1.95	1.95	1.95	0.00
Rivers and riverbeds	16	1	241.45	2.2	15.09	1.11	53.97	14.18
Sand, gravel and bare rocks	78	5	435.43	3.9	5.58	0.01	54.32	9.68
Shrubs and Grassed Territories	290	20	778.26	7.0	2.68	0.01	47.54	5.04
Small-scale non-agricultural areas	17	1	0.59	0.0	0.03	0.01	0.09	0.02
Surfaced roads and neighboring territories	33	2	51.45	0.5	1.56	0.01	6.82	1.81
Urban Structures	4	0	5.44	0.0	1.36	0.06	4.36	2.01
Vines	9	1	23.16	0.2	2.57	0.58	7.32	2.22
Wetlands	1	0	8.02	0.1	8.02	8.02	8.02	0.00
Yards	85	6	74.61	0.7	0.88	0.01	3.88	0.77

Annex 2.6. Land cover features and composition in 5 km buffer around Egyptian vulture nests, Northern versus Southern Bulgaria

Northern Bulgaria landscape features	Number of patches	Patches coverage in %	Area size in ha	Area size in %	Average area size ha	Maximal area size ha	Minimal area size ha	Standard deviation
Arable lands	1474	11	402.99	33.4	0.27	8.45	0.00	0.66
Areas for Sport and Recreation	24	0	0.45	0.0	0.02	0.02	0.01	0.01
Areas with other / non agricultural / purpose	10	0	3.83	0.3	0.38	1.24	0.01	0.45
Areas with Poor Vegetation	48	0	4.12	0.3	0.09	0.55	0.00	0.11
Brownfields	4	0	0.21	0.0	0.05	0.18	0.00	0.09
Built-up areas outside the settlements	4724	35	31.99	2.6	0.01	3.37	0.00	0.05
Channels	53	0	1.47	0.1	0.03	0.30	0.00	0.05
Field roads, livestock treks and openings	579	4	6.14	0.5	0.01	0.24	0.00	0.02
Forest Meadows and Pastures	9	0	0.54	0.0	0.06	0.32	0.00	0.10
Forest Territories	512	4	407.48	33.7	0.80	46.53	0.00	3.57
Group Line Objects (Gorge)	12	0	3.92	0.3	0.33	1.20	0.01	0.39
Gullies, Ravines and Grooves	135	1	8.18	0.7	0.06	0.86	0.00	0.11
Lakes, Dams and Ponds	77	1	4.04	0.3	0.05	1.10	0.00	0.14
Landfill and Tailings	12	0	4.31	0.4	0.36	1.68	0.01	0.57
Mixed land use	245	2	23.66	2.0	0.10	0.86	0.00	0.13
Naked and eroded terrain	9	0	1.10	0.1	0.12	0.47	0.00	0.17
Natural Grasslands	147	1	15.66	1.3	0.11	2.12	0.00	0.21
Near Urban areas	14	0	2.15	0.2	0.15	0.46	0.00	0.19
Orchards	72	1	3.35	0.3	0.05	0.28	0.00	0.06
Other perennials	14	0	0.77	0.1	0.05	0.24	0.00	0.07
Pastures and meadows	925	7	78.58	6.5	0.08	2.51	0.00	0.20
Perennials (perennial crops)	92	1	6.94	0.6	0.08	0.79	0.00	0.14
Quarries, open pits and Landslip	20	0	3.43	0.3	0.17	1.03	0.01	0.24
Railway lines and adjacent territories	36	0	3.85	0.3	0.11	0.38	0.00	0.10
Rivers and riverbeds	91	1	13.48	1.1	0.15	1.16	0.00	0.20
Sand, gravel and bare rocks	95	1	7.92	0.7	0.08	1.75	0.00	0.19
Shrubs and Grassed Territories	1798	14	115.73	9.6	0.06	5.34	0.00	0.23
Small-scale non-agricultural areas	309	2	0.09	0.0	0.00	0.00	0.00	0.00
Surfaced roads and neighboring territories	143	1	14.02	1.2	0.10	1.65	0.00	0.23
Transport Infrastructure	34	0	0.06	0.0	0.00	0.01	0.00	0.00
Urban Structures	75	1	9.63	0.8	0.13	2.80	0.00	0.38
Urbanized Territories	1	0	0.01	0.0	0.01	0.01	0.01	0.00
Vines	69	1	4.15	0.3	0.06	0.40	0.00	0.09
Water areas and wetlands	6	0	0.58	0.0	0.10	0.31	0.03	0.11
Wetlands	17	0	1.85	0.2	0.11	0.60	0.01	0.16
Yards	1425	11	21.14	1.8	0.01	0.71	0.00	0.03

Southern Bulgaria landscape features	Number of patches	Patches coverage in %	Area size in ha	Area size in %	Average area size_ha	Maximal area size_ha	Minimal area size_ha	Standard deviation
Arable lands	676	4	38.92	2.7	0.06	0.66	0.00	0.09
Areas for Sport and Recreation	7	0	0.09	0.0	0.01	0.02	0.00	0.01
Areas with other / non agricultural / purpose	6	0	0.45	0.0	0.08	0.23	0.00	0.10
Areas with Poor Vegetation	103	1	7.08	0.5	0.07	1.39	0.00	0.17
Built-up areas outside the settlements	3398	21	18.39	1.3	0.01	0.53	0.00	0.01
Channels	10	0	0.17	0.0	0.02	0.05	0.00	0.02
Field roads, livestock treks and openings	461	3	3.49	0.2	0.01	0.14	0.00	0.01
Forest Meadows and Pastures	87	1	2.68	0.2	0.03	0.80	0.00	0.09
Forest Territories	705	4	885.58	61.6	1.26	60.54	0.00	5.40
Group Line Objects (Gorge)	1	0	0.06	0.0	0.06	0.06	0.06	0.00
Gullies, Ravines and Grooves	317	2	10.82	0.8	0.03	0.58	0.00	0.07
Lakes, Dams and Ponds	381	2	42.00	2.9	0.11	14.63	0.00	0.95
Landfill and Tailings	8	0	0.80	0.1	0.10	0.40	0.00	0.15
Mixed land use	1553	9	97.36	6.8	0.06	1.48	0.00	0.10
Naked and eroded terrain	10	0	0.20	0.0	0.02	0.09	0.00	0.03
Natural Grasslands	90	1	3.59	0.3	0.04	0.58	0.00	0.08
Near Urban areas	4	0	0.05	0.0	0.01	0.03	0.00	0.01
Orchards	48	0	1.44	0.1	0.03	0.49	0.00	0.07
Other perennials	3	0	0.05	0.0	0.02	0.03	0.00	0.01
Pastures and meadows	3189	19	120.84	8.4	0.04	1.22	0.00	0.07
Perennials (perennial crops)	66	0	0.70	0.0	0.01	0.10	0.00	0.02
Quarries, open pits and Landslip	9	0	0.23	0.0	0.03	0.06	0.01	0.02
Railway lines and adjacent territories	11	0	0.47	0.0	0.04	0.15	0.00	0.05
Rivers and riverbeds	48	0	21.06	1.5	0.44	4.62	0.00	0.84
Sand, gravel and bare rocks	293	2	25.57	1.8	0.09	1.96	0.00	0.22
Shrubs and Grassed Territories	3168	19	121.34	8.4	0.04	1.93	0.00	0.11
Small-scale non-agricultural areas	377	2	0.16	0.0	0.00	0.00	0.00	0.00
Surfaced roads and neighboring territories	103	1	9.76	0.7	0.09	1.02	0.00	0.22
Urban Structures	78	0	1.91	0.1	0.02	0.49	0.00	0.06
Vines	206	1	9.81	0.7	0.05	0.77	0.00	0.12
Wetlands	8	0	0.85	0.1	0.11	0.61	0.00	0.21
Yards	985	6	10.61	0.7	0.01	0.12	0.00	0.01