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# Variation of structural and functional characteristics of grasslands in the foraging areas of the Eurasian black vulture *(Aegypius monachus* L.)

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## Abstract

One of the most crucial attributes of natural grassland functions is their ability to sustain avifauna. This is especially important for protected wild bird species. The Eurasian black vulture *(Aegypius monachus* L.) breeds across southern Europe and Asia, but is endangered throughout its European range. One of its southern-eastern limits of expansion is the Dadia-Lefkimi-Soufli National Park (Dadia NP) in north-eastern Greece. The present research explores the relation between the structural and functional characteristics of grasslands adjacent to the Dadia NP integrated in the foraging areas of the Eurasian black vulture. The research was conducted in June 2007 and included field measurements of vegetation cover, plant species composition, floristic diversity, and above-ground dry biomass. It was found that the Eurasian black vulture forages over grasslands that are characterised by: (a) approximately 40% bare ground cover, (b) a 3:2:1 ratio of Graminae: Umbeliferae: Compositae, (c) high floristic diversity, and (d) low (440 kg $ha^{-1}$) and medium (611 kg $ha^{-1}$) above-ground biomass.

Keywords: raptors, grassland structure, diversity ordering diagram, Dadia National Park

## Introduction

The Eurasian black vulture *(Aegypius monachus* L., Accipitridae) is one of the largest raptors in the world and is presently distributed in a few Mediterranean countries and Central Asia. It usually breeds in dense *Pinus, Juniperus,* or *Quercus* forests at altitudes of 1,000-2,000 m, nesting in trees or occasionally on cliff edges. Its populations have declined severely over most of its former range in the Western Palearctic in the last 200 years as a result of persecution, habitat loss, poisoning by bait put out to kill wolves and other predators, and higher hygiene standards that have reduced the amount of carrion available; it is currently listed as near threatened (NT) (Snow and Perrins, 1998; IUCN, 2008). Recently, various conservation programmes have resulted in the recovery of specific populations, particularly in Spain, where numbers had increased to about 1,000 pairs by 1992 after an earlier decline to 200 pairs in 1940-70, as well as in the Dadia NP, Thrace, NE Greece (Snow and Perrins, 1998; Skartsi *et al.,* 2008).
Generally, natural and semi-natural grasslands sustain high avifaunal biodiversity, e.g. 173 "priority" bird species in Europe are associated with low-elevation grasslands and plain agricultural lands (Tucker and Evans, 1997). Natural grasslands are one of the best foraging habitat types for the Eurasian black vulture in terms of food availability (Carrete and Donázar, 2005; Vasilakis *et al.,* 2008). Nevertheless, little is known about

the structural and functional characteristics of the grasslands that sustain Eurasian black vultures. The purpose of the present research was to define the floristic cover and composition, the floristic diversity, and the productivity of the grasslands that attract the Eurasian black vulture.

## Study area and methods

The Eurasian black vulture is the flagship species of the protected area of the Dadia NP (Natura Site GR-1110002), an area legally protected since 1980 and consisting of two nucleus zones of absolute protection (922 ha and 6,368 ha) and one peripheral zone (35,710 ha), expanded in an elevation range of 3-651 m. The forest consists of pure and mixed *Quercus* spp. as well as other broad-leaved species. The area sustains 219 bird species (including 36 out of the 38 raptors of Greece), 40 reptiles and amphibians, and 48 mammals. Studies of population size have shown that the colony of Eurasian black vultures increased from 25 individuals in 1979 up to 89-100 in 2001, thanks to various conservation measures that included the operation of a feeding station in 1987, but nowadays it is considered rather stable with 19-20 breeding pairs (Skartsi *et al.,* 2008). The optimal nesting habitat is mature trees surrounded by openings or with low-height vegetation located on steep slopes (Poirazidis *et al.,* 2004). Their foraging areas include their nesting zones and coincide with the neighbouring extended livestock husbandry areas, mostly shrublands and grasslands.

In June 2007 three grassland areas were distinguished in terms of intensity of use by Eurasian black vultures according to a range use study carried out in the year 2004 by means of radio-tracking (Vasilakis *et al.,* 2008). The grassland in the area of Kechros received a high number of visits, that of Nea Sanda a medium number, and that of Fillyra a low number. Three plots (0.1 ha each) were randomly located in each grassland area. For cover and floristic composition three 20-m transects were randomly set on the ground in each plot and the first contacts of an 80-cm metal stick, placed vertically on the transect line at 20-cm intervals, were recorded. For floristic diversity five metal quadrats (50 cm x 50 cm) were placed randomly on the ground in each plot, and plant species and the number of individuals per species were recorded. For above-ground biomass production three similar quadrats were placed randomly on the ground in each plot, and the above-ground biomass was selected and oven-dried to determine its dry matter production.

For cover/composition percentages and the above-ground biomass production of the three grasslands: (a) typical descriptive statistics were calculated, (b) the Levene test of homogeneity of variance and the one-way ANOVA were applied, and (c) a post-hoc statistical comparison test of the means took place for an $a = 0.05$ level of significance. Initial percentage values were prior arc-sin transformed. For the floristic diversity of the three grasslands the Renyi diversity ordering diagram was constructed in order to explore the diversity comparability of the three grassland communities and their ranking according to a family of diversity indices. Information on the use of the Renyi index can be found in Vrahnakis *et al.* (2005).

## Results and discussion

The exploration of the structural components of the three grasslands revealed that the Eurasian black vulture used the grassland with high rock/bare ground cover (Kechros) and low vegetation cover more intensively (***$P < 0.001$) (data not shown). The rate

of the three dominant botanical families in this grassland was approximately 3:2:1 for Graminae:Umbeliferae:Compositae, while there was not any clear pattern of cover by botanical families in the grasslands that received medium or low use by the Eurasian black vulture. For all the grasslands, these three botanical families add up to over 50% of the total vegetation cover. *Cynodon dactylon* is the dominant species in all the grasslands, while spine-leaved species, such as *Eryngium campeste* and *Notobasis syriaca*, characterise the canopy of these grasslands. The above-ground dry matter production of the grassland with high use by the vultures (420.2 kg ha$^{-1}$) is not statistically different (NS, $P > 0.05$) from that of the grassland with medium use (611.2 kg ha$^{-1}$), while both are significantly lower (*, $P < 0.05$) than that of the grassland with low use (1,053.5 kg ha$^{-1}$) (data not shown).

The Renyi diversity ordering diagram, for a range of diversity indices, revealed that the grassland of Kechros is more diverse compared to those of Nea Sanda and Fillyra, since the Kechros diversity line superimposes the lines of Nea Sanda and Fillyra; the latter two are not comparable in terms of diversity, since their diversity lines are intersected (Figure 1).

Generally, the abandonment of traditional livestock husbandry practices leads to changes in the composition of vegetation, thus resulting in the reduction of landscape diversity, with negative consequences for avifauna (Tucker and Evans, 1997). The present results stress the need to retain grasslands and open habitats in the foraging areas of the vultures. In this sense, it is not only the Dadia NP, but also the neighbouring grasslands in the species' foraging areas that need to be included into a management scheme. Additionally, the restoration of traditional livestock husbandry practices, to control shrub encroachment, will be beneficial not only for the "flagship" Eurasian black vulture (Vasilakis *et al.*, 2008), but also for other wildlife and the local economy.

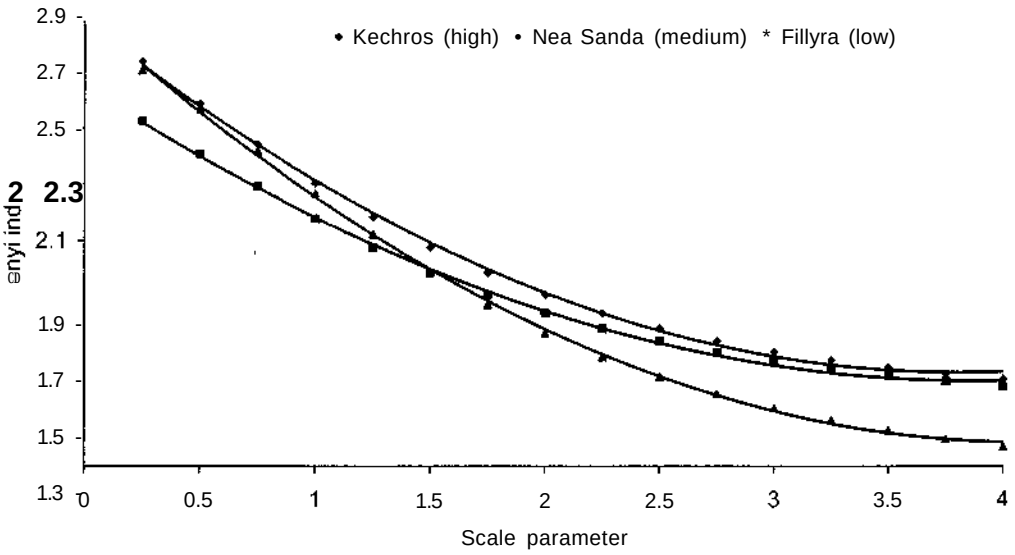


Figure 1. Renyi diversity ordering diagram for the three grasslands

This study is a first approach. It has to be taken into account that not only the structural and functional characteristics of the grasslands but also other factors, such as the relief, the topography, land use, and human disturbances affect the selection of areas for foraging (Vasilakis *et al.*, 2008). Further research on these can provide valuable information about the best conservation management practices.

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