

Effects of grazing on vegetation of abandoned arable fields in a sub- humid Mediterranean environment

Karakosta C.¹, Mantzanas K.², Papadimitriou M.², Papanastasis V.P.²

¹Ministry of Environment, Energy and Climatic Change. Chalkokondili 31, 10432, Athens, Greece

²Laboratory of Rangeland Ecology, Aristotle University, 54124, Thessaloniki, Greece

Abstract

Arable land abandonment is a major land use change in the Mediterranean region. Plant colonization and vegetation succession in these areas depend on local climatic conditions, soil quality and, especially, on management practices. Livestock grazing can modify or alter the process of succession by facilitating the colonization of certain species at the expense of others. The aim of this study was to investigate the effects of grazing on vegetation of old fields. The research was conducted in the Taxiarchis village located in the Holomontas mountain of Chalkidiki, northern Greece, with a sub-humid Mediterranean climate. Plant cover and biomass were measured in adjacent moderately to heavily grazed mainly by goats and protected plots of an old field abandoned for 20 years. Species richness and abundance were also recorded and the Shannon –Wiener and equitability diversity indices were calculated. Total plant cover was significantly decreased due to grazing, but herbaceous cover was not significantly affected. Woody species did not appear in the grazed plots, while in the protected ones they covered 12.8% of the ground. Current year's and total herbage biomass was significantly decreased due to grazing. Total biomass (herbage and woody) was dominated by the herbaceous component and differed significantly between the two treatments. Shannon – Weiner index and equitability were significantly higher in the grazed plots, due to the significant increase of species numbers and abundance. The results indicate that moderate to heavy grazing can control woody species invasion and enhance plant species diversity in old fields of sub-humid Mediterranean environments.

Keywords: Shannon index, Grazing, Production, Herbaceous species, Woody species.

Introduction

Arable land abandonment is a major land use change in the Mediterranean region. In Greece, such abandonment is widespread in mountainous areas (Papanastasis 2007). Plant colonization and vegetation succession in these areas depend on local climatic conditions, (Zhang and Dong 2009, Osem et al. 2004), soil quality (Fernandez-Lugo et al. 2009) and especially management practices. Vegetation of abandoned arable fields is closely related to the applied grazing management. Livestock can significantly affect plant species composition (Akiyama and Kawamura 2007) and, consequently, modify or alter the process of succession by facilitating the colonization of certain species at the expense of others. The

kind of animal and the degree of grazing pressure are regarded as the two main factors affecting vegetation dynamics (Rook et al. 2004). The aim of this study was to investigate the effects of livestock grazing on vegetation dynamics of old fields.

Materials and methods

The research was conducted in the Taxiarchis village located in the Holomontas mountain of Chalkidiki, North Greece. The climate is Mediterranean sub-humid. In an old field abandoned for 20 years, adjacent moderately to heavily grazed mainly by goats and protected plots were established. Plant cover was measured along 5 transects in each plot with the point method (Cook and Stubbendieck 1986). Species richness and abundance were recorded using 30 quadrats (25 x 25 cm each) and the Shannon –Wiener and equitability diversity indices were calculated. Furthermore, herbaceous and woody species biomass was measured in 10 quadrats (1x1m each for the woody species and 50x50cm each for the herbaceous ones) by cutting vegetation with hand-scissors at the ground level.

In the laboratory, herbage and woody biomass was sorted out by hand into current year's and old growth components. Only the current year's growth is reported in this paper. All biomass samples were oven dried at 60° C for 48 h and weighed. Data for cover, biomass and diversity in grazed and protected plots were compared by using a t test. Significant differences for all statistical tests were evaluated at the level of $p \leq 0.05$. All data analyses were conducted using the software package SPSS 11.0.

Results and discussion

Total plant cover was significantly decreased by 20% due to grazing, but herbaceous cover was not significantly affected (Table 1). Livestock grazing eliminated woody species presence, indicating its negative effects on secondary succession, as these species dominate in the later successional stages of old fields in Mediterranean environments (Papanastasis 2007). Specifically, woody species did not appear in the grazed plots, while in the protected ones they covered almost 13% of the ground (Table 1).

Total biomass was dominated by the herbaceous component (Table 2). In the grazed plot, current year's herbaceous and total biomass were significantly decreased by 49% and 62%, respectively indicating moderate to heavy grazing pressure. These results confirm previous studies where it was found that the most important effect of grazing is the reduction of aboveground biomass (Bonanomi et al. 2006, Billeter et al. 2007),. The

absence of shrubs in the grazed plot should be attributed to the fact that goats were the predominant kind of animal grazing in the study area. Goats have been shown to reduce woody biomass (Celaya et al. 2007) as shrub species can be more sensitive to both consumption and trampling generated by grazing than the herbaceous species in the Mediterranean region (Tzanopoulos et al. 2007).

Table 1. Plant cover (%) in grazed and protected plots

Cover class	Grazed	Ungrazed
Herbaceous	74,20a	79,40a
Woody	0.00b	12,8a
Total	74,20b	92,20a

¹Means within the same class followed by the same letter are not statistically different at the 0.05 level.

Table 2. Current year's e biomass (g DM m⁻²) in grazed and protected plots

Biomass class	Grazed	Ungrazed
Herbaceous	112,04b	219,14a
Woody	0.00b	78.32a
Total	112,04b	297,46a

¹Means within the same class followed by the same letter are not statistically different at the 0.05 level.

Species richness, the Shannon – Weiner index and equitability were significantly higher by 52%, 46% and 26%, respectively in the grazed plots than in the ungrazed ones (Table 3). Similar results have been reported by other researchers as well. For example, Noy- Meir et al. (1995) have found higher species diversity in a grazed than in adjacent ungrazed grassland in Israel. Also, Iovi et al. (2003) recorded a higher Shannon - Weiner index of diversity in heavily grazed rangelands than in lightly grazed ones in Greece. It seems that goat grazing can increase species diversity, with potentially more herbaceous species to thrive in the community as shrub dominance decreases (Celaya et al. 2010).

Table 3. Species diversity in grazed and protected plots

Index	Grazed	Ungrazed
Species richness (no. species/0.25 cm ²)	15,87a	7,67b
Shannon	2,37a	1,28b
Equitability	0,86a	0,64b

[†]Means within the same row followed by the same letter are not statistically different at the 0.05 level.

Conclusion

The results indicate that moderate to heavy grazing can control woody species encroachment and enhance plant species diversity in old fields of sub-humid Mediterranean environments.

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