Grazing effects on floristic diversity of a juniper-oak rangeland

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Abstract

The aim of the present study was to investigate the effects of grazing intensity on plant cover and floristic diversity of a juniper - oak rangeland ecosystem in the Mediterranean region. The research was conducted in an area, which is grazed mainly by goats, at Megalo Dereio in Evros region, northeastern Greece. Three experimental plots were selected in a rangeland dominated by *Juniperus oxycedrus* with the spontaneous presence of *Quercus frainetto*: 1) a lightly grazed plot, 2) a moderately grazed plot and 3) a heavily grazed plot. An area of 25 m^2 in each plot was fenced in autumn 2008, in order to be protected from grazing. The plant cover, the species composition and the herbage production were measured in June 2010 and ecological diversity indices as well as the forage utilization percent were determined. The plant cover was significantly reduced by heavy grazing. The floristic diversity was not affected by the different grazing intensities. There was however, a significant reduction of it where protection from grazing was applied.

Keywords: Overgrazing - Plant cover - Silvopastoral system - Species composition.

Introduction

Biodiversity plays an essential role to all levels of the ecosystem service hierarchy: as a regulator of supporting ecosystem processes, as a service and as a good that is subject to valuation (Mace et al. 2012). Consequently, one of the main challenges for rangeland managers is to identify effective grazing management strategies in order to maintain biodiversity and enhance multiple rangeland ecosystem services.

It is well substantiated that grazing pressure is an important determinant of plant diversity in rangeland ecosystems (Dorrough et al. 2007, Yayneshet et al. 2009). Grazing effects, in natural plant communities, include changes to vegetation structure and composition as certain species are favoured by grazing so that their numbers and cover will increase, while others are disadvantaged and will reduce in number and cover (Belsky

1992). Furthermore, livestock grazing is considered essential in maintaining species diversity, as in many Mediterranean ecosystems it has been decreased when grazing was removed (Noy- Meir et al. 1989).

On the other hand, livestock grazing is considered as the most important factor of soil erosion and consequently desertification in the Mediterranean region (Papanastasis 1998). Defoliation of vegetation by the grazing animals results in reduced plant cover which is essential for combating soil erosion. The degree of plant cover reduction is seriously affected by grazing intensity (Papanastasis and Noitsakis 1992).

The aim of this paper was to evaluate the effect of different grazing intensity by small ruminants on plant cover and floristic diversity of a juniper - oak rangeland ecosystem in the Mediterranean region.

Materials and methods

The study was conducted in the area of Megalo Dereio which is located in Evros prefecture, northeast Greece at 380 m a.s.l. The climate of the area is classified as sub-Mediterranean, with a mean air temperature of 13.7° C and an annual rainfall of 560 mm. The study area extends in the thermophilous deciduous oak zone i.e. Quercion frainetto subzone sensu, Dafis (1973) and Horvat et al. (1974) and is dominated by *Juniperus oxycedrus* with the spontaneous presence of *Quercus frainetto.* The area is grazed mainly by goats. Three experimental areas of similar vegetation but with different grazing intensity were selected: i) a lightly grazed, ii) a moderately grazed and iii) a heavily grazed. An area of 25 m^2 in each plot was fenced in the autumn of 2008, in order to be protected from grazing. A similarly-sized area was assigned next to the fenced plot for comparison. The sampling of herbaceous vegetation (the number of species, frequency of occurrence and herbage yield) was carried out in four 0.5 m x 0.5 m quadrats in every grazed and protected plot in June 2010. The difference of fenced and open plots yield was used to calculate forage utilization percent. It was calculated to be 20% in the lightly grazed plot, 50% in moderately grazed plot and 70% in the heavily grazed one. Four transect lines of 20 m long were established in every grazed plot. The plant cover was measured by using the line-point method (Cook and Stubbendieck 1986) in June 2010. Contacts were obtained every 20 cm.

The nomenclature of the recorded taxa follows Strid and Tan (1997, 2002) and Tutin et al. (1968-1980; 1993). Floristic diversity was determined by the number of species (N), the Shannon-Wiener diversity index (H'), the Simpson diversity index (D) and the Berger-Parker dominance index (d). The formulae of the indices are given below (Henderson 2003):

$$H' = -\sum_{i=1}^{S} p_i \ln p_i \qquad D = 1 - \sum_{i}^{S_{obs}} p_i^2 \qquad d = \frac{N_{max}}{N_T}$$

where S is the maximum recorded number of taxa, pi is the proportional abundance of the i-th taxa, N_{max} is the number of records of the dominant taxon and N_T is the total number of records.

General linear models procedure (SPSS 18 for Windows) was used for ANOVA. The LSD at the 0.05 probability level was used to detect the differences among means (Steel and Torrie 1980).

Results and Discussion

Species richness and floristic diversity, as described by the diversity indices and by Berger-Parker dominance index, were significantly higher when grazing was applied (Table 1). Floristic diversity tends to be higher in the heavily grazed plot compared to both moderately and lightly grazed ones, but this increase did not produce significant results with the exception of the Berger-Parker dominance index. No significant interactions between the grazing intensity and the grazing protection treatments were recorded (Table 1).

Table 1. Floristic diversity indices of the different grazing treatments.

	L G		M G		H G			Significance		
	G	P	G	P	G	P	LSD	PT	GI	PTxGI
N	5.75	3.00	8.25	4.00	7.75	6.33	1.78	*	ns	ns
H’	1.39	0.78	1.24	0.98	1.68	1.29	0.32	*	ns	ns
D	4.68	2.05	3.63	2.30	5.20	3.20	0.93	*	ns	ns
d	0.40	0.70	0.51	0.62	0.35	0.46	0.09	*	*	ns

LG, Lightly Grazed; MG, Moderately Grazed; HG, Heavily Grazed; G, Grazed plot; P, Protected plot; PT, Protection from grazing treatment; GI, Grazing Intensity; LSD, Least significant difference

*P≤0.05; ns, non significant

Many authors have found that grazing abandonment leads to a decrease in plant species richness (Poschlod et al. 2005, Guretzky et al. 2007). Cessation of livestock grazing modifies both the disturbance regime and interactions among plant species (Marc et al. 2003). Thus, the reduction of floristic diversity found in the present study could be related to dominance of woody species such as *Juniperus oxycedrus* subsp. *oxycedrus* and *Cistus incanus* subsp. *creticus* in the protected plots (Kyriazopoulos et al. 2010).

The plant cover decreased progressively as grazing intensity increased. Its lowest value was recorded in the heavily grazed plot (Figure 1). Similar results have been reported by Kyriazopoulos et al. (2010) in an open coppice oak forest located close to the study area. Livestock consume the aerial parts of vegetation and involve mechanical actions such as trampling (Crawley 1997). Thus, light grazing would have a profound effect on vegetation recovery. This drastic reduction of plant cover may increase the risk of soil erosion. Moreover, bare soil was limited in the lightly grazed plot compared to the moderate and heavily grazed plots (Figure 1). Apparently, these results confirm that grazing causes a reduction in vegetative cover (Pluhar et al. 1987, Hill et al. 1992).

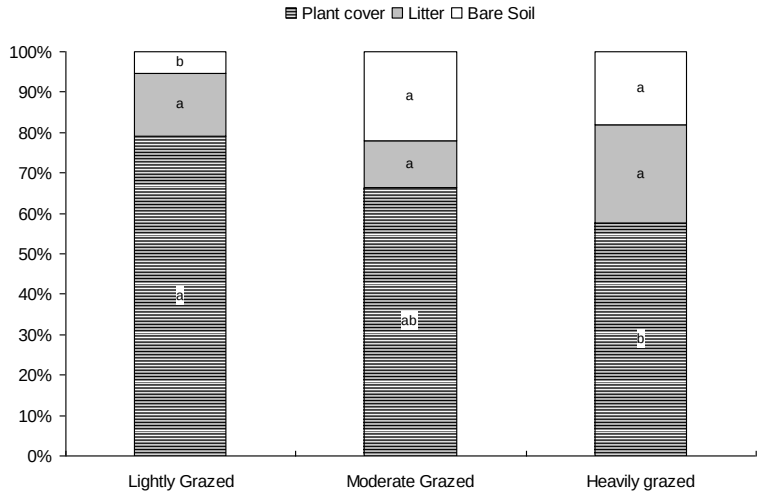

Figure 1. Cover (%) in the different grazing intensities. Means within each group followed by the same letter are not significantly different (P≤0.05).

Conclusions

Protection from grazing reduced floristic diversity. Heavy grazing slightly increased floristic diversity in comparison to light and moderate grazing. However, it resulted in a drastic reduction of plant cover, which may increase the risk of soil erosion. Thus, moderate grazing could be considered as the most appropriate grazing intensity as it slightly decreased plant cover and can enhance floristic diversity.

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References

Belsky A.J. 1992. Effects of grazing, competition, disturbance and fire on species competition and diversity in grassland communities. *Journal of Vegetation Science*, 3:187-200.

Cook C.W. and J. Stubbendieck J. 1986. Range Research: Basic Problems and Techniques. Soc. Range Manage. Denver, Colorado. 317 pp.

Crawley M.J. 1997. Plant-herbivore dynamics. In: M.J Crawley (ed). Plant Ecology. Blackwell Science, Oxford. pp. 401–474.

Dafis S. 1973. Classification of the forest vegetation of Greece. *Scientific Annals of the Department of Forestry and Natural Environment*, 115(2):75-91 (In Greek).

Dorrough J., J. Ash, S. Bruce, and S. McIntyre. 2007. From plant neighborhood to landscape scales: how grazing modifies native and exotic plant species richness in grassland. *Plant Ecology*, 191:185–198.

Guretzky J.A., K.J. Moore, C.L. Burras and E.C. Brummer. 2007. Plant species richness in relation to pasture position, management, and scale. *Agriculture, Ecosystems & Environment*, 122:387-391.

Henderson P.A. 2003. Practical Methods in Ecology. Blackwell Science Ltd., Oxford, UK. 300 pp.

Hill M.O., D.F. Evans and S.A. Bell. 1992. Long term effects of excluding sheep from hill pastures in North Wales. *Journal of Ecology*, 80:1–13.

Horvat I., V. Glavac and H. Ellenberg. 1974. Vegetation Südosteuropas. Gustav Fischer Verlag. Stuttgart. 768 pp.

Kyriazopoulos A.P., E.M. Abraham, Z.M. Parissi, G. Korakis and Z. Abas. 2010. Floristic diversity of an open coppice oak forest as affected by grazing. *Options Méditerranéennes,* 92:247-250.

Mace G M., K. Norris and A. H. Fitter. 2012. Biodiversity and ecosystem services: a multilayered relationship. *Trends in Ecology and Evolution*, 27(1):19-26.

Marc T., P.V. Jean, O. Annie, C.G. Jean and C.L. Jean. 2003. Vegetation dynamics and plant species interactions under grazed and ungrazed conditions in a western European salt marsh. *Acta Oecologia*, 24:103–111.

Noy-Meir I., M. Gutman and Y. Kaplan. 1989. Responses of mediterranean grassland plants to grazing and protection. *Journal of Ecology*, 77:290-310.

Papanastasis V.P. 1998. Grazing intensity as an index of degradation in semi-natural ecosystems: the case of Psilorites mountain in Crete. In G. Enne (Ed). Indicators for Assessing Desertification in the Mediterranean. Universita di Sassari, Sassari. pp. 146-158.

Papanastasis V.P. and B.I. Noitsakis. 1992. Rangelands Ecology. Giahoudis- Giapoulis publications, Thessaloniki. 244 pp. (In Greek).

Pluhar J.J., R.W. Knight and R.K. Heitschmidt. 1987. Infiltration rates and sediment production as influenced by grazing systems in the Texas rolling plains. *Journal of Range Management*, 40:240-244.

Poschlod P., J.P. Bakker and S. Kahmen. 2005. Changing land use and its impact on biodiversity. *Basic and Applied Ecology*, 6:93–98.

Steel R.G.D. and J.H. Torrie. 1980. Principles and Procedures of Statistics. 2nd edition.

McGraw-Hill, New York. 481 pp.

Strid A. and K. Tan (eds). 1997, 2002. Flora Hellenica Vol. 1-2. Patra, 547 + 511 pp.

Tutin T.G., N.A. Burges, A.O. Chater, J.R. Edmonson, V.H. Heywood, D.M. Moore, D.H. Valentine, S.M. Walters and D.A. Webb (eds). 1993. Flora Europea I. 2nd edition. Cambridge, 581 pp.

Tutin T.G., V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S.M. Walters and D.A. Webb (eds). 1968, 1972, 1976, 1980. Flora Europaea II - V. Cambridge, 469 + 385 + 505 + 452 pp.

Yayneshet T., L.O. Eik and S.R. Moe. 2009. The effects of exclosures in restoring degraded semi-arid vegetation in communal grazing lands in northern Ethiopia. *Journal of Arid Environments*, 73(4–5):542–549.