

The Effect of Different Type of Herbivores, Grazing Types and Grazing Intensities on Alpine Basiphilous Vegetation of the Romanian Carpathians

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The major purpose of the present study was to test the hypothesis that there are significant differences in vegetation structure, plant species composition, and soil chemical properties in relation to type of grazing animals, various levels of grazing intensity and grazing type, and if potential differences alter with ecosystem productivity (increase in more productive ecosystems). The study was conducted in three mountain ranges of the Romanian Carpathians with a predominance of alkaline substrates (the Bucegi Mts, the Little Retezat Mts and the Ceahlău Massif). Statistical analyses were performed in R statistical software environment. The effects of grazing animals (cattle, horses and sheep), grazing types (fence, regular, irregular) and grazing intensity (low, medium, high) on the community structure were tested using ordination methods. In the case of soil properties, General Linear Mixed Model was applied. Special statistical approach eliminated the differences between the examined mountains and sites.

Type of grazing animal does not significantly influence species cover but it is related to specific species occurrence. According to our results, grazing horses had similar effects as cattle compared to sheep. Grazing in restricted areas (surrounded by fence) and regular unrestricted grazing were more similar if compared to irregular grazing. When comparing the intensity of grazing, high and medium intensity were more similar to each other than to the low intensity grazing. Cattle grazed sites had significantly higher lichens cover, while the sheep patches were covered with increased overall herb layer (forbs, graminoids and low shrubs together). Medium grazing intensity decreased the lichens cover, cover of overall herb layer, and total vegetation cover compared to high and low grazing intensity. Grazing type had important impact on the lichens cover and cover of overall herb layer. The lichens cover appeared to decrease while the cover of overall herb layer increased the most in restricted areas compared to irregularly and regularly grazed sites. When analyzing soil properties, Generalized mixed models revealed reliable results in the differences among categories of grazing types and intensity. These differences were only noticeable in calcium concentration being calcium the most decreased by medium grazing intensity and the most increased by irregular grazing. Grazing had significant effects on individual plant species occurrences and covers. Horses decreased presence of *Anthoxanthum odoratum* and regular grazing sites as well as fences had significantly higher occurrence of trampling tolerant species *Nardus stricta* compared to sites with irregular grazing. The type of grazing herbivores influenced covers of *Agrostis capillaris*, *A. rupestris*, *Campanula rotundifolia*, *Festuca supina*, *Luzula multiflora*, and *Ranunculus pseudomontanus*. The grazing types significantly altered covers of *Agrostis capillaris*, *Alchemilla* sp. div., *Campanula rotundifolia*, *Festuca supina*, *Luzula multiflora*, *Nardus stricta*, and *Potentilla ternata* (*Potentilla aurea* subsp. *chrysocraspeda*). The intensity of grazing had important impact on covers of *Agrostis rupestris*, *Alchemilla* sp. div., *Campanula rotundifolia*, *Festuca supina*, *Luzula multiflora*, *Poa alpina*, *Potentilla ternata*, and *Ranunculus pseudomontanus*.

Key words: alpine meadows; pastures; GLMM; NMDS; (nested) PERMANOVA