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Abstract. Pseudoalpine grasslands of Oiti National Park are degraded due to the interruption of the traditional land use practices including transhumance, periodical burning and firewood collection resulting in the dominance of competitive plants and, especially, the invasion of the dwarf juniper (*Juniperus communis ssp. nana*). The objective of this research was to study the treatments applied imitating traditional management practices for the restoration of grassland flora. In the autumn of 2013, prescribed burning was applied and after one year an area covered with "wolf" grasses was cut. In addition, an area outside the core of the park that was grazed by sheep was divided into three grazing intensity treatments. In all areas, 33 pairs of protected with mesh wire and freely grazed plots were established in spring of 2015. At the end of the growing period, in July, cover and species composition was ocularly estimated, while biomass was measured in quadrats (2015 and 2016). Except the burning treatment, cutting and grazing did not affect plant cover while species composition was positively influenced especially by burning and cutting that favored low growing species with higher nutritional value (*Festuca alpina* and *F. polita*). In contrast, biomass was significantly affected only by burning and grazing. It is concluded that moderate sheep grazing should be legally allowed in the core of the Park including the use of prescribed burning which is very effective in controlling dwarf juniper.

Keywords: prescribed burning - cutting of herbaceous plants - grazing intensity - biomass

Restauration des prairies pseudoalpine dans le parc national Oiti, Grèce centrale

Résumé. *Les prairies pseudoalpines du parc national d'Oiti sont dégradées en raison de l'interruption des pratiques traditionnelles d'utilisation des terres, y compris la transhumance, le brûlage périodique et la collecte de bois de chauffage entraînant la dominance de plantes compétitives et, en particulier, l'invasion du genévrier nain (Juniperus communis ssp. nana). L'objectif de cette recherche était d'étudier les traitements appliqués imitant les pratiques de gestion traditionnelles pour la restauration de la flore des prairies. A l'automne 2013, des brûlages dirigés ont été pratiqués et au bout d'un an une zone couverte d'herbes « à loups » a été coupée. De plus, une zone à l'extérieur du cœur du parc qui était pâturée par des moutons a été divisée en trois traitements d'intensité de pâturage. Dans toutes les zones, 33 paires de parcelles protégées avec des grillages et des parcelles pâturées librement ont été établies au printemps 2015. À la fin de la période de pâturage, en juillet, la couverture et la composition des espèces ont été estimées oculairement, tandis que la biomasse a été mesurée en quadrats (2015 et 2016). À l'exception du brûlage, la coupe et le pâturage n'ont pas affecté la couverture végétale tandis que la composition des espèces a été positivement influencée en particulier par le brûlage et la coupe qui ont favorisé les espèces à faible croissance et à valeur nutritionnelle plus élevée (Festuca alpina et F. polita). En revanche, la biomasse n'a été significativement affectée que par le brûlage et le pâturage. Il est conclu que le pâturage modéré des moutons devrait être légalement autorisé dans le cœur du parc, y compris l'utilisation du brûlage dirigé qui est très efficace pour contrôler le genévrier nain.*

Mots-clés. *Brûlage dirigé - coupe de plantes herbacées - intensité de pâturage - biomasse*

I - Introduction

Nomadic animal husbandry was the main factor in the creation and shaping of meadow landscapes in the mountain ranges of the country (Ispikoudis et *al*. 2004), which include the grasslands of the pseudo-alpine zone. Not only sheep grazing (to a lesser extent goats and large animals) contributed to their preservation, but also the habit of nomadic breeders to set fires at the end of the summer grazing season (Fotiadis et *al*. 2004), shortly before leaving for the winters, in order to control the weeds (herbaceous and woody), as well as the frequent cutting of the woody plants of the grasslands to meet their needs for fuel. With the reduction of nomadic livestock from 1960 onwards, the cover and composition of the vegetation of these ecosystems gradually changed, but also their shrinkage due to the expansion of the forest resulting in the reduction of biodiversity (Papanastasis 2012). A typical case of the above developments is the mountain complex of Oiti, in Central Greece. The sheep farming that was practiced in the past, mainly by Sarakatsani, but also in general the traditional activities have disappeared, after its proclamation as a National Park (Government Rule 56 / A BD 218/1966), when grazing in its core was completely banned. The consequence of these developments was that certain competing species prevailed in the grasslands of the pseudo-alpine zone and invaded woody plants, thus altering their flora (Mantzanas et *al*. 2014).

The purpose of the work was to study the treatments applied in imitation of the traditional management activities for the flora of the degraded grasslands of the Oiti National Park.

II - Materials and methods

Oiti is located in region of Fthiotida and has a maximum height of 2152 m. According to Karetsos (2002), the natural vegetation consists mainly of fir forests (*Abies cephallonica*) and secondarily of grasslands, which grow in the forest in the pseudo-alpine zone, and which also contain the dwarf cedar bush (*Juniperus communis spp. nana*) in various degrees of cover. The latter is represented by the priority habitat type with code 6230 * which represents rich in species of grasslands with Nardus, in a silicate substrate of the mountainous area (Ministry of Environment, Physical Planning and Public Works 1999). In October 2013, the dwarf cedar was burned as planned, as an imitation of the fires set by the nomadic shepherds in Oiti, before the creation of the National Park (NP) in 1966. Also, in the fall of 2014, the tall grasses were cut with a machine. Both of these treatments took place at the "Livadies" site, in the area of the core of the NP, where, although prohibited, there was occasional grazing by free-range cattle. The cutting of the plants was repeated in the autumn of 2015. In addition, in the location "Alubei", which is located on the edge of the core and is grazed by sheep, areas with three grazing intensities (intense, moderate, light) were distinguished. In all these places were placed in the spring of 2015 (before the start of grazing) thirty three (33) pairs of protected (wire cages) and free of grazing (control) sampling surfaces, with dimensions 1.5x1.5 m each. Specifically, 12 pairs were placed in the burning treatment (6 in burnt dwarf cedar and 6 in adjacent unburned area), 12 in the cutting treatments (from 6 in two different positions) and 9 pairs in the three grazing intensities (three in each intensity). These surfaces were moved to neighbouring locations in the spring of 2016. In July 2015 (at the end of the growing season), measurements of vegetation cover and composition were made on the sampling surfaces. Cover was assessed visually in each area by two independent observers and included the percentage of area of each frame covered with vegetation, dry matter and bare soil. For the composition, the three dominant plant species on each surface were identified, also by two independent observers. Then, two square frames measuring 0.50x0.50 m each were randomly placed in each surface, where the above ground biomass was cut with scissors and transferred to the Laboratory for drying and weighing. The biomass measurements were repeated in July 2016. The biomass data of each year were analyzed with the statistical plan of the combined factors with the SPSS

22 program.

III - Results and discussion

Except the burnt treatments, which resulted in reduced vegetation coverage and increased bare soil and dry matter relative to the unburned, the other treatments had no significant effect on vegetation cover, either soil or dry matter (Table 1). The cutting had a significant effect on the fequency of the species, because it enhanced the low-growing species, such as *Astragalus hamosus, Festuca alpina* and *Hieracium hoppeanum*, at the expense of the high-growing species (*Agrostis gigantea, Filipendula vulgaris* and *Thymus longicaulis*) (Table 2).

Table 1. Plant cover in three treatments

Site	Treatment	Protection	Cover		
			Vegetation	Bare soil	Dry matter
Livadies	Cut	Yes	85.0	10.2	4.8
		No	81.3	11.7	7.0
Livadies	Not cut	Yes	85.4	6.7	7.9
		No	84.6	7.9	7.5
Aloubei	Heavy grazing	Yes	75.8	10.0	14.2
		No	67.5	17.5	15.0
Aloubei	Moderate grazing	Yes	82.5	10.8	6.7
		No	70.8	15.0	14.2
Aloubei	Light grazing	Yes	89.2	5.0	5.8
		No	71.7	13.3	15.0
Livadies	Burnt	Yes	35.0	40.4	24.6
		No	36.7	42.0	21.3
Livadies	Not burnt	Yes	57.5	25.8	16.7
		No	52.5	24.6	22.9

Table 2. Frequency (%) of dominant species in cutting treatment

Plant species	Cut		Not cut	
	Protection	Control	Protection	Control
Agrostis gigantea	-	-	25	8
Astragalus hamosus	42	42	17	8
Centaurea nervosa	42	42	83	50
Festuca polita	17	17	8	-
Festuca alpina ssp. *briquetii*	67	67	58	67
Filipendula vulgaris	-	-	8	25
Galium verum	42	42	-	50
Hieracium hoppeanum	33	33	17	17
Thymus longicaulis ssp. *longicaulis*	-	-	17	17
Trifolium medium	25	25	50	42
Other species	33	33	17	17

Among the three degrees of grazing, intense grazing had a greater effect than moderate and especially light, because it reduced the dominant species, such as *Festuca alpina* (Table 3). The effect of burning was greater, which enhanced the presence of photophious species *Centaurea solstitialis, Galium verum, Polygonum arenarium* and *Verbascum epixanthinum*,

which in fact did not exist in the flora of the neighbouring (without dwarf) grassland (Table 4). It is speculated that the seeds of these species should have been in the ground (bank), under the dwarf cedar.

Table 3. Frequency (%) of dominant species in grazing treatment

	Heavy grazing		Moderate grazing		Light grazing	
Φυτικό είδος	**Protection**	**Control**	**Protection**	**Control**	**Protection**	**Control**
Agrostis gigantea	33	33	-	-	-	-
Astragalus hamosus	33	33	-	-	-	-
Festuca alpina ssp. *briquetii*	100	83	83	100	100	100
Filipendula vulgaris	-	-	33	17	50	83
Galium verum	17	-	-	-	50	17
Plantago holosteum	33	-	-	-	17	17
Poa bulbosa	33	17	-	17	-	-
Trifolium arvense	-	-	50	33	-	-
Trifolium fragiferum	-	-	-	17	67	-
Trifolium repens	33	33	33	33	-	50
Other sprcies	17	67	100	83	17	33

Table 4. Frequency (%) of dominant species in burning treatment

	Burnt		**Not burnt**	
Φυτικό είδος	**Protection**	**Control**	**Protection**	**Control**
Astragalus hamosus	8	8	50	25
Centaurea solstitialis	33	17	-	-
Festuca alpina ssp. *briquetii*	25	42	58	83
Galium verum	58	50	-	-
Hieracium hoppeanum	-	8	25	25
Hypericum perforatum	-	8	25	8
Plantago holosteum	-	-	75	11
Polygonum arenarium	25	25	-	-
Thymus longicaulis ssp. *longicaulis*	-	8	17	33
Verbascum epixanthinum var. *epixanthinum*	33	17	-	-
Other species	33	75	50	33

Regarding biomass yield, the cutting treatment did not give statistically significant differences, in contrast to the burning treatment, where there were significant differences between 2015 and 2016 (Tables 5 and 7), which shows that the second treatment was more efficient than the first. Regarding grazing treatment, it reduced production in both years, but statistically significant differences were found only in the second year (2016). In contrast, there were no statistically significant differences in burning treatments, which means that grazing intensity was slightly at the core of the national park.

Table 5. Average yield biomass (Kg/ha) in cutting treatment

Year		
	Cut	**Not cut**
2015	2,639 a*	2,339 a
2016	2,226 a	1,766 a
	Protection	**Control**
2015	2,654 a	2,325 a

2016	2,575 a	1,417 b

* Same letters on the same line show that there are no statistical differences in the significance level of 0.05.

Table 6. Average yield biomass (Kg/ha) in grazing treatment

Year	Heavy grazing	Moderate grazing	Light grazing
2015	1,326 b*	1,758 b	4,681 a
2016	1,733 a	1,826 a	2,141 a
	Protection		**Control**
2015	3,165 a		2,012 b
2016	3,099a		703 b

* Same letters on the same line show that there are no statistical differences in the significance level of 0.05.

Table 7. Average yield biomass (Kg/ha) in burning treatment

Year		
	Burnt	**Not burnt**
2015	1,629 a*	601 b
2016	1,311a	742 b
	Protection	**Control**
2015	1,256 a	975 a
2016	1,257a	796 a

* Same letters on the same line show that there no statistical differences in the significance level of 0.05.

In contrast, grazing statistically significantly reduced biomass on grazed areas outside the core of national park. Statistically significant effects were moderate and, in particular, intense grazing only in the first year of 2015 (Table 6).

IV - Conclusions

Both prescribed burning and cutting are effective methods for repairing degraded pseudo-alpine grasslands. Burning is more drastic but can be applied once to control dwarf cedar in pseudo-alpine grasslands, while favoring photophilous herbaceous species and enhancing aboveground biomass. Cutting, on the other hand, is a less effective method, although it can control competing species, but it must be applied on an annual basis. It turns out that in order to restore the pseudo-alpine grasslands of Oiti mountain, controlled burning should be introduced as a management tool and the normal (moderate) grazing of livestock in the core of national park, mainly sheep, should be allowed.

Recognition of help

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