Firebreak maintenance with equines in Serra de Tramuntana mountains (Mallorca, UNESCO world heritage)

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Abstract. Wildfires are a major problem in Mediterranean mountain areas due to dry and hot summer conditions that usually last for 1 to 4 months/year. Moreover, in the last decades, traditional pasture activities have been abandoned or reduced to a great extent as a consequence of socioeconomic changes underwent in many Mediterranean countries, what led to an increase of herbaceous and shrubby flammable material. At the same time, mountain areas are a point of interest for tourism and recreational activities, that has increased the number of visitors and thus, the wildfire risk. Wildfire prevention is therefore a major concern of the environmental services of those countries. Firebreaks are one of the most effective ways of reducing wildfires severity and spread. However, their maintenance with conventional methods is difficult, expensive and time consuming, especially in sloping and rocky areas. The objective of this work was to assess the effectivity of using herds of mixed equine species at high stock rates to maintain firebreaks in the Tramuntana Mountains (Mallorca Island, West Mediterranean Basin). Vegetation consumption by a herd of equine species (horses, mules and donkeys) was determined in a Mountain area dominated by *Ampelodesmos mauritanica*, *Calicotome spinosa* and *Pistacia lentiscus*. The results show that equines consume most biomass of the dominant species *A. mauritanica*, reducing flammable material to a great extent at the same time. In addition, they also consume tender leaves and the bark of *C. spinosa*. *Pistacia lentiscus* underwent low consumption rates. As a conclusion, equines appeared to be highly effective in firebreaks maintenance, especially in sloping and difficult access areas.

Keywords. Wildfire prevention – Equine – Mediterranean mountains – *Ampelodesmos mauritanica*.

L'entretien du pare-feu par les équidés dans les montagnes de Serra de Tramuntana (Majorque, patrimoine mondial d'UNESCO)

Résumé. *Dans les régions Méditerranéennes montagneuses, les feux des forêts constituent un fléau majeur en raison d'étés secs et chauds, s'étalant habituellement de 1 à 4 mois. En outre, au cours de ces dernières décennies les activités de pâturage traditionnel ont été abandonnées ou bien réduites dans une large mesure suite aux changements socio-économiques subis dans de nombreux pays méditerranéens, induisant par conséquence une augmentation des matériaux herbacés et arbustifs inflammables. De plus, les montagnes présentent un point d'intérêt majeur pour le tourisme et les activités récréatives, ce qui a augmenté le nombre de visiteurs et par le même temps le risque d'incendies forestiers. Par ailleurs, la prévention des incendies est devenue une préoccupation majeure des services de l'environnement de ces pays. Pour réduire la vitesse de propagation et la gravité des incendies de forêt, des pare-feux ont été considéré comme l'un des moyens efficace pour faire face à ce fléau. Cependant, l'entretien de ces derniers avec les méthodes classiques est difficile, long et coûteux, en particulier dans les zones rocheuses avec de fortes pentes. L'objectif de ce travail est d'évaluer l'effectivité de troupeaux mixtes d'espèces équines de forte densité à fin de maintenir les pare-feux dans la « Tramuntana » (Majorque, Ouest du bassin méditerranéen). La consommation de la végétation par un troupeau d'équidés (chevaux, mulets et ânes) a été suivie dans une zone de montagne qui est dominée par* Ampelodesmos mauritanica, Calicotome spinosa *et* C. lentisque. *Les résultats obtenus montrent que les équidés consomment une grande partie de la biomasse de A. mauritanica, l'espèce dominante, ce qui réduit les matériaux inflammables de façon importante. En outre, ils consomment aussi des feuilles tendres et l'écorce de* C. spinosa. *Par contre,* C. lentisque *a subi un faible taux de consommation. En conclusion, les équidés semblent être très efficaces dans la zone d'entretien de pare-feu, en particulier dans les zones en pente et d'accès difficile.*

Mots-clés. *Prévention des incendies – Equine – Montagnes méditerranéennes* – Ampelodesmos mauritanica.

I – Introduction

In Mediterranean mountain areas, wildfires are a major problem due to dry and hot summers. Moreover, in the last decades, traditional pasture activities have been abandoned or reduced to a great extent as a consequence of socioeconomic changes underwent in many Mediterranean countries, what led to an increase of herbaceous and shrubby flammable material. At the same time, Mountains are a growing point of interest for tourism and recreational activities, resulting in an increased number of visitors and thus, wildfire risk. In such a situation, wildfire prevention is a major concern of the environmental services of those countries. Firebreaks are one of the most effective ways of reducing wildfires severity and spread. However, their maintenance with conventional methods is difficult, expensive and time consuming, especially in sloping and rocky areas. The objective of this work was to assess the effectivity of using herds of mixed equine species at high stock density to maintain firebreaks in the Tramuntana Mountains (UNESCO World Heritage) in Mallorca Island (West Mediterranean Basin).

II – Material and Methods

The study was carried out in Galatzó area (39.6N, 2.5E), located at the Southwest edge of the Serra de Tramuntana (Mallorca, Spain) from 2014 to 2015. The climate during the experimental period was typically Mediterranean, with an annual precipitation of 355 mm and 566 mm in 2014 and 2015, respectively. Mean temperature was 16.7ºC and 16.4ºC in 2014 and 2015, respectively. Drought period lasted from June to August in 2014 and from April to July in 2015.

Firebreak maintenance was carried out by keeping a relatively large number of animals in small (2000 m^2) stockyards during a limited number of days. Herd composition and the number of days that the animals were kept in the stockyard was fixed according to common practices and depended on the season and animal availability (Table 1).The instantaneous stock density was calculated as heads/ha.

Table 1. Biomass consumption (kg dry matter m^{-2}) and stockyard traits: season, length of animals stay at the stockyard (days), number and type of animals, instantaneous stock density (nº of animals ha^{-1}). Values are means† ± standard error. Different letters denote Duncan's significant differences (p<0.05)

Season	Nº of days	Nº of mules	Nº of horses	Nº of donkeys	Stock density	Biomass consumption
Spring	5.1 ± 0.63ab	2.0 ± 0.00b	5.0 ± 0.00b	35.2 ± 1.27b	213.3 ± 6.87b	0.52 ± 0.055a
Summer	3.5 ± 0.96a	1.7 ± 0.21b	3.3 ± 1.05b	35.3 ± 2.95b	201.7 ± 21.08b	0.44 ± 0.135a
Atumn	6.8 ± 0.48b	1.0 ± 0.00a	0.0 ± 0.00a	26.0 ± 0.00a	135.0 ± 0.00a	0.51 ± 0.079a
Winter	5.5 ± 0.50ab	1.0 ± 0.00a	0.0 ± 0.00a	26.0 ± 0.00a	135.0 ± 0.00a	0.33 ± 0.055a

† Number of stockyards (replicates) per season were: 9 in spring, 6 in summer, 4 in autumn and 2 in winter.

Biomass consumption in each stockyard was estimated by measuring fresh biomass before animal entrance and after animal leaving in 4 plots of each 4 m^2. Dry biomass was calculated by determining water content (oven drying during 72 h at 70ºC) of a fresh biomass subsample of each stockyard. Remaining biomass after grazing in each stockyard was negligible and it was not measured.

Botanic composition was determined along 20m x 1m transects in 8 stockyards before animal entrance and after animal leaving.

Statistical analyses were performed by using SPSS 19.0 statistical package (IBM, Chicago, IL, USA).

III – Results and discussion

Between 135 and 213 animals were kept in the stockyards, with stock densities significantly lower in winter and autumn than in spring and summer; grazing period ranged between 3 and 8 days (Table 1). As a result, annual stocking densities were between 1.8 and 3.7 heads $ha^{-1}year^{-1}$ (data not shown). Such annual stock densities can be considered high for Mediterranean shrublands (Bianchetto *et al*., 2015). However, this kind of management of the herd and the stockyards allowed high biomass consumption within a short period of time, maximising firebreak maintenance. In that sense, biomass consumption ranged from 0.16 to 1.12 kg of dry matter m^{-2}, and it was neither correlated to stock density nor to the period animals stayed in the stockyard ($p>0.05$ in both cases). Moreover, there were no significant differences in biomass consumption among seasons ($p>0.05$, Table 1). Summing up, those results suggest that the maintenance procedure was efficient enough to ensure high consumption rates of biomass regardless animal availability and season.

Ampelodesmos mauritanica was the most consumed species. The soil covered by that species decreased significantly from 55% before animal entrance to 13% after animal leaving the stockyard. In a similar way, non-vegetated areas increased significantly from 28% to 76% before and after foraging, respectively (Fig. 1). Other species which were significantly reduced by grazing were *Pistacia lentiscus* and *Chamaerops humilis*. On the contrary, *Calicotome spinosa*, *Juniperus oxycedrus* and *Hypericum balearicum* (an endemic species) were not significantly reduced by animal consumption (Fig. 1).

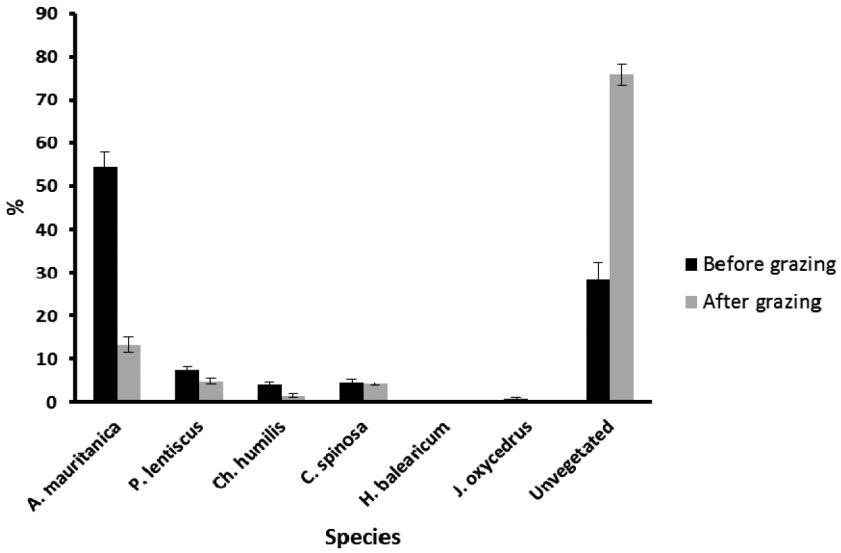

Fig. 1. Botanical composition of biomass before and after grazing (% of soil cover). * Denotes significant differences ($p<0.05$) within species.

IV – Conclusions

Equine grazing at high stocking densities for short periods appeared to be an efficient method in firebreak maintenance in Mediterranean rangelands dominated by *Ampelodesmos mauritanica* since biomass consumption was high and the proportion of this species was significantly reduced. Future works should evaluate how long and how often those firebreaks need to be grazed in or-

der to assess economic viability of such practice. The analysis of plant biodiversity before and after grazing, as well as the animal health and welfare, would be also major objectives in the long term of the study.

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