Forest Ecology and Management 257 (2009) 731–738

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Abandonment and management in Spanish dehesa systems: Effects on soil features and plant species richness and composition

Reyes Tárrega *, Leonor Calvo, Ángela Taboada, Sergio García-Tejero, Elena Marcos

Departamento de Biodiversidad y Gestión Ambiental, Facultad de Ciencias Biológicas y Ambientales, Universidad de León, Area de Ecología, E-24071 León, Spain

ARTICLE INFO

Article history:
Received 15 July 2008
Received in revised form 4 October 2008
Accepted 6 October 2008

Keywords:
Land use change
Management
Oak dehesa
Quercus pyrenaica
Species richness
Topsoil
Understory composition

ABSTRACT

Quercus pyrenaica dehesas have been traditionally used as communal extensive grazing systems in the León province (NW Spain). In this region, recent abandonment of rural areas and the subsequent gradual decrease in livestock load have led to the invasion of shrubs in the understory, increasing the risk of fires. Indeed, even if there is no need of creating new pasturelands for livestock breeding, the remaining landowners keep on burning to clear these montane patches. Alternatively, the regional administration encourages shrub cutting as a better way of managing these areas and preserving the pasturelands. Our aim was to determine the effects of the dehesa abandonment and shrub cutting on plant species richness (annual herbs, perennial herbs and woody plants) and species composition, as well as on topsoil properties. For that, we compared three types of dehesas with different management regimes: (1) grazed dehesas (used at the present), (2) abandoned dehesas (more than 20 years without grazing) and (3) dehesas where shrub cutting was applied after abandonment (i.e. cleared dehesas). We selected three replicates or stands per dehesa type. The highest organic matter content (O.M.), total nitrogen (N) and available phosphorus (P) were found in cleared dehesas, while the lowest values corresponded to the grazed ones. Abandoned dehesas were characterized by the highest values for available calcium (Ca^{2+}). No significant differences were detected regarding the vegetation richness values (S alpha, gamma or beta), although higher mean values of S alpha and gamma were found in grazed dehesas, and lower values in the cleared ones. Concerning the vegetation life forms, grazed dehesas held significantly greater species richness and cover of annual herbs, while abandoned dehesas had significantly higher woody species cover. Both grazed and abandoned dehesas harboured plant species (38 and 13 species, respectively), which were exclusively found in one dehesa type. Contrary to that, cleared dehesas scarcely had "exclusive" species. To conclude, our results indicated that shrub cutting alone (not followed by livestock grazing) may cause loss of plant species richness, suggesting that it is not the most appropriate management method to restore vegetation, except for reducing the risk of fire.

1. Introduction

Dehesas are the most extended agroforestry systems in Europe (Eichhorn et al., 2006) and have been considered as an example of sustainable management (Gómez-Gutiérrez and Pérez-Fernández, 1996), although this has been discussed by other authors that indicate failures in oak regeneration (Plieninger, 2007). The dehesa systems are the result of a traditional form of management of the Mediterranean forests, in which native trees (*Quercus ilex*, *Q. suber*, *Q. pyrenaica*, *Juniperus* spp., etc.) are spaced out or inserted in a continuum of grasslands (Gómez-Limón and de Lucio Fernández, 1999). The maintenance of isolated trees has important effects on soil fertility and grass production in areas with oligotrophic soils and summer dry period (González Bernáldez et al., 1969; Escudero, 1985; Joffre and Rambal, 1993; Joffre et al., 1999; Gallardo, 2003; Moreno et al., 2007). Indeed, the Mediterranean dehesas can simultaneously support livestock, forestry and agricultural production without irreversible endangering the ecosystem functioning (Linares, 2007). Moreover, they show an interesting balance between resource exploitation and the conservation of biodiversity (González Bernáldez, 1981; Díaz et al., 1997; Montero et al., 2000; Plieninger and Willbrand, 2001).

The areas where extensive livestock grazing has been developed for thousands of years, as in the Mediterranean Basin, usually harbour great plant species richness (Naveh and Whittaker, 1979; Puerto et al., 1990; González Bernáldez, 1991; De Miguel and Gómez Sal, 2002). Modifying the type of use and management of these pasturelands can lead to important changes in the vegetation

* Corresponding author. Tel.: +34 987 291567; fax: +34 987 291563.
E-mail address: r.tarrega@unileon.es (R. Tárrega).

0378-1127/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.foreco.2008.10.004

diversity and species composition (Pineda et al., 1981; Díez et al., 1991; Montalvo et al., 1993; Gómez-Limón and de Lucio Fernández, 1999; Poschlod et al., 2005). In Spain, as well as in most of Europe, the economic development and policies of the last decades have determined the progressive underutilization or abandonment of vast rural areas. Consequently, in these areas there has been a considerable increase in the woody biomass load and, thus, in the risk of fires, also potentially resulting in changes in plant species composition and soil conditions (Gómez-Limón and de Lucio Fernández, 1999; Luis-Calabuig et al., 2000; Peco et al., 2005, 2006).

In the study region (NE of the León province, NW Spain), the dehesa systems are located in naturally developing *Q. pyrenaica* (deciduous oak) forested areas. Although these dehesa ecosystems have several characteristics in common with the typical dehesa systems of SW Spain (mainly dominated by *Q. ilex*, evergreen oak), such as the coexistence of the traditional exploitation of resources and the conservation of biodiversity (see Taboada et al., 2006), there are also other features that differentiate them. Firstly, although both types of dehesas belong to the Mediterranean climate, the summer dry period is less marked in the dehesa systems of León province. Secondly, the northern dehesas are used as communal pasturelands, in contrast to the typical privately owned dehesas of W and SW (Rodríguez, 2001). It is very difficult to establish the livestock load of the dehesas in our region, which is moreover usually highly variable. Nowadays, some of these dehesa ecosystems are still being used, but others have been abandoned since the 70s and 80s and are thus characterized by a strongly developed shrubby understory. Recently in the study area, the regional administration (Junta de Castilla y León) has initiated management practices in the abandoned dehesas, specifically shrub cutting, in order to reduce the risk of fires and to preserve the pasturelands. This type of management of abandoned grasslands was previously applied as the usual method for restoring vegetation in other European countries (Poschlod et al., 2005). However, not just the abandonment, but also the subsequent management activities developed in the abandoned areas would strongly affect plant community diversity and composition (Bakker, 1989; Bakker and Berendse, 1999; Poschlod et al., 2005; Öckinger et al., 2006).

In this study, we intended to determine the effects of the abandonment and the subsequent management practices developed in *Q. pyrenaica* dehesa ecosystems, on the understory plant species diversity and composition, as well as on the topsoil properties. For that, we compared three types of dehesa systems with different management regimes (Fig. 1): (1) grazed dehesas, where the extensive traditional grazing system is maintained, (2) abandoned dehesas and (3) dehesas where shrub cutting was applied after abandonment in order to reduce the understory biomass load (cleared dehesas). We considered plant species richness at both small (sampling unit of 1 m^2) and stand scales, also analysing the spatial heterogeneity based on their comparison.

Fig. 1. The three types of dehesa ecosystems studied, defined by the different management practices applied. G = grazed dehesas; A = abandoned dehesas; C = cleared dehesas.

2. Materials and methods

We studied three types of oak (*Q. pyrenaica*) dehesa systems with different management regimes (Fig. 1): (1) grazed dehesas at the present ("G"), (2) abandoned dehesas ("A") (more than 20 years without grazing) and (3) cleared dehesas ("C") (where shrub cutting was applied only once, 1–2 years before the study was done, part of the slash being apparent on the ground by the time of sampling, see Fig. 1); and three replicates, stands or sites of each type (nine independent dehesas in total, the three sites of each management type were not clustered together). These dehesa ecosystems were the result of a traditional livestock (generally, sheep and goats, but sometimes cows too) management method in which the forest has been cleared, leaving a low density of trees that have been pruned to favour crown development at the expense of height growth. In the study stands, tree density is approximately 100 trees/ha, tree height is around 10–12 m and trunk perimeter (1 m above ground level) about 1–1.5 m. To minimise variability, geographically close dehesas were selected