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Management of Montados and Dehesas for High Nature Value: an interdisciplinary pathway

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Abstract Mediterranean oak woodlands, Montados in Portugal and Dehesas in Spain have long been acknowledged as potential land use systems of high nature and social value providing relevant ecosystem services and biodiversity conservation. Nevertheless, these systems are now under severe threat, both due to abandonment in certain areas and overuse in others, extremes that may be limited by appropriate management practices and strategies. The High Nature Value concept can be a pathway for the understanding and assessment of management practices best adapted to the balance of the Montado and Dehesa, and also to the assessment of the thresholds of change, so that the long term sustainability of the Montado systems is preserved. This special issue aims to contribute for the understanding of how the Montado and Dehesa classification as High Nature Value may be a path for sustainable management. This classification can be achieved by different ways and implies different components of the Montado, and thus the first four papers of this special issue address different approaches and methodologies for the identification of HNV Dehesas and Montados, the following seven papers deal mostly with the effect of management practices on biodiversity and other Dehesas and Montados values and finally the last two papers address the causes for Montado decline and suggest mitigation measures for that decline.

Keywords Open Mediterranean oak woodlands · HNV farming · Multifunction · Research challenges · Biodiversity

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Introduction

Montados (in Portugal) and Dehesas (in Spain) are silvo-pastoral systems characterized by open canopy woodlands of mainly *Quercus suber* and *Quercus rotundifolia*, mingled in some areas with other Mediterranean tree species, with natural or cultivated grassland in the undercover. Covering ~3.5 milion ha in the South-East region of the Iberian Peninsula (Pinto-Correia et al. 2011), these human shaped ecosystems have high habitat heterogeneity, due to the changing composition and density of the tree cover, in combination with an undercover mosaic of grasslands with dispersed or patches of shrubs. Sometimes, but much rarely nowadays, these grasslands are intermixed with agricultural crops. Pronounced patchiness of vegetation communities and

marked seasonality of plant and animal biological cycles are characteristic features of Montados (Ferraz-de-Oliveira et al. 2013) (Fig. 1).

The Montados and Dehesas have long been acknowledged as potential land use systems of high nature and social value providing relevant ecosystem services and biodiversity conservation. This is a result of the high diversity in vegetation, fauna and land cover, the balance between the forestry and the grazing uses, and the particular character of the resulting landscapes, all coexisting within the constraining environmental conditions of the Mediterranean region. Nevertheless, the system is now under severe threats, either due to poor or non-existent land-management practices leading to extensification and abandonment in less fertile and more peripheral areas or due to pressure for intensification by chronic overuse in others (Pinto-Correia and Godinho 2013; Bugalho et al. 2011).

The High Nature Value (HNV) concept, both in research and policy domains, emerged in Europe in the early 1990s. It aimed to emphasize the role of certain farm systems in the conservation of biodiversity in rural areas (Bignal and Mccraken 2000). In the HNV farming framework, HNV farmland can be defined as "those areas in Europe where agriculture is a major (usually the dominant) land use and where that agriculture supports or is associated with either a high species and habitat diversity or the presence of species of European conservation concern, or both" (Andersen et al. 2003). Besides the concept of HNV farmland, the drivers for the achievment of such a condition should be considered. The classification of farming systems as HNV is mainly associated with the impact of the different driving forces which are responsible for the HNV status, and these are highly dynamic and change over time (Cooper et al. 2007), therefore an HNV classification is never a permanent condition. Typically, HNV farming systems are low intensity and low input systems (animal stocking rates, fertilizers and pesticides), with a high structural diversity (a mosaic of land cover and land use). In addition, the use of semi-natural vegetation by livestock, often in combination with the presence of other semi-natural elements (field margins, hedges, ponds and rocky outcrops), are determinant feature of these systems (Cooper et al. 2007).

The underlying idea to the HNV concept assumes that low intensity farming practices often correspond

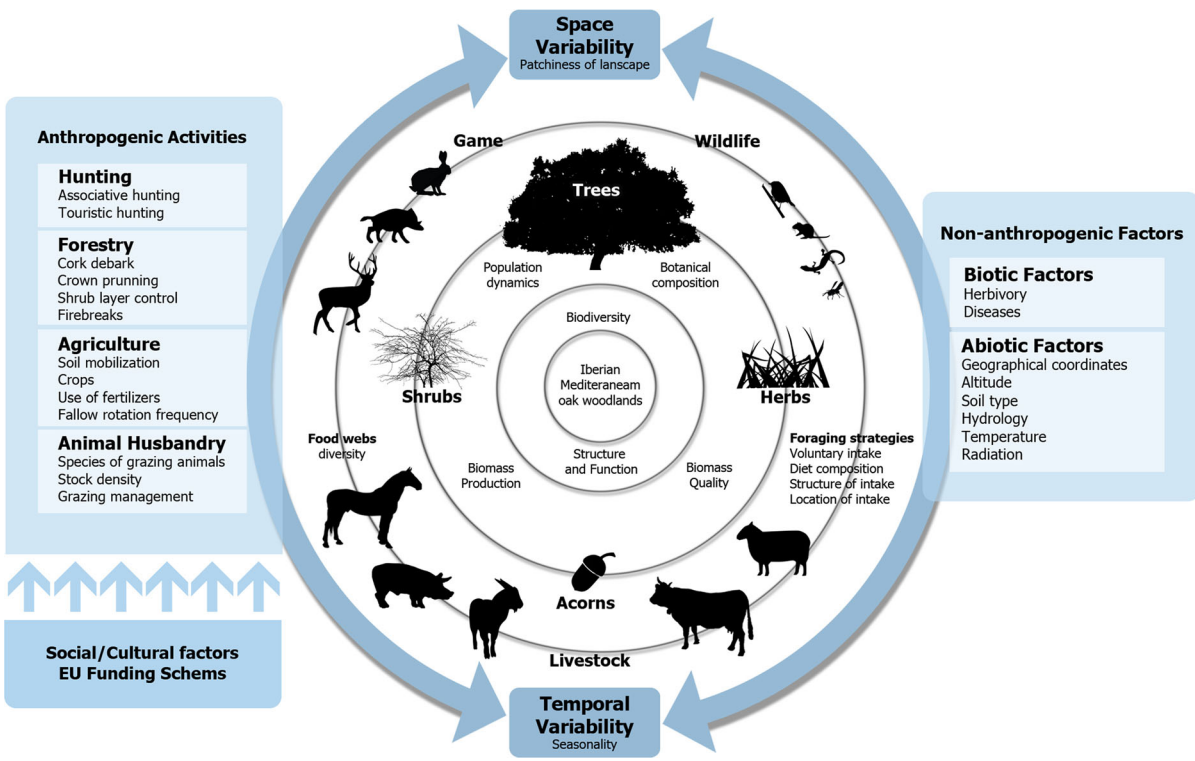

Fig. 1 Montado key characteristics and dynamics (Ferraz-de-Oliveira et al. 2013)

to an overall biological diversity in farmland (Beaufoy et al. 1994). The main goal of this approach is not to classify and establish individual areas as HNV farmland. Instead, it intends to preserve and expand the agricultural systems of HNV in Europe through support measures namely under the Common Agricultural Policy (CAP) (Beaufoy and Cooper 2009). To this end, a set of indicators is used to identify HNV farmland current extension as well as monitor (quantitative and qualitative) changes in the conditions that support biodiversity (Beaufoy and Cooper 2009). These provide information on the dynamics of the system and its long-term sustainability resulting from management practices and strategies. However, the construction of appropriate indicators and indices depends on the existence of a deep and accurate knowledge on the effects of the different farming practices adopted on biodiversity (Ribeiro et al. 2010; Godinho and Rabaça 2011; Godinho et al. 2011).

In the Montado and Dehesa, the design and data construction for these indicators is particularly complex, as the issue is the effects of farm pressure on different layers of land cover, and their related nature value, and balance: the pasture, the shrub and the trees. These land cover layers are interrelated, but they are nevertheless object of separated management strategies and practices, and have separated functional roles for the balance of the system and the public goods and services that they support. For example, shrubs may be important for the botanical and functional diversity as well as to support and function as habitat for wild fauna, but they function, at the same time, as shelter for young trees and are thus highly relevant for oak tree regeneration. Therefore density, dispersion, distribution and composition of the shrub layer is relevant when analysing the High Nature Value. And these characteristics depend both on the present and past land management practices as well as on the biophysical context of each location.

Present challenges for research and the aim of this SI

In face of the current pressures and in order to ensure a sustainable management of Montados and Dehesas, there is an urgent need to produce knowledge on the resilience thresholds of these systems. Significant gaps exist in our ability to understand the relationships between management and the support of landscape structure as well as ecosystem services, including cultural values, at different spatial and temporal scales. To define which Montados and Dehesas may be linked to the multiple ecosystem goods and services that are valued by society today, criteria, indicators and tools that make the identification and monitoring of these silvopastoral systems, a straightforward task, are required. The methodological approach is not simple, as different disciplinary fields and data sets have to be combined. Interdisciplinary integration is the way, even if often the research pathways and the possible results, are uncertain—but through this integration, the needed innovation in approaches and research methods can be achieved (Nowotny et al. 2004).

The High Nature Value concept can be a pathway for the understanding and assessment of management practices best adapted to the balance of the Montado and Dehesa, and also to the assessment of the thresholds of change, so that the long term sustainability of the Montado systems is preserved. Following, the objective of this special issue is to contribute for the understanding of how the Montado or Dehesa classification as High Nature Value may be a path for sustainable management, and as such to contribute to link science to practice. This classification can be achieved by different ways and implies different components of the Montado, and thus the proposed papers cover a range of different approaches to the assessment of Montado and Dehesas values and management questions.

The papers in this special issue resulted from a selection of manuscripts originally presented at the "ICAAM International Conference 2013—MONTADOS and DEHESAS as High Nature Value Farming Systems: implications for classification and policy support", held in Évora, Portugal in February 2013. Those manuscripts were revised and updated to its present form for publication in this Special Issue.

Main contributions for this special issue

The first set of four papers in this SI address the assessment of Montado and Dehesas values. Different approaches and methodologies for the identification of HNV Dehesas and Montados are suggested and discussed. The first paper by Acebes et al. "Towards

the identification and assessment of HNV Dehesas: a meso-scale approach" develops and applies a methodology for identifying and assessing HNV Dehesas, based on GIS-analyses of land cover cartographies of a region covering 10 municipalities (c. 2300 km^2) in the southernmost region of Spain (Andalusia). Godinho et al. in the second paper "A remote sensing-based approach to estimating montado canopy density using the FCD model: a contribution to identifying HNV farmlands in southern Portugal", demonstrates the implementation and effectiveness of the Forest Canopy Density (FCD) model in producing a remote sensing-based map of Montado canopy density over a large territory (c. 8567 km^2) in southern Portugal. The authors suggest that such a detailed land cover mapping may be used to promote a more accurate identification and assessment of HNV farmland in Montado areas. The third paper by Bugalho et al. "Using the high conservation value forest concept and Pareto optimization to identify areas maximizing biodiversity and ecosystem services in cork oak landscapes" follows in the attempt to identify areas maximizing biodiversity and ecosystem services in cork oak Montados. Following this aim, the authors exemplify the application of HCVF to the cork oak landscape using a WebGIS tool that integrates the HCVF framework, in conjunction with Pareto optimization. A case study using threatened bird and reptile species, as examples of biodiversity attributes, and carbon storage and water recharge rate of aquifers, as examples of ecosystem services attributes is presented. The authors suggest that discrimination of levels of farming intensity within HNVF systems such as Montado, could be attained using a similar approach (Pareto optimization), provided information on management intensity indicators is available. At a more local scale approach, the forth paper by Catarino et al. "Can birds play a role as High Nature Value indicators of montado system?" assessed and tested several bird groups and parameters such as species diversity and richness, as HNV indicators for Montados.

The second set of papers address mostly the effect of management practices on biodiversity and other Dehesas and Montados values. In the fifth paper "Overgrazing in the Montado? The need for monitoring grazing pressure at paddock scale", Sales-Baptista et al. frame and describe the overgrazing risk in Montados and argue the use of grazing pressure over stocking rates as indicator for monitoring changes and support management decisions in Montados. The authors further suggest the use of currently available imaging and communication technologies to assess pasture dynamics and livestock spatial location in order to provide information to farm managers' operational use and also to rangeland research. The sixth paper by Almeida et al. "The effects of grazing management in montado fragmentation and heterogeneity" relates, at a landscape scale, Montados structural diversity to grazing management, namely animal species and stocking rates. The authors found that cattle's' grazing has an adverse effect on Montado fragmentation, while sheep grazing have stronger impact on the heterogeneity within Montado patches. In the seventh paper "Exploring the causes of high biodiversity of Iberian dehesas: the importance of wood pastures and marginal habitats", Moreno et al. carried out an extensive survey (155 plots sampled) on the effect of nine general habitat categories on the abundance and species richness of four taxonomic groups (vascular plants, bees, spiders and earthworms). The results obtained confirmed the hypothesis that the high diversity of Dehesas depends on the coexistence of a wide mosaic of habitats, including marginal habitats, which seemed to harbor a disproportionately high number of species as compared to their small extent. The eighth paper, "Regeneration patterns of Quercus suber according to montado management systems" by Simões et al. evaluates the effect of two Montado management practices (harrowing every 3–4 years and shrub clearing with shredder every 5–7 years, both with the presence of grazing cattle) on oak tree regeneration at early stages. From the results obtained for regeneration and shrub coverage, the authors concluded that cork oak recruitment was promoted by the protective effect of medium (40–60 %) shrub cover, while both sparse coverage and shrub encroachment could negatively affect cork oak regeneration. Furthermore, shredding every 7 years when compared to harrowing every 3 years, enables shrub development while maintaining cover below the threshold for safe oak regeneration, extending thus the recruitment temporal window. The ninth paper—"Assessment of the diversity of epigeous *Basidiomycota* under different soil-management systems in a montado ecosystem: a case study conducted in Alentejo"—by Santos-Silva and Louro evaluates the effects of Montado soil-management on

macrofungal diversity. From an extensive survey conducted over 5 years, in experimental plots subjected to different soil management practices (9 years before the survey started), the authors concluded that soil tillage resulted in a decrease in mycorrhizal taxa, even a long time after disturbances have taken place. Arosa et al. in the tenth paper—"Temporal effects dominate land use as factors affecting soil nematode communities in Mediterranean oak woodlands"—adds to the management factors (agricultural, pastoral and forestry uses), the temporal effects and evaluates their impact on soil nematode community structure. In the eleventh paper—*"Emergy Analysis of a Silvo-Pastoral System, a case study in Southern Portugal"*, Fonseca et al. use the Emergy Evaluation System to evaluate the emergy flow in a case study farm. The emergy analysis methodology considers the whole farm system within a unique model enabling the evaluation of mutual influence among variables. The authors present a case study of a cattle rearing farm in a Montado area and produce a set of indices that describe the system and help in the design of management strategies to maximize emergy flow in the farm.

The last two papers of this special issue address the causes for Montado decline and suggest mitigation measures for that decline. The twelfth paper—"Birds as predators of cork and holm oak pests"—by Ceia et al. relates the recent identified decline of Montados to insect pests. The authors identify bird species that regularly feed on cork and holm oak pests and further provide a comprehensive framework on the role of those birds as potential predators in controlling cork and holm oak insect pests.

The last paper by Godinho et al., "Assessment of environment, land management, and spatial variables on recent changes in montado land cover in southern Portugal" describes the pattern of Montado distribution in Portugal between 1990 and 2006 and analysis the effect of 14 independent variables (presumably relate to Montado decline), on the Montado loss over that period. The results obtained indicate that most variance in the large-scale distribution of recent Montado loss is due to land management, either alone or in combination with environmental and spatial factors.

These are research results on the HNV value of the Montado and Dehesa which contribute to progress the state of the art in understanding and assessing these systems. Much more is needed to fully support management questions that require this type of research to continue.

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