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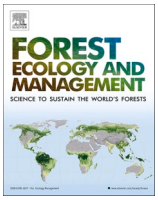

Perspectives: Cessation of traditional pruning threatens communal dehesas of deciduous oaks in the Western Mediterranean

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ABSTRACT

Open woodlands (*dehesas*) conformed traditional agrosilvopastoral systems in the Western Mediterranean. Communal deciduous oak dehesas were essential to rural economies for centuries. They were managed through tree pruning and grazing, enabling the coexistence of pasture and tree cover. The singular nature of this ecosystem fosters the persistence of ancient trees and species associated with old growth forest, even within intensively managed ecosystems. However, unlike large private evergreen oak *dehesas*, smaller communal deciduous *dehesas* remain largely unprotected, despite being the major reservoir for old growth forest species: fungi, mosses, lichens, saproxylic invertebrates, and cavity-dwelling vertebrates. The abandonment of traditional management and pruning cessation has triggered scrub encroachment, biodiversity loss, and the structural decline of old trees. These woodland ecosystems could aid the recolonization of mature forests taxa in the expanding young forest surface. However, they are vanishing unnoticed due to their small size, isolation, and lack of formal recognition. Their preservation is urgent, yet hindered by insufficient data, lack of protection frameworks, and disappearing traditional knowledge. Communal deciduous oak *dehesas* exemplify how cultural landscapes can support old-growth biodiversity, aligning with EU restoration goals.

The Western Mediterranean's complex history of human activity led to widespread deforestation until very recent times (García-Ruiz et al., 2020). In this historical context, *dehesas,* savannah-like open oak woodlands characterized by scattered old trees under traditional agrosilvopastoral practices, were the predominant forested landscape across many territories. Tree branches were regularly trimmed at a height beyond the reach of livestock to provide firewood and fodder, stimulate acorn production while preserving the integrity of the main tree trunk. Long term persistence was also granted by promoting tree recruitment using enclosures to protect from herbivores (Pulido and Díaz, 2005). This practice enabled the coexistence of grassland for livestock and tree cover for centuries. These woodlands, termed as *dehesa* in Spain and *montado* in Portugal, have played a primary role in preserving forest biodiversity in the Western Mediterranean. Today, they are considered a conservation hotspot in the region. Oak *dehesas* cover large extensions in Western Iberian Peninsula that are usually in the private hands of large landowners with property rights dating back to Christian Reconquest process (Ruiz Maya, 1979). The environmental value of this ecosystem has been recognized with its inclusion in EU protection schema, but only for evergreen oaks (Habitat 6310; Council Directive 92/43/EEC). In contrast to the large private *dehesas*, communal *dehesas* (*dehesas boyales*), which are frequently dominated by deciduous oak species, have been in the background. Habitat 6310 did not grant their protection, and despite natural forests of some of their dominant species are included in the Habitat Directive, pollarded deciduous oak forests are not specifically recognized. Since their extension is much smaller than that of large private *dehesas*, usually occupying just a few hectares, communal *dehesas* are now often surrounded by forests, undergoing shrub encroachment by management abandonment, and are therefore visually unnoticeable. Their regional distribution is also different to the distribution from evergreen private *dehesas*, being more abundant in northern and central Iberian Peninsula.

The origin of these communal *dehesas* can also be tracked back to the Middle Ages. The creation of the rural settlements during the Christian Reconquest included these forests and their exploitation in the granted privileges (i.e. *fueros*) to peasants by medieval kings (Guadilla-Sáez et al., 2020). Communal *dehesas* were pivotal for rural economies, serving as the main source of firewood as well as critical for the

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maintenance of oxen and mules, the basic workforce for ploughing arable lands. The initial management of these woodlands was based on rules developed by commoners, this traditional ecological knowledge designed to balance local environmental conditions with socioeconomic demands, which were gradually formalized into law. This rich body of customary law and traditions provides an impressive example of how intensive land use can be reconciled with sustainability. Many of these commons survived the intense privatization measures of the 19th century (Lana Berasain. 2024), but their management structures were finally disbanded due to rural exodus and the rise of agricultural mechanization during the second half of 20th century. As the economic relevance of these commons became marginal, most of the traditional practices were abandoned, leading to an abrupt loss of historical traditions and their gradual transformation. Nevertheless, communal *dehesas* still play a relevant role in the local imaginary.

The main reason for pollards' longevity is cultural. Pollarding implied strict protection of the main trunk. Customary uses, but also regulations ranging from local (Aragón Ruano, 2010) to royal, as the famous edict from Spanish Catholic Kings in 1496 (Viana Razola, 1805) granted protection to pollards. These safeguards enabled pollarded trunks to grow well beyond cutting size without being fell down. But, pollarding also increases tree biological longevity. This is a counterintuitive outcome since pollarding is a very aggressive practice; however, trees under periodic pruning reach higher longevity than surrounding trees. This fact has been empirically observed in many fast-growing pollards: narrow-leaved ash has been recorded reaching up to 250 years (Candel-Pérez *et al.* 2022) or black poplar up to 200 years (Camarero et al., 2022), ages significantly greater than non-pollarded trees. Pollarding reduces secondary growth, and evidence shows that trees with slower growth rates achieve higher ages, both at interspecific and specific levels (*see a detailed discussion on potential mechanisms in* Brienen et al., 2020). Moreover, the regular trimming of the branches resets regularly tree height, leading to smaller trees. Tree height is a factor strongly associated to mortality risk: hydraulic constraints increase with trees heigh, and taller trees are considered more vulnerable to drought (McDowell and Allen, 2015; Stovall et al., 2019), a major mortality factor under Mediterranean climate (Ruiz-Benito et al., 2013). Additionally, by creating smaller trees, pollards are more resistant to mechanical damage by wind (Fortuin et al., 2023). Altogether, cultural and biological drivers have led to the paradoxical finding of a large concentration of ancient trees in areas subjected to intense human management (Olano et al., 2023)

Recurrent branch pruning leads to injuries that evolve into pockets of dead wood and cavities (Sebek et al., 2013), creating the ideal conditions for the preservation of old-growth forests species in an intensely managed ecosystem (Speight, 1989). Communal *dehesas* from deciduous oaks are heavens for old growth forest taxa, from cavity nesting birds than benefit from the abundance of otherwise limited holes and cavities (Wiebe, 2011) to a wide array of organisms that are linked to dead wood including fungi, moss, lichens, and saproxylic invertebrates (Siitonen and Ranius, 2015; Sebek et al., 2016). The presence of tree hollows favors species richness; in fact, doubling the mean number of trees with hollows per hectare (from 10 to 20 trees) has been reported to increase species richness of saproxylic beetles by more than 7 % (Micó et al. 2022). In most Mediterranean areas, populations of these groups are restricted to these woodlands that act as biological shelters for many specialists or threatened species (Galante, 2021). The large old trees of communal *dehesas* also harbor cryptic flora (fungi and lichens) and fauna (saproxylic insects) whose diversity plays a critical ecological function. These organisms contribute to essential functions such as organic matter decomposition and nutrients recycling, the maintenance of plant diversity through pollination, pest control via predation and parasitization, and the maintenance of animal diversity as a key element in food webs (Ramírez-Hernández et al., 2014, Micó 2018).

The lack of traditional management is leading to the waning of this ecosystem. Scrub encroachment is one of the first observable effects of abandoning livestock grazing (Olea and San Miguel-Ayanz, 2006). Water use and interception by shrubs reduce soil moisture intensifying drought stress (Rolo and Moreno, 2019). This encroachment has also negative impact on plant diversity (Tárrega et al., 2009; Peco et al., 2012). A dense scrub cover seems to negatively affect some saproxylic beetle diversity metrics, such as species richness and abundance. A real scenario in which scrub density coverage is maintained below 20 % as occurs in areas with livestock grazing, beetle species richness and abundance increase by more than 7 % and 23 %, respectively, and consequently on the functions they perform (Micó et al. 2022). Lack of pollarding also dismisses the creation rate of important microhabitats for the conservation of forest biodiversity (Regnery et al., 2013; Müller et al., 2013; Micó, 2018).

In the Iberian Peninsula deciduous oak pollarding largely ceased during the 1960–70 in communal *dehesas* (Colangelo et al., 2024; Sanmiguel *et al.* 2024). As pollards get out of their turn (lapsed pollards), they develop large crowns. These trees are more prone to suffer branches breakages due to structural imbalance (Fig. 1), as well as more vulnerable to drought stress (Camarero et al., 2024), resulting in higher tree mortality (Read et al., 2013; Bengtsson et al., 2021; *Olano pers. obs.*). These synergistic effects of pruning cessation and climate change may co-occur with a new cohort of trees that is rapidly outgrowing pollards.

The importance of communal *dehesas* is enhanced by their current demise. Rural depopulation and steep changes in land use has altered the physiognomy of Western Mediterranean landscape, led to an abrupt increase in forest surface that has nearly doubled in less than a century (Valbuena-Carabaña et al., 2010). Forests are no longer scarce in most areas of Spain, and communal *dehesas* do not occur any more in a matrix of arable fields and pastures. In this spatial context, communal *dehesas* play a critical role as a future source of flora and fauna species associated with mature forests (Ramilo et al., 2017), particularly for species able to live across different forest types, thus facilitating their rapid expansion into these new forests (Piovesan et al., 2022). Preserving communal oak *dehesas* is thus critical to ensure novel forests' recolonization.

Although, there is a growing consensus on the high value of communal oak *dehesas*, no specific protection has been established. We lack even very basic knowledge: we do not know where they are, as a systematic inventory and cartography is missing. Currently, identifying the communal *dehesas* in a region requires intense survey in the field, interviewing local people and exploring historical aerial photographs. Positive signals are emerging, such as multiple singular initiatives to maintain or recover oak pollards management, but a larger framework is necessary to integrate all these efforts. Furthermore, these approaches need long-term persistence of the initiatives beyond the financing schemes of single projects. The time window to preserve all the values and information of communal woodlands is closing as lack of management increases oak pollards mortality (Colangelo et al., 2024). Moreover, the last generation of commoners who managed this ecosystem, and who have the memory and knowledge of how people were able to combine an intense use with the maintenance and enhancement of environmental values over more than a millennium, are also no longer among us. Meanwhile, the European Biodiversity Strategy for 2030 (P9_TA(2021)0277) emphasizes the conservation of mature forests, but the conservation of historical cultural landscapes with old trees does not have a clear instrument, beyond the protection of single monumental trees. The case of communal oak *dehesas* in Western Mediterranean is a clear example on how cultural landscapes may be critical for the preservation of mature forests biodiversity (Piovesan et al., 2022; Çolak et al., 2023). Preserving these ecosystems is necessary to satisfy the aims of the recently approved EU Restoration Law (EU 2024/1991). However, unless active conservation policies are urgently established, this ecosystem and the biodiversity they have preserved for centuries may be lost before they can accomplish their long-held mission of preserving old-growth forests biodiversity.

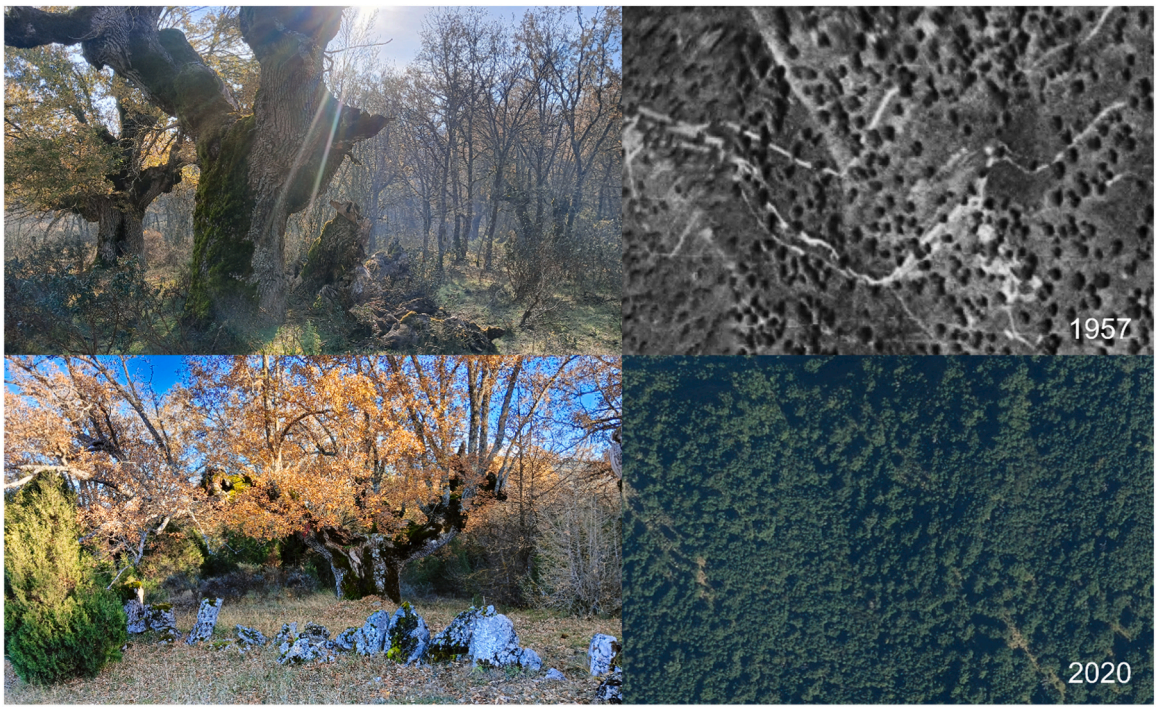

Fig. 1. Left upper, tree showing branch breakage and initial stages of forest closure in Mambrillas (Burgos, Spain); left bottom, stones showing the perimeter of the nearby dehesa of Hortigüela (Burgos, Spain) with tree showing signs of structural imbalance. Right, aerial photographs from up 1957 and bottom 2020 showing a dramatic forest encroachment in Terroba dehesa (La Rioja, Spain).

CRediT authorship contribution statement

J.M. Olano: Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing. **E. Micó:** Writing – review & editing. **C.J. Durà-Alemañ:** Writing – review & editing. **M. García-Hidalgo:** Writing – review & editing. **G. Sangüesa-Barreda:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

No data was used for the research described in the article.

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