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# The role of monumental trees for the preservation of saproxylic biodiversity: re-thinking their management in cultural landscapes

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## Abstract

Ancient trees present structural and functional characteristics fundamental for sustaining complex and unique assemblages of species. They are a resource globally threatened by both intensive land uses and lack of recruitment. Their disappearance would involve not only the loss of majestic organisms with high intrinsic value, but may also result in the disappearance of rare and endangered species. Italy is currently implementing a new list of noteworthy ancient trees (i.e. monumental trees) and the preliminary results of this new inventory have been analysed as a case study of a national initiative. The provisional list included 950 complete records, corresponding to 65 genera and 118 species. The most abundant species was *Quercus pubescens* Willd while the most common genera were *Quercus*, *Larix*, *Cedrus*, *Fagus* and *Platanus*. Age and size were the most used criteria for inclusion of trees in the census. The fundamental novelty of the new inventory is that it is based on a set of well-defined criteria of monumentality and that it clearly

recognised the ecological value of ancient trees. Preserving a tree for its ecological role requires a profound cultural shift. The value of microhabitats, structures that have historically been considered defects, should be recognised and managed accordingly. Ancient trees are often part of disappearing cultural landscapes: to preserve the richness and diversity of these habitats, new policies and regulations are needed. The preservation of landscapes, where there is still a high density of ancient trees, should be a priority for all European countries in order to conserve their unique associated fauna and for their irreplaceable functional value for biodiversity conservation.

**Keywords**
Ancient tree, deadwood, microhabitat, saproxylic, veteran tree

## Introduction

Ancient trees, historically preserved for their aesthetic value, are nowadays recognised as key resources that sustain broad and unique assemblages of species. Several names have been used to identify them, such as champion or heritage trees (Orłowski and Nowak 2007), large old trees (Lindenmayer et al. 2012), ancient trees (Hall and Bunce 2011) and veteran trees (Read 2000). With time, these trees may reach a biomass and complexity not achieved by any other living organism (Blicharska and Mikusiński 2014). Having long passed their silvicultural maturity, they tend to present special features that contribute to increasing their ecological value, such as cavities, decaying wood and bark losses (Siitonen and Ranius 2015). It is their age and size, together with the environmental conditions that occur where they live, which determine the occurrence of complex decay processes (Lindenmayer et al. 2014) and which lead to the development of a diversified array of microhabitats. Tree microhabitats are small distinctive substrates, used by several species for forage and shelter (Vuidot et al. 2011) and they are gaining increasing attention as indicators of sustainable forest management (e.g. FOREST EUROPE 2015). The contribution of ancient trees for the conservation of saproxylic species is unmatched since they present an exceptional diversity of microhabitats, some of which may last for centuries (Siitonen and Ranius 2015). The decline of old and hollow trees threatens the conservation of numerous endangered species (Sebek et al. 2013).

Even if, over time, ancient trees tend to accumulate decayed wood, it is important to stress that they "are not necessarily moribund" (Siitonen and Ranius 2015). As time passes, their anatomy tends to change to accommodate these structural alterations: with a process called retrenchment, the canopy becomes smaller and lower (Alexander 2001) and other self-optimisation mechanisms (see Mattheck and Kubler 1997) contribute to their stability and longevity.

They represent a charismatic element, appreciated for their majestic aesthetics and as a cultural heritage, which supports plentiful organisms of fungi, lichens, vertebrates and invertebrates (Alexander 2001; Alexander 2008). The biodiversity they host is unique: in landscapes where they are still well represented, they provide the habitat for rare and threatened species (Butler et al. 2001). Large old trees have been compared to islands, as they also show a species-area relationship, with larger trees hosting assem-

blages significantly richer and more numerous than smaller trees (Le Roux et al. 2015). In Europe, they tend to survive as part of different cultural landscapes, playing a key ecological role (Alexander, 1999). Old hunting forests, parks of manors and wood-pastures are amongst the places where ancient trees have managed to survive in Europe (Alexander 2001). Ancient trees are a component of silvopastoral systems, which encompass habitats including woodland and grassland at the same time, and show distinctive structures and species composition not generally found elsewhere (Bergmeier et al. 2010). Manning et al. (2006) argued that, considering the unequal effect large old scattered trees have on ecosystems and landscapes, irreplaceable by any other resource, the concept of "functional uniqueness" should be extended to these structures.

The first Italian law that has extended protection to ancient trees dates back to 1939 (Law n. 1497, 29/06/1939), but back then, they were included as "immovable things that have remarkable characteristics of natural beauty". A pioneering census was carried out in 1982: on the initiative of Italian Forest Service, more than 22,000 trees were recorded which resulted in the identification of 1,253 trees of noteworthy interest (Bortolotti 1989). A tree was included in this first census if it presented an exceptional size for its species, a peculiar shape, noteworthy aesthetic features or for its historical-cultural value (Lisa 2011). Numerous regional laws were issued afterwards to preserve monumental trees, but, to be effective, their management and conservation required unified regulations. To upscale the process from regional to national scale, Law n.10 14/01/2013 and Ministerial Decree 23/10/2014 were enacted to require that Municipalities undertake surveys and assess the status of monumental trees, according to predefined protocols. The purpose of the present study was to analyse the preliminary results of the new Italian inventory of monumental trees. To assess its progress, the abundance and distribution of the available records were compared with the data collected during the 1982 census. The obtained results, together with International literature, were used to make recommendations for the management of this rare and threatened resource.

## Methods

### Drafting of the Italian Inventory

The targets for the new Italian inventory of monumental trees were single trees, tree lines and shrubs with a remarkable development, belonging to both native and non-native species. Ministerial Decree 23/10/2014 identified seven criteria that should be met, jointly or alternatively (one criterion is sufficient), for the tree to be listed as monumental. These criteria are: 1. significant age and size (with species-specific trunk circumference thresholds); 2. peculiar shape (due to a tree living within its optimum ecological conditions, produced by climatic factors or subjected to human interventions); 3. ecological value (when the tree is the habitat of rare and/or endangered animal species, included in the Habitats Directive (92/43/EEC) and/or Red Lists); 4. botanic rarity (considering both exotic and locally rare species); 5. plant architecture

(single trees or small groups that are an integral part of architectural elements); 6. landscape value (trees that are distinctive elements, with toponymy value or historic continuity) and 7. historic-cultural-religious aspects (trees that contribute to the sense of belonging and recognisability of a place, memory of historic events, traditions, religious reference, legends etc.).

Law n.10 14/01/2013 established that municipalities should assess monumental trees present in their territory, with the support of the Forest Service. Specific training was organised for the personnel involved in this assessment. The field surveys were performed by 1-2 people, in urban areas, forests and agricultural areas as well. During the surveys, a specifically designed identification sheet was completed with data on the location, taxonomy, structure, status, required interventions and a brief description of the reasons why the tree or shrub should be considered monumental and according to which criteria. All this information, together with the photographs of the tree or shrub, was passed to the regional authority for approval or rejection. The approved records were then transferred to the Ministry of Agricultural, Food and Forestry Policies for their inclusion in the national list of monumental trees.

### Data analysis

To evaluate the progress of the new inventory, it was compared to the data gathered in the1982 survey by the Forest Service. The 1982 database is available on the webpage of Italian Monumental Trees (http://www.corpoforestale.it/Alberi_Monumentali) while the preliminary results of the new inventory are stored in a specifically designed geoportal (Geoalberimonumentali) with restricted access. For the analysis, data were downloaded from the geoportal on 17/02/2017 and included trees and shrubs recorded from 11/06/2014 to 15/02/2017. Only records with no missing fields were included in the analyses. If a species was included in the database using several synonyms, its taxonomy was rationalised using the freely available working list "The Plant List" (http://www.theplantlist.org/).

## Results

The provisional list of the new Italian census of monumental trees included 950 complete records. Compared to the 1982 inventory, the former comprised a higher number of trees (1,253) which were more uniformly distributed across the country (Figure 1). During the 1982 survey, a total of 143 species belonging to 75 genera were recorded while the provisional 2017 list included 118 species belonging to 66 genera (Suppl. material 1). In both inventories, the large majority of the species were Angiosperms (65% and 71% respectively).

The most recorded genera changed geographically and through time: while the 60% of the trees included in the 1982 list belonged to *Quercus*, *Fagus*, *Cedrus*, *Castanea* and

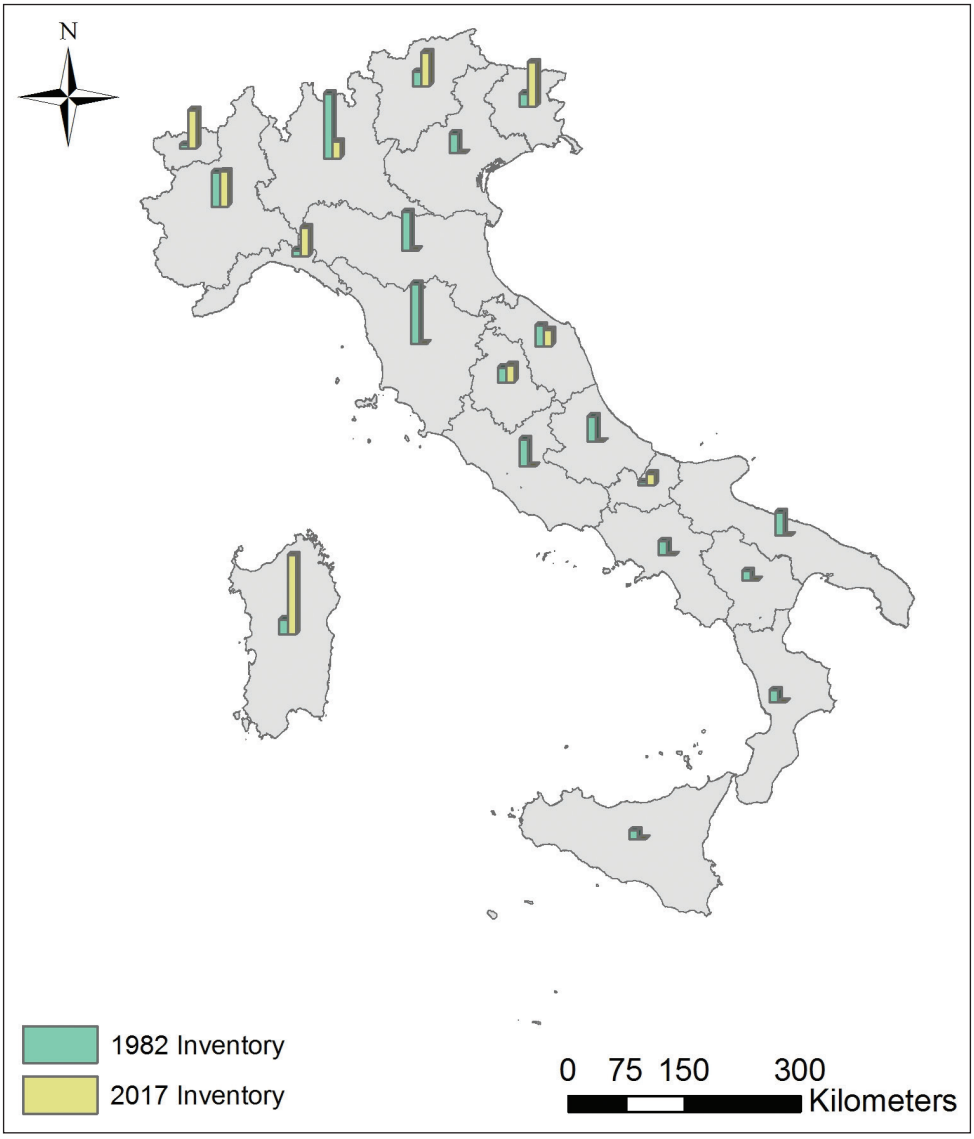


**Figure 1.** Number of trees recorded during the two inventories (1982 and 2017) in the different Italian regions.

*Pinus*, the vast majority of the trees in the 2017 list trees belonged to *Quercus*, *Larix*, *Cedrus*, *Fagus* and *Platanus* (Figure 2). The most abundant species was *Quercus pubescens* Willd in both lists, followed by *Fagus sylvatica* L. in 1982 and by *Larix decidua* Mill. in 2017. Although the highest recorded species were trees, the percentage of included shrubs significantly increased from 1982 to 2017 from 4% to 6% ($X^2$ = 13.369, df = 1, p-value = 0.0003). Both lists included invasive alien species: *Ailanthus altissima* (Mill.), Swingle (in the 1982 list) and *Robinia pseudoacacia* L. (in the 2017 list).

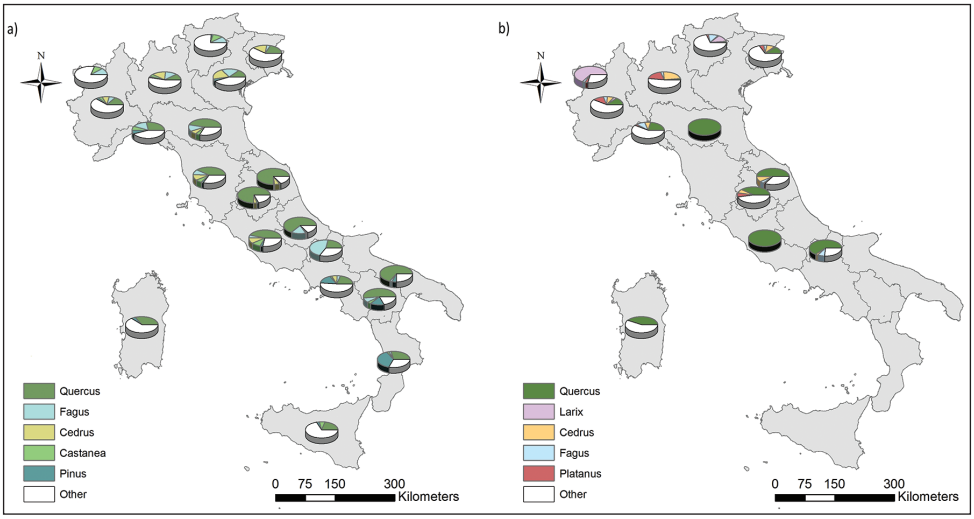


**Figure 2.** Distribution of the most abundant genera included in the a) 1982 inventory and b) 2017 inventory.

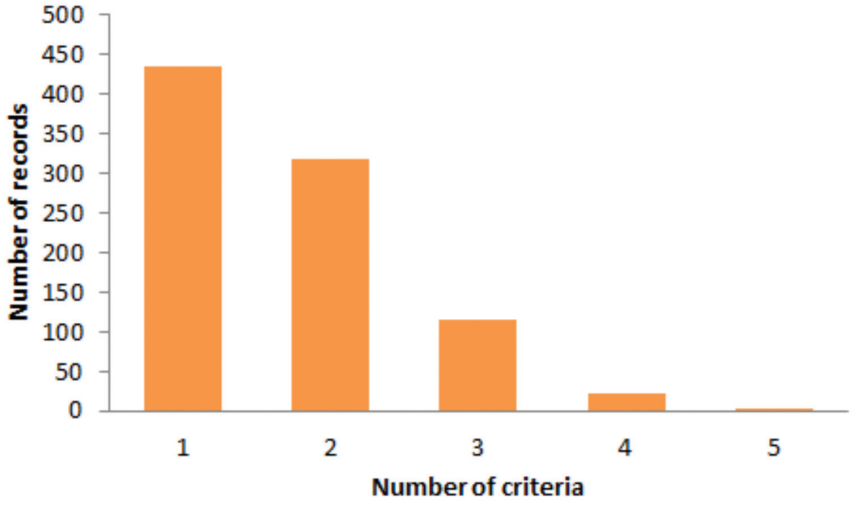


**Figure 3.** Number of criteria associated with each record in the 2017 inventory.

The highest number of records (49%) was included in the 2017 provisional list by applying just one criterion (Figure 3) and for 94%, the criterion for inclusion was the age and size of the tree. Alone or together with other criteria, age and size were associated with 95% of the records. The ecological value was assigned to 9% of the records, in association with age and size (always) and other criteria. Since the definition of the criteria is only part of the 2017 inventory, the corresponding data for the 1982 list was not available.

## Discussion

The new inventory compared with the previous one showed two fundamental improvements. First, it is based on a set of well-defined criteria of monumentality. Second, the ecological value of ancient trees for preserving rare associated saproxylic species and other animals which are strictly dependent on the availability of tree microhabitats, is explicitly stated. Compared to the other criteria, preserving a tree for its ecological role requires a profound cultural shift. The value of microhabitats, structures that have historically been considered defects, should be recognised and managed accordingly. Even if the percentage of trees listed as monumental for this criterion was low in the provisional list, it represents an encouraging starting point.

The provisional list showed a very heterogeneous distribution of the records across the country, suggesting that, compared with the previous census, there were factors affecting data gathering. In particular, considering that, according to the new law, the survey must be implemented by municipalities, the process may be suffering from the varied enthusiasm and participation of local authorities. The central coordination of the 1982 census by the Forest Service has probably played a key role in standardising the geographic reach of the survey at the national scale. Nevertheless, considering that the analysed data are part of an ongoing process, the number of records from less active regions will hopefully increase with time.

Several exotic trees were part of the preliminary list of monumental trees, such as *Liriodendron tulipifera* L.(n=8), *Sequoiadendron giganteum* (Lindl.) J.Buchholz (n=40), *Styphnolobium japonicum* (L.) Schott (n=6). However, the inclusion of invasive alien species amongst non-native species should be carefully evaluated: both surveys included species considered to be amongst the 100 most invasive alien species recorded in Europe (DAISIE 2009). These species are controlled or removed according to other frameworks and their preservation as monuments may be counterproductive (e.g. protecting a tree whose seedlings should be actively eliminated). International approaches (e.g. DAISE, 2009) could be used to guide the inclusion/exclusion of problematic species.

The records included in both lists and the current management suggest that the situation it Italy is similar to that which has been observed elsewhere: ancient trees are too often the remnants of long-abandoned traditions. Two of the main threats responsible for their loss in agricultural landscapes are land use intensification and the disappearance of traditional management (Siitonen and Ranius 2015). Actions that should be taken to reverse this process are summarised below.

### Restore traditional management to conserve and increasancient trees

Pollarding is one of the three pathways identified by Read (2000) for the creation of ancient trees. The slowed growth of the trunk due to pollarding, together with the small resulting canopy, protects these trees from wind damage, contributing to their longevity (Hartel et al. 2015). Moreover, pollarding greatly increases the probability

of hollow formation (Sebek et al. 2013), providing a microhabitat that hosts complex and specialised communities of species. The interruption of the traditional pruning of pollards compromises not only recruitment but also the survival of the trees that have managed to outlive abandonment. Without intervention, the rate of loss of pollard trees may be dramatic, since the uncut branches tend to become large and compromise tree stability (Dagley et al. 2001, Cantero et al. 2014).

Wood-pastures are facing similar abandonment issues and inaction cannot be a successful strategy to retain and restore large old trees in agricultural landscapes. Several factors threaten the perpetuation of wood-pastures: structural simplification, the disappearance of large old trees and land-use policies that do not recognise their multifunctional nature (Hartel et al. 2015). To preserve and restore the biodiversity of these environments, the relationship between large herbivores and vegetation must be reinstated (Vera 2000). As these cultural landscapes rely on haymaking and livestock grazing to free veteran trees from competitors, the re-establishment of the traditional style of management represents the way forward (Siitonen and Ranius 2015). Even sanctuaries such as Fontainebleau and Białowieża are suffering from a minimum intervention regime: the lack of grazing has contributed to a shift towards a high forest structure with canopies too close to allow the replacement of the large old oak trees (Butler et al. 2001).

It is through both abandonment and intensification, changing from multifunctional to mono-functional land-uses (Hartel et al. 2015), that the loss of cultural landscapes, fundamental for the provision of monumental trees can be observed. In northern Italy, it was once common to pollard mulberry trees (*Morus alba* L., *M. nigra* L.) for silkworm breeding and, at the beginning of the 20$^{th}$ century, this farming system covered 289,000 hectares (Sereni, 1976). Remaining lines of old pollarded mulberry trees along canals and field borders may suggest the presence of these old plantations (Figure 4). Their rarefaction, fragmentation and lack of regeneration threaten the survival of endangered saproxylic beetles, such as *Osmoderma eremita* (Scopoli, 1763) which managed to survive in agricultural areas due to the microhabitats present in these trees (Corezzola et al. 2012). Even if ancient trees should be preserved as the habitat for endangered saproxylic species included in the Annexes II and IV of the Habitats Directive, specific regulations for the heterogeneous environments where these trees occur are currently lacking. Wood pastures and, in general, mosaic habitats, tend to be neglected in both the Habitats Directive and the Natura 2000 network (Alexander, 2016). Annex I of the Habitats Directive (1992) includes only a few typologies of wooded pastures present in Europe (e.g. 9070 Fennoscandian wooded pastures) and as forest habitats. Cultural landscapes, not listed amongst these few (such as pollarded mulberry fields), are generally managed as agricultural areas and land owners are allowed to cut trees without facing the strict regulations of forest habitats. To conserve the diversity of European wooded pastures *sensu lato*, it is thus essential to design specific categories, currently missing from Annex I, evaluating their status and extent (Bergmeier et al. 2010).

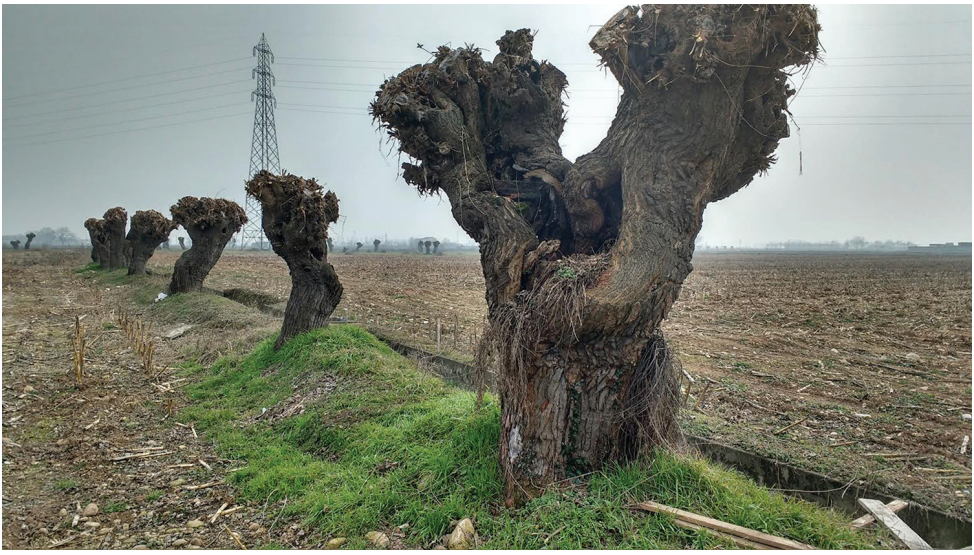

**Figure 4.** Lines of pollarded mulberry trees (*Morus* spp.) in the Po river plane, Italy. The pollarded trees present evident large stem cavities due to the pruning of the upper branches. Photo by F. Mason.

Simulations by Gibbons et al. (2008) suggest that recruitment events, taking place every 30–90 years, would ensure the temporal continuity of ancient trees in agricultural landscapes. The long time span proposed by the authors allows adjusting recruitment to the most cost-effective timing. Every intervention that alters the environmental conditions of ancient trees should be carried out cautiously. For example, Dagley et al. (2001) indicated that clearing the vegetation around an ancient tree should be a gradual process, not to increase wind-throw susceptibility. Precise guidelines of good management should be provided to tree owners and managers (see Read 2000 and Lonsdale 2013).

## From single trees to landscapes

Conserving veteran trees through time and space may represent the basis for establishing new networks, diffusing genetically valuable saplings originated from local large old trees and restoring natural corridors such as riparian areas (Orłowski and Nowak 2007). For instance, pollarding trees growing along linear elements could support the creation of stepping stones re-connecting refugia of saproxylic species (Sebek et al. 2013).

## Coordinating national initiatives: a call for a common European platform

The provisional results suggest the importance of centralised rather than localised (i.e. relying on regional authorities rather than on municipalities) management systems for

the success of the process. The Italian census of monumental trees is just one of the initiatives developed in Europe to monitor and preserve ancient trees. While surveying methods for ancient trees are similar across European countries, the definition of what constitutes a monumental tree varies (Lisa 2011). A common European platform could represent the basis for more effective recognition of the importance of cultural habitats and their associated ancient trees. The preservation of open-grown trees and the re-establishment of traditional management (e.g. through the creation of new pollards) should not just be target of single management plans (e.g. Dagley et al. 2001) but be part of an international strategy to preserve European cultural landscapes and their key features.

## Conclusions

Ancient trees are declining in forests worldwide (Lindenmayer et al. 2012) and their disappearance will affect ecosystem processes along with the persistence of numerous species (Lindenmayer et al. 2014).The consumption of natural resources has been threatening the survival of these living monuments (Rigoni Stern 1990) for decades. To prevent the disappearance of ancient trees in cultural landscapes, new policies are needed, with unique temporal (centuries) and spatial (landscapes) reach (Lindenmayer et al. 2014) which require the implementation of traditional management (Butler et al. 2001). Considering the time-lag for their development, these new policies are needed now, otherwise we will have to face an unprecedented temporal discontinuity of a resource fundamental for biodiversity conservation. The preservation of landscapes, where there is still a high density of ancient trees, should be a priority (Siitonen and Ranius 2015) for all countries, for the unique associated fauna and for their intrinsic value.

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## Supplementary material 1

**List of recorded species**

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Data type: Adobe PDF file

Explanation note: The supplementary material contains the list of species recorded during the 1982 and 2017 inventories, showing for each species: number of individuals, average circunference and average height.



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