Co-funded by the European Union

Milestone 8

Impact of conservation actions

Brief report

WP7 - Monitoring and evaluation

Responsible beneficiary: CNR – Consiglio Nazionale delle Ricerche
Supporting beneficiaries: DREAM Italia, CNPF, EKBY, FORESTAS
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Version (date): 30/07/2025

Table of contents

Summary

To monitor the impact of the conservation actions planned in the different target habitats (WP4), surveys were conducted to evaluate the forest structure, presence of deadwood and tree microhabitats, before the implementation of such actions. This report summarises the ex-ante status, evaluated before silvicultural activities had taken place. The recorded data will be used in the ex-post evaluation, which will be performed after the completion of the conservation actions.

Introduction

Forest structure refers to the spatial and functional arrangement of biophysical elements within the three-dimensional framework of forest ecosystems. It both influences and reflects ecosystem processes and biological diversity (Gadow et al., 2012), making it fundamental to understanding the past, present, and future dynamics of forests (Spies, 1998). Comprehensive information on tree species composition, their hierarchical positioning, and the presence of deadwood is essential to monitor the effect of the project conservation actions.

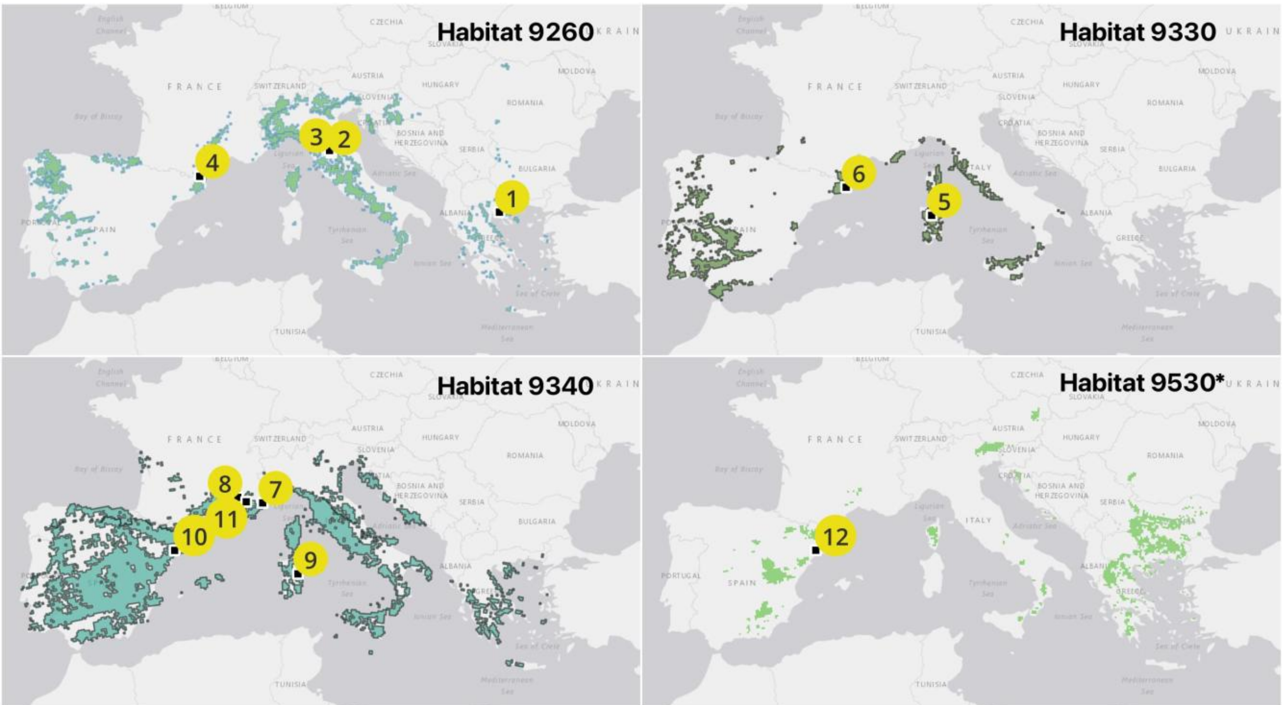

Figure 1. Distribution of the four habitat types (European Environment Agency, 2020) and location of the twelve sites included in the project. 01) Chortiatis (GR), 02) Pratomagno (IT), 03) S. Antonio (IT), 04) Muntanya de les Salines (ES), 05) Goceano (IT), 06) Pla de Castell (ES), 07) Préalpes de Grasse (FR), 08) Massif du Luberon (FR), 09) Montes (IT), 10) Bosc de Poblet (ES), 11) Valensole (FR), 12) Plans i Baridana (ES).

The distribution of trees with varying diameters, shaped by natural processes of growth and mortality over time and space, constitutes forest structure—an ecologically significant characteristic of forest communities. Numerous methodologies exist to characterize forest structure, including classifications based on developmental stages (Valbuena et al., 2016), growth and mortality patterns (Coomes and Allen, 2007), stand ecology (O'Hara et al., 1996), and diameter distributions (Linder et al., 1997).

Habitat trees, which contain at least one tree-related microhabitat (Bütler et al., 2020), provide essential ecological niches for numerous specialized species (Larrieu et al., 2018). These microhabitats, including cavities, crevices, and other morphological features, serve as breeding, feeding, or sheltering sites. In managed forests, premature harvesting often prevents the formation of such features. To enhance biodiversity and forest resilience, it is vital to identify, preserve, and promote these microhabitats through appropriate management strategies.

Deadwood is a key component of structural complexity and a key resource that supports the preservation of roughly 30% of forest-dwelling species (Stokland et al., 2012). Tree-related microhabitats (hereafter referred to as TreMs) have also been identified as key features for forest biodiversity (Larrieu et al., 2018) which support also species not directly associated with deadwood (Stokland et al., 2012).

Methods

Field surveys were conducted on 72 plots, distributed in the twelve forests sites included in the project (Fig. 1). Such 72 plots were distributed in order to include both the Island for Biodiversity (IBs) and the edge areas.

In the plots, designated under Task T2.1, data on indirect biodiversity indicators (i.e., structure and TreMs) and direct biodiversity indicators (i.e., saproxylic species, vascular plants, epiphytic lichens, phytophagous arthropods, birds and bats) were collected. Such data will be used quantify the effect of the conservation actions (WP4).

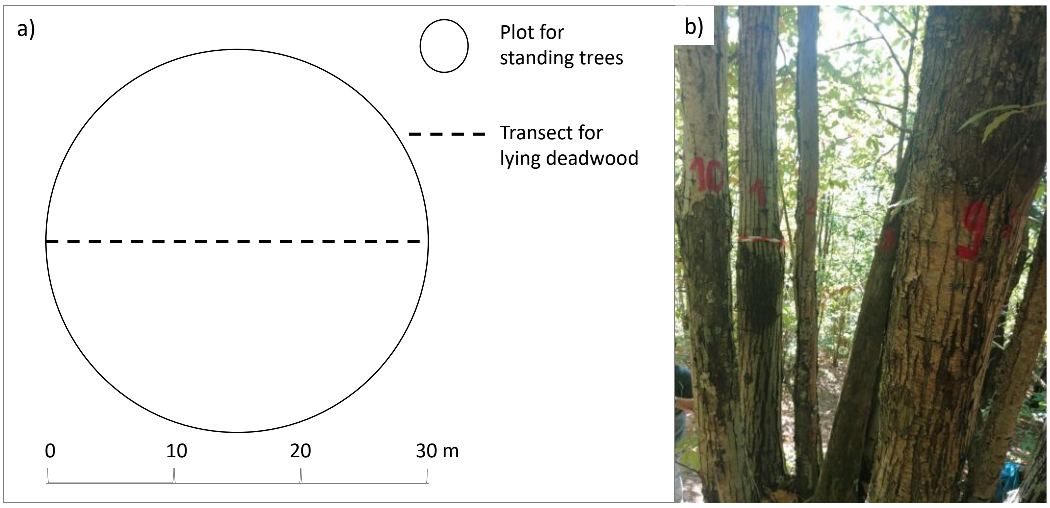

Figure 2. Plot design: a) sampling unit used for standing trees, tree microhabitats and lying deadwood; b) central tree with band and tree numbering.

For biodiversity data, see Milestone 1 “Validation of biodiversity indicators TreMs-related”. Forest structure measurements and tree microhabitat assessment was performed inside circular projected areas of 706.5 m2 (15 m radius), centred on the survey plots of Task 2.1 (Figure 2). The centres of the plots were identified in the field by a red and white stripe on the central tree. Inside each plot, the measured trees, snags and stumps were numbered using enamel paint, to enable future comparisons. Inside each sampling plot, the diameter at breast height (DBH), defined as 1.35 m up from the highest point of ground at the tree's base, was measured on living and dead standing trees with a diameter > 7.5 cm. For a subsample of 20% (representative of the DBH distribution of the plot), tree height was measured as well.

For each standing tree (live and dead), the surveyors reported the species, the tree type (high tree, coppice stool, standard), and the social position (dominant, co-dominant, intermediate, suppressed; Figure 3). In case of dead standing tree, a decay class was assigned. Inside each sampling plot, snags (diameter > 10 cm, height > 1.3 m) and stumps (diameter > 10 cm, height <1.3 m) were inventoried. For both deadwood types, species and the decay class were assigned.

Each standing tree was inspected to record the presence of tree-related microhabitats (TreMs). For their description and size limits we followed Bütler et al (2020), considering seven macro-categories:

1. Cavities: Woodpecker breeding cavities; Rot-holes; Insect galleries; Concavities.
2. Tree injuries and exposed wood: Exposed sapwood only; Exposed sapwood and heartwood.
3. Crown deadwood
4. Excrescences: Twig tangles; Burrs and cankers.
5. Fruiting bodies of saproxylic fungi and slime moulds: Perennial fungal fruiting bodies; Ephemeral fungal fruiting bodies and slime moulds.
6. Epiphytic and epixylic structures: Epiphytic and parasitic crypto- and phanerogams; Nests; Microsoils.
7. Exudates: Fresh exudates.

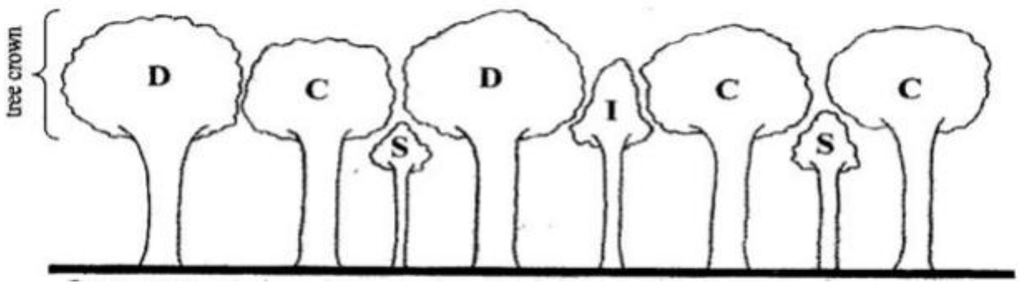

Figure 3. Tree social position: D= dominant, C= Co-dominant, I= intermediate, S=suppressed**.**

Results

Management differed across sites and the habitat types. The most common silvicultural system was coppice, which was historically applied in habitat types 9260, 9330 and 9340. Indeed, coppice management has a long history in the Mediterranean region, dating back to ancient times when it was widely used to provide fuelwood, charcoal, and small timber for construction and tools. Coppicing was a key component of rural economies, supporting domestic energy needs and industries. However, the decline of wood as an energy source and rural depopulation in the 20th century led to the widespread abandonment of coppice forests, many of which have since evolved into high forest or dense shrublands.

Habitat type	Site	Current silvicultural system	Most common regeneration method	Last silvicultural intervention
9260	Chortiatis (GR)	Coppice, selection	Coppice	Uneven-aged entry
	Pratomagno (IT)	Coppice with standards	Coppice and mixed natural regeneration coppice	Even-aged final harvest
	S. Antonio (IT)	High forest, selection and unmanaged	Mixed natural regeneration coppice	Even-aged final harvest
	Muntanya de les Salines (ES)	Coppice, unmanaged	Mixed natural regeneration coppice	Uneven-aged entry
9330	Goceano (IT)	High forest, unmanaged	Mixed natural regeneration coppice	Even-aged final harvest
	Pla de Castell (ES)	High forest, unmanaged	Mixed natural regeneration coppice	Uneven-aged entry
9340	Préalpes de Grasse (FR)	Coppice with standards, high forest unmanaged	Coppice and mixed natural regeneration coppice	Even-aged final harvest
	Massif du Luberon (FR)	Coppice, unmanaged	Coppice	Even-aged final harvest
	Montes (IT)	High forest, selection	Mixed natural regeneration coppice	Even-aged final harvest, even-aged intermediate cutting, uneven-aged entry
	Bosc de Poblet (ES)	Coppice, unmanaged	Mixed natural regeneration coppice	Uneven-aged entry
	Valensole (FR)	Coppice, simple and unmanaged	Coppice	Even-aged final harvest
9530*	Plans i Baridana (ES)	High forest, shelterwood	Natural regeneration	Even-aged intermediate cutting

Table 1. Summary of forest management in the GoProFor Med project areas.

A total 7,374 trees (living and dead), belonging to 42 species were inventoried. An extract of the average structural collected are listed in Tab. 2. We recorded 6,750 TreMs in total, all the 47 types were observed at least once (Fig. 4).

Today, Mediterranean coppices still cover vast areas and are increasingly valued for biodiversity conservation, and biomass energy, although their management faces challenges from climate change. Chestnut stands, which in Italy were devoted to fruit production, are under threat by

Phytophthora diseases and are evolving towards thermophilic mixed stands. The management of olm oak was mainly under the coppice system, but some areas of Montes (Italy) showed the characteristics of old growth stands, with high amount of deadwood and ancient trees. The cork oak management is mainly under the coppice system, and in some areas is focused on the production of cork, which is an important production for the local population. In the project sites, alongside traditional coppice systems, forest managers have recently promoted uneven-aged management approaches to enhance structural diversity and ecological resilience (Tab. 1). The black pine stands of the habitat 9530* are mainly even aged plantations and are managed under shelterwood system.

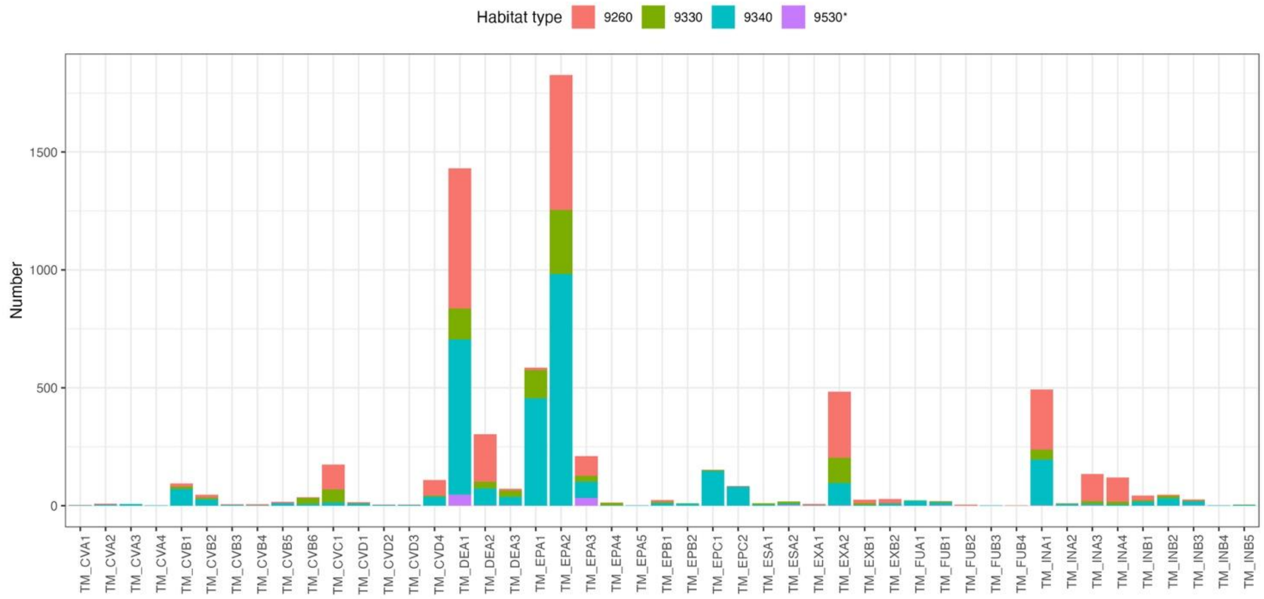

Figure 4. Total number of recorded TreMs per habitat type.

Approximately, half (54%) of sampled trees showed at least one TreM (Fig. 4). In the four studied habitat types, the dominant tree species hosted the majority of the TreMs, with a significant contribution of two other species: *Q. pubescens* in cork and holm oak forests; *P. sylvestris* in Mediterranean pine forests (Tab. 3). Cavities, burrs, cankers, and fungi fruiting bodies were in general very scarce. Woodpecker cavities were particularly sporadic, and the "flute" (CVA4) was recorded only twice, on very large trees (DBH>90 cm).

While the combination of most abundant TreMs changed with the habitat type, the presence of dead branches and epiphytic species was ubiquitous (Tab. 3). In general, large diameter classes (DBH > 50cm) were only observed for living trees, as a conquence, the recorded TreM-diversity was higher for living trees (with exception of cork oak forests), and no dead trees bearing TreMs were recorded in pine forests (Fig. 5).

Habitat type	Site	DBH (cm)	Height (cm)	Numb. species	Living trees BA (cm)	Total deadwood (m^3)	Numb. decay classes
9260	Chortiatis (GR)	13.7	13.0	1.5	32.5	72.7	4.5
	Pratomagno (IT)	18.4	10.0	2.8	49.3	67.4	2.7
	S. Antonio (IT)	20.4	13.8	4.2	31.0	122.2	3.3
	Muntanya de les Salines (ES)	21.3	14.3	5.2	53.3	84.3	3.2
9330	Goceano (IT)	21.3	7.4	3.0	41.9	5.6	1.3
	Pla de Castell (ES)	17.8	7.3	4.7	25.6	7.0	2.8
9340	Préalpes de Grasse (FR)	13.7	6.6	1.8	54.5	3.8	1.7
	Massif du Luberon (FR)	12.0	7.2	3.3	30.6	5.2	3.2
	Montes (IT)	23.2	11.8	2.3	54.2	53.5	2.5
	Bosc de Poblet (ES)	16.7	8.2	4.2	43.2	24.2	3.2
	Valensole (FR)	12.2	5.9	3.9	28.1	14.9	2.7
9530*	Plans i Baridana (ES)	25.1	13.3	2.7	36.5	15.2	2.2

Table 2. Average structural data for the twelve forest sites. BA: basal area, DBH: diameter at breast height.

Habitat type	TreMs	Average alpha-diversity: total (living/ dead trees)	Average gamma-diversity (std. Dev.)	Tree species with trems	Dominant tree species
9260	Dead branches (23%), Foliose and fruticose lichens (22%), Epicormic shoots (11%), Bark loss (10%)	1.00 (1.02/0.95)	10.29 (4.09)	*Castanea sativa* (95%)	*C. sativa* (86%), *Ostrya carpinifolia* (3%), *Ilex aquifolium* (3%)
9330	Foliose and fruticose lichens (28%), Dead branches (14%), Bryophytes (mosses and liverworts) (12%), Epicormic shoots (11%)	1.19 (1.19/1.26)	12.42 (5.09)	*Quercus suber* (79%), *Q. pubescens* (10%)	*Q. suber* (67%), *Q. ilex* (19%), *Q. pubescens* (8%)
9340	Foliose and fruticose lichens (31%), Dead branches (21%), Bryophytes (mosses and liverworts) (14%)	0.85 (0.87/0.39)	10.77 (4.49)	*Quercus ilex* (72%), *Q. pubescens* (23%)	*Q. ilex* (78%), *Q. pubescens* (15%)
9530*	Dead branches (52%), Ivy and lianas (woody vines) (36%)	0.33 (0.34/0.00)	3.5 (1.97)	*Pinus nigra* (57%), *P. sylvestris* (26%)	*P. nigra* (63%), *Q. ilex* (15%), *P. sylvestris* (12%)

Table 3. Summary of recorded TreMs, a-diversity (TreM diversity per tree), main tree species showing TreMs and dominant species recorded for the four habitat types.

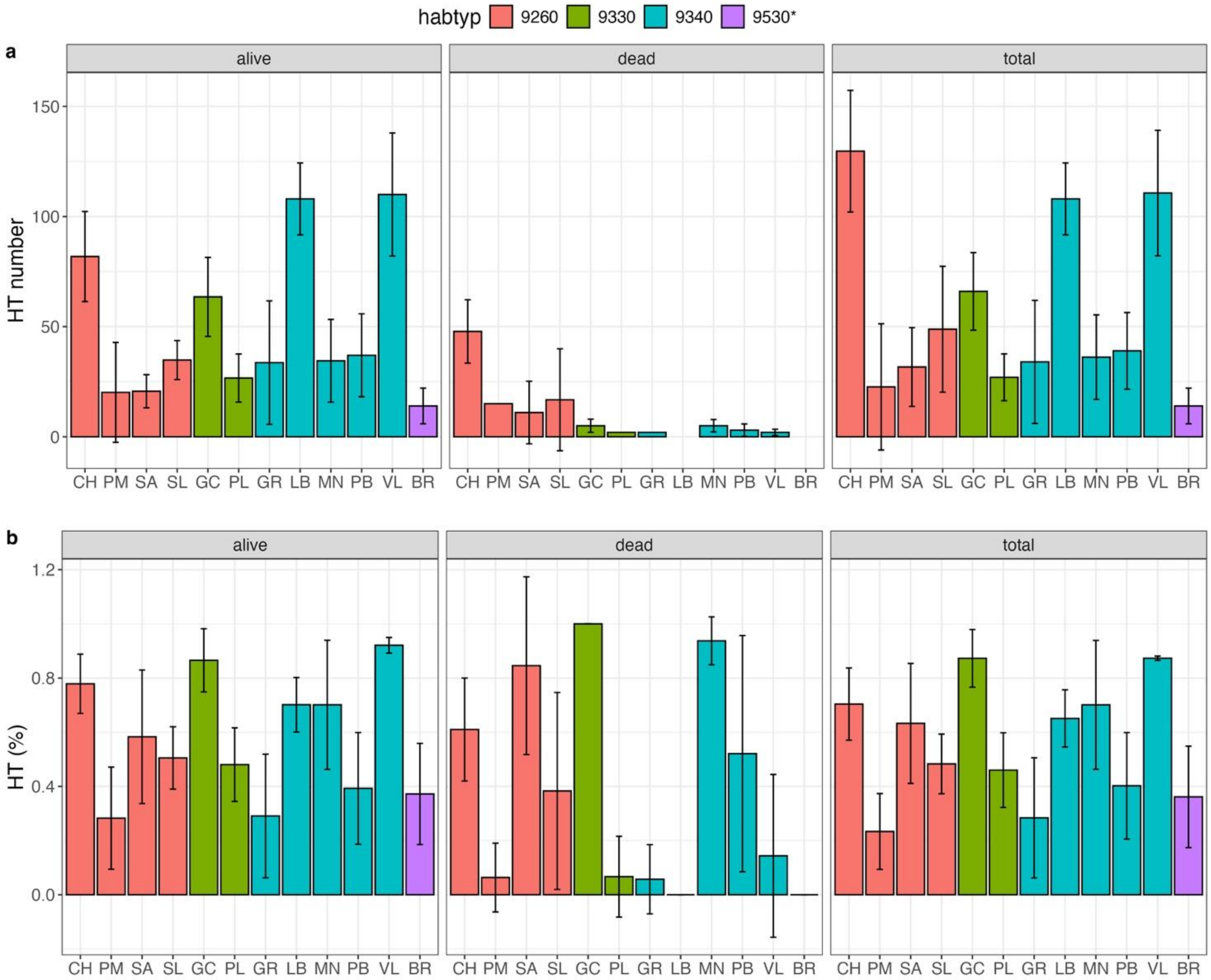

Figure 5. Habitat trees (i.e., trees with at least one TreM) occurrence in the different sites, according to the tree status (dead, alive or total): a) number of habitat trees per site (average and standard deviation); b) percentage of habitat trees per site (i.e., ratio between number of recorded habitat trees and total number of recorded trees). CH – Chortiatis (GR), PM – Pratomagno (IT), SA - S. Antonio (IT), SL - Muntanya de les Salines (ES), GC – Goceano (IT), PL - Pla de Castell (ES), GR - Préalpes de Grasse (FR), LB - Massif du Luberon (FR), MN – Montes (IT), PB - Bosc de Poblet (ES), VL – Valensole (FR), BR - Plans i Baridana (ES).

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