Martelloscopi PProSpoT

Virtual tree marking areas for professional training

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Three virtual tree marking areas have been created to be included in the LIFE + PProSpoT project in order to train forestry students and experts to be confident with tree-oriented silviculture techniques for preserving or favoring sporadic tree species. This paper introduces these new tools, describing how they were developed and why.

In the Tuscan forests, as in the rest of Italy and in other European countries, there are numerically dominant species of trees and less frequent species, called "sporadic." Sporadic occurrence may depend on the following factors:

- characteristics of the species which make it unable to create stands, despite belonging to the dominant species;
- silvicultural treatments that do not consider the ecological needs of the species;
- both the aforementioned factors.

The LIFE + PProSpoT project [LIFE09 ENV / IT/000087] aims to protect and enhance sporadic tree species through tree-oriented silviculture. The Tuscany Regional Administration, partner in the project, preserves 23 sporadic species as regulated by a specific article of the Regional Forest Law. All these species are important to biodiversity, but some are also a source of valuable timber (for example cherry, maple, ash and the genus *Sorbus*).

For all these reasons, related both to productive and environmental aspects, the LIFE + PProSpoT project's objective is to better manage the plants of these species by targeted and localized interventions, not only to preserve them, but also to increase their presence and, at the same time, increase the ecological and economic value of the forests. Targeted cultural practices, which favor optimal development both from an ecological and productive point of view, can be a very interesting investment for forest owners and, in general, for society. Of course it takes time to achieve tangible results because of the risks and uncertainties of the timber market and the forest-wood chain typical of Italy.

A forest training session organized within LIFE+ PProSpoT project.

In European countries such as France and Germany, for decades tree-oriented silviculture has been applied to meet the ecological requirements of tree species, even those that are numerically dominant. This approach is characterized by silvicultural interventions aimed to enable a balanced and rapid development of single target trees. The interventions are from above and localized around the plants in order to gradually eliminate the surrounding competition.

Depending on the purpose, whether to preserve biodiversity alone or to protect biodiversity and produce valuable timber, the target plants are chosen using differing criteria. In the first case, to be successful, it is important to select individual trees (or groups of plants) that are vigo-

rous and not in a stage of weakening. When the goal is biodiversity and production, the target trees should be chosen taking into account species (e.g., regulating specific forest composition), vigor, crown and stem shape, position of the plant in relation to other selected target trees.

To be able to correctly select target plants requires skills that are not currently part of the heritage of knowledge of Italian technicians and experts. Consequently, part of the PProSpoT project has been dedicated to training, creating a "martelloscopio" (virtual tree marking area) to allows students hands-on practical training in the forest so that they may become confident with the principles and intervention choices of tree-oriented silviculture for sporadic species.

Martelloscopi

What's a "martelloscopio"?

A martelloscopio is a training area located in the forest where experts and forestry technicians may practice a virtual tree marking and, during the same day, observe the following aspects:

- graphical representation of the stand before and after the realization of the single silvicultural intervention;
- intensity of intervention on the individual species;
- variations in the tree species stand composition.

Each tree is assigned a number. The people involved in the tree-marking simulation simply write down the numbers of the plants that, according to their opinion, should be felled. A software system (SVS - Stand Visualization System[(1)]) provides a 3D graphic depiction of the stand model before and after intervention, in terms of composition and structure, by excluding data related to felled trees.

The use of a virtual tree marking area to train students and technicians is already widespread in many European countries. Until now, these tools have depicted only high forest stands, often conifer forests. In Italy, to our knowledge, these software systems have been created for forests in South Tyrol, but they have never been realized for Apennine forests and, more importantly, for coppices.

How to create a "martelloscopio"?

From a practical point of view, to create a tree population model, it is necessary to be familiar with the tree species and know some dendrometric parameters and the tree coordinates in relation to a known point.

The dendrometric parameters that must be collected for each plant are the following:

- species;
- diameter at breast height (1,30 m);
- height;
- crown insertion height;
- crown radius taken in 4 directions, at 90° to each other;

Each tree, at the time of measurement, must be marked with a progressive number. Then, using the software, a crown shape and a characteristic color for each species is selected. All data from each area are collected and inserted into a spreadsheet. At this point, it is possible to:

- insert the entire tree component into the software model, resulting in a virtual representation of a stand reality;
- remove individual spreadsheet lines corresponding to the marked trees in order to show variation in stand structure after silvicultural intervention;
- quantitatively calculate the hypothetical felling of trees

Life + PProSpoT virtual tree marking areas

Due to the training requirements typical of tree-oriented silviculture, the choice of areas and forest wood types were carefully conducted.

When the purpose of silvicultural interventions is only biodiversity preservation, it is not necessary to distinguish development stages of the plants, but merely to improve crown illumination of the more vigorous sporadic species trees to encourage fruiting. In this case, weak or shaded plants (thus those unable to react to new light conditions) are not taken in account.

But when the goal is double, biodiversity protection and timber production, intervention varies according to both tree development stage and stand characteristics

The two important development phases to distinguish when the objective is twofold are:

- Qualifying stage. The purpose is to encourage the development of a straight stem without branches for a length at least equal to the minimum necessary to reach higher market standards (for example, for veneer, 250 cm). In this phase, the smaller the central cylinder (where knots are present) and the smaller the diameter of the knots, the higher the value. In the qualifying stage, the crown of the target plant should be strongly compressed by its surroundings so as to force development in height to reach and surpass the stand canopy layer. Silvicultural interventions must essentially promote apical dominance and free growth of the stem. In this stage, trees or branches that can mechanically damage or shade the apex of selected target plants must be removed.
- Dimensioning stage. Starting when the plant has reached the minimum stem length and is free of branches, as required by the market (or desired by the silviculturist, which means, at most, ½ the final height, or, even better, 1/3 or ¼ the final height). In this phase, the purpose is to obtain maximum diameter growth, as constant as possible. During this stage, the silviculturist should use localized thinning from above to maintain that the crown is well lit and safe from mechanical damage by surrounding competitors, in case of strong winds.

The forest types present in the areas involved in the project (Colline Metallifere, Grosseto province and Appennino Pistoiese, Pistoia province) are as follows:

- Young high forests
- Adult high forests
- Young coppices
- Aged coppices.

Considering the different characteristics of the areas involved in the project, the development stages of the potential target plants and training needs, three areas were selected to realize three different "martelloscopi", including a total surface area of 2.1 ha.

The characteristics of the three virtual tree marking areas are here described.

Martelloscopio 1 - High forest (Figure 1, Table 1). Located in the Appennino Pistoiese, close to Abetone it covers an area of 10,800 m^2. This is a heterogeneous area, originally a beech and silver fir high forest where artificial regeneration was spread inconsistently throughout. Nowadays it is partly a beech mature high forest and partly a mixed conifers and hardwoods stand in the pole stage. The most frequently found sporadic tree species are sycamore maple (*Acer pseudoplatanus* L.) and common ash (*Fraxinus excelsior* L.), but wild cherry (*Prunus avium* L.) and common Laburnum (*Labur-*

(1) *SVS - Stand Visualization System is a free licensed software, created by the USDA, the United States Department of Agriculture, Forest Service. SVS and instructions can be downloaded (only in English) at* ***http://forsys.cfr.washington.edu/svs.html***

num anagyroides Medik.) can also be found.

Martelloscopio 2 - Aged coppice (Figure 2, Table 2). Located in the Colline Metallifere, in the province of Grosseto, it covers an area of 4,800 m². This stand is a coppice of Manna ash and Hop Hornbeam, and Turkey oak can also be found (mainly standards). The last logging occurred 47 years ago. The most frequently found sporadic species are: Wild Service Tree (*Sorbus torminalis* L.), field maple (*Acer campestre*) and True Service Tree (*Sorbus domestica* L.).

Martelloscopio 3 - Young coppice (Figure 3, Table 3). Located in the the Colline Metallifere, in the province of Grosseto, it covers an area of 5,400 m². As in Martelloscopio 2, the presented forest is a coppice of Manna ash and Hop Hornbeam, and standard Turkey oak can also be found, but the last logging was done 13 years ago. The most frequently found sporadic species are Wild Service Tree (*Sorbus torminalis* L.), field maple (*Acer campestre*), True Service Tree (*Sorbus domestica* L.) and common European holly (*Ilex aquifolium* L.).

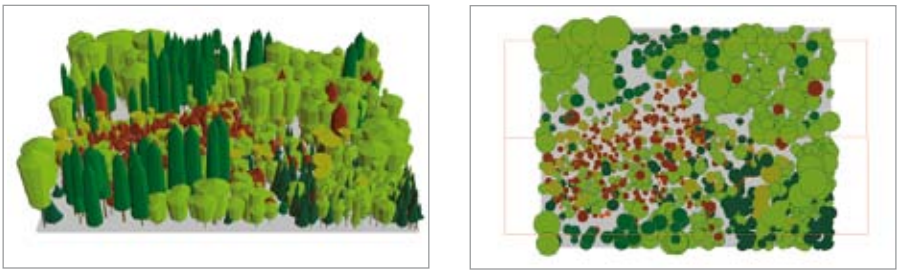
All virtual tree marking areas were also selected according to accessibility, to make the realization of training courses more feasible.

Uses of the martelloscopi

The LIFE + PProSpoT Project includes training activities using the three "martelloscopi", the main teaching tool. After a class on the silvicultural approach and appropriate silvicultural techniques, the students will visit the virtual tree marking areas equipped with basic information about the stand, allowing the student "hands-on" practice of the following activities:

- **recognize the plants** belonging to sporadic species;
- **identify target trees** and select them according to appropriate distances and characteristics, depending on whether the main purpose is to protect biodiversity only or combine this aspect with the production of valuable timber;
- **check for correct distance** between the selected plants;
- **simulate tree-marking** in favor of the target plants, taking into account context and silviculture management of the rest of the stand. The proposed intervention could in fact be mixed: tree-oriented silviculture for sporadic species and usual treatment for the rest of the stand.

The students, individually or in a group, will record, in a table, the numbers corresponding to selected target plants and to marked competitors. The software will then produce 3D images of the results of the virtual intervention, providing various sections and angles to illustrate how the stand looks before and after the virtual logging. It is also possible to verify the geographic position of all plants. Data on the variation in species composition,



Surface	10.800 m²
Total number of trees	1.243
Number of trees per hectare	1.151
Basal area	38,06 m²
Basal area per hectare	35,24 m²/ha
Average height (of average basal area)	22,1 m
Dominant height	27 m
Threshold measuring of the diameter	7,5 cm for all species

Species	Number of trees (%)	Basal area (%)	DBH (cm)
Fagus sylvatica	41,5	33,08	17,6
Acer pseudoplatanus	22,6	9,71	12,9
Picea abies	14,4	7,65	14,4
Salix caprea	7,1	2,58	11,9
Abies alba	6,7	38,65	47,5
Fraxinus excelsior	3,3	1,43	13
Larix decidua	1,9	5,97	35,5
Sorbus aucuparia	1,1	0,62	14,6
Laburnum anagyroides	1,1	0,25	8,9
Prunus avium	0,2	0,04	9,4
Sambucus nigra	0,1	0,02	10

Figure 1 e Table 1 - Martelloscopio 1 - High forest (PT).

Surface	4.800 m²
Total number of trees	1.867
Number of trees per hectare	3.890
Basal area	18,28 m²
Basal area per hectare	38,08 m²/ha
Average height (of average basal area)	12,1 m
Dominant height	17,9 m
Threshold measuring of the diameter	1 cm for sporadic tree species; 5 cm for the other species

Species	Number of trees (%)	Basal area (%)	DBH (cm)
Ostrya carpinifolia	54,7	35,3	17,4
Fraxinus ornus	23,8	22,7	9,0
Quercus Cerris	16,3	39,6	10,9
Acer campestre	1,7	0,5	8,5
Sorbus torminalis	1,7	1	5,9
Sorbus domestica	0,8	0,3	12,5
Ilex aquifolium	0,4	0,1	6,6
Quercus petraea	0,3	0,45	4,5
Acer monspessulanum	0,2	0,01	9,0
Carpinus betulus	0,1	0,04	2,6

Figure 2 e Table 2 - Martelloscopio 2 - Aged coppice, Troscione (GR).

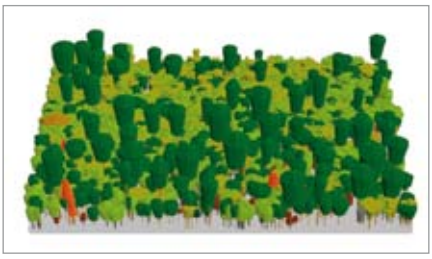
basal area and volume (separated for each species) is also provided. Images and data will be used for a final discussion and debate on the plants selected and tree-marking choices.

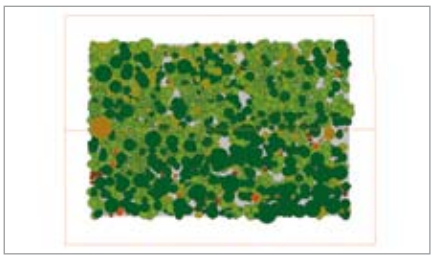
Advantages

The virtual tree marking areas realized thanks to the LIFE + PproSpoT project, offers an extensive educational potential, which can meet the needs of several categories of interested parties, i.e. stakeholders, such as:

- Professionals working privately in the field, who must be adept at species recognition, choosing target plants and conducting tree-marking of competitor plants.
- Public employees required to issue felling permits or directly verify intervention methods in the field;
- Forestry enterprises, who need to be adept at recognition of the sporadic species protected by the Tuscan Forest Law to avoid incurring fines;
- Forest owners, who need to realistically assess the advantages and disadvantages of tree-oriented silviculture for the preservation of sporadic tree species;
- Researchers, who will have access to the multitude of data collected from the three different forest types as a base of study;
- High school and university forestry students, who can experience "hands-on" the cases hey have studied in the classroom and in textbooks.

The LIFE + PProSpoT project virtual tree marking areas are an important learning tool, but they are not the only training tools being used. In addition, the student will have the opportunity to physically observe real interventions in an 80 ha area within different forest types at varying stages of development (Sansone et al., 2012) and 800 ha of an innovative planning method that integrates traditional silviculture with tree-oriented silviculture to preserve sporadic tree species (Fantoni et al. 2012). During autumn 2012, in both of the LIFE + PProSpoT project areas, two seminars aimed primarily at stakeholders in the Tuscan region will be held. During the same period, for dissemination on a national scale, the areas will host the annual Pro Silva Italia excursion. In a future article, the results of the initial endeavor of the virtual tree marking areas will be presented.





Surface	5.400 m²
Total number of trees	11.222
Number of single plants	1.049
Number of coppices stumps	796
Number of trees per hectare	20.781
Number of single plants per hectare	1.943
Number of coppices stumps per hectare	1.474
Basal area	15,46 m²
Basal area per hectare	28,63 m²/ha
Average height (excluding reserves)	6,6 m
Average height of reserves	17 m
Threshold measuring of the diameter	2 cm for sporadic tree species; 5 cm for the other species

Species	Number of trees (%)	Basal area (%)	DBH (cm)
Ostrya carpinifolia	62,4	44,7	3,5
Fraxinus ornus	27,9	25,9	4,1
Quercus Cerris	5,0	23,4	4,9
Acer campestre	2,3	1,2	3
Ilex aquifolium	1,1	2,1	5,8
Sorbus torminalis	0,5	1,5	7,4
Sorbus domestica	0,2	0,1	3,6
Acer monspessulanum	0,2	0,1	2,8
Quercus petraea	0,1	0,8	10,1
Quercus ilex	0,1	0,1	3,6
Pyrus pyraster	0,1	0,05	4,2
Cornus sanguinea	0,1	0,05	6

Figure 3 e Table 3 - Martelloscopio 3 - Young coppice, Troscione (GR).

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Il presente articolo è stato prodotto nell'ambito del Progetto - LIFE09 ENV/IT/000087 P.Pro.Spo.T. - Policy and Protection of Sporadic tree species in Tuscany forest. ***www.pprospot.it***

INFO.ARTICOLO

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Key words: *Training, martelloscopio, virtual tree marking area, tree oriented silviculture, sporadic species, LIFE+ PProSpoT Project, Tuscany.*

Acknowledgements

We would like to thank the following people for their collaboration in the collecting of data: Francesco Pelleri, Dalila Sansone, Serena Ravagni and Claudio Bidini (CRA-SEL), Massimo Bidini and Leda Tiezzi (Compagnia delle Foreste), Simone Torrini, Valentina Cappelli and Virginia Morelli (professionals in the field).

We would also like to thank the UNIONE DEI COMUNI MONTANA DELLE COLLINE METALLIFERE and the ex-COMUNITÀ MONTANA DELL'APPENNINO PISTOIESE for havving provided support in choosing the best areas for the realization of virtual tree marking areas.