Tree-oriented silviculture in young coppices

Silvicultural practices to enhance sporadic species: the LIFE+PPRoSpoT project experience

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The Life+ PProSpoT project represents the chance for Tuscany to apply tree-oriented silviculture, at forest district level, in stands located in hilly and mountain areas of Central Anti-Appennino. In this paper intervention criteria to be applied in young coppices within typical mediterranean mixed hardwoods stands are described.

The principles of the tree-oriented silviculture approach and the first application cases in Tuscany have been already reported in papers and technical guides (Mori *et al.* 2007, Pelleri *et al.* 2010, Pelleri 2010). The proposed techniques are aimed to protect and enhance valuable sporadic tree species; the criteria are defined in accordance with the Tuscany Regional Forest Law (LR 48/2003, art. 12) about the protection of sporadic tree species in forests. Protection and enhancing must be considered both from an ecological and productive point of view.
The Life+ PProSpoT project involves two demonstrative cases in two forest areas, different for species composition and past silvicultural systems:

- Colline Metallifere forest district - Monti di Prata area (Province of Grosseto), covered by mixed hardwoods coppices at different development stage
- Appennino Pistoiese forest district - Abetone Melo area (Province of Pistoia), covered by beech (*Fagus sylvatica*) and fir (*Abies alba*) high forests and chestnut (*Castanea sativa*) coppices over usual rotation age.

The focus of tree-oriented silviculture approach is the single tree and not the whole stand (Del Favero 2005); the system should guarantee the improvement of the minority tree species (Spiecker 2008) that naturally occur in the forests of Tuscany. Over time most plants belonging

to sporadic species reduced the ability to be competitive compared to dominant tree species due to: lower growth rates, higher light requirements, specific site conditions. In some cases the traditional silvicultural systems, characterized by widespread fellings aimed to foster social dominant species, caused a progressive reduction of the presence of sporadic species particularly in aged stands.

In areas where the presence of sporadic species is significant, where the skidding and forest roads network is efficient and where the ecological site conditions are favorable to plant growth, the tree-oriented silviculture approach allows both the maintenance of conditions suitable for the persistence of the specific composition (also by species regeneration) and a more valuable timber production.

This paper is focused only on Colline Metallifere area and highlights criteria for silvicultural interventions within typical mediterranean mixed hardwoods young coppice stands.

Case study site

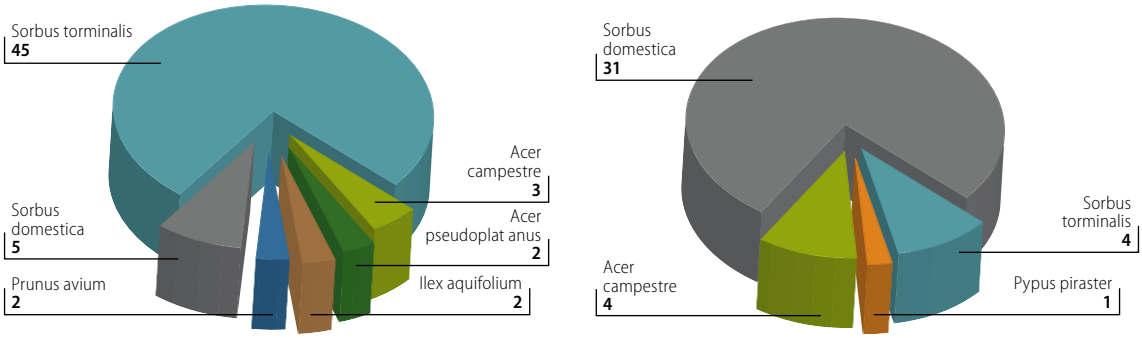
Two forest compartments of Colline Metallifere - Monti di Prata forest were selected: A37 and B18. Both stands are mixed hardwoods coppices where Turkey oak (*Quercus cerris* L.) is the dominant species. The main difference between the sites is the presence of sporadic species (Graph 1).

Forest compartment A37 is richer in terms of number of sporadic tree species; the most spread is *Sorbus torminalis*. The higher presence of the sporadic species is confirmed by the value of basal area, 5.83 % for A37 while in B18 is only 0.44% and the most representative species is Sorbus domestica.

All the conditions required to apply tree-oriented silviculture criteria are satisfied for both stands. In particular suitable ecological site conditions, forest roads network and significant presence in terms of species and trees number allowed us to select enough target trees.

Where the sporadic species presence is low and very irregular, all the tree-oriented silviculture actions will be mainly aimed to preserve the biodiversity at stand level. In such conditions all the proposed actions would include the whole plants belonging to sporadic species and not only those that could be exploited for wood production.

The dual purpose of protection and enhancing involves actions able to maintain or increase both the forest natural specific composition and, at the same time, the growth of single sporadic trees species to the end of the productive cycle. The remaining part of the stand will be managed keeping the coppicing system. The combination of the two silvicultural systems will increase the value of the forest both from an ecological point of view (maintenance of plants of selected species in good growth



Graph 1 - Species distribution of selected as target plants; in brackets trees number (left A37 and right B18).

Compartment	Surface (ha)	Stand (coppice) age	Target plants (n)	DBH (cm)	Height (m)	Crown insertion height (m)	Crown diameter (m)
A37	9.38	15	59	13,8	10,7	4,3	4,16
B18	8.97	13	40	4,19	5,92	2,68	1,64

Table 1 - Average characteristics of targets trees in the studied forest compartments.

		Stem quality class				
Compartment	**Free branch bole length (m)**	**A**	**B**	**C**	**D**	**not classified**
A37 (A method)	3,78	1,67%	41,67%	38,33%	15%	3,33%
B18 (B method)	2,88	20%	55%	25%		
B18 (C method)	3,02	10%	85%	5%		

Table 2 - Length mean value of stem and distribution (%) in quality classes of selected target trees.

condition to produce seed and, potentially, to regenerate) and economic (adding high quality timber to firewood production obtained by traditional coppicing).

Silvicultural interventions

In both forest compartments 99 target trees were selected, classified marked and positioned using GPS (59 trees in the A37 and 40 in B18). The same method was applied in all areas included in the project 800 hectares (Fantoni *et al.* 2012). The main parameters considered during the selection phase were the following:

- forest roads network
- plant vigor
- stem quality.

A target tree should be easily achievable in order to avoid high logging costs. The tree must be vigorous and, so, potentially competitive. Moreover it shouldn't show weakening signs and, when productive purposes are added to biodiversity preservation, stem characteristics must be suitable to the standards required by high quality timber market (Chièze and Sardin 2005).

The main characteristics of the selected trees are reported in Table 1. The trees were at the end of the pruning stage or at the beginning of the thinning stage; the mean value of the length of the free branch bole, was more than 3 meters (Table 2). The assessment of the aspects concerning the stem quality was made according to the method described by Nosenzo *et al*. (2008) for trees grown in plantations established to produce high quality timber (arboriculture for wood production).

The proposed system is a crown thinning generally at high intensity around the target tree but at low intensity at stand level. Comparing this method with a traditional system the main differences, are both spatial (action restricted to the surface around the target tree and not uniform over the entire stand) and in terms of setting up. Fellings are not focused on all the plants belonging to pre-defined social classes and widespread throughout the whole stand, but are oriented to eliminate the direct competitors of the target tree.

The thinning technique here described is known as "dètourage" (Claessens 2004) and it is commonly used in Central European forests where the aim of tree-oriented forestry is to produce valuable timber (Bastien and Willhelm 2003). After having reduced the lateral competition on target tree crown, the space available to expand crown increases stimulating higher growth in diameter until a next dètourage is required. The time between two consecutive thinnings depends on the intensity (distance between the target tree crown and the competitors) and on the crown expansion capacity. Thus it is function both of the species and the site conditions.

Within the demonstrative cases of the LIFE + PProSpoT two different methodological approaches have been adopted to assess the feasibility of this method and so the easiness to replicate both during tree marking and the felling phase.

Species	DBH (cm)	Height value (m)	Crown insertion height (m)	Crown diameter (m)
Acer campestre	10,5	10,47	3,07	3,1
Acer pseud.	10,1	10,75	4,15	5,43
Sorbus torminalis	13,37	10,49	4,24	4,06
Ilex aquifolium	9,5	5,3	1	3,34
Prunus avium	22,75	15,1	6,3	6,69
Sorbus domestica	16,64	12,42	5,84	3,59

Table 3 - Compartment A37 (method A): main variables measured on target trees (mean values).

Species	DBH (cm)	Height value (m)	Crown insertion height (m)	Crown diameter (m)
Acer campestre	3,75	5,4	2,1	1,87
Sorbus domestica	3,6	5,38	2,53	1,61
Sorbus torminalis	3,75	5,82	2,6	1,45

Table 4 - Compartment B18 (method B): main variables measured on target trees (mean values).

Species	DBH (cm)	Height value (m)	Crown insertion height (m)	Crown diameter (m)
Acer campestre	3,95	5,85	2,6	2,55
Sorbus domestica	4,93	6,47	2,9	1,87
Sorbus torminalis	2,6	5,1	2,2	1,19
Pyrus piraster	4,7	7,3	2,9	2,14

Table 5 - Compartment B18 (method C): main variables measured on target plants (mean values).

Compartment	Gap diameter post felling (m)	*Dètourage* width (m)	Competitors felled (%)	Reduction of Hegyi index (%)
A37	7,71	1,77	12 (35,3%)	62%
B18 (5 m)	8,82	3,59	31 (100%)	100%
B18 (3 m)	6,93	2,64	14 (40%)	50%

Table 6 - Thinning parameters.

A37	Plants (n)	Stumps (n)	Basal area (m^2)	DBH (cm)	Height (m)
Stand (before thinning)	5.292	1.087	16,93	5,55	8,77
Thinning	368		1,41	5,79	8,95
Removal	6,95%		8,33%		

Table 7 - Stand and thinning parameters in A37 (15 years).

B18	Plants (n)	Stumps (n)	Basal area (m^2)	DBH (cm)	Height (m)
Stand (before thinning)	2.874	2.341	11,84	6,85	7,65
Thinning	225		0,9	6,94	7,69
Removal	7,83%		7,60%		

Table 8 - Stand and thinning parameters in B18 (13 years).

Figure 1 - Example of dètourage thinning (system) around a target tree.

1. In the forest compartment A37 all the trees in direct competition with the target tree have been removed. In this case it was considered a direct competitor a tree with the crown close less than 1-2 meters to one of the target tree (method A). All the other trees (usually dominated subjects with crown in a lower position) were left.
2. The criteria adopted in B18 were different. All the plants that had the stem in a radius of 3 or 5 meters far from the target tree (respectively method B and C) were cut regardless of actual competition between the crowns. Tables 3, 4 and 5 show the characteristics of the target trees separated by species, compartments and methods.

All the main dendrometric parameters were measured on all target trees. To evaluate the competition dynamics it was used Hegyi index[1]. The reduction of the competition at single tree level was assessed comparing the variation of the index values before and after logging (Table 6). Due to the lack of literature, the data collected during monitoring will help us to understand the relation between index variation and growth dynamics of the selected trees.

Discussion

At stand level the thinning intensity was weak: 8% in terms of basal area, 7.4% in terms of number. The logged trees are similar to those still present in the stand (Table 7 e 8). In order to calculate the competition index, all the trees present in a radius of 5 m from each target trees were considered competitors. On average, 19 competitors for each target trees were eliminated with differences in relation to the method approach.

In A37 (method A) the thinning eliminated 35.3% of the competitors and, on average, a gap 7.7 m wide was opened. In B18 (method B) 100% of the trees were felled. In this case the opened gap had a diameter of 8.8 m on average[2]. In the other case (method C) 40% of the competitors were eliminated, leaving a gap with a mean diameter of 6.9 m (Table 6). Dètourage width (the mean distance between the crown projection of the target plant

(1) *Hegyi index is calculated as the ratio between the dimensions of the target tree and of the competitors considering the distance: H= Σ (Cd/TGd)*1/(distance between C and TG) [C= competitor, TG= target tree, d=diameter]. The main difficulty to apply Hegyi index is to define the competitors. In our case all the trees at a maximum distance of 5 m from the target tree were included.*

(2) *The gap surface was calculated from the crown projections of the border trees. This approach left to each target tree 61 m^2, on average 32% larger than the space left to the target trees in A37.*

and the crown of the competitors) was 1.77 m in A37, 3.59 m in B18 5 m, 2.64 m in B18 3 m (Figure 1).

Working time

High qualified technical staff is required to identify, select, label and georeference the target trees and marking competitors; technicians in charge to select target trees must be able to give a class of potential (expected) stem quality. In our case the work was carried out by teams made of two people; the productivity of each team reached, on average, 6 target plants per hour due to the high density of the stands.

The workers of Colline Metallifere forest district were in charge of cutting operations; each team was made by two people, one with the chainsaw.

Data regarding felling and processing time are incomplete and regards only the particle B18. The dètourage required on average 50 minutes per team and per each target tree (1 h 40' per worker).

Usually interventions, in aged coppices like this, are not economically convenient. In this case only 0.35 mst of firewood per target tree were obtained on average and the economic value of the total firewood was not enough to cover the costs. However it must be pointed out that this kind of thinning is not usually applied in Italy and this probably has lengthened the working time.

Although at this stage of development the thinning is crucial and ensure to sporadic trees species optimal growing conditions. The results of our case study highlight the importance of equipping the teams with maps indicating contour lines and the position of each target tree, so that it is possible to save time during the search of target trees especially in highly dense stands as young coppices.

Another important issue is to operate directly (not in contract) because there is a high risk to cause permanent damages to target trees during the felling of competitors.

Remarks

The interest for the implementation of localized interventions in young coppices is linked to high reaction of this kind of stands to changes in the competition dynamics - especially direct competition - resulting in crown expansion, consequent diametric growth, as well as future fructification. In aged coppice instead, where stem quality and crown shape have already been determined by past growth conditions, the reaction to treatments is limited and the chance to improve growth and stem quality is strongly reduced.

However the project PProSpoT monitored target trees treated with localized interventions in aged coppice and the results will be reported in a forthcoming paper. Experiences of interventions according to tree-oriented silviculture approach in Italy are a few (Giulietti *et al.* 2009, Pelleri *et al.* 2009, Raviglione *et al.* 2011, Wolinsky *et al.* 2006), mostly made in high forests, thus species and stand structure contexts are very different.

Not much is known about the growth dynamics of sporadic species in mediterranean context; the available surveys were conducted in central Europe and most of the time involved different species.

The monitoring of our interventions will give the first results about growth and competition dynamics of sporadic species in coppices located in mediterranean environment. The main purpose of our work is to provide indications useful to calibrate intensity and time between two consecutive interventions. It is relevant to develop a model of forestry that combines biodiversity protection and improvement of the stand values, integrated and respectful of the traditional coppicing, and that can be sustainable also from an economic point of view.

Bibliografia

Bastien Y., Wilhelm G.J., 2003 - **Selvicoltura d'albero: un approccio per la produzione di legname con buone caratteristiche e di grandi dimensioni.** Sherwood - Foreste e Alberi Oggi n. 86:5-13.

Chièze F., Sardin T., 2005 - **Designazione degli alberi obiettivo.** Sherwood - Foreste e Alberi Oggi n. 117: 9-12.

Claessens H., 2004 - **Réflexion sur le détourage des feuillus à croissance rapide.** Forêt wallone n. 71 : 3-11.

Del Favero R., 2005 - **Considerazioni sulla gestione dei boschi alpini di latifoglie per la produzione di legname di qualità.** In: Foreste Ricerca Cultura. Scritti in onore di Orazio Ciancio. Accademia Italiana di Scienze Forestali, Firenze: 153-166.

Fantoni I., Miozzo M., Rella E., 2012 - **Pianificazione e specie sporadiche.** Prime esperienze italiane in ambito del Progetto LIFE+ PProSpoT. Sherwood, Foreste ed Alberi Oggi n. 184: 9-14

Giulietti V., 2008 - **Short term scientific mission report. COST E42, growing valuable broadleaved tree species.** *www.valbro.uni-freiburg.de/stsm.-php*.

Giulietti V., Ferretti F., Pelleri F, 2009 - **Prove di diradamento in acero-frassineti di neoformazione nella Comunità Montana Agno-Chiampo (VI): risultati dopo il secondo intervento.** Annali CRA-SEL, 35, 2007-2008: 87-100.

Mori P., Buresti Lattes E., Bruschini S., Giulietti V., Grifoni F., Pelleri F., Ravagni S., Berti S., Crivellaro A., 2007 - **Selvicoltura delle specie sporadiche in Toscana.** Agenzia Regionale per lo Sviluppo e l'Innovazione nel settore Agricolo-forestale (ARSIA) della Toscana, Firenze, 352 pp.

Nosenzo A., Berretti R., Boetto G., 2008 - **Piantagioni da legno. Valutazione degli assortimenti ritraibili.** Sherwood - Foreste ed Alberi Oggi, n. 145: 15-19.

Pelleri F., Pividori M., Giulietti V., 2009 - **Cure colturali in acero-frassineti secondari in Italia settentrionale.** Atti III Congresso Nazionale di Selvicoltura, Taormina, 16-19 ottobre 2008: 887-893.

Pelleri F., 2010 - **La selvicoltura d'albero e le specie sporadiche nei cedui.** ATTI del 46° Corso di Coltura in Ecologia - San Vito di Cadore 7-10 giugno 2010. "Gestione multifunzionale e sostenibile dei boschi cedui: criticità e prospettive": 189-200.

Pelleri F., Giulietti V., Sansone D., Samola A., Nitti D., 2010 - **Valorizzazione delle rosacee arboree. Esperienze nei cedui delle colline metallifere (GR).** Sherwood - Foreste e Alberi Oggi, n. 160: 5-11.

Raviglione M, Collattin A., Motta R., Nosenzo A., Berretti R., Meloni F., Wolinski A., 2011 - **Interventi selvicolturali sperimentali in boschi di faggio della Val Sessera.** ***www.regione.piemonte.it/foreste/cms/media/files/pian_gest/ricerca/progetto_valsessera.pdf***

Regione Toscana, 2003 - **Regolamento Forestale della Toscana.**

DPGR n. 48/R

Spiecker H., 2008 - **Specie sporadiche. Un'opportunità per foreste multifunzionali.** Sherwood - Foreste ed Alberi Oggi n. 145: 4-8

Wolynsky A., Berretti R., Motta R., 2006 - **Selvicoltura multifunzionale orientata alla qualità.** Sherwood - Foreste ed Alberi Oggi n. 118: 5-12.

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The paper describes first tree-oriented silviculture interventions in Tuscany young broadleaves coppice. The interventions have been planned in the framework of the Life+ project PProSpoT with the aim to introduce the tree –oriented silviculture in Tuscany forests. Different criteria of crown thinnings have been carried on only around target sporadic trees species to increase the available space for crown-growing.
This approach allows of maintaining forest biodiversity and increasing the value of sporadic species' timber.

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