



Tree-oriented silviculture in European beech high forests

Silvicultural practices aimed both at enhancing sporadic species and at managing the dominant species

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In this paper intervention criteria applied to European beech (*Fagus sylvatica*) high forests are described. The activities were carried out in the Abetone forest area (Pistoia province, Central Apennine, Italy) to preserve and to enhance sporadic tree species in Tuscany, according to the actions scheduled by The LIFE+ PProSpOT project. Different silvicultural approaches to integrate interventions to favour sporadic species with the traditional practices to manage the remaining part of the forest stand are presented.

In Tuscany the traditional forestry practices are oriented to the maximization of the wood production of the dominant species. This aspect, together with the general lack of knowledge of the ecological needs of the minor species and with the progressive aging of the stands, has led to a gradual simplification of the tree species composition, mainly to the detriment of some hardwood species henceforward defined "sporadic". The PProSpOT project (LIFE09 ENV/IT/000087) results from the need to deal with this issue, aiming at preserving, spreading and at enhancing sporadic tree species in the forests of Tuscany (www.pprospot.it). During the project activities tree-oriented silviculture criteria were applied (BASTIEN e WILHELM 2003,

AA.VV. 2007). This approach suits the ecological needs of sporadic species (SPEICKER



Tree-oriented silviculture intervention to favor 100 target plants

2008) because it provides **targeted and localized interventions to create optimal growth conditions for selected trees (target plant), according to various criteria** (environmental and ecological value, species rarity, wood economic value).

In this paper the method applied in *Fagus sylvatica* pure high forests and in *Abies alba*-*Fagus sylvatica* mixed stands in the Abetone-Melo forest (Central Apennine, Pistoia Province, Italy) is described. Such method will be applied to a total surface of 14 ha by the project deadline. The specific objective of the demonstrations is to show how to combine the usual silvicultural treatments of the dominant species with the preservation and enhancement of the sporadic species.

GENERAL CRITERIA

Stands dynamics

In Central Apennine high forests, in beech-silver fir mixed stands (during **thicket stage** and **pole stage**), the pioneer species as *Laburnum anagyroides*, *Sorbus aria*, *Sorbus aucuparia* are frequent, being characteristics of the first stages of these kind of stands; while during the following stages they tend to become increasingly rare. It is not uncommon to find also *Fraxinus excelsior*, *Acer pseudoplatanus*, *Acer platanoides*, *Prunus avium*; these species are competitive with silver fir and beech thanks to the higher growth rate of the young plants and, specifically for *Acer pseudoplatanus*, to a good shade tolerance. During the **young high forest stage** the frequency of the pioneer sporadic species strongly decreases due to beech height and canopy development. Only *Acer pseudoplatanus* is able to compete with the beech for the light and consequently it maintains a more balanced crown structure; this is why it is the most frequent sporadic species to be found over the adult high forest stage.

METHODS

During PProSpoT activities, the following kinds of silvicultural interventions were applied in the Abetone forest area; the major criteria to select sporadic species plants were their attitude and stem structure to produce valuable timber.

SdA Modality: tree-oriented silviculture to favor target plants belonging to both dominant and sporadic species. The interventions were called as follows according to the number of target plants:

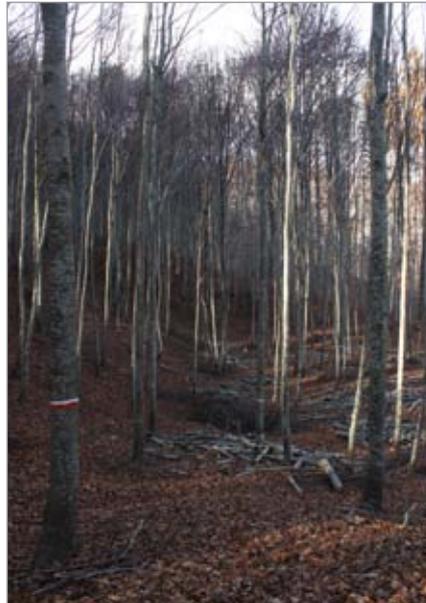
- **Sda 50** - localized intervention around 50-60 target plants (area B);
- **Sda 100** - localized intervention around 100-110 target plants (area A e C);

SPop+SdA Modality: tree-oriented silviculture to favor target plants belonging only to sporadic species and traditional silviculture treatments (thinning from below) in the remaining part of the stand (area D);

SPop Modality: stand silviculture consisting of a traditional thinning from below (area E⁽¹⁾).

The trials were carried out in pure beech and in silver fir-beech mixed stands of different age and with a different specific composition

(1) There was not any particular treatment to favor sporadic species, but to monitor the reaction to the intervention 100 potential target plants per ha were selected (both dominant and sporadic species).



Traditional thinning from below.

and frequency of sporadic species.

Data were collected in permanent plots (about 2.500 m²), while the interventions were applied in the whole forest sub-compartment. The compartments were selected taking in account the higher frequency of the sporadic species according to the Piano di Gestione (Management Plan) implemented during the PProSpoT project activities (FANTONI *et al.* 2012). According to the Plan in Abetone-Melo forest the average number of the sporadic species is 17,5 plants/ha.

Table 1 summarizes the main dendrometric characteristics before silvicultural treatments: the data highlight the differences between the areas regarding species composition and sporadic species density.

The most important dendrometric parameters after the thinning, according to the intervention modality, are reported in Table 2. Where the interventions were applied on the whole stand (Areas E and D), about 50% of the total number of the plants were felled; the percentages are lower in the areas where only localized treatments were applied. In terms of basal area and volume the values tend to be more homogenous (around 18-24%).

SdA Modality: tree oriented silviculture to favor sporadic species and beech and silver fir best plants.

Following this approach a thinning from above was applied only around the most promising trees of beech and sporadic species:

Areas A and B - beech high forests, originated from a previous establishment

cut, 48 years old, never thinned and in dimensioning stage. Two intervention modalities were applied according to the number of target plants: 57 plants per ha (Area B - SdA 50) and 100 plants per ha (Area A - SdA100). In area A a higher number of target plants was selected as a precaution, that may be reduced during the future interventions (BASTIEN e WILHELM 2003).

Area C - Pole stage stand, 30 years old, natural origin, never thinned, towards the end of the qualifying phase. Even in this case the first thinning favored 110 target plants per ha (beech and sporadic species, SdA 100). The chance to select only 50-60 plants in the future is open.

Target plants selection - Only beech vigorous plants, with straight stems and free of defects, were selected. As for sporadic species, considering the reduced number of plants and the consequent greater importance of biodiversity preservation, less selective criteria were adopted: vigorous plants were chosen including trees with stem and/or crown defects. A general criteria was the selection of target plants at a minimum distance of about 10 m in areas A and C (SdA 100) and at a distance of 13-14 m in area B (SdA 50). The target plants were labelled with a painted ring in order to make them easily recognizable for the workers and to consequently reduce damages caused by the felling of the neighbourhood plants.

Thinning modality - Target plants crowns were isolated, eliminating the nearest competitors by a 1-1,5 m wide detourage (Table 3). In area C (pole stage) intervention intensity was lower due both to uncompleted qualification of target plants (crown insertion height 4,2 m) and to the high H/DBH ratio (>100). Delimiting was also carried out on the target plants in this area, in order to shorten as much as possible the time to reach an adequate length of a branches-free stem. Table 2 shows how the density was reduced due to the interventions to 11-17% in terms of plants number, which corresponds to 17-24% of the basal area, felling from 15 to 63 m³/ha. In these stands the existing forest road network was efficient, hence no new trails were necessary.

Return time - In the younger beech stands the usual return time between the first two thinnings is of about 4-5 years. Afterwards the return time increases up to 6-8 years (BASTIEN *et al.* 2005, WILHELM 2004).

SPop+SdA Modality: Stand silviculture associated to targeted and localized interventions to favor best trees of sporadic species.

Area D - Beech-silver fir mixed high forest, 67 years old, thinned in the past following low intensity criteria. A thinning from below was applied on whole stand and it was associated to a thinning from above around 7 plants/ha belonging to sporadic species.

Target plants selection - Due to the stand old age the well-shaped and vigorous plants of *Fraxinus excelsior* and *Sorbus aucuparia* (very rare) were mostly selected. The general criteria was to preserve plants capable of taking advantage of the thinning in order to produce fruits and consequently seeds.

Thinning modality - Firstly the target plants were identified and labeled; their direct competitors were marked (détourage). Then the tree marking was extended to the rest of the stand carrying out a thinning from above of medium intensity. In Area D 46% of the plants were felled, corresponding to 22% in terms of basal area (Table 2)

Return time - 4-6 years for SdA and 10-15 years for SPop. For this reason it will be necessary to alternate an intervention only on sporadic species with an intervention on the whole stand.

SPop Modality: Traditional silviculture with thinning from below.

This kind of intervention was carried out in one stand and it was used as control area.

Area E - Beech high forest, 50 years old, never thinned. A thinning from below was applied on the whole stand, paying attention not to mark sporadic species trees.

Target plants selection - For demonstration purposes only 100 plants/ha were selected and labeled (beech and sporadic species) to compare the reaction to the different modalities in a 50 years old high forest (SdA 50, SdA 100 and SPop).

Thinning modality - in area E the thinning reduced the density to 58% (corresponding to 23% in terms of basal area)

Return time - The thinning should be applied every 10 to 15 years

CONCLUSIONS

The aim of the described interventions is to show (and also to test) if it is possible to integrate the stands current silviculture with tree species biodiversity preservation and enhancement of the sporadic species. From a technical point of view tree-oriented silviculture, applied both to dominant and sporadic species, allows to regulate the competition, considering the detail of each

single situation; thus it is possible to favour less competitive species and, when possible, to enhance the most interesting plants in relation to high quality timber production. Traditional silvicultural treatments usually operate at stands scale and evaluate the wood production at stand level without paying attention to the ecological needs and the different competition ability of minor species. Generally sporadic species are preserved by forest regional rules but not treated with a specific silviculture. The integration between the two systems (tree-oriented silviculture and traditional stand silviculture) allows a type of forest management based on the traditional systems and, at the same time, to preserve and enhance the sporadic species by targeted interventions.

Despite the fact that there is still no economic evaluation of this method, it is possible to hypothesize that the first thinning according tree-oriented silviculture will be more expensive than a traditional one, as a consequence of the higher required level of care and the more numerous difficulties during felling and bunching.

A correct assessment of tree-oriented silviculture method for the beech high forest of the Central Apennine, from an ecological and cultural point of view, will only be

Area	Forest type	Age	Density (n ha ⁻¹)	Basal area (m ² ha ⁻¹)	Volume (m ³ ha ⁻¹)	Basal area mean (cm)	Height (m)	Dominant height (m)	Sporadic species (n ha ⁻¹)	Sporadic species ⁽¹⁾
Area A	Beech high forest	48	2.493	27,18	262,3	11,8	15,1	20,4	7	La, Sau,
Area B	Beech high forest	48	2.118	26,37	243,2	12,6	14,3	19,5	25	La, Ap
Area C	Beech pole stage	30	4.305	18,74	142,2	7,4	10,2	12,4	55	Sa, La,
Area D	Beech-silver fir mixed high forest	67	1.276	53,90	755,7	23,2	23,4	30,0	40	Ap, Sau
Area E	Beech high forest	48	2.421	31,29	337,7	12,8	16,4	22,3	64	La, Ap, Sau

⁽¹⁾ La = *Laburnum anagyroides*, Sa = *Sorbus aria*, Sau = *Sorbus aucuparia*, Ap = *Acer pseudoplatanus*, Fe = *Fraxinus excelsior*.

Table 1 - Stands characteristics before interventions. Species composition and sporadic species density.

Area	Intervention modality	Stand stage	Target plant (n ha ⁻¹)	Density (n ha ⁻¹)	Basal area (m ² ha ⁻¹)	Volume (m ³ ha ⁻¹)	Basal area mean diameter (cm)	N %	Logging G %	V %
Area A	SdA 100	Dimensioning stage	100	2.136	20,93	199,7	11,1	14,5	23,6	23,9
Area B	SdA 50	Dimensioning stage	57	1.868	21,02	194,8	12,4	11,2	20,3	19,9
Area C	SdA 100	Qualifying stage	110	3.583	15,43	117,3	7,4	16,7	17,7	17,5
Area D	SPOP +SdA	Dimensioning stage	7	680	41,80	611,7	27,9	46,7	22,5	19,1
Area E	SPOP	Dimensioning stage	--	1.021	24,07	275,2	18,7	57,8	23,1	18,5

Table 2 - Interventions characteristics before and after thinning.

Area	Total target plants (n ha ⁻¹)	Sporadic species target plants (n ha ⁻¹)	DBH (cm)	Height (m)	Crown inserti on height (m)	H/DBH	Crown dept.	Crown diameter (m)	Détourage range (m)
Area A	100	4	23,6±7	20,1±3	7,2±2	89±6	0,64±0,1	5,4±1,3	1,39±0,7
Area B	57	4	21,9±7	18,0±3	7,4±1	85±12	0,58±0,1	5,2±1,4	1,02±0,8
Area C	110	10	11,3±2	11,3±2	4,2±1	102±15	0,63±0,1	3,4±0,5	0,97±0,3
Area D	7	7	34,4±8	25,4±2	14,1±3	96±15	0,43±0,1	5,5±1,6	0,36±0,9
Area E	100*	7	24,0±4	20,6±3	8,6±2	87±10	0,58±0,1	5,5±1,3	--

*After the intervention 100 target plants were sampled as control in area E.

Table 3 - Average characteristics (±SD) of the target plants (beech plus sporadic species) and detourage range.

possible at the end of the experience. It is crucial to respect the scheduled interventions timing, to monitor the target plants growth and evaluate carefully the contexts where the proposed management method is sustainable.

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INFO . ARTICOLO

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Abstract: *Single tree oriented silviculture for productive beech forests. How to combine the enhancing of sporadic species and the management of the stand.*

In the Apennine beech and beech-fir forests the tree composition is generally very simplified. The minor tree species are usually present in the young stages, but they are transitory and result very sporadic in the old stages. The conservation and the enhancing of minor tree species in these forests can be obtained through two different approaches: i) applying single tree oriented silviculture to the whole stand (minor species and dominant species); ii) managing the stand in a traditional way and applying single tree oriented silviculture only to the minor tree species. In this paper a description of different thinnings, realized during the Life+ P.ProSpot project, is reported.

Key words: Management, single tree oriented silviculture, sporadic species, beech, P.ProSpot project, Tuscany.



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