

Conservation strategies for the habitat 9210* Apennine beech forests with *Taxus* and *Ilex*

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Abstract: Different criteria should be considered when elaborating strategies for conservation actions of forest habitats. An approach integrating phytosociological and stand structure surveys with the predictive modeling of species distribution is applied to analyse the spatial distribution and dynamics of the Apennine beech woods with *Taxus baccata* and *Ilex aquifolium*. The Mann-Whitney test used to verify the homogeneity of the habitat has shown that beech woods with *Taxus* differ from those with *Ilex* with respect to climatic, topographic, structural and environmental parameters: the firsts have proven to be more microthermic, mesophilous and characterised by a denser and less stratified canopy. Regression tree analysis was used to analyse the relationship between bioclimatic parameters and the spatial distribution of *Taxus* and *Ilex* abundance: the distribution of *Taxus* is influenced by precipitation variables, while *Ilex* is influenced mainly by temperature variables. This result determined *Ilex* having a potential area that surrounds, at lower altitudes, that of *Taxus*. A stepwise multiple regression analysis has been applied to identify the factors influencing the regeneration of the two species: beside climatic parameters, *Taxus* regeneration is negatively influenced by soil nitrate concentration (an indicator of livestock disturbance) while *Ilex* is negatively influenced by the beech forest cover. The applied multi criteria analysis suggested the elaboration and implementation of two differentiated strategies for conservation actions and reforestation plans for the beech typologies of this high-priority habitat; moreover these are integrated with traditional practices.

Keywords: 9210* Apennine beech forests with *Taxus* and *Ilex*, Disturbance by grazing Fragmentation

Introduction

In Italy the beech forests with *Ilex aquifolium* and *Taxus baccata* are distributed in the Apennines, mainly in the centre-south, with isolated fragments in Sicily, usually above 900 meters of altitude. *Taxus* and *Ilex*, relicts of the Cenozoic flora, characterized by warm-humid climatic conditions, survived the glaciations of the Quaternary period in refugia areas and may have followed *Fagus* in the successive postglacial expansion. This process, possibly characterised by long-range dispersion events, determined their current fragmented presence and reduced consistency. Both the species are linked to humid climatic conditions and have low resistance to intense cold. Less abundant in other habitats, they probably own their presence to the ability to adapt to local conditions and to their reproductive strategies. Such peculiarities ensured that the habitat "Beech forests of the Apennine with *Taxus* and *Ilex*" was considered, within the Habitat Directive, among those with high conservation priority. Aim of this work is to study the climatic, topographic, structural and environmental characteristics of this habitat and the factors influencing the regeneration of the two characteristic species. This was done by integrating phytosociological and stand structure surveys with the predictive modeling of species distribution in order to support the elaboration and implementation of conservation strategies and reforestation plans.

Materials and methods

Data set

75 sample plots were identified by GPS coordinates and dendrometric, phytosociological and regeneration surveys were carried out (Fig. 1). The phytosociological surveys, carried out using the Braun Blanquet scale, were used to obtain the average values of the Ellenberg indicators. These indicator values describe the ecological optima for the species along ecological gradients using an ordinal scale applied on several environmental parameters such as light, temperature, continentality, soil moisture, pH and nitrogen content.

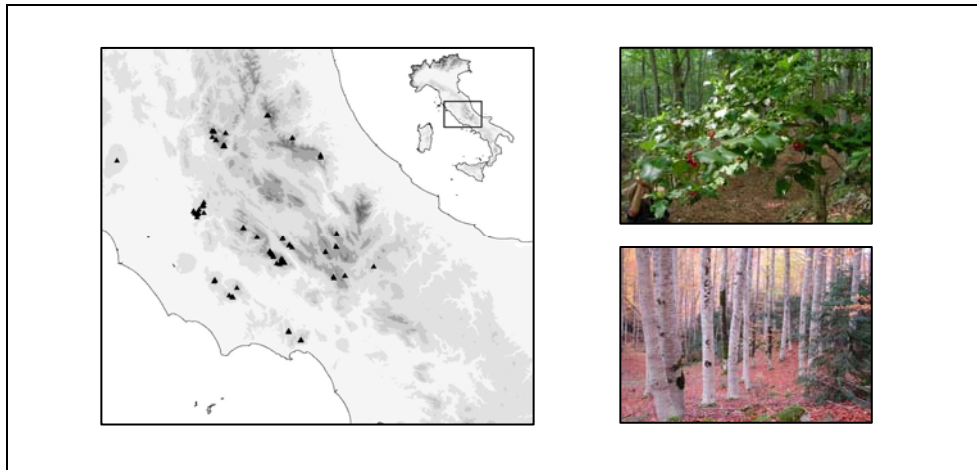


Figure 1. Study Area and sample plots of beech woods with *Ilex* (above) and with *Taxus* (below).

Climatic data in GRID format with a spatial resolution of 500 m were obtained by interpolating precipitation and temperature data recorded in 300 meteorological stations and calculating the average data for the 1960 – 1990 period.

The regeneration surveys were done by measuring the heights of all the individuals with a diameter at breast height of less than 2,5 cm and higher than 20 cm (in order to distinguish sproutings from seedlings). In this way an index of Regeneration expressed in cm of regeneration per hectare was obtained.

Data analysis

Since in almost all the plots we found either *Taxus* or *Ilex* and very rarely both at the same time, we carried out the Mann-Whitney test, comparing the median of each variable, so as to find which factors differ meaningfully between the beech woods with *Taxus* and those with *Ilex*.

Potential spatial distribution of *Taxus* and *Ilex* abundance was obtained by using the Regression Tree Analysis to analyse their relationship with climatic variables (Iverson & Prasad, 2002).

A stepwise multiple regression analysis was applied in order to identify the factors influencing the regeneration of *Taxus* and *Ilex*. The Regeneration index was used as dependent variable, and climatic, environmental, structural variables were used as

independent variables. For each regression a subset of predictors was selected using a stepwise method.

Results and discussion

According to our results it seems evident that *Taxus* and *Ilex* occupy inside the Apennine beech forests two differentiated ecological niches. In particular, as it is shown by the maps of their potential distribution obtained by the Regression Tree Analysis on bioclimatic data, *Ilex* potential area surrounds, at lower altitudes, that of *Taxus*, with only a small overlapping area (Fig. 2).

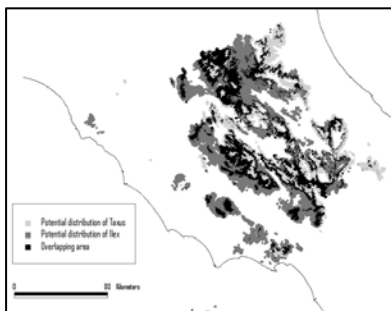


Figure 2. Current potential distribution of *Taxus*, *Ilex* and overlapping area.

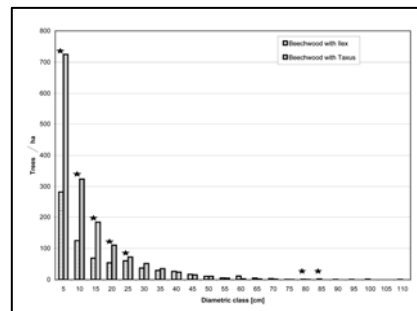


Figure 3. Pooled dbh-distributions of trees in beech woods with *Taxus* and those with *Ilex*. Significant differences between the stand categories are marked with asterisks (Mann-Whitney test, $p < 0.05$).

Differences exist also regarding the structure of the two beech wood types. In fact, on one side, the pooled dbh-distributions show a similar inverse-J shape suggesting viable beech populations (Fig. 3). However, beech woods with *Ilex* are characterised by structural conditions that allow more light to reach the forest floor, as indicated by their lower density and higher mean diameter of trees. This is probably due to a higher disturbance caused by human activities favoured by their easier accessibility, lower altitude and less steep slopes: irregular cuts for civic uses - particular areas of forests where citizens are allowed to harvest timber (Feliziani 2006) - are more frequent in beech woods with *Ilex*. This factor seems to have an effect on the regeneration of *Ilex*. In fact, according to the results of the multiple regression analysis, beside climatic variables such as total precipitation and maximum temperature, *Ilex* is negatively influenced by the cover of the beech trees measured as basal area per hectare (Table 1, above). For this reason, it can be hypothesized that the traditional practices favoured the regeneration of *Ilex*, reducing the forest cover and allowing more light penetration. *Taxus* regeneration, instead, is positively influenced by the total precipitation and negatively by the nitrogen content expressed by the relative Ellenberg indicator (Table 1, below).

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Table 1. Summary of the stepwise multiple regression for *Taxus* (above) and *Ilex* (below) Regeneration index.

	R	R square	Adjusted R square	Std. error of the estimate
<i>Ilex</i> Regression	0,794	0,632	0,591	20028,874
	Unstand. coefficients		Standardized coefficients	
	B	Std. error	Beta	T
(constant)	-49331,996	65116,678		- 0,758
Maximum temp.	8348,282	2191,403	0,450	3,810
Annual precipitation	-68,86	21,343	- 0,382	- 3,226
Basal area/ha	-901,079	240,787	-0,430	- 3,742
	R	R square	Adjusted R square	Std. error of the estimate
<i>Taxus</i> Regression	0,559	0,313	0,277	29243,011
	Unstand. coefficients		Standardized coefficients	
	B	Std. error	Beta	T
(constant)	44245,814	56755,217		0,780
Nitrogen content	-20052,876	6318,598	- 0,431	- 3,174
Annual precipitation	65,777	29,592	0,302	2,223

High level of nitrogen content determined the presence of competitive nitrophilous species such as *Rubus ulmifolius* and *Alliaria petiolata*. These species are favoured by disturbance caused by livestock, especially cows. They can also directly influence *Taxus* regeneration by eating seedlings and sproutings (for *Ilex* the problem is lower because of its highly thorny leaves). In this case, the toxicity of *Taxus* for the cows, referred by some authors (Paule et al. 1993), has not been recorded during this study.

Conclusions

The applied multi criteria approach has proven to be a useful tool to analyse the ecological factors influencing the spatial distribution and dynamics of Apennine beech woods with *Taxus* and *Ilex*. In particular beech woods with *Taxus* differ from those with *Ilex* with respect to climatic, topographic, structural and environmental parameters. Such differences have a remarkable importance in determining their spatial distribution and the regeneration of the two characteristic species. For this reason, it was necessary to elaborate two differentiated strategies for conservation actions and reforestation plans of the beech typologies of this high - priority habitat; moreover these should be integrated with traditional practices.

References

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