EPIDOMETRIC, BIOCLIMATIC AND SILVICULTURAL CHARACTERIZATION OF OAKLANDS (*QUERCUS PETRAEA* MATTS. LIEBL) IN NORTHWEST OF THE IBERIAN PENINSULA BY CLUSTER ANALYSIS: MANAGEMENT GUIDELINES

Ignacio J. Díaz-Maroto[1], Pablo Vila-Lameiro[2]

[1]Department of Agroforestry Engineering, University of Santiago de Compostela, Spain; ignacio.diazmaroto@usc.es
[2]Department of Agroforestry Engineering, University of Santiago de Compostela, Spain

The forests of *Quercus petraea* object of this work are part of the oaklands that cover most of the surface of the NW of Spain and the 38% of the forest. The general trend of these autochthonous forests is the regression changed by reforested using fast-growing species with higher productivity and incomings, impossible to achieve with the current oaklands by the method of management applied. This method consists, curiously, in the absence of any method. Consequently, the regional administration tries to vary and reverse this tendency. However, from the point of view of production, these oaklands have a high potential, not just due to the high value of its timber. Beyond timber production, it is of great interest and benefits of the complementary forest products (mushrooms, honey, herbs, small fruits, ...). Then it's necessary to avoid degradation / disappearance of the species. Moreover, it should be added the effect that these forests have in the water balance, keeping edaphic layer, in development of wildlife and vegetation... with recreational and hunting use that this allow. Often, these forests are considered sensitive areas of special planning. Consequently, the lack of specific and updated information about them justifies works like this, that far of proposing imminent economic goals for results, we try to obtain baseline information for the improvement, maintenance and possible expansion of these formations. The starting point for driving the management of forest species begins by the description and characterization of eco-dasometric, already done in previous work. In this paper was set as objective the establishment of relations between the state forest and other parameters, especially related to bioclimatic and regeneration trends. That characterization was completed with the determination of the causes that explain the current distribution of *Quercus petraea* in the NW of the Iberian Peninsula. This knowledge is applied to compare the similarities between the theoretical and current locations within the study area. As a result it has been possible to classify the stands of *Quercus petraea* in the NW of the Iberian Peninsula by cluster analysis, can clustering several groups of forests. The first one, include young oaklands that develop with higher densities and a high radial growth. Its topography is the most rigorous of studied sites. In addition, significantly more mature stands with density according to the previous group, but lower radial growth and similar topography. These forests correspond to more Mediterranean climatic locations. Finally, mature stands, with radial growth around 1.5 mm/year are present with less topographic adversity. These oaklands are linked to more Atlantic climate and higher quality sites. The distribution of these three clusters is linked to different climatic conditions with apparent independence of human activities and good correlation with natural regeneration patterns. In the end, and as application of this classification, it was obtained a geographical distribution of the studied forests providing management and silvicultural improvement guides.

Keywords: *Quercus petraea*, silviculture, climatic, cluster, management.
Parole chiave: *Quercus petraea*, selvicoltura, climatico, cluster, gestione.

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1. Introduction

Quercus petraea (Mattuschka) Liebl., is a species with a very concrete distribution area, more reduced than other Fagaceae. Its natural stretching area spans to the most Western European border, specially to the centre and South. It is spread from the Nordic countries to Sicily and from the British Isles to the extinct USSR, reaching Western Asia.

Within the Iberian Peninsula, its distribution appears very disperse, but, however, it is larger than *Quercus* robur´s. Concretely, it is exclusively manifested in the northern area and only in the northern mountain range, from Galicia to Catalonia, being its main manifestations the chains of Leon, Palencia, Santander Basque Country and Navarra (Amaral, 1990; Vila-Lameiro, 2003). The species is shortly used for reforestations on the Iberian Peninsula, being frequently found

forests formed by pollard trees used to obtain firewood. The abundance of trees from sprat of stool, or even root, justifies their regeneration method as a coppice forest, but without selection of the best coppice shoots and, therefore, these trees use to have a low commercial value (Díaz-Maroto *et al*., 2005).
Natural regeneration of oak is increasingly abundant on abandoned agricultural lands, which have very good improvement possibilities by means of an adequate management, as they are formed by young, vigorous and little damaged stems because unfortunate silvicultural treatments were not applied, as they were in another stands (pollard or selective felling of the best specimens). Getting oak stems with good forest habit is difficult and it requires a specific silviculture which has not been applied on the study area. Trees that naturally had these characteristics related to the production of quality timber have been indiscriminately harvested, which has leaded to an important genetic degradation of these stands (Díaz-Maroto *et al*., 2005). However, little frequent operations as cleaning and brush out allow to abandon rapidly the state of "oak scrubland" present in many stands, in which strong competence affects very much to the growth, and being also more sensitive to fires (Vila-Lameiro, 2003). The initial density of oak stands must be higher than 10000 stems/ha, which lets improving their shape.
It is necessary to respect the layer of shadeloving species in subsequent operations, which usually exists naturally and favour the formation of good quality oak stems. Thinnings will be moderated, due to the sharp trend of oaks to form sprouts, which are stimulated by lighting of their trunk, and the dominant and codominant trees will be specially managed (Vila-Lameiro, 2003).
In case of scrublands where a previous selection of 400 to 600 sprouts/ha has been done after a clear cut, it is possible to practice coppicing with standards, keeping the accompanying coppice shoots to reduce the appearance of epicormic shoots and the incidence of wind (Díaz-Maroto *et al*., 2005).

2. Material and methods

2.1 Study area

The study area comprises the Autonomous Community of Galicia which is situated in the north-west of the Iberian Peninsula and covers an area of ~ 3 million hectares. The mean altitude in the region is 508 m and slopes of more than 20% occur in half of the region. The lithological composition of the substrate is plentiful and includes granite, schist, slates and quartzite; the climate is very varied, although generally classified as Humid Oceanic, with a certain Mediterranean influence in some zones. Annual precipitation varies between 600 mm to more than 3000 mm (Díaz-Maroto *et al*., 2005).

2.2 Description of sampling, data recording and parameters measured

Initial stratification of the study area was not advisable because of the wide dispersal and heterogeneity of the oak stands throughout the region (Rubio *et al.*, 1997); therefore, we considered the study area as a single unit when selecting the areas for sampling and posterior data recording. The area was firstly delimited, avoiding certain areas where the presence of *Quercus petraea* was unlikely because the forest site characteristics (physiographic, climatic and edaphic) are not appropriate for these species (Timbal and Aussenac, 1996). The sampling zones were then selected, taking care to include a sufficiently representative number of oak stands, on the basis of the data included in the Forest Map of Spain (Ruiz de la Torre, 1991), obtaining the existing vegetation mosaics where *Q. petraea* is present, and the sampling zones were selected from within these, with the help of information provided by forestry administration personnel and data reported in previous studies.
Due to the dispersion and heterogeneity of the studied oak stands, it is unviable to initially stratify them (Díaz-Maroto *et al*., 2005), so the study area has been considered as one unit, eliminating certain regions where the site particularities make the presence of some of the two studied species very difficult.
As no stratification of the territory was made, the location of the stands was chosen attending to a certain criterion of homogeneity, trying to maximize the representation of the characteristics of each region. Initially, it was considered a minimum stand area between 0.5 and 1 ha, which would permit installing inventory plots without any problem derived from the border effect (Hummel *et al*., 1959, Díaz-Maroto *et al*., 2006). The election of the sampling site must be resolved so that the chosen point does not present any accidental characteristic regarding to the region which it is representing.
When the stands were located, a permanent display of 92 sampling plots was installed with a rectangular shape and variable dimensions, attending to the stand density, so the number of trees of which diameter is bigger than the minimum inventoriable (5 cm) is not below 50 (Hummel *et al*., 1959; Rondeux, 1993). Physiographic, dendrometric and profile data were taken, which, together with the climatic ones adapted to the sampling points, were useful to elaborate a group of parameters of the physiograhic, climatic and edaphic habitat of each species (Gandullo *et al*., 1991; Timbal and Aussenac, 1996; Rubio *et al*.,1997; Blanco *et al*., 2000).
A total of 39 parameters were measured: 25 ecological (4 physiographic, 5 climatic and 16 edaphic) and 14 stand parameters (Table 1).
The physiographic parameters used to describe the orography of each of the zones studied were altitude and mean slope, soil depth to parent material and closest distance from the sea (Rubio *et al*., 1997; Díaz-Maroto *et al*., 2005, 2006). The climate was described by the following parameters: total annual and summer precipitation, annual mean temperature and annual mean of absolute maximum and minimum temperature (Carballeira *et al*., 1983). Within the ecological parameters, 16 edaphic parameters were also considered for evaluating the chemical properties and the soil fertility (Gallardo *et al*., 1995; Covelo and Gallardo, 2002;

Marcos and Lancho, 2002; Bravo-Oviedo and Montero, 2005), including pH (H_2O), organic matter, total nitrogen, carbon/nitrogen ratio (C/N ratio), available phosphorus and exchangeable potassium, calcium and magnesium. We considered both the total value for the entire edaphic profile, calculating the weighted mean for the whole profile by the method of Russell and Moore (1968), as well as the surface value, using the data for the upper 20 cm, except where this corresponded to more than one horizon, when a weighted mean was calculated. Finally, to evaluate the structure and the silviculture of these forests, the following stand parameters were calculated: number of trees and basal area per hectare, mean arithmetic and quadratic diameters, dominant diameter (mean diameter of 100 thickest d.b.h. trees per hectare), mean arithmetic and quadratic heights, Assmann's dominant height (Assmann, 1970), standard deviation and coefficient of variation of the diameter and height distributions, Hart's index (HAI) (which estimates the distribution of trees in relation to dominant height trees) and Czarnowski's index (trees number in a squared plot of side equal to the arithmetic mean height) (Timbal and Aussenac, 1996; Claessens *et al*., 1999).

2.3 Statistical analysis

Measurement of the set of parameters allowed the establishment of a database of information on the biotopes and the silvicultural characteristics of *Quercus petraea* stands in Galicia. To explain which of these parameters best characterize the silvicultural treatments and present situation of Galician oak forests, as well as to study the possible relationship with the biotope, two types of analysis were carried out.

The application of univariate analysis (Walpole *et al*., 1999) allowed calculation of a series of characteristic values for the habitat of the species. To identify the most statistical significant parameters a bivariate analysis (correlation matrix) was made between silvicultural information and dasometrical and silvicultural parameters, and between silvicultural information and the parameters that describe the biotope (Walpole *et al*., 1999). Subsequently, the correlation matrix made possible to set out a Principal Component Analysis (PCA) (SAS Institute Inc., 2004). With this, it could be identified how dasometric/silvicultural and ecological parameters, more significantly related, explain the variability of oak stands of *Quercus petraea* (Timbal and Aussenac, 1996; Ryan, 1997).

The idea of PCA consists on obtaining lineal combinations of the original variables, so they explain the most possible quantity of variability of data. The PCA technique presents a double use: it allows representing optimally within a small dimension space, observations of a general space with bigger dimension. It also allows converting the original variables generally correlated, into new non-correlated variables that make the interpretation easier (SAS Institute Inc. 2004).

3. Results

From the data obtained in the stand inventories and, later, from the parameters calculated, we obtained the information necessary to characterize the habitat of *Quercus petraea* on a regional scale in the northwest of Spain. The descriptive statistics for the 39 parameters considered are shown in Table 2.

In most cases, the stands occur at altitudes above 1000 m and with steep slopes, sometimes extremely steep (more than 75%) and predominantly in shady orientations. To characterize the *Q. petraea* habitat on a regional scale in the north-west Iberian Peninsula, the values corresponding to the parameters selected in the study of biotope and silvicultural status were considered as reference data.

The univariate analysis of the physiographic and climatic descriptive statistics revealed that the highest variability was obtained in the orientation and mean temperature in the coldest month parameters, with coefficients of variation higher than 70%, and in some extreme cases, i.e. annual mean of absolute minimum temperatures and duration of drought, the values were higher than 100 and 200%, respectively. The lowest variability corresponded to temperature range, annual potential evapotranspiration and hydric index, with coefficients lower than 10%. Of the 18 edaphic parameters, 12 showed VC higher than 40%, and in some of these (surface phosphorus, total and surface calcium) higher than 100%; only the total and surface pH showed low variability, with CVs lower than 10%. Within the silvicultural statistics, the high VC of the parameters number of *Q. petraea* non-inventoriable or dead trees, total number of non-inventoriable or dead trees and regenerated saplings were notable. In contrast, the height variables (mean arithmetic height, mean quadratic height and Assmann's dominant height), the dominant diameter and the basal area showed the lowest variability.

The physiographic, climatic and edaphic parameters were used to identify the most discriminatory ecological parameters in the habitat of the sessile oak. As a result of the classification, with the establishment of Pearson Lineal correlation coefficients these forests can be well characterized by one physiographic (mean altitude), two climatic (winter precipitation and temperature index) and, above all, several edaphic parameters (surface pH, surface potassium, surface organic matter and total calcium) (Tab. 3). Similar bivariate analysis was then used to select the silvicultural parameters that showed the most significant interrelationships, i.e. number of trees per hectare, mean arithmetic diameter, mean quadratic diameter, mean arithmetic height, Assmann's dominant height, mean quadratic height and dominant diameter. In theory, these variables should be the best descriptors of the use and present status of *Q. petraea* forests in the study area.

All this information represented the starting point of the most important aim of this work: Design a Principal Component Analysis of the most descriptive parameters managed in the current study. As result of this analysis, for new variables from combinations of the previous parameters were created, accounting for more than 70% of the existing variability, and they can be assimilated to maturity of the stand, surface pH, surface potassium, and forest altitude.

4. Discussion

The *Quercus petraea* studied forests was most variable in terms of physiographic and climatic parameters, with coefficients of variation higher than 70% for some parameters. This initial univariate analysis of the physiographic and climatic parameters also showed the important variability of duration of drought, annual mean of absolute minimum temperatures, mean temperature in the coldest month, orientation... In extension, the absence of drought in many forests, as was contrasted years ago by Carballeira *et al*. (1983), gave rise to important variation of the duration of drought in the whole of studied forests. The direct consequence drives to the wide range of sites where *Q. petraea* is sited in the NW of the Iberian Peninsula.

The orientation of these forests is not always to north, as is considered as fixed many times. In these forests the shady locations predominate. However, in this area, *Q. petraea* is a semi-light-demanding species with a "non typical" sites with orientations between east and west (Vila-Lameiro, 2003). Propping up these ideas, the termal variability is high, with a wide temperature range, accentuated by the altitude range within the study area (Vila-Lameiro and Díaz-Maroto, 2002).

This wide distribution is possible due to many of these forests have survived in sites where felling is very difficult because of the physiographic conditions (Fernández Prieto and Vázquez, 1985), with an homogeneous humid oceanic climate, with scarce continental influence (Amigo and Romero, 1994).

Related to the silvicultural characterization, the *Q. petraea* forests in the NW of the Iberian Peninsula present a high variation on age, site quality, and harvesting techniques. The principal consequence of this reality is that, at present, there're no pure stands (Vila-Lameiro, 2003). The statistics of the dendrometric/silvicultural parameters provide an idea of the heterogeneity of these forests. This heterogeneity is mainly focused in non-inventoriable and dead trees and in the regeneration status. Although the presence of non-inventoriable trees of sessile oak is rare, the mortality is high, in contrast to the accompanying species, which adapt well to the closed undergrowth with little available light, at least in the early stages of development (Jarret 1996; Kelly, 2002). From the set of stand parameters selected by bivariate analysis to describe the use and present status of the oak stands, the results showed that the species is affected by certain unsuitable silvicultural treatments to which the stands have been subjected, such as pollarding and felling of trees to provide firewood and food for livestock. However, these are the suitable parameters for correctly definition of sessile oak stands in Galicia (Timbal and Aussenac, 1996; Rubio *et al*., 1997), and it can be established that the distribution of the stands are more closely related to the physiographic and climatic characteristics than to edaphic factors probably because the substrates' character on which the stands develop is similar (Díaz-Maroto *et al*., 2005, 2006).

The PCA results are consistent with the spatial distribution, being notable the relation between plots in the Asturian mountains, in Ancares (Lugo and Leon) and in the Leonese valleys. All these groups, make reference, as was said, to the exploitation practices, frequently with marked differences between this three big distribution areas (Vila-Lameiro, 2003).

5. Conclusions

The plot discriminant analysis was efficient in classifying the biotopes occupied by *Q. petraea* in the northwest Iberian Peninsula, obtaining a classification of the randomly sampled plots. However, the distribution of sessile oak forests in the study area depends as much on the physiographic and climatic characteristics of the territory, such as the edaphic conditions.

The data obtained could be used to find silvicultural alternatives to manage and maintain these forests and to obtain more profitable production than by traditional methods, such as high forest conversion of the stands, maintenance of the coppice forest in areas where firewood is still used, silvopastoral improvement in zones with grazing importance and the restoration of very degraded stands through reforestation with other native broadleaved trees.

Table 1. Ecological, phisiographycal and silvicultural parameters.

Number	*Parameter (unit)*	*Code*
1	Mean altitude (m)	ALT
2	Mean slope (%)	PND
3	Soil depth to the parent rock (cm)	PRO
4	Closest distance from the sea (km)	DM
5	Annual precipitation (mm)	PT
6	Summer precipitation (mm) SP	PE
7	Mean annual temperature (°C)	TM
8	Annual mean of absolute maximum temperatures (°C)	TMA
9	Annual mean of absolute minimum temperatures (°C)	TmA
10	Total pH in H_2O	PH
11	Surface pH in H_2O	PHS
12	Total organic matter (%)	MO
13	Surface organic matter (%)	MOS
14	Total nitrogen (%)	N
15	Surface nitrogen (%)	NS
16	Total C/N ratio	C/N
17	Surface C/N ratio	C/NS
18	Total available phosphorus (ppm)	P
19	Surface available phosphorus (ppm)	PS
20	Total exchangeable potassium (ppm)	K
21	Surface exchangeable potassium (ppm)	KS
22	Total exchangeable calcium (ppm)	Ca
23	Surface exchangeable calcium (ppm)	CaS
24	Total exchangeable magnesium (ppm)	Mg
25	Surface exchangeable magnesium (ppm)	MgS
26	Number of trees per hectare (N_0 ha^{-1})	DEN
27	Basal area per hectare (m_2 ha^{-1})	ABA
28	Arithmetic mean diameter (cm)	DMA
29	Quadratic mean diameter (cm)	DMC
30	Standard deviation of the diameter distribution (cm)	DED
31	Coefficient of variation of the diameter distribution (%)	CVD
32	Dominant diameter (cm)	DOM
33	Arithmetic mean height (m)	HMA
34	Quadratic mean height (m)	HMC
35	Standard deviation of the height distribution (m)	DEA
36	Coefficient of variation of the height distribution (%)	CVA
37	Assmann's dominant height (m)	HAD
38	Hart's index (%)	IHA
39	Czarnowski's index	ICZ

Table 2. Statistical descriptive parameters of *Quercus petraea* stands with n=92.
(SD: Standard Deviation, VC: Variation Coefficient). Variables present adimensional units.

Parameter	*Mean*	*SD*	*CV (%)*	*Maximum*	*Minimum*
ALT (m)	1053,3	196,3	18,6	1395	540
PND (%)	48,4	17,6	36,4	90	7,9
PRO (cm)	103,6	44,6	43,1	190,0	25,0
DM (Km)	84,8	20,8	24,5	129,0	34,0
PT (mm)	1589,5	249,1	15,7	2006,0	1150,0
PE (mm)	192,5	28,5	14,8	227,2	143,5
TM (ºC)	8,8	2,0	22,7	11,0	5,0
TMA (ºC)	20,8	2,8	13,5	23,4	17,7
TmA (ºC)	-2,6	2,9	111,5	-0,1	-5,9
AMT (ºC)	13,3	0,7	5,3	14,8	12,0
PH	4,73	0,36	7,6	5,65	4,23
PHS	4,59	0,43	9,4	5,60	3,90
MO (%)	7,83	4,04	51,6	19,83	1,82
MOS (%)	10,09	4,56	45,2	24,31	2,89
N (%)	0,25	0,11	44,0	0,55	0,07
NS (%)	0,32	0,13	40,6	0,72	0,10
C/N	17,92	3,75	20,9	23,14	8,83
C/NS	14,07	4,06	28,9	20,99	6,63
P (ppm)	9,53	7,49	78,6	24,80	0,93
PS (ppm)	12,57	14,49	115,3	52,69	0,76
K (ppm)	90,04	52,90	58,8	275,09	25,69
KS (ppm)	114,68	56,19	49,0	264,51	37,10
Ca (ppm)	203,21	275,67	135,7	1135,07	13,19
CaS (ppm)	291,29	342,47	117,6	1431,85	14,01
Mg (ppm)	45,54	42,50	93,3	164,96	3,76
MgS (ppm)	61,88	46,78	75,6	198,87	4,79
DEN (No ha-1)	990,0	495,9	50,1	2950,0	267,0
ABA (m2ha-1)	31,3	6,8	21,7	54,0	17,6
DMA (cm.)	21,4	7,9	36,9	41,5	2,4
DMC (cm)	23,8	7,2	30,3	43,2	12,0
DED (cm)	8,5	2,5	29,4	15,5	3,7
CVD (%)	39,7	11,2	28,2	65,0	16,0
DOM (cm)	35,2	7,6	21,6	55,1	18,7
HMA (m)	15,7	3,2	20,4	23,9	11,3
HMC (m)	4,0	0,4	10,0	4,9	3,4
DEA (m)	3,0	0,9	30,0	5,8	1,1
CVA (%)	15,8	6,3	39,9	39,0	6,5
HDA (m)	17,5	3,9	22,3	27,3	10,2
IHA (%)	20,5	5,9	28,8	37,0	11,0
ICZ	23,1	11,1	48,1	56,2	7,0

Table 3. Pearson Lineal correlation coefficients between the most statistical significant parameters.

	DEN	*NIQ*	*NMQ*	*NIT*	*NMT*	*REG*	*ABA*	*DMA*	*DMC*	*DED*	*CVD*	*DOM*	*HMA*	*HMC*	*DEA*	*CVA*	*HDA*	*IHA*	*ICZ*
DEN	1,000	,392**	,596**	n.s.	,511**	n.s.	n.s.	-,604**	-,782**	-,510**	n.s.	-,602**	-,455**	-,387**	n.s.	,372**	-,365**	-,491**	,584**
NIQ		1,000	n.s.	,281*	n.s.	n.s.	n.s.	-,294*	n.s.	n.s.	n.s.	n.s.	-,427**	-,361**	n.s.	n.s.	-,534**	,348*	n.s.
NMQ			1,000	n.s.	,879**	n.s.	n.s.	-,357**	-,444**	n.s.	n.s.	-,324*	n.s.	n.s.	n.s.	,312*	n.s.	-,336*	,399**
NIT				1,000	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
NMT					1,000	n.s.	n.s.	-,372**	-,454**	n.s.	,274*	-,350*	n.s.	n.s.	n.s.	,329*	n.s.	-,324*	,339*
REG						1,000	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
ABA							1,000	,373**	,379**	,303*	n.s.	,398**	,504**	,472**	n.s.	n.s.	,435**	n.s.	,367**
DMA								1,000	,823**	-,604**	-,305*	,660**	,604**	,547**	n.s.	-,351*	,472**	n.s.	n.s.
DMC									1,000	,596**	n.s.	,784**	,639**	,554**	n.s.	-,350*	,508**	,361**	-,329*
DED										1,000	,598**	,731**	,400**	,337*	n.s.	n.s.	,433**	n.s.	n.s.
CVD											1,000	n.s.	n.s.	n.s.	n.s.	,667**	n.s.	n.s.	n.s.
DOM												1,000	,493**	,429**	n.s.	n.s.	,465**	n.s.	n.s.
HMA													1,000	,774**	n.s.	-,353*	,885**	-,285*	,383**
HMC														1,000	n.s.	-,305*	,680**	n.s.	n.s.
DEA															1,000	n.s.	312*	-,291*	n.s.
CVA																1,000	n.s.	n.s.	n.s.
HDA																	1,000	-,510**	,413**
IHA																		1,000	-,781**
ICZ																			1,000

Statistical signification level (s): *, s > 95%; **, s > 99%; n.s., non significative.

RIASSUNTO

Caratterizzazione incrementale, bioclimatica e selvicolturale dei boschi di quercia (*Quercus petraea* Matts Liebl.) nel nord-ovest della Penisola Iberica attraverso cluster analysis: linee guida di gestione

Le foreste di *Quercus petraea* oggetto di questo lavoro sono parte delle foreste quercia che coprono la maggior parte della superficie del NW della Spagna..
La tendenza generale di queste foreste autoctone è stata la progressiva trasformazione in piantagioni di specie a rapido accrescimento, che hanno una maggiore produttività, impossibile da raggiungere con i querceti attuali e con il metodo di gestione applicato. Questo metodo consiste, stranamente, in assenza di qualsiasi metodo. Di conseguenza, l'amministrazione regionale cerca di variare e invertire questa tendenza.
Tuttavia, dal punto di vista della produzione, questi querceti hanno un elevato potenziale, non solo a causa del valore elevato del loro legname. Al di là della produzione di legname, sono di grande interesse anche i prodotti forestali "secondari" (funghi, miele, erbe aromatiche, piccoli frutti, ...). Quindi è necessario evitare la degradazione / scomparsa della specie. Inoltre, va aggiunto l'effetto che queste foreste hanno nel bilancio idrico, per la conservazione del suolo, della fauna e della vegetazione etc. e l'uso ricreativo e di caccia che essi permettono. Spesso, queste foreste sono considerate aree sensibili di pianificazione speciale. Di conseguenza, la mancanza di informazioni specifiche e aggiornate su di loro giustifica uno studio come questo, che lontano dal proporre obiettivi economici imminenti per i risultati, cerca di ottenere informazioni di base per il miglioramento, la manutenzione e la possibile espansione di queste formazioni. Il punto di partenza per guidare la gestione delle specie forestali inizia dalla descrizione e caratterizzazione ecologica e dendrometrica, già fatto in precedenti lavori. In questo lavoro è stato fissato come obiettivo la creazione di relazioni tra la foresta demaniale e altri parametri, in particolare quelli connessi alle tendenze bioclimatiche e alla rinnovazione.
Tale caratterizzazione è stata completata con la determinazione delle cause che spiegano l'attuale distribuzione di *Quercus petraea* nel NW della penisola iberica. Questa conoscenza è utilizzata per confrontare le somiglianze tra le posizioni teoriche e effettive della specie all'in-terno dell'area di studio.
Il risultato è stata la classificazione dei popolamenti di *Quercus petraea* nel NW della penisola iberica attraverso la cluster analysis. Il primo gruppo, comprende giovani querceti che si sviluppano con densità superiori e un'elevata crescita diametrica. Sono state poi individuate foreste significativamente più mature con densità simili al gruppo precedente, ma con incrementi diametrici inferiori in situazioni topografiche simili. Queste foreste corrispondono a aree con clima più mediterraneo. Infine, il gruppo delle foreste mature, con una crescita diametrale circa 1,5 mm/anno sono presenti in stazioni meno accidentate. Questi querceti sono collegati a un clima più atlantico e maggiore fertilità. La distribuzione di questi tre gruppi è legata a diverse condizioni climatiche con apparente indipendenza dalle attività umane e buona correlazione con i *pattern* naturali di rinnovazione. Alla fine, e come applicazione di questa classificazione, è stata ottenuta una distribuzione geografica delle foreste studiate in grado di fornire indicazioni per il miglioramento selvicolturale e gestionale.

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