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OLD-GROWTH FORESTS IN ITALY: TOWARDS A FIRST NETWORK

Although the forest systems in Italy have been subjected to the influence of human activities ever since thousands of years, some remote areas maintained a high degree of naturalness, representing an important legacy both in terms of resources and biological diversity. In recent decades, the increasing costs of silvicultural practices has led to the concentration of timber exploitation in the most easily accessible zones and, consequently, to the abandonment of several stands. As a result, the interest in woodlands driven by predominantly natural dynamics has been growing considerably.

These general observations provided the starting point for the project Old-growth forests in Italian National Parks*, which is promoted by the Nature Protection Directorate in collaboration with the* Biodiversity, Plant Sociology and Landscape Ecology *Interuniversity Research Centre of the Sapienza University of Rome. The first phase of this project was conducted between 2006 and 2009. It was aimed at gathering information on Italian forests with old-growth features, selecting those that satisfy the old-growth forest definition drawn up for the purposes of this project. The selected forests have been mapped, classified according to an old-growth scale and included in a geodatabase that stores structural and vegetation data. Although Italy does not boast forests that have never been touched or have not been disturbed for several centuries, numerous forests with old-growth features were identified and studied. The considerable variety of vegetation types that characterize these forests makes this sample an important starting point for a nationwide Old-growth Forests Network, which may become the object of important monitoring initiatives, taking into account also persistent woodlands.*

Key words: National Biodiversity Strategy; Italian National Parks; old-growth features; vegetation series; forest types; old-growth forests network.

Parole chiave: strategia nazionale per la biodiversità; parchi nazionali italiani; caratteri di vetustà; serie vegetazionali; tipologie forestali; rete di boschi vetusti.

1. Introduction

The term old-growth forest has broadly been used to indicate stands in a developmental phase characterized by a high structural heterogeneity. Although various attempts have been made to define the term "old-growth"

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more accurately, these forests are inevitably characterized by some similarities and numerous differences depending on the forest types; a widely accepted definition for this term has consequently not yet been found. A concise definition was proposed in a conference, organized by FAO in 2001, that was aimed at the harmonization of forest related definitions. The definition of old-growth forest drawn up by the participants on that occasion is *an old-growth forest is a primary or a secondary forest which has achieved an age at which structures and species normally associated with old primary forests of that type have sufficiently accumulated to act as a forest ecosystem distinct from any younger age class* (UNEP/CBD/SBSTTA, 2001). It is, however, difficult to apply this definition when attempting to identify old-growth forests; simply because primary forests of most forest types no longer exist, especially in Europe. We have, therefore, decided to cite some of the definitions (which refer to temperate forests) that have been proposed since 1980, in order to provide a brief illustration of the scientific discussion surrounding this issue and highlight the most widely accepted criteria.

In Northern America, the interest surrounding old-growth forests suddenly increased in the 1980s, following some noteworthy studies conducted particularly in the Pacific Northwest. An "Old-growth definition task group" was founded, in that region to draw up a definition based on precise parameters that had previously been identified as significant by FRANKLIN *et al*. (1981), such as the number of stems over a certain size and the amount of standing and fallen deadwood. Indeed, this observation underlies one of the most widely used definitions of old-growth: *Old-growth forests are ecosystems distinguished by old trees and related structural attributes […] that may include tree size, accumulations of large deadwoody material, number of canopy layers, species composition, and ecosystem function* (USDA, 1989). Studies from the temperate region of South America report on forests with old-growth features in Chilean Islands. Although the studies conducted in this region do not focus on criteria in the old-growth definition, the main structural features of such forests are identified: tree basal area, density of shade-tolerant species, tree species richness, presence of large canopy emergent trees, high vertical heterogeneity and minimum stand ages older than 200 years (GUTIÉRREZ *et al*., 2009; LOMBARDI *et al.,* 2010a).

In Asia, the temperate forests most widely recognized as being old-growth in the literature are the ones located in the Changbaishan Natural Reserve (China). Although the studies conducted in this area do not focus on the definition of old-growth either, they do describe the main structural and compositional features of those forests. From a structural point of view, the J-shaped diameter class distribution characterizes this site, as does the occurrence of large trees. Besides these features, the Chinese studies highlight

the importance of the spatial pattern of trees and canopy openings (WANG *et al.*, 2008).

Australian scientists were the first to focus on the diverging features of old-growth forests according to the different forest types and regions, thus recognizing the difficulties involved in defining such ecosystems. The Australian point of view focuses on the disturbance regime to which forests are subjected, the definition provided by WOODGATE *et al.* (1996) being *a forest which contains significant amounts of its oldest growth stage in the upper stratum – usually senescing trees – and has been subjected to any disturbance, the effect of which is now negligible*.

The European Perspective takes in account structural features (large old trees) and disturbance history (lack of human disturbance at least since the development of the trees now present) (NILSSON *et al.*, 2002). The definitions reported in a French review on this topic (GILG, 2004) are:

– *ecosystems that are differentiated by the presence of old trees and by the structural characteristics that are included;*
– *forests including the final stages of site development, which typically differ from more recent ones by: tree size, the accumulation of large quantities of deadwood, the number of arborescent storeys, specific composition and ecological functions;*
– *forests without signs of recent logging that contain native species.*

There are several reasons, related to biodiversity and forest management, that justify the study of old-growth forests. Many authors recognize old-growth forests as an important reference point when evaluating human impact on forest ecosystems (PETERKEN 1996; KEETON 2006; CIANCIO *et al.*, 1999), within the global view of achieving a Sustainable Forest Management which integrates ecological, social and economic objectives (UNCED, 1992; FAO, 2005). In this contest, the term of "*hemeroby*" is often used for the purpose of defining the degree of human influence on forests (HILL *et al.*, 2002).

Moreover, forest management has been shown to have an impact on biological diversity of different taxonomic groups, such as invertebrates (SIITONEN, 2001), lichens, mosses, fungi (NORDEN *et al.*, 2007), birds (JANSSON and ANDREN, 2003) and vascular plants (AUDE and LAWESSON, 1998). In recent decades, numerous studies have highlighted the important role played by old-growth forests in maintaining a high degree of biological diversity (FRANKLIN and SPIES, 1991; KEDDY and DRUMMOND, 1996). Indeed, biological diversity results from the presence of interior forest species which benefit from low disturbance levels and from the presence of suitable microhabitats created by structural heterogeneity (NORDÉN and APPELQVIST, 2001). The scale at which disturbance acts is also very important for species diversity. Old-growth forests are more often affected by a small-scale

disturbance (*gap dynamic*), which causes a high structural heterogeneity that markedly influences the species/area curve (PETERKEN, 1996).

Moreover, small-scale disturbance is closely related to the concept of Ecological Continuity, i.e. the persistence for a long time and in the same place, of similar environmental conditions only marginally affected by disturbance events. This term is often applied to old-growth forests, as well as natural woodland and many forest organisms are assumed to be dependent on this condition.

Also deadwood play a key role to maintain biological diversity (CHRISTENSEN and EMBORG 1996). Decaying wood is recognized as a typical features of old-growth forests since the amount of deadwood depends on stand age and disturbance regime. It is fundamental for a variety of species in different taxonomic groups, such as invertebrates (SAMUELSSON *et al.*, 1994), fungi (HEILMANN-CLAUSEN 2001), bryophytes (ÓDOR and STANDOVÁR 2001), lichens (HUMPHREY *et al.*, 2002), amphibians (RAYMOND and HARDY 1991), small mammals (HARMON *et al.*, 1986), birds (MIKUSINSKI and ANGELSTAM, 1997) and plants (BURRASCANO *et al.*, 2008).

The need to study old-growth forests has been recognized both in the scientific literature and by several international agreements designed to promote biodiversity conservation, since the beginning of 2000, in several initiatives aiming to establish European Forest Reserves Networks (CULLOTTA *et al.*, 2005). The Pan-European Biological and Landscape Diversity Strategy (Action Theme 9) indicates the following goals:

– the conservation of adequate areas to ensure the preservation of all types of forests in Europe [...], the majority of the remaining ancient secondary woodland;
– the conservation of forest habitats of species requiring large undisturbed forest ecosystems, including the high profile Bern Convention, Habitats Directive and UNECE threatened species. At regional scale the strategy aims to strengthen sustainable management and protection of viable old-growth forests in south-western and south-eastern Mediterranean regions to prepare case studies and ensure the exchange of expertise in the process.

Despite the fact that the forest area in Europe are expanding at an annual net rate of 510000 ha (EUROPEAN COMMISSION, 2010), the European Strategy for Plant Conservation (2008-2014) has pointed out that old-growth forests with a high biodiversity, are threatened by intense logging, at times illegal, especially in southeastern Europe. To preserve plant diversity, the strategy aims to ensure the sustainable management of at least 30% of forests exploited for commercial purposes.

Old-growth forests are very rare in Europe, and even more so in the Mediterranean region (GILG, 2004). In Italy, the exploitation of natural

resources dates back thousands of years, though it was particularly severe during World War II and immediately after. Stands with old-growth characteristics were unknown until a few years ago (MOTTA, 2002), while recently detected stands have been the subject of thorough investigations by Italian researchers (PIOVESAN *et al.*, 2005; BURRASCANO *et al.*, 2008 and 2009; MOTTA *et al.*, 2010; VETTORI *et al.*, 2010).

The Ministry of Environment, Land and Sea Protection funded a research program aimed at creating an Old-growth Forest Network in Italian National Parks. This project was coordinated by the "Biodiversity, Plant Sociology and Landscape Ecology" Interuniversity Research Center of the Sapienza University of Rome and involved all the Italian National Parks, several University Departments and the National Forest Service. The ultimate goal of this research program is the creation of a Network of old-growth stands that characterizes, as closely as possible, the Italian forest types (BARBATI *et al.*, 2007; EEA, 2006) from an ecological and phytogeographic point of view. This network represents a starting point for further investigations aimed at identifying sustainable management guidelines especially in terms of biological diversity. It would be very important to follow rigorous procedure to select areas and plots for monitoring stands with characters of old-growth or persistent woodlands, even according to recent and advanced proposals (CORONA *et al.*, 2010).

2. MATERIAL AND METHODS

The different phases of the project, aimed to built up a base for the Italian network are synthesized in Figure 1. In order to collect data and to detect stands with old-growth and persistent features it was decided to start from the most important protected areas, and a questionnaire was sent to 23 National Parks Agencies and the related coordinating units (CTA) of the National Forest Service. A preliminary list of stands was then drawn up by combining the questionnaires and suggestions given by local experts. Sites were then selected from the list according to how representative they were, and surveys have been conducted by local experts. Vegetation and structural analyses were performed in each selected site to describe the stands and evaluate their membership to Vegetation Series by means of phytosociology. Structural sampling was performed following an *ad hoc* protocol (BURRASCANO *et al.*, 2008). The survey scheme was designed to highlight the main old-growth features, such as the presence of large, old trees and deadwood, in order to determine the degree of old-growth of each stand. In order to assess the degree of representativeness of the stands, a census of the

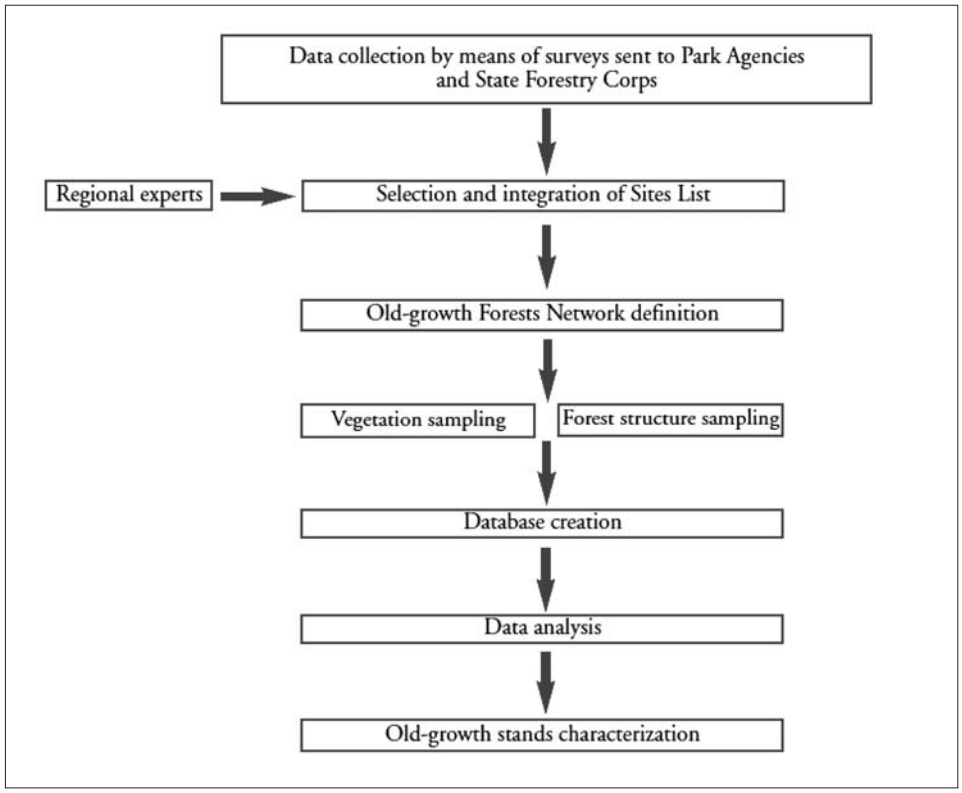

Figure 1 – The stages followed in order to built up the network (in: BLASI *et al.*, 2010).

Vegetation Series was conducted in each National Park. The map of forest types, derived from Corine Land Cover (CLC) map (IV level) (MARICCHIOLO *et al.*, 2005) and the Map of Vegetation Series of Italy (BLASI, 2010) were intersected. This overlay allowed to estimate the extension of each forest type within the Italian National Parks and, consequently, to select old-growth forest network sites according to their degree of representativeness (Figure 1).

3. STANDING TREES SURVEY SCHEME

Circular areas with 4, 13 and 20 m radius have been surveyed. Standing trees were measured if diameter at breast height (DBH) was equal to or greater than 2.5 cm in the smaller survey area; if DBH was equal to or greater than 10 cm in the intermediate area; while in the largest circle, standing trees were surveyed only if DBH was equal to or greater than 50 cm. Height were measured on every 10 sampled trees; the height of the other trees was

estimated by standard two-way volume equations related to each species (MAF, 1984). The species of all the surveyed trees was recorded; moreover we classified each tree according to a four-grade vitality scale: 1, living; 2, living with dead parts; 3, standing dead; 4, snag (standing dead trees between 1.3 and 4 m hight).

4. Lying deadwood survey scheme

In order to assess woody necromass, the survey scheme proposed in the European ICP Forest level - II monitoring areas was used as reference (Travaglini *et al.*, 2006; Lombardi *et al.,* 2008). The survey unit consists of a circular plot with 12 m radius, concentric with the previously described survey units. We measured lying deadwood components (logs, lying woody debris and stumps) with a diameter greater than 10 cm. The protocol required field surveys of DBH and length of all dead downed trees; length and diameter at half-length of all lying deadwood pieces; height and diameter at the top end of all stumps. Finally, the decay level of each deadwood component was recorded through a visual assessment of morphological wood features according to the five-class system described by Hunter (1990).

5. Old-growth level assignment

In order to assign a level of old-growth to each stand, three structural features were considered:
– diameter distribution of living trees;
– amount of deadwood (volume);
– quality of deadwood (decomposition classes).

Diameter distribution and number of large trees attest to stand age and heterogeneity; the amount of deadwood, including the analysis of its various components, is internationally considered as an indicator of old-growth (Pedlar *et al.*, 2002; Wirth *et al.,* 2009); lastly, the number of decomposition classes and the maximum decomposition class within each site were used to estimate the period of time in which no disturbance events occurred (whether it be felling or woody debris collection).

As regards-living structure, from 0 to 4 points were assigned to each stand. The score depended on how closely the living structure fitted the diameter correspondence curves usually associated to old-growth stands, i.e. the reverse J-shape curve, which attests to the presence of numerous young trees and a decreasing number of trees with a larger DBH, and the rotated sigmoid curve, which is the semilog graph of the tree number per DBH class

(LORIMER and FRELICH, 1984). Another point was assigned on the basis of the number of large trees (DBH > 40 cm) per hectare. Every site with more than 70 large trees per hectare gained a point (NILSSON *et al.*, 2002). A further four points were assigned for the amount and the quality of deadwood, two points being assigned for amount of deadwood per hectare and two points for the quality, the latter being determined on the basis of the number of decomposition classes and maximum class observed.

The stands scores thus ranged from a minimum of 0 to a maximum of 9 points. Each stand was then assigned to one of three old-growth levels: low (0÷3), medium (4÷6) or high (7÷9).

A list of the vegetation series present, a map of the old-growth forests included in the Network and the structural and vegetation analysis of the selected sites were produced for each National Park.

As the number of sites detected on the basis of the questionnaire showed that interpretation of the definition provided varied depending on the park, field surveys were conducted to assess the accuracy of the information provided by the questionnaires.

Sites were ultimately selected on the basis of both their old-growth level and the Potential Natural Vegetation of the site in order to include as many forest types as possible in the network.

6. MAIN RESULTS AT NATIONAL AND AT SITE LEVEL

A preliminary list of stands was drawn up by combining the questionnaires and suggestions given by local experts. Sites were then selected from the list according to how representative they were, and surveys were conducted by local experts (Table 1).

Table 2 refers to the level of old-growth assigned to one of three old-growth levels: low, medium or high. A map of the old-growth forests included in the Network, where the structural and vegetation analysis of the selected sites were produced for each National Park is showed in Figure 2. Sixty-eight forests were included in the Network, as showed in Table 3, where also the number of forest types included in the network are reported. The parks in which most sites were found are the largest, the most heterogeneous and oldest. As regards forest types, *Fagus sylvatica* woods largely prevail among the numerous forest types included in Old-Growth Forest Network. Nevertheless, the number of forest types (Table 3) included in the network is relatively high (16).

Among the selected stands, some sites could be discussed. One of those displaying the most marked old-growth features is located in *Valle Cervara*,

within the Abruzzo, Lazio and Molise National Park. From the silvicoltural point of view, it was untouched for at least one century because of far and difficult access; moreover, it was never subjected to catastrophic disturbances in this period. The old-growth examined stand extends over an area of approximatively 24 hectares, on a north facing slope between 1600 and 1850 m a.s.l. It is dominated by *Fagus sylvatica*, and can be referred to the *Cardamino kitaibelii - Fagetum sylvaticae* (*Aremonio-Fagion*) association, which includes the neutro-basiphilous beech woods located at the highest altitudes in the central and northern Apennines. This forest was selected for further analysis because of its structure, which is highly diversified as it includes almost all phases of the forest life cycle (PIOVESAN *et al.*, 2005). The various cohorts are due to the progressive death of dominant trees, some of which are older than 500 years (this finding could disprove the previously held belief that the beech life cycle in Mediterranean region is shorter than 300 years), thereby creating a gap in the canopy that allows the regeneration of younger individuals.

Table 1 – Sites detected within the parks on the basis of the questionnaire (in: BLASI *et al.*, 2010).

National Park	*Sites detected*
Gran Paradiso	22
Abruzzo, Lazio & Molise	20
Pollino	19
Stelvio	18
Sila	18
Dolomiti Bellunesi	11
Aspromonte	8
Gennargentu	8
Gran Sasso	8
Majella	7
Valgrande	4
Cilento	3
Gargano	3
Asinara	2
La Maddalena	2
Sibillini	2
Circeo	1
Vesuvio	1
Total	*157*

Table 2 – Number of site in relation to the level of old growth assigned, considering three structural features: diameter distribution of living trees, amount of deadwood (volume) and quality of deadwood (decomposition classes) (in: BLASI *et al.*, 2010).

Old-growth level	*# of sites*
Low	26
Medium	37
High	5

Attributes such as stem density, large tree density, basal area, volume and biomass per hectare are comparable to those proposed by many authors for old-growth beech forests in Europe and for old-growth forests in general (NILSSON *et al.*, 2002; KEDDY and DRUMMOND, 1996; PETERKEN, 1996). The diameter distribution of the Valle Cervara stand can be modelled by a rotated-sigmoid curve, considered the natural steady-state diameter distribution (LORIMER and FRELICH, 1984). Although this site does contain a large amount of decaying wood it is less than that generally found in old-growth forests elsewhere in Europe and North America.

In order to investigate the compositional features of the Valle Cervara forest, a comparison was made between this forest and a managed beech

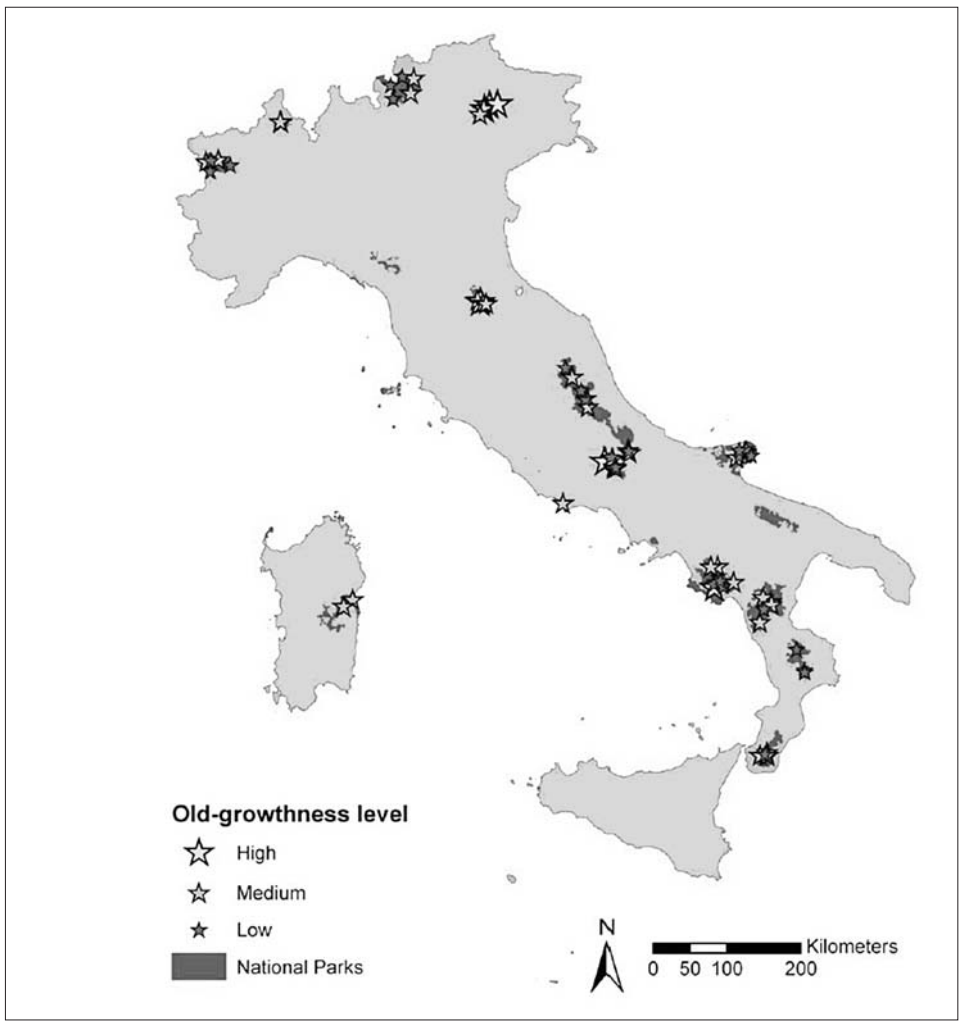

Figure 2 – Selected Old-growth Forests in Italian National Parks (in: BLASI *et al.*, 2010).

forest with similar environmental characteristics and the same potential natural vegetation (BLASI *et al.*, 2000; BLASI and MICHETTI, 2005; BURRASCANO *et al.*, 2008).

This approach was adopted in order to:

1) investigating differences in plant species composition;
2) assessing if these differences give rise to a higher plant diversity;
3) relating forest structure to differences in plant species composition identifying the structural attributes more strongly related to the unmanaged forest vegetation.

Table 3 – Sites selected according to vegetation type. The total number is higher than the N. of sites because some are made up of a mosaic of forest types (in: BLASI *et al.*, 2010).

National Park	*Sites selected*
Cilento & Vallo di Diano National Park	8
Gargano National Park	7
Abruzzo, Lazio & Molise National Park	6
Pollino National Park	5
Aspromonte National Park	5
Stelvio National Park	5
Dolomiti Bellunesi National Park	5
Gran Paradiso National Park	5
Majella National Park	4
Gran Sasso & Monti della Laga National Park	4
Foreste Casentinesi, Monte Falterona & Campigna National Park	4
Sila National Park	3
Gennargentu & Golfo di Orosei National Park	2
Monti Sibillini National Park	2
Valgrande National Park	2
Circeo National Park	1
Total	*68*
	Sites selected per National Park

Forest type	*Numbers of sites*
Fagus sylvatica woods	27
Fagus sylvatica and conifer mixed woods	13
Mesophilous mixed woods	4
Larix decidua and *Pinus cembra* woods	3
Larix decidua dominated woods	3
Quercus cerris dominated woods	7
Quercus ilex dominated woods	3
Picea abies dominated woods	3
Abies alba dominated woods	2
Pinus sylvestris woods	2
Carpinus betulus dominated woods	2
Pinus nigra subsp. *laricio* dominated woods	2
Quercus petraea dominated woods	1
Juniperus phoenicea and *Olea europaea* woods	1
Alnus cordata dominated woods	1
Alnus glutinosa dominated woods	1
Total	*75*

These analyses were performed in an attempt to compensate for the total lack of such information in Italy and the general scarcity of data regarding old-growth forest composition in Southern Europe. The results highlight significant differences between the two stands both from a structural and a compositional point of view. Indeed, the old-growth stand differs from the managed beech forest stand not only in the amount and quality of deadwood and in the diameter class distribution, but also in the

degree of vascular plant diversity, which is greater in the old-growth stand. The structural variables adopted for the purposes of this survey (lying woody debris, standing deadwood, number of decay classes, number of large trees and of diameter classes) proved to be what determines old-growth stand vascular plant species composition to the greatest extent, and are therefore those that need to be preserved most in a conservation-oriented forest management (BURRASCANO *et al.*, 2008). When the understorey species were analysed (BURRASCANO *et al.*, 2009), besides displaying a higher species richness, the old-growth stand revealed significant differences in plant species composition, functional traits, Ellenberg's indices and taxonomic distances. Indeed, the species that are typical of the old-growth forest included species that differed considerably in terms of functional traits: nemoral species with low dispersal ability, due to large seeds and to their dispersal mode, as well as species with traits that are more suited to open habitats, such as those characterized by a competitor strategy and small seeds that are prevalently dispersed by wind. The occurrence of diverse microhabitats in the unmanaged forest further enhanced the differences between the two stands, even in terms of Ellenberg's species indices. Most of the unmanaged forest indicator species are characterized by high light indices and nutrient concentration. Such species can compete successfully because of the gaps and the accumulation decaying wood in the old-growth forest, which determine a variety of forest floor microclimatic conditions. Finally, differences between the two stands in terms of taxonomical structure are not due exclusively to higher species richness, but also to the fact that the phylogenetic relatedness of two taxa is often linked to ecological similarity.

These results suggest that forest management induced ecological differences that could affect plant species composition; there is, therefore, the need to monitor forests more closely so as to be able to develop new approaches and practices in forest management aimed at the conservation of biodiversity, in line with the systemic approach in silviculture (CIANCIO and NOCENTINI, 2003).

Also some examples of persistent woodlands were studied across the Italian Peninsula, both on the Alps and on the Apennines. For instance, in the Dolomiti Bellunesi National Parks, some interesting persistent woodlands occurs. Particularly, nearby the municipality of Longarone (Bl), a Mountainous mixed spruce-silver fir forests of the transition zone of the Alps was investigated (LOMBARDI *et al.*, 2010b). The forest is currently unmanaged and grazing activities are absent. Through the measure and the analysis of forest structural attributes, the effective maintenance of actual conditions was evaluated, also using dendrochronological and lichen analyses and deadwood

decomposition dynamics. The stand structure suggests a deficiency in dimensional equilibrium between plants, and a tendency to form persistent woodlands.

In the Dolomiti Bellunesi National Park, also a mountain pine (*Pinus mugo* Turra) forests showed interesting traits typical of a persistent woodland (TOGNETTI *et al.*, 2010): the forest of *Monti del Sole*. This forest occurs on steep slopes, in an area where the accessibility is very difficult. For this reason, the stand has now reached structural and compositional traits typical of the mature stage of forest dynamics. Tree ages is remarkable and well differentiated and also an interesting spatial heterogeneity occurs, providing optimum habitat for many vertebrates. Moreover, this stand has a well-developed understorey vegetation.

Persistent woodlands should be monitored in the next decades, considering their capability to evolve to old-growth features, in absence of strong disturbances. In this sense, the study of direct and indirect indicators of past human influences is of crucial importance to identify woodlands that, even if still young, could evolve to significant old-growth traits in reasonable times. Therefore also the identification of the different stages succeeding from managed forests abandoned by human influences to old-growth forests, throughout persistent woodlands, should be understood throughout permanent monitoring. This approach could help to clarify the processes that characterize the *land use abandonment* that is a typical traits of several thousand hectares of forested areas.

7. POSSIBLE INTEGRATIONS TO THE NETWORK

This primary study was succeeded by other projects, such as the MIUR PRIN 2007 (*Sperimentazione di tecniche di misurazione della necromassa per la identificazione dei boschi vetusti*), where the main question was if deadwood occurrence can be considered as an indicator of naturalness in Mediterranean potential old-growth or persistent forests. In order to characterize unmanaged stands, their level of naturalness and the role of deadwood in identifying old-growth conditions in Mediterranean forests, 12 forest reserves across the Apennines in Italian peninsula were selected and a census of deadwood occurrence was conducted. Deadwood volume, types and decay stage were so inventoried and compared with living biomass and the occurring species.

This research represent a good opportunity to improve the first National network of old-growth forests in the National Parks, implementing new interesting forest areas occurring across the Apennine and Alpine

ecoregions (PIOVESAN *et al.*, 2010), suggesting also the need of integration of research activities, matching the knowledge of different research groups.

Moreover, this project could give also new results on the importance of a particular indicator of old-growth conditions: deadwood occurrence, its distribution and decay characterization. Particularly, results obtained should help to modulate the old-growth level already assigned to the selected forest stands (CHIRICI, 2010).

Moreover, in Italy, despite the rarity of old-growth forests *sensu strictu*, several other studies could be integrated, since they have already shown that thousand hectares of forested areas have reached structural and compositional traits typical of the mature stage of forest dynamics (MOTTA 2002; PIOVESAN, *op.cit.*) and have an important role for biodiversity conservation. Research on forest structure and stand dynamics shows that some traits of old-growth structure can be found in much younger forests (SPIES and FRANKLIN, 1988).

Forests in the Mediterranean region are currently experiencing human-guided reconstruction that should be distinguished from natural processes of forest succession, and these processes often exhibit divergent and unpredictable pathways.

As in many other Mediterranean areas, several forest area have reached a typical structural maturity of great interest for researchers and conservationists. This type of stands, showing an interesting late successional forest dynamics, may however not be easily defined following strict classification scheme of old-growth traits (SPIES, 2004): so, as already proposed, they could be defined as persistent woodlands (MARCHETTI *et al.*, 2010).

8. CONCLUSIONS

The study of old-growth forests and persistent woodlands opens a new season of forest research and conservation policies in Italy. Indeed, these results represent an important starting point for research plans and monitoring actions. The sites displaying the highest level of old-growth could be monitored using an ecosystem approach including biodiversity investigations, particularly on taxa known to be related to old-growth forests (saproxylic organisms, lichens, bryophytes, etc.). These analyses would shed further light on the Italian forests with the highest degree of naturalness, thereby enhancing our knowledge of such ecosystems. It may be possible to extend the comparison approach adopted for the Valle Cervara case study, combined with in depth biodiversity analysis, to other forest types in order to

develop an accurate model of the natural dynamics in Italian forest types. Such a model would be extremely useful as a means of drawing up specific management guidelines aimed at biodiversity conservation in protected areas. These actions, along with the involvement of political decisionmakers, administrations, agencies, the academic world and stakeholders, would contribute to forest management policies aimed at enhancing the value of Italian forests. Indeed, the value of forests is no longer linked to timber production alone, but even to more important issues such as carbon sequestration, biodiversity conservation, as well as several other ecosystem services that are critical for people's quality of life in the 21th century.

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RIASSUNTO

I boschi vetusti in Italia: verso un *network* nazionale permanente

In Italia, nonostante gli ecosistemi forestali abbiano siano stati oggetto di interventi antropici da migliaia di anni, alcune aree forestali localizzate in contesti difficilmente accessibili sono ancora caratterizzate da un elevato grado di naturalità, rappresentando un'importante eredità in termini di risorse e diversità biologica.

Negli ultimi decenni, l'incremento dei costi delle attività selvicolturali ha indotto a concentrare la pianificazione dei tagli nelle aree più facilmente accessibili, causando molto spesso l'abbandono dei territori più remoti.

In parallelo, aumenta l'interesse della comunità scientifica nei confronti di quei popolamenti dominati prevalentemente da dinamiche naturali.

Queste constatazioni sono il punto di partenza del progetto *Old-growth forests in Italian National Parks*, promosso dal Dipartimento Protezione della Natura del Ministero dell'Ambiente, in collaborazione con il Centro di Ricerca Interuniversitario *Biodiversity, Plant Sociology and Landscape Ecology* dell'Università "La Sapienza" di Roma.

La prima fase del progetto è stata realizzata dal 2006 al 2009, con l'obiettivo di raccogliere informazioni sull'eventuale presenza di popolamenti forestali con caratteri di vetustà nell'ambito dei parchi nazionali, selezionando poi le realtà che soddisfacessero la definizione di vetustà alla base del progetto. Le aree forestali individuate sono state poi mappate, classificate in relazione ad una scala di vetustà ed inserite in un *geodatabase* in cui sono stati registrati gli aspetti strutturali e vegetazionali dei siti.

Anche se il territorio nazionale non vanta la presenza di popolamenti mai influenzati dalle attività umane o che comunque da secoli non sono stati in nessun caso

oggetto di disturbi antropici, i risultati ottenuti hanno permesso di identificare e studiare molteplici realtà forestali con caratteri di potenziale vetustà. Inoltre, la considerevole varietà di tipologie forestali che le caratterizzano rendono lo studio effettuato un sostanziale punto di partenza nell'ottica della realizzazione di una rete nazionale di boschi vetusti, considerando anche l'occorrenza dei popolamenti persistenti.

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