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OLD-GROWTH FORESTS: REPORT FROM THE PLOTS ESTABLISHED BY ALDO PAVARI

The canonical attributes of old-growth forests, their importance for management approaches fostering the development of structurally complex conditions are reported. The relict presence of primary forests led to withdraw from the regular silvicultural management patches of forests and assign them to a non-intervention regime. They have been referred to as "unmanaged forest reserves". In this context, at mid 1900, A. Pavari established a network of 24 permanent plots at the purpose of "saving from anthropogenic disturbance and studying the natural evolutive pattern of different forest types to establish well-grounded rules of management". Most of plots set up by Pavari have nowadays lost their effectiveness because of various occurrences. Five plots are described here as for their numerical, structural and compositional dynamics. The recorded parameters draw systems that, even if far from equilibrium, show the occurrence of positive evolutive patterns. Differences to natural forests are, basically, the heritage of the previous multiple uses of forest soil and stand as well. On this basis, the component species have modified their presence in term of richness, evenness and dominance, depending on their auto-ecology, resistance or resilience. The long-term monitoring of primary forests and secondary systems left to the natural evolution finds out manifold, sound reasons today. The practice of ordinary management has been reduced greatly and the foreseeable trend is to increase further over the next period. According to its progress, many forests are experiencing a prolongation of the prearranged rotations and a post-cultivation phase is becoming the rule; stands are therefore getting older. Findings by old-growth forests and unmanaged forest areas monitoring will provide references for managing this diffuse condition.

Key words: old-growth forests; unmanaged forest reserves; stand dynamics; monitoring.
Parole chiave: boschi vetusti; foreste in evoluzione naturale; dinamica; monitoraggio.

1. INTRODUCTION

The sentence "attitudes to the forest have rarely been neutral" (MATHER, 1990, in KANOWSKI and WILLIAMS, 2009), well addresses the subject matter with reference to the changed values accorded old forests. In many

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doi: 10.4129/ifm.2010.6.05

contemporary Western societies, old forests have assumed an iconic status; old trees might be described as "charismatic megaflora", paralleling the longer-established phenomenon of "charismatic megafauna" (KANOWSKI and WILLIAMS, *op. cit.*).

The term "old-growth forest" usually defines the late successional stage of forest development and, generally, structural characteristics as number and size of dominant trees, multilayered canopies, presence of snags, down logs and coarse woody debris, are being used to describe them (HELMS, 1998). Old-growth forests are characterized by a shifting mosaic of grown up or overmature large-sized canopy trees, complex stand structures, presence of gaps and of a variety of tree sizes, standing dead trees and snags, large logs and deadwood on the forest floor, a developed and often patchy understory. The USDA (in WATSON, 2001) describes old-growth forest as a forest stand usually aged at least 180 to 220 with moderate-to-high canopy closure; a multi-layered, multi-species canopy dominated by large overstorey trees; high incidence of large trees, some with broken tops and other indication of old and decaying wood (decadence); numerous large snags; heavy accumulation of wood, including large logs on the ground. The above features do not appear simultaneously, nor at a fixed time in stand development. Specific attributes of old-growth forests develop through forest succession until the collective properties of an older forest are evident (WATSON, *op. cit.*). This statement is quite important because it underlines the dynamic progress in space and time of all the concerned attributes towards the canonical physiognomy. These structures are developed through an intricate regime of spatially and temporally heterogeneous small to meso-scale gap disturbances, such as branch falls or the death and fall of single trees or groups of trees (RUNKLE, 1982; HANSON and LORIMER, 2007, in GRONEWOLD *et al.*, 2010). Old-growth forests support assemblages of plants and animals, environmental conditions and ecological processes that are not found in younger forests or in small patches of large, old trees (WATSON, *op. cit.*). Thus, spatial variability of key compositional and structural attributes within forest stands can function to maintain populations of some species over time and, ultimately, the diversity of the system. Changes in community composition and/or a loss of structural heterogeneity may therefore degrade ecosystem resilience, or the magnitude of disturbance that a system can experience before it shifts into an alternative state (HOLLING, 1973, in BURTON *et al.*, 2009). Most of old-growth forests have been progressively submitted to harvesting and managed for wood production through centuries and nowadays only patchy remnants of these forest types remain throughout.

The evidence of their importance is anyway given by the current increased emphasis on management approaches that sustain or foster the development of structurally complex, older forest conditions, or aimed at creating old-growth or late-successional structural attributes in managed stands, including standing dead trees (snags) and large downed woody debris (FRANKLIN, 1989; MC GEE *et al.*, 1999; SEYMOUR and HUNTER, 1999; FRANKLIN *et al.*, 2007, in GRONEWOLD *et al.*, *op. cit.*). For this purpose, the study of dynamics and patterns of disturbances in old forest patches, can help defining a type of silviculture that mimics natural occurrences. In this connection, the extension of rotation lengths beyond those traditionally applied, can increase the abundance of several forest attributes related to non-timber values without subsequent losses in timber yields and better meet stand structural and compositional goals desired today (DI FILIPPO *et al.*, 2004; MOTTA *et al.*, 2008; GRONEWOLD *et al.*, *op. cit.*).

A paper by VANDEKERKHOVE *et al.* (2009) provides the recent history of forest protection. Besides primary forests, nowadays reduced to small fragments, a relatively large forest cover has been withdrawn from regular silvicultural management and deliberatively assigned to a non-intervention regime and referred to as "unmanaged forest reserves". In the 19th century, the main objective for the assignation of reserves was aesthetic and ethical, namely to conserve the last remains of virgin forest in Central Europe (WELZHOLZ and JOHANN, 2007; BUCKING, 2007). Over time, the value of these "virgin forest" reserves for nature conservation and scientific research became increasingly recognized (PARVIANIEN *et al.*, 1999; BUCKING, *op. cit.*) and essential to the development of nature-based silviculture as they provide reference base-line values and ranges for structural parameters such as the amounts of living and deadwood, species composition and gap dynamics (LEIBUNDGUT, 1959, 1978; KORPEL, 1992). Hence, scientific criteria such as representativeness became a focus in the selection of new reserves. The aim was to develop a network of unmanaged reference sites to represent all forest types and site conditions present in a certain area or country (LEIBUNDGUT, 1959; MLINSEK, 1976; PARVIANIEN *et al.*, *op. cit.* and 2000; MEYER *et al.*, 2007). As a consequence, new reserves are and have been selected in managed forests, as there are no virgin forests remaining for many forest types. Natural dynamics in these, previously managed forests are clearly different from virgin forests. Whereas the latter are considered in a dynamic equilibrium with respect to interchanging development phases (LEIBUNDGUT, 1978; KORPEL, 1995; SANIGA and SCHUTZ, 2001), the stands included in the newly established unmanaged forest reserves are still developing in a more unidirectional way towards equilibrium. Indeed, they all start from a man-made structure that is more or less divergent from the reference model, with generally lower stockings and species composition and dominance that have been influenced and altered by human intervention (BURRASCANO *et al.*, 2009; VANDEKERKHOVE *et al.*, *op. cit.*).

In a geographical context where forests have been exploited over thousands of years and no pristine forest appears to be left (MOTTA, 2002), in 1952 Aldo Pavari started in Italy the "Protected areas Plan" aimed at "saving from anthropogenic disturbance and studying the natural evolutive pattern of different forest types to establish well-grounded rules of forest management" (literally quoted by Pavari 1952, internal report). For this purpose, 24 permanent large monitoring plots (3 to 6 hectares wide) were selected, bounded and fenced to avoid any further disturbance of forest soil and forest stand as well. The basic concept of providing the proxies of patterns and processes occurring under natural evolution as a reference for managing criteria was in this way established already sixty years ago. Ahead of his time, Pavari had the clear perception that the future strategy had to be aimed at unifying the direct values of production and the emerging environmental services. A few assumptions that will be derived and formalized later as systemic silviculture, social forestry, sustainable and adaptive management, multifunctional role of forests, conservation of biodiversity, were in this way envisaged in the original purposes. Additional contents to the established long-term monitoring are nowadays the new questions related to global change and to the ability of complex systems to adapt or mitigate the impact of biotic and abiotic stressors, including climate deviations. Forest types were selected in accordance with their representativeness of Italian forests, their naturalistic and biological features and productive significance. They originally included the full gradient of types from the Mediterranean "macchia" up to the high elevation, alpine coniferous forests.

The first documents of Pavari's work about the "Protected areas Plan" remained unpublished in internal reports at the Stazione Sperimentale di Selvicoltura in Florence. His heritage proceeded with the scientists working at the same Institution, transferred later to Arezzo.

This contribution is a review of data already published and related to: (i) the few, so far untouched Pavari's unmanaged forest areas and (ii) two plots established later and recently included in the same monitoring protocol. Linkages between long-term forest monitoring and management are finally addressed in the paper.

2. THE UNMANAGED FOREST AREAS

Most of plots set up by Pavari at mid 1900 have nowadays lost their effectiveness because of various occurrences as forest fires, uncontrolled grazing, renewal of the customary practice of management following the transfer to local administrations. Recently, two plots were added to the protocol, both of them unmanaged since sixty years ago and located in Tuscany, one inside a Strict Reserve and the other one in a Regional Park (Table 1). The first plot, placed in the Forest of Sassofratino, was established by M. Padula (National Forest Service) in 1980; the second one, located in the Maremma Regional Park, was set up by P. Piussi (University of Florence) in 1991.

Table 1 – Study areas currently monitored: type of protection in progress, stand type and site characteristics.

	Foresta Umbra (FG)	Montedimezzo (IS)	Sassofratino (FO)	Maremma (GR)	Macchia della Magona (LI)
Protection type	National Park	Man and Biosphere Reserve	Strict Reserve	Regional Park	Natural protected area
Forest type	*Fagus sylvatica* high forest	Mixed high forest (*Quercus cerris* & *Fagus sylvatica*)	Mixed high forest (*Abies alba* & *Fagus sylvatica*)	Mediterranean macchia	Mediterranean macchia
Elevation (m asl)	750	1040	980	160	210
Aspect	N	N	SW	N-NE	N- NW
Soil	Fully developed Brown soil	Brown calcareous-clayey soil	Fully developed Brown acid soil	Calcareous soil	Clay soil
Mean Temp (°C)	11.6	8.5	8.0	14.5	14.7
Annual Rainfall (mm)	1041	1006	1800	667	725

The first area is a mixed high forest. The second one, located in the "macchia", is also a forest type already represented in the Pavari's network. Peculiar to this type are its "old-growth" features developed with ageing, in spite of the generally reduced stand age and small-sized stems. Basic attributes of the undisturbed "macchia" are in fact structural complexity, high amount of deadwood, noteworthy biodiversity. References about such a condition are reported in literature: research on forest structure and stand dynamics indicates that some elements of old-growth structure can be found in much younger stands (SPIES and FRANKLIN, 1988, in MARCHETTI *et al.*, 2010). The time needed by forest species, both shrub and trees, to develop into complex structures varies according to dominant species life history (longevity, growth rates, permanence time through generations), site quality and disturbances; it may therefore range widely, up to millennia (CORONA *et* *al.*, 2010). Further specific features of these often shrub-dominated communities are to lack trees or to grow a scattered tree layer, to be short-lived but, at the same time, to show a regenerative pattern of shrub species (mortality of main axis and re-sprouting from lateral and basal buds) that implies a slow evolution and the occurrence of a "dynamic-steady" process in the short, medium run. Only over longer periods, and in absence of any further anthropogenic disturbance, the possible wider entry of tree species will be able to modify substantially both stand structure and specific composition.

All the case-studies (Table 1) are under public ownership and located in forest reserves, national and regional parks. They include the beech-silver fir high forest in the Northern Apennines up to types of "macchia" (GUIDI *et al.*, 1994; GUIDI and MANETTI, 1994; GUIDI *et al.*, 1997; GUIDI and MANETTI, 2000; MANETTI and BRUSCHINI, 2000; MANETTI *et al.*, 2009; MANETTI and GUGLIOTTA, 2009).

3. CHARACTERIZATION OF THE SURVEYED PLOTS

Field surveys were focused on stand structure, tree growth and main ecological processes. Tree density per layer and species, ingrowth and mortality rates, individual growth (dbh and tree height) were periodically measured on the entire plot area to determine both carrying capacity and competition in progress as a function of forest origin, stand type, component tree species and site index (Table 2). Detailed analyses of tree aggregation pattern and canopy properties were undertaken by transects or sub-plots. A series of indexes were then calculated to estimate: (i) the functional importance of each species or social rank; (ii) the species richness and evenness of tree and shrub layer; (iii) the pattern of tree aggregates; (iv) the canopy properties (Table 3 and 4).

The quality and progress of ingrowth and tree mortality, the spatial aggregation patterns and the structural and compositional changes occurring over following time-windows, provide estimators of the status, dynamics and self-regulating ability of the system and help recognizing its evolutive phase and proximity to "naturalness".

3.1. Ingrowth and tree mortality

«Birth and mortality: both of them are inseparable and complementary aspects of the same phenomenon» (DALLA CASA, 1996).

Parameters framing the study areas as for tree composition, physiognomy and ingrowth-mortality processes are reported in Table 2.

Table 2 – Main mensurational parameters at the study-sites (last inventory).

	Foresta Umbra (FG)	Montedimezzo (IS)	Sassofratino (FO)	Maremma (GR)	Macchia della Magona (LI)
Forest type	Mixed high forests			Mediterranean macchia	
Dominant species	*Fagus sylvatica* & *Ilex aquifolium*	*Fagus sylvatica* & *Quercus cerris*	*Fagus sylvatica* & *Abies alba*	*Arbutus unedo* & *Erica aborea*	*Quercus ilex* & *Erica arborea*
Other main species	*Acer* spp.; *Tilia* spp.; *Fraxinus excelsior*	*Acer campestre*; *Carpinus betulus*	*Acer* spp.	*Phillirea* spp.; *Quercus ilex*; *Fraxinus ornus*	*Phillirea* spp.; *Viburnum tinus*; *Fraxinus ornus*
Age (yrs)	Fs = 19-269 Ia = 18-64	Fs = 30-150 Qc>150	Fs = 30-200 Aa = 77-175	> 56	> 70
Dominant height (m)	38.6	31.9	31.0	11.3	8.4
Mortality rate	5% (25 yrs)	22% (15 yrs)	20% (18 yrs)	29% (15 yrs)	22% (3 yrs)
Total stem number ($n°ha^{-1}$)	1034	847	387	10483*	24100*
Small-sized (<21 cm) trees ($n°ha^{-1}$)	925	599	211	–	–
Large-sized (>50 cm) trees ($n°ha^{-1}$)	63	91	84	–	–
Mean dbh (cm)	55.1	26.8	38.4	6.5	4.6

* including shrubs

Table 3 – Indexes of canopy and structural features.

	Foresta Umbra (FG)	Montedimezzo (IS)	Sassofratino (FO)	Maremma (GR)	Macchia della Magona (LI)
Forest type	Mixed high forests			Mediterranean macchia	
Period between two inventories	Before and after a gap occurrence	18 years	–	15 years	–
Leaf area index	–	8.6 - 6.3	4.9	–	4.5
Canopy cover (%)	96 - 87	93 - 80	87	97 - 90	98
Crown overlapping (R %)	184 - 168	228 - 187	119	231 - 219	119
Vertical stand structure Pretzsch index (A)	0.73 - 0.73	2.18 - 2.32	1.91	0.23 - 0.53	0.70

Table 4 – Biodiversity indexes.

	Foresta Umbra (FG)	Montedimezzo (IS)	Sassofratino (FO)	Maremma (GR)	Macchia della Magona (LI)
Forest type	Mixed high forests			Mediterranean macchia	
Chapman Importance index (%)	Fs = 64 Ia = 32 Other sp. = 4	Fs = 53 Qc = 25 Other sp. = 22	Fs = 56 Aa = 41 Other sp. = 3	Au = 36 Ea = 21 Other sp. = 43	Qi = 24 Ea = 20 Other sp. = 56
Number of species	8	15	11	8	9
Shannon Index (SH)	1.11	1.55	0.99	1.46	2.45

The Foresta Umbra study-site: the high number of small-sized trees (89% aged between 19 and 50 yrs) points out the continuity in time of beech regeneration and the rearrangement of stand structure following the suspension of silvicultural practices. Beech trees aggregate in the gaps established by the fall of over-mature canopy trees, whilst the location of holly trees cohorts is under the beech cover, according to variable-sized and developed clusters.

The Montedimezzo study-site: the number of trees has been increasing owing to the successful natural regeneration of beech, hornbeam and field maple up to the inventory 1991. The last survey period registered vice versa an opposite trend due to mortality of complementary species (field maple and hornbeam; - 22% over 15 yrs) and, in general, of small-sized trees. A few beech and Turkey oak, large-sized canopy trees, have fallen down in the meantime.

The Sassofratino study-site: the site is characterized by the reduced number of small-sized trees. Both beech and silver fir are equally-represented but, whilst all the developmental phases are present for beech; silver is at a standstill in the regeneration phase and highlights the occurrence of high mortality rates in the average-sized classes. Whole tree upsetting is not present, frequent are vice versa stem breakages of silver fir individuals. The number of large-sized trees in quite similar in the three study-sites.

The Maremma and Macchia della Magona study-sites: the areas of Mediterranean "macchia" show a lively dynamics resulting in a high shrub density, a reduced or null presence of tree species in and over the shrub layer and high mortality rates.

3.2. Vertical stand structure

«Conservation is a state of harmony between men and land» (LEOPOLD 1949).

Data descriptive of the vertical arrangement of stand structure (Table 3, Figure 1) allowed to define both tree layering (Pretzsch index-A) and crown overlapping (R). Canopy cover was quantified by LAI measurements.

The Foresta Umbra study-site: a two-storied remarkably simplified stand structure is highlighted by the indexes (A = 0.73; R = 168%).

The Montedimezzo study-site: in spite of canopy values similar to the previous site, the stand structure is here considerably layered (A = 2.32) and this arrangement increases over time. The reduction of cover between the two inventories (18 yrs) is due to the establishment of a gap following the fall of a few large-sized canopy trees. The outstanding LAI value underline stand heterogeneity, high productivity and prompt dynamics in progress.

The Sassofratino study-site: stand structure shows a quite reduced complexity (R = 119%) but an intermediate layering (A = 1.91). These values explain an equal distribution of trees among layers and a low crown overlapping. LAI value is lower than in the previous site but is similar to those measured into the same forest type (MANES *et al.*, 2010).

As for the areas located into the Mediterranean "macchia".

The Maremma study-site: the complexity index is high (R = 219%), but stand structure is considerably simplified (A = 0.53), quite all the individuals being located in the intermediate and lower layer. There is evidence of an increased layering in progress.

The Macchia della Magona study-site: in this site too, where light-demanding species are predominant, the stand structure is poorly layered (A = 0.70) and crowns are scarcely overlapped (R = 119). The low structural complexity is confirmed by the measured LAI value.

3.3. Biodiversity

«Conservation means development as much as it does protection» (T. ROOSVELT).

Diversity originates with the ability of the system to maintaining an inner differentiation and different species living together. It ensures a larger number of actual and potential connections and therefore strengthens the system resistance and resilience against external pressures. Compositional diversity of tree and shrub species is considered here (Table 4).

The "importance index" (CHAPMAN *et al.*, 2006), that ranks the functional importance of each species, shows that the second species is enough significant in the beech-dominated areas (mixed high forest type); the complementary species are vice versa, even if numerous, negligible in Foresta

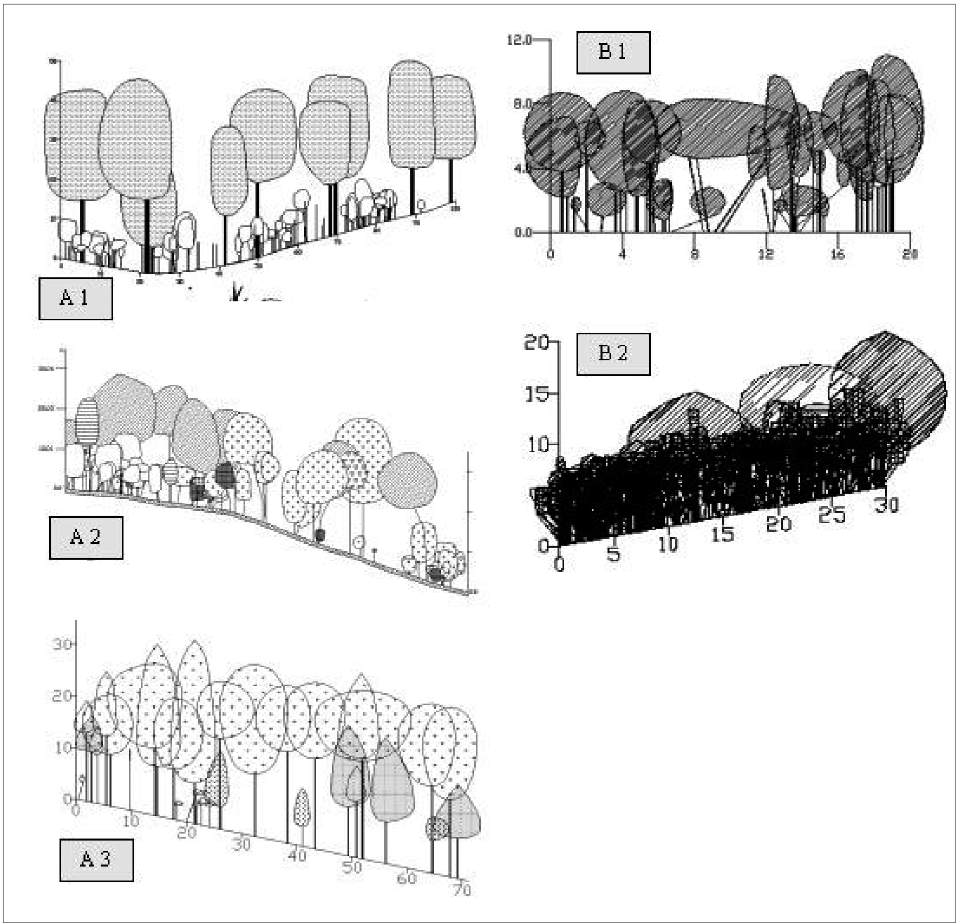

Figure 1 – Profiles of vertical stand structure.

A 1 = *Foresta Umbra* – Two-layered structure. The continuous cover of top layer is mainly made up of old, large-sized, beech trees. Maple spp., hornbeam, broadleaved linden, common ash, mountain ash are sporadically present in the same layer. Holly and elder trees share the lower layer with beech regeneration.

A 2 = *Montedimezzo* – Bi- to multi-layered structure as a function of the spatial arrangement of Turkey oak and beech, the two species characterizing the top layer. The upper part of the stand profile, where Turkey oak is prevailing, show a higher specific diversity and a more complex layering. Stand structure becomes more simplified both in the intermediate, where a gap has become recently established, and in the lower layer dominated by beech.

A 3 = *Sassofratino* – Uniform stand structure, basically multi-layered. The upper layer is made up of large-sized beech trees; both in the intermediate and lower layers silver fir shares the growing space with beech, the former species showing a poor vegetative status.

B 1 = *Macchia della Magona* – Layering is quite absent; the spatial arrangement of "macchia" species is uniform. No trees, usually released at each coppice cycle, are present.

B 2 = *Parco della Maremma* – The one-layered stand structure is made up by the dense shrub texture; a few, old holm oak and cork oak standards, released at the previous coppice cycle, characterize the upper level of vertical structure.

Umbra and Sassofratino, whilst well-represented in Montedimezzo. It affects obviously the Shannon index, which is higher in the last area.

As for the "macchia" plots, they show a greater functional balance to each component species and therefore display a higher compositional diversity.

In synthesis, these parameters describe systems showing the occurrence of positive evolutive patterns. Differences to natural forests recorded in processes and in structural dynamics are, basically, heritage of the multiple uses occurred in the past. The component species have modified their presence in term of richness, evenness and dominance, depending on their auto-ecology and ability to persist in terms of resistance or resilience.

As for the "macchia" plots, they may be considered in the monitored time-window as proxies of "old-growth forest" because they maintain a tendentially steady configuration as for taxonomic, physiognomic and structural features (MANETTI *et al.*, 2009). In these sites, the short rotations and the summation of customary uses applied in the past to the forest crop and soil, together with over-grazing and incidence of forest fires, have reduced the original site-index. All these factors contributed to preserve at now only the less-demanding species. The foreseeable evolutive pattern of these stands will be oriented towards the holm oak-dominated type, in the long run.

4. THE LINKAGE BETWEEN MONITORING AND MANAGEMENT

Connections between long-term monitoring of primary forests and secondary systems left to natural evolution and forest management, finds out manifold, sound reasons today. The practice of ordinary management has been reduced greatly over the last 50 years across quite all the forest types and the foreseeable trend is to increase further in the near future. Well-known reasons, basically deriving from the decreased economic importance of forests and of direct forest products, are on the grounds of this change. Many forests are experiencing, as a matter of fact, the prolongation of the prearranged rotations and a *post*-cultivation phase is becoming the rule; the immediate result is that stands are getting older and older. Forest contexts well-ordered before by the customary practices will presumably be left to the apparent "chaotic" disorder of natural occurrences on wide areas, including the final stages of development *i.e.* the mature and regeneration phases (FABBIO and BERTINI, 2009). Monitoring old-growth forests and unmanaged forest areas could provide a reference for managing this diffuse condition and their surveying will address more knowledge about the final stages of forest cycle. In this context, the ability of old forests in providing long-lasting carbon storage in the soil, enhances their role in a new perspective. The need of a careful and diffuse monitoring activity is furthermore increased by the biotic and abiotic pressures acting on forest systems, the outcome of stressors being enlarged by the climatic shift towards less favourable growth conditions at our latitudes and by the repeated occurrence of extreme events.

RIASSUNTO

Boschi vetusti e indicazioni dalla sperimentazione nelle parcelle Pavari

Il lavoro descrive le caratteristiche proprie delle foreste vetuste e definisce l'importanza di queste formazioni per identificare approcci di gestione che prevedono lo sviluppo di condizioni di complessità strutturale. La presenza ormai relitta di foreste primarie in Europa ha portato a sottrarre alla gestione ordinaria tratti di foresta ed assegnare loro un regime di protezione integrale. In questo contesto, all'inizio degli anni '50, Aldo Pavari realizzò una rete di 24 aree permanenti con lo scopo di *seguire l'evoluzione naturale delle diverse formazioni forestali del nostro Paese, in modo da avere sicure basi per impostare i problemi del trattamento dei nostri boschi*. Quasi tutte le aree individuate da Pavari sono andate perdute a causa di varie circostanze quali incendi, pascolo, ripresa della gestione. In questo contributo viene descritta la dinamica demografica, compositiva e strutturale di 5 aree di ricerca rappresentative di formazioni forestali di macchia mediterranea e faggeta-abetina. I parametri registrati descrivono sistemi che, anche se lontani dalla fase di equilibrio, mostrano dinamiche evolutive positive. Le differenze con le foreste naturali risiedono essenzialmente nei precedenti usi del suolo e del soprassuolo. In funzione di ciò, le specie componenti hanno modificato la loro presenza in termini di ricchezza, abbondanza e dominanza secondo la loro autoecologia, capacità di resistenza e resilienza. Il monitoraggio di lungo termine delle foreste primarie e secondarie in evoluzione naturale trova oggi molteplici e valide ragioni. La pratica della gestione ordinaria si è fortemente ridotta nel tempo e prevedibilmente si ridurrà ancora nel prossimo futuro. A seguito di questo, molte foreste stanno invecchiando, la lunghezza del turno si dilata e la fase di post-coltivazione sta diventando la regola. Di conseguenza il monitoraggio delle foreste vetuste e delle aree non gestite sarà di riferimento per governare questa condizione diffusa.

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