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SILVICULTURE: BIODIVERSITY, GENETIC RESOURCES, PROTECTED AREAS AND FAUNA

The Authors synthesize the main themes discussed in the Session "Silviculture, biodiversity, genetic resources, protected areas, and fauna" of the Third Italian National Congress of Silviculture. Attention was focused on genetic variability of forest trees, criteria and indicators for forest biodiversity monitoring, forest habitat fragmentation, forest recolonization of pastures and open areas, forest type classification, renaturalization of simplified forest systems, in particular plantations, forest management systems based on traditional local knowledge, characterization and management of Natura 2000 forest habitats, forest management in National Parks, relationship between silviculture and wild ungulates. The Authors conclude that forest biodiversity conservation must take into account both the complexity of forest ecosystems and of their interactions with the social, economic and cultural environment.

Key words: genetic variability; deadwood; complex biological systems; renaturalization; wild ungulates.

1. Introduction

In our country the commitment to the preservation of biodiversity has been understood at all the regulatory levels: national, regional, and local. In the last few years this understanding has stimulated an increasing diffusion of nature protection and biodiversity conservation projects. According to the Italian National Forest and Carbon Sink Inventory (2005) 27.5% of forest land is under nature conservation regulations; 14.1% of wooded lands are included in protected areas and 22.2% of wooded areas is included in Natura 2000 Sites. These facts testify to the importance of forests for the preservation of biodiversity within nature conservation policies. They also highlight the necessity for a continuous integration process between the use of forest resources and their preservation with the final goal of moving towards an increasing consensus on forest management policies and practices.

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The numerous contributions presented to the Congress of Taormina in the Session "Silviculture, biodiversity, genetic resources, protected areas, and fauna" testify to the strong and increasing interest of the forestry world for operative and experimental themes regarding the conservation of biological diversity and the analysis of its relationships with forest ecosystem functionality and management. From this Session, over 65 contributions – both essays and posters –have been published in the Proceedings of the Congress, involving over 170 researchers and technicians from every part of Italy. These contributions present a rich panorama of the experimental, research, and field activity in regards to the relationship between biodiversity and silviculture in their multiple aspects.

This paper presents a synthesis of the principal themes which have been discussed in the Session. As it is not possible to cite all of the works, please refer to the Proceedings for a complete treatise (http://www.aisf.it/AttiCNS/default.htm).

2. Conservation of genetic resources

If one begins from the smallest "scale" of reference, the intraspecies, one can see that scientific interest is turned in particular to the role that genetic diversity plays in the space/time organization of species.

Forest trees have changed and change their autoecology and physiology through an adaptive process which is very refined in relation also to the length of their biological cycle. The evaluation of the adaptive/evolutionary potential of forest tree populations in the different parts of the species natural distribution area, together with the evaluation of their ability to confront climatic changes, is fundamental to the preservation both of the genetic resources and the biocenosis in which they participate.

Since the genetic code at the level of an individual, population, and species represents the fundamental basis for adaptation and at the same time is a priceless reservoir to be exploited, conservation strategies can't but be directed towards the entire gene pool as, among other things, it is not possible to predict what role they could play in the future. As a result, silviculture must reconcile the use of forests with the preservation of polimorphic adaptations and genetic pools of populations (Giannini, 2009).

In this sense, useful indications could be provided in the future by studies of population genetics and genomics. The so-called "genomic ecology" offers at present interesting research perspectives. The research on genetic variability in forest plants has produced interesting results that open

up stimulating prospects. The possibility of shedding a light on the relationship between genetic variability within species, community infrastructures, and ecosystem functionality, arriving at filling the gap between variability measured through neutral markers and quantitative trait variability, is becoming more and more concrete (VENDRAMIN *et al.*, 2000; VETTORI *et al.*, 2004; PAFFETTI *et al.*, 2007). At the same time it is now reasonable to expect a revival of the classic uses of the knowledge about genetic variability, thanks also to the increasing availability of low cost markers. This will open interesting prospects about the definition in evolutionary terms of forest stands in diverse site and environmental conditions, which is particularly important to the understanding of adaptation to climate change (MENOZZI, 2009).

The large variety of species and subspecies, above all in the areas of our country richer in endemisms such as the islands, is stimulating research on indigenous woody species (RAIMONDO *et al.,* 2009) and on the genetic characterization of forest trees (VETTORI *et al.*, 2007; SAPORITO *et al.*, 2009). On an operative level, interesting prospects have arisen from germoplasm and DNA banks that aim to fill the gaps in our knowledge of within scale variation and dynamics of genetic diversity (SCHIRONE *et al.*, 2009).

3. CHARACTERIZATION OF FOREST BIODIVERSITY

The large latitudinal extension of the Italian Peninsula, the presence of mountain ranges orientated in a longitudinal and latitudinal sense, and the nearness of the African and Eurasian continental areas, determine a high variety of climatic regions, bioclimates, and climatic types (BLASI, 2009).

A lot has been done in the attempt to define criteria and indicators for sustainable forest management and methods for forest biodiversity monitoring. But the identification of the most appropriate data sources and survey methods for obtaining such indicators is still object of heated scientific debate, above all at the European level. At present, research is orienting towards identifying harmonization procedures to fully exploit the informative contents of national forest inventories for biodiversity monitoring (CHIRICI *et al.*, 2009)

In forest ecosystems most of the species diversity, even at an intraspecies level, is found among bacteria, protoplasms, molluscs, fungi, lichens, and arthropods that live predominately in the forest soil and that are fundamental to the efficiency of the ecological processes. In this context, research on

deadwood, considered one of the most relevant indicators for the evaluation of the state of naturalness and biodiversity in forest ecosystems, is particularly interesting (PETRICCIONE *et al.*, 2009). The classification of the levels of deadwood decay and of their relation to the diversity of microbal and lichen communities is a novel and promising research area (CECCHERINI *et al.*, 2009; TOGNETTI *et al.*, 2009).

Little information is currently available about the quantity of deadwood found in Mediterranean forest environments. In Italy, research conducted to expand such knowledge is rather recent and focuses, in most cases, on the evaluation of different data collection techniques and on the quantification of deadwood volume in forests managed with different intensities (TRAVAGLINI *et al.*, 2006; TRAVAGLINI *et al.*, 2007).

The fragmentation of forest habitats is recognized as one of the main causes of the loss of biodiversity at a global level. In the Italian landscape, characterized by a long history of exploitation for agricultural uses, forest fragmentation is an ancient phenomenon, above all in the plain and hilly areas. The study of forests which have remained isolated, the analysis of the effects of fragmentation, the relationship between forest structure and particularly sensitive biodiversity indicators such as bird species, represent examples of how researchers from both biological and forestry backgrounds can find fertile grounds for cooperation (TAFFETANI, 2009; TELLINI FLORENZANO *et al.*, 2009).

A somewhat contrasting phenomenon is the recolonization of once cultivated or grazed land by forest vegetation. With some localized differences, in Europe forests have been expanding for the last two centuries (WATKINS, 1993), at a rate which in the last fifteen years has settled around 0.07% a year. Almost half of the surface recently re-colonized by forests is located in Spain and in Italy (MCPFE, 2007); the Alps are the region in which this process is most obvious and it already is an interesting field of study with respect to both implications on management and biodiversity conservation at a landscape level (SITZIA and VIOLET, 2009).

Connected to this subject is the matter of the maintenance of open areas for biodiversity preservation. This is taking on an ever greater importance because often the effects of the abandonment of agricultural lands and pastures, deriving from socio-economic factors, sum to the effects of restrictions due to the inclusion in parks and nature protection areas. The maintenance of open spaces which are the elective habitat of numerous species of plants and animals in many cases is becoming a necessity (CERVASIO *et al.*, 2009).

4. Silviculture and biodiversity

The influence of different cultivation and management techniques on the specific and structural diversity of forest stands is an important part of the contributions presented to the Congress of Taormina

At an operative level, forest type classification systems are a useful tool to analyze the interactions between silviculture and biodiversity. At present, almost all Regions have Forest type classification systems (Del Favero, 2009).

In our country all forest systems have been influenced, although in different measures, by human activity. Forest exploitation has almost always resulted in the simplification of the structure and composition of forest stands. In order to rehabilitate these simplified forest systems, a management strategy based on *renaturalization* can favour the restoration of natural processes, that is to say of the mechanisms of self-organization and self-perpetuation, with an increase of the resistance and resilience of the forest stands.

Stands originated from reforestation projects carried out in the past and which characterize the forest landscape of vast areas of our country, are typical examples. These stands, originated from planting, often have problems with stability and functionality. A silvicultural approach based on favouring natural evolution towards stands of indigenous, self-regenerating species, represents the best solution to give also an economical prospect to these simplified forest systems. Various experimental studies have demonstrated how management oriented towards renaturalization can restore consistency between the primary objectives of the reforestation projects (i.e. recreating a functional forest on degraded lands) and actual management (Cristaudo *et al.*, 2009; La Mela Veca, 2009; Nocentini and Puletti, 2009).

The analysis of forms of traditional forest use connected to local knowledge can supply very useful indications to outline a silvicultural and management approach which can guarantee the conservation of forest formations which are typical to certain environments. An example of this is the "merizi", a system for the regeneration of stone pine forests based on tree retention from the old cycle. Capitoni *et al.* (2009) describe this traditional silvicultural technique for the monumental stone pine stands in the Tenuta di Castelporziano near Rome.

Another example of silvicultural system based on traditional knowledge has been described by Barreca *et al.* (2009) for the Calabrian black pine forest of Ragabo, on Mount Etna. The complex structure of these stands is maintained by the application of a method of selection felling based on local

knowledge. This type of treatment has guaranteed the maintenance of the Calabrian pine forest, a typical element of the unique forest landscape of the Etna Volcano.

5. Silviculture and nature conservation areas

In Italy, Natura 2000 network includes 2284 Sites of Community Interest and 594 Special Protection Zones, which represent respectively 14.5% and 15.0% of the surface area within the national territory. If one excludes the overlapping areas, the area of national territory covered by Natura 2000 sites is approx. 20.6% (Biondi *et al.*, 2009).

The analysis of the ecological conditions that characterize the individual *habitats* and the connections between these habitats inside Nature 2000 sites, is fundamental for defining appropriate management guidelines and therefore species conservation. It has been pointed out that the implementation of management plans based on systemic silviculture must be based on the cultural and scientific integration between botanists and forest managers, overall in order to analyze basic knowledge and to correctly implement monitoring processes (Biondi *et al.*, 2009).

Numerous studies and operational proposals for the characterization and management of Natura 2000 habitats were presented during the Session. This is a clear demonstration of how the forestry world has now become fully aware of the environmental and nature conservation roles of forests (e. g. Bassi, 2009; Campanaro *et al.*, 2009; Picone *et al.*, 2009). An interesting real life example of this are the guidelines for the management of Natura 2000 forest sites in the Veneto Region, with particular reference to the impact of forest management on habitats both in the mountain areas and in the lowland areas in the Region (Munari *et al.*, 2009).

At a national level, as well as in the context of Natura 2000, the 130 State Nature Reserves managed by the Italian State Forest Service serve an important role for the preservation of biodiversity: for example, of the 88 bird species considered to be most at risk in Italy, a good 61 nest within State Nature Reserves. In addition, wetlands managed by the State Forest Service are important both as nesting areas and as resting areas for birds during their winter migrations (Uricchio *et al.*, 2009).

Much discussion has arisen regarding the criteria and operating procedures for the management of forests within National parks. This is exacerbated by the fact that few parks have implemented the planning instruments provided for by the State law on nature protection areas (n. 394/1991). An example of a possible shared solution is the Forest

management plan for the Casentino Regional Forest (Arezzo Province, Tuscany) situated within the Casentino Forests National Park. The philosophy of this management plan considers silviculture as a fundamental instrument for the accomplishment of the National Park's end goals (BRESCIANI *et al.*, 2009).

6. SILVICULTURE AND FAUNA

Results of experimental investigations on the effects of forest management activity on forest *habitats*, both in relation to the conservation of animal populations and to their vital necessities, have been presented and discussed. Special attention was given to the "ungulate problem", and to the conflicts that this question generates when one attempts to pin point operative solutions. These conflicts demonstrate of how difficult it is to reach a consensus regarding the management of both forest and fauna which is integrated and truly shared by the many stakeholders involved in the question.

In Italy, for over half a century, great attention has focused on the damages caused by ungulate feeding, above all cervidae, to the natural regeneration of forest species. The widespread effect of ecotonisation of ex-grasslands and pastures, the abandonment of coppices and forests with negative economic returns in many areas, the presence of extensive State and Regional Forests (where hunting is prohibited) along with the creation of new nature conservation areas, have permitted a slow but continuous recovery of wild ungulate populations, although with differences for species and territorial contexts (DE BATTISTI and COLPI, 2009).

The analysis of data gathered in studies carried out in diverse mountainous and alpine environments and administrative situations (DE BATTISTI and COLPI, 2009) has shown that the damages caused to forest regeneration are often the consequence of the concentration of animals in a particular area, which serves as seasonal refuge, above all winter refuge, caused by disturb of normal feeding and resting areas by human interventions such as hunting or other activities. Research has shown that only a real understanding of the impact that forest management can exert on wild ungulates allows for a correct interpretation of the impact of these animals on forests. This understanding thereby conditions subsequent actions to try to resolve, or at least to ease, these conflicts.

It is therefore evident that this problem requires an interdisciplinary approach, particularly within such complex areas as those protected by the National Parks System. A correct, interdisciplinary approach must involve

technicians from the various administrations and move towards the integration of the various management methods to form a unified management approach which is valid across the whole territory. It must be noted that the complexity of this problem requires very different solutions from the mere control of ungulate population numbers or just the protection of forest stands in the regeneration phase (GENNAI and GRIGIONI, 2009).

Analyzing various case studies in Mediterranean *macchia* environments, CASANOVA and MEMOLI (2009) agree that data regarding the presence, number and structure of ungulate populations must be put into the context of the specific forest areas in which they are found. Many areas of Mediterranean *macchia* are particular in that they can host populations of boar, roe deer, fallow deer, and sometimes mouflon and red deer. CASANOVA and MEMOLI conclude that there is not much value in defining the theoretical population density of a species which each phytocoenosis is capable of sustaining. It is more correct to focus on increasing diversity of forest types and stand structures at the landscape scale, thus providing different possibilities of food and refuge during the year. In some areas, hunting bans are creating excessive pressure which is causing serious problems for natural forest regeneration (RECANATESI *et al.*, 2009).

There is a unanimous consensus on the fact that truly sustainable forest management cannot disregard the conservation or the restoration of natural mechanisms for the auto-regulation of forest ecosystems. The influence of fauna on forests can be interpreted as "damaging" in two cases. The first is when it significantly alters the aforementioned mechanisms for auto-regulation. The second, is when it creates an obstacle for the re-naturalization of simplified forest systems where it is important to favor structural and compositional diversification.

The protection of biological diversity within forest ecosystems, taking also wild ungulates into account, often means entering into conflict with other uses and interests. It seems clear that only through a revision of the basic assumptions of silviculture and management it is possible to outline an approach which is coherent with the goal of managing forests in a sustainable manner while conserving their biological diversity. In other words, the best guarantee for a balanced relationship between animal populations is a management strategy that aims at the overall perpetuity and functionality of forests.

The introduction or reintroduction of new organisms in pre-existing animal communities or the control of the multiplication of species whose adaptability has not been previously verified at unusual demographic levels, must be considered with regards to the functionality of systems and of biocoenotic relationships (MASUTTI, 2009).

A field of research which has produced interesting methodological and operational results is the study of bird species typical of forest environments, in particular "sensitive" species or who's conservation is at risk (LA MANTIA, 2009). An interesting example is the investigation of the criteria used by black woodpecker (*Dryocopus martius*) for the selection of reproductive sites and their characterization from a silvicultural point of view; the outcome is the definition of management and silvicultural techniques which will favor this important species (COLPI *et al.*, 2009).

7. CONCLUSIONS

The works presented to the Congress of Taormina and the following debate, have shown that in order to attempt to give coherent answers to the problem of the relationship between silviculture, forest management and biodiversity conservation there are some reference points which are indispensable. The scientific and technical worlds agree on the fact that biodiversity conservation cannot disregard the complexity of forest ecosystems and their relationship with society, both in its economic and cultural aspects. The key words of this approach are monitoring, adaptation, sharing, and consensus.

An important characteristic of natural systems is their constant change: evolution is the principle which unites all of biology. It is the one logical mechanism which can explain biodiversity as it is seen today and which is able to offer a historic perspective on the dynamics of life. Therefore the objective of conservation cannot be to halt genetic change, nor can it seek to maintain the status quo, but rather it must act in a way that insures that populations and ecosystems can respond in an adaptive manner to these changes (MEFFE and CARROLL, 1997). Forest trees, because of their biological characteristics and evolutionary history play a special and particular role in the conservation of global biodiversity (GIANNINI, 2009).

In order to achieve biodiversity conservation it is necessary to abandon the reductive vision which sees forests only as marketable trees or as a list of species. Rather, forests should be considered and managed as *complex and adaptive biological systems* which learn and evolve. The question of forest biodiversity conservation must be confronted from within a dynamic vision of reality: one must, in fact, take into account the fact that each forest is the product of natural and man made events in an ever changing environment.

It is necessary to differentiate management at diverse space/time scales and favor the presence of those elements which can act as connections between various scales (NOCENTINI, 2005). This approach, which SCHULTE *et*

al. (2006) have defined as "diversity generates diversity", is better suited to conserving biodiversity in all those situations, as in our country, where human impact has occurred over a long period of time and has molded the landscape in a significant way.

The question of the space/time scale of reference is not only of scientific interest, but also has a crucial impact from the practical point of view: the MILLENNIUM ECOSYSTEM ASSESSMENT (2005) has clearly highlighted that many environmental problems originate from the mismatch between the scale at which ecological processes occur and the scale at which decisions on them are made. Outcomes at a given scale are often critically influenced by interactions of ecological, socioeconomic, and political factors from other scales.

In particular, the **"**landscape**"** approach to the study of biodiversity allows us to maintain a tight hold on the connections between environmental and human factors (BLASI, 2009).

Research in the field of biodiversity conservation in forest systems still has a long way to go. Because the interpretation of the results of studies at different scales is often contradictory, one must take on the responsibility to take action even when there is a lack of certainty. Instead of seeking to *manage* complexity in order to achieve "desired" results, research should orient itself towards operative strategies based on the *interaction* with the processes which characterize natural systems.

In conclusion we feel that we can attest that an *elective affinity* exists between silviculture and biodiversity: the large number of contributions which were submitted for this Session confirm this, and we are sure that the lively debate which has already been sparked in the wake of the Congress of Taormina will bring about significant advancements from both a scientific and practical point of view.

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