NATURE-BASED FORESTRY IN CENTRAL EUROPE

Alternatives to Industrial Forestry and Strict Preservation

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Preface

Nature-based management started in and around Central Europe as a response to forest overexploitation and degradation in fragile mountain landscapes. Switzerland was the first country that prohibited clear-cut forest management by law in 1902. It was followed by Slovenia in 1948/49. In the last half of the century nature-based forestry gained more and more followers across Central Europe, and elsewhere in Europe and the World in the last decade.

Despite declared support for sustainable forest management by European societies, nature-based management is endangered by many circumstances. One of the reasons is because it is more labour intensive. It is intrinsically bound to production of large diameter timber, to which many external benefits for the environment and society are linked, yet this represents a major obstacle for mechanization and rationalization. Furthermore, many European countries are increasingly importing cheep timber from abroad, while protecting large forest areas at home.

However, there are also many tendencies favourable for development of nature-based forestry, such as the recurrent energy crises, rising consumption of wood, increasing demand for social and protection functions of forests, and emphasis on nature conservation.

Therefore, favourable tendencies should be utilized in appropriate ways, while at the same time much effort should be invested in overcoming the developmental constraints. In this way, nature-based forestry, which for more than two hundred years remained in the shadow of conventional forestry, may for the first time in history face an important expansion and development, which would significantly raise the quality of life in Europe.

This volume contains contributions from thirteen experts in the field of nature-based forestry, from practising foresters with excellent long-term examples of natural multipurpose managed forests to university teachers and *researchers. The main objectives of the book are to: (1) present the historical development of nature-based forestry, (2) point out contemporary problems, developmental constraints, and forest threats, (3) draw attention to possible consequences of decreased forest tending and increased non-management, (4) discuss the possible answers and solutions, (5) expose the rationality of continual nature-based management of forests and their resources, and (6) stimulate discussion on solutions and encourage professional and political alliances to promote nature-based forest management in Europe and the World.*

One of the important aims of this book is also to demonstrate that nature based forestry is, in contrast to common understanding, more than solely a Swiss selection system or continuous cover forestry. It is based on natural processes, and therefore it freely and smoothly combines different silvicultural systems. Nature based forestry is successfully applied in various circumstances from multipurpose production forest, to protection and urban forests. Moreover, it has, due to its flexibility, a great potential for adaptation to special demands and further development.

Nevertheless, nature based forestry is closely linked to different geographical regions with various cultural environments. Therefore, we would like to note that the viewpoints and ideas of each individual author are not necessarily shared by all the contributors in this book. Instead, the various viewpoints found in this collection of papers represent a broad continuum of ideas encompassed by nature based forestry in Central Europe, some of which are more oriented toward preservation, while others are more oriented toward management.

The book will serve as an overview of contemporary paradigms, ideas, solutions and overall, examples of good practices for development, and hopefully future expansion of nature-based forestry. It is based on the experiences from Central European forestry practice, yet it cannot be used as scheme for practical work. For this, interested foresters or forest owners should step in contact with Pro-silva Europaea regional organizations. The book can be used by practising foresters, forest owners, researchers, landscape ecologist and planners, forestry students, nature conservation experts, as well as the broader forest interested public.

The work is dedicated to the 80th birthday of Prof. Dr. Dr. hc Dušan Mlinšek, former president of IUFRO, who has significantly shaped the contemporary doctrine of nature-based forestry in Slovenia, Central Europe, and the World.

I especially thank the members of the international editorial board Prof. Marijan Kotar, Prof. Jean-Philippe Schütz, Prof. Pietro Piussi, Prof. Slavko Matić and Prof. Dušan Mlinšek for their useful comments. Constructive reviews of all of the manuscripts were provided by Prof. Franc Gašperšič *and Dr. Primož Simončič. For help with language and style I am grateful to Thomas A. Nagel. All these efforts greatly improved the manuscript. I also thank Uroš Kolar for translation of some papers, precise technical work, and overall logistics. I acknowledge the financial support from the Slovenian Research Agency and Ministry of Agriculture, Forestry and Food, which enabled the printing of this book.*

Prof. Dr. Jurij Diaci

Historical development of nature-based forestry in Central Europe

Elisabeth Johann*

Abstract

The expansion of human society has always influenced the features of forest ecosystems. Each period of human history has been characterized by the presence of a certain type of forest according to human activities. The historical development of Central European silviculture goes back to the formation of economic systems in the time of early capitalism. It was set off by an increasing need for available timber, which resulted in clear cuttings and artificial afforestation since the Middle Ages. Farm forests and woodlands situated far from settlements were cut selectively and therefore maintained in quite a natural condition.

During the 19th century, the tradition of European forest science gave way to economic liberalism. It produced the monocultural, even-age forests, where the German forest became an archetype for imposing the neatly arranged constructs of science on disordered natural systems. Practical goals encouraged mathematical utilitarianism, which seemed, in turn, to promote geometric perfection as the outward sign of a well-managed forest. Consequently, the rationally ordered arrangement of trees offered new possibilities for controlling nature.

As a response to this far-to-nature oriented forestry, which aimed at shaping even-aged, uniform monocultures, foresters such as Karl Gayer, Morosow, and Möller, stimulated by newfound loyalty to the natural diversity of species, called for a turning "Back to nature" by the end of the 19th century. Careful consideration of the forest as a multi-faceted biological ecosystem came into vogue.

However, the improvement of silviculture cannot be discussed without taking into account a variety of influential factors in the field of policy, forest policy, forest legislation, forest administration, and economics in general. Apart from analysing the historical progress of nature-based forestry, this paper will examine the main driving forces that influenced its development in the 20th century. One important question is why did quantitative techniques, even in the face of opposition, survive in forestry practise in many parts of Europe, while in other parts nature-based forestry was introduced and successfully developed?

Key words: natural regeneration, silviculture, afforestation, selection cutting

* Elisabeth Johann, Austrian Forest Society, 9173 St. Margareten, Oberdörfl 9, Austria
Tel. 0043 6644628392, E-mail: elis.johann@utanet.at

1 Introduction

The development of human society has always influenced the features of forest ecosystems. Each period of human history has been characterized by the presence of a certain type of forest according to human activities. There is a general societal agreement about the importance of the maintenance of forests. However, questioning what kind of forests should be maintained gives rise to disagreement. What are the most important functions required by the society: timber supply, nourishment of the rural population, protection, the safeguarding of soil fertility, water preservation, biodiversity, and recreation? The management of old, well-developed stands requires long-term planning. Therefore, it is a good indicator of how society is able to care for future sustainable development.

During the last 500 years a sharp reduction in the complexity of forest structure has occurred at all spatial scales. A multi-aged forest matrix has been replaced by a patchwork of forest stands of various ages. At present, many stands are younger than 100 years and dominated by even-aged forests. The current landscape structure created by forest management differs radically from the earlier structure (Axelsson, 2001).

In Europe, where the surface area of forest remains around 30% of the total land area, the increasing area of plantations has caused a drastic reduction of biodiversity. Furthermore, only small remnants of virgin forests remain in central Europe (Leibundgut, 1993).

2 Material studied

Modern definitions of woodland history – also discussed by Mantel (1990) – reflect on the whole complexity of the historical development of forests and woodland, with and without anthropogenic impact in prehistoric and historic times. Thus, this overall definition of forest and woodland history includes a wide range of subjects such as palaeobotany, archaeology, sociology, and cultural history. When evaluating the history of human impacts on ecosystems, one must rely on historical data and be aware of the limitations therein. This study relies on the following sources: original written historical documents such as forest management plans and reports related to economic activities stored in the archive of the Austrian Forest Society (Österreichischer Reichsforstverein) in Vienna since 1947, the private archive of the forest enterprise Auersperg in the "Haus- Hof und Staatarchiv" Vienna, contemporary scientific papers published since the middle of the 19th century, and secondary literature of the present day. Working with historical sources involves some degree of subjective interpretation. In order to limit such subjectivity, the development has been compared by means of the contemporary discussions published in forest journals and reports from the middle of the 19th century onwards (Österr. Vierteljahresschrift für Forstwesen, Vienna, 1851–1960).

3 Results

3.1 Silvicultural practises in preindustrial times (1500 – 1800)

In the densely populated regions of Europe, forests have been under human influence for thousands of years. In Southern and Central Europe, forests gave way to human settlement and diminished into forest islands during the Middle Ages at the latest. Because of settlement activities, such as hunting, mining, glass mills, traffic, and slash and burn agriculture, forested areas outside agricultural land suffered from constant strain caused by human activities. The history of forestry in Slovenia, for example, was strongly influenced by Central European developments, including serious forest exploitation in connection with iron and glass industries, excessive felling due to extensive agricultural production, and extreme deforestation in the Mediterranean area, where only 5 – 10% of the forest was left.

The driving forces for the preference of different silvicultural methods during the course of history are summarized in Table 1.

Table 1: Driving forces for the preference of single tree felling or clear cutting systems (1500 – 1900)

Period	Single tree felling	Clear cutting systems
1500 -	*Farmers* Varying demand for all diameters Demand for continuous standing volume Multiple use of the woodland *Handicraft* Special demands such as shingles, sieves, potash	*Mining Industry* High demand for charcoal and fuel wood Long and difficult transport over far distances Forest laws (in some countries) *Timber trade* for the supply of big cities and international markets
1700 - 1850	*Small scale timber and benchwood trade* High demand for valuable timber of big diameters No use for small diameters	
1850 -	*Forests with dedicated forest rights* Multiple use	Small scale forest owners and farmers also started with clear cutting to reduce harvesting costs and gain grazing ground
1900 -	Following the example of big forest enterprises and thereby also influenced by science, tradition and fashion clear cutting was practised quite common also in areas where single tree felling was rather easy to put into action	

Forest management in farm forests, as well as in secluded forest areas (particularly in the South), preferred single-tree felling to harvest the specific diameters required (fuelwood, timber, fences, wheels i.e.). Besides forest grazing, litter harvesting and slash and burn practises contributed more to the rural economy compared to timber production. Forest management with regard to industrial demands preferred clear-cuts to cheapen transport costs. As a consequence, the size of clear cut areas extended up to 300 or 400 ha. Moreover, they were often illegally opened to forest grazing just after the completion of logging operations. Regeneration was left to nature and - depending on the soil - developed after 20 to 35 years if browsing did not take place.

The second half of the 18th century was characterized by efforts to rejuvenate the forests, either by natural or artificial regeneration, with seeds or seedlings. Artificial regeneration was favoured by German foresters with practical experience, the so-called “holzgerechte Jäger”, but also by those with management experience, the so-called “Kameralisten”, and forest botanists (Mantel, 1990). From the 18th century onwards conifers (pine and spruce) were the most favoured species. Artificial regeneration was particularly necessary in mining districts where the high demand for charcoal had left large areas of clear-cuts or even wasteland. This is the reason why reafforestation activities with spruce started as early as the 16th and 17th century in some regions in Germany and Austria (Oberpfalz, Thüringer Wald, Württemberg, Lüneburger Heide, Sachsen).

3.2 Silvicultural ideas and practises at the beginning of the industrial epoch (19th century)

In Europe, the relationship between men and forests developed quite divergently with regard to place and time. Whereas in Central Europe the protection of forests had great societal importance, countries situated on the Atlantic coast such as UK or the Netherlands worried less about the vanishing forests because they were able to import timber from Central Europe, the Nordic countries, or even overseas. Thus, the amount of timber passing the Danish coast increased 80-fold from the 11th to the 18th century (Radkau, 2000, pp. 222–223).

The particular model of Central European forestry, with a focus on sustainable management, derived from the fact that countries like Germany of the Austro-Hungarian Monarchy had no available external resources. Industrial activities within colonies, as well as the entire population, depended wholly on wood and timber growing in their own forests. This is the reason they became the classical countries with afforestation of high forests at the beginning of the 19th century. Another reason may have also derived from the fact that Germany and Austria had a decentralized administration and legislation, promoting the autonomy of many small states. As a result, multiple scientific doctrines and practises developed in Germany, which were adapted to the given conditions of specific sites (Radkau, 2000, pp. 225). Therefore, cooperation between forest science and traditional knowledge was preferred rather than shunned, as it was in many other countries of the world.

Since the 18th century forestry was introduced on a wider scale and gave rise to extended silvicultural activities. Regions with a high demand for charcoal and timber were the first to encounter clear cutting systems with artificial regeneration. This method can locally be traced back to the 16th century.

The development of clear cutting systems and artificial regeneration was closely associated with conifers. The large extent of clear cuts caused demand for sowing and planting, and the development of artificial regeneration methods gave rise to increased usage of clear-cuts.

3.3 “German classic school of forestry”

The development of the particular Central European approach showed economic as well as ecological advantages. Only when forestry was practised in a sustainable way could industrial as well as economic growth be guaranteed.

Clear cutting with subsequent planting became quite common from 1820 onwards (Thomasius, 2001b) and was promoted by the German forester and teacher at the Forest Academy in Tharandt, Heinrich Cotta and the "German classic school of forestry". Conifers were highly favoured because the demand for softwood was strong, the rotation period was short, intermediate cutting of small diameter stems was also profitable, and the growing stock was high when final cutting took place. Successful regeneration of spruce or pine converted the former mixed forest into large areas of monocultures of conifers (Schmidt-Vogt, 1977; Mantel, 1990; Thomasius, 2001a, b).

Silviculture copied agriculture in manifold ways. It adopted the cycles of planting, cultivation, harvest, and replanting. Nature had to subordinate to the concept of foresters. They intended to cultivate a forest from an economic and production standpoint. Spruce was planted because it promised the highest yield within the shortest period. Human intervention was visible. It followed the ideal of designed nature. And finally, ecological and esthetical aspects had to stand back. More than 200 years of Central European forestry were managed according to the principles mentioned above. Present-day forests and landscape are still distinctly shaped by this epoch.

The dynamic development of conifer plantations in the late 19th century was characterized by improved techniques, the establishment of nurseries, seed trading across Europe, and cheap labour, especially done by women. The high income from the forest along with the willingness to invest money in forest management and improved research activities with regard to seed genetics are part of this process (Simpson, 1904; Heyder, 1983; James, 1996; Smout and Watson, 1997; Moriniaux, 2000; Schmidt, 2002; Rochel & Husson, Dupouey, 2003).

All over Europe, afforestation activities started. Advanced artificial regeneration with conifers began because of changes in the timber market, particularly from an increasing demand for softwood along with price increases (Wessely, 1852, pp. 393–396). Economic considerations, including the question of the highest financial yield, played an important role. A few more driving forces can also be identified. For example, afforestation was driven by political and strategic considerations, done with the aim to improve environmental and living conditions by re-cultivating wasteland located in the plains of Germany (Mantel, 1990; Schmidt, 2002), as well as in the mountain regions of Switzerland, Italy, Austria, and Slovenia (Dasen, 1951; Bloetzer, 1978; Johann, 1985, 1995, 2001; Schuler, 1989, 2002, 2003).

3.4 Influence of the doctrine of the highest financial yield

Afforestation in the 19th century was also influenced by the doctrine of Pressler, which promoted silvicultural techniques to gain the highest financial yield. For this financial reason fast growing species with a short rotation period and high quality and price were preferred (Schmidt-Vogt, 1977; Mantel, 1990). From the 1860s the idea of planting softwood to gain a high profit margin and to increase yield spread all over Europe, which also later influenced forest management methods in India and the United States (James, 1996). Under the influence of the doctrines of Pressler, the proportion of broadleaves in the kingdom of Saxony was reduced by half from 1834/43 to 1884/93. In the South Bohemian forests the proportion of spruce in former mixed stands increased to almost 90%, whereas other species, such as birch and beech, were reduced dramatically or even eliminated (Kral, 1980, 1983) (see Figure 1).

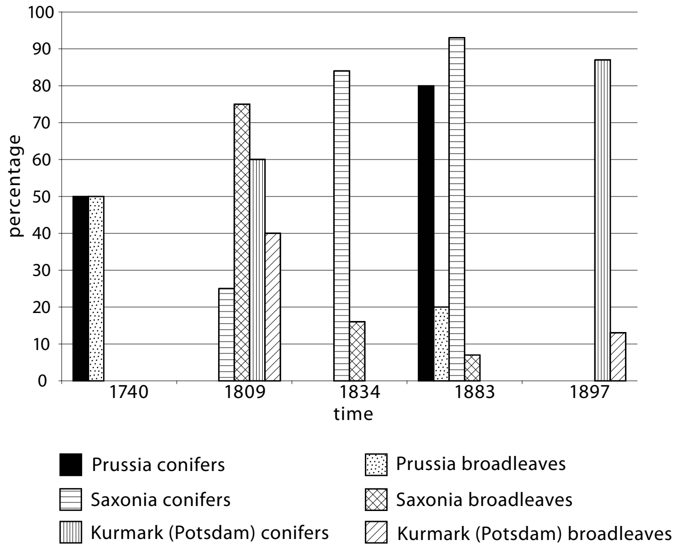


Figure 1: Development of the distribution of tree species in Germany

In Germany, natural forest regeneration was replaced by confer plantations over a wide range, yet the intensity differed regionally. Whereas in Bavarian lowlands and hilly sites the rejuvenation of spruce still occurred naturally in the 1870s, artificial regeneration (clear cutting with subsequent plantation of spruce seeds) dominated in the northern parts of Germany as early as the 1850s and onwards.

During the 19th century, the tradition of European forestry science gave way to economic liberalism, which resulted in monocultures and even-age forests. The German forest became an archetype for imposing the neatly arranged constructs of science on disordered natural systems. Practical goals encouraged mathematical utilitarianism, which seemed, in turn, to promote geometric perfection as the outward sign of the well-managed forests. As a result, the rationally ordered arrangement of trees offered new possibilities for controlling nature. The developments in German forestry were the scientific and intellectual basis for advancements in many other countries. In Slovenia, for example, the plantations also followed the model of the "German classical school of forestry", especially in Styria and Carinthia (Ministrstvo za Kmetijstvo, 2002). Spruce was extensively introduced onto sites comprised of deciduous trees (primarily beech), which resulted in dramatic changes in species composition. Beech declined markedly, particularly in young stands. In the provinces of Kranj and Goricia, clear cuts and non stocked gaps in the former mixed forests (with a percentage of beech around 70%) were replanted almost exclusively with spruce (80% of the plants) in the 1890s.

The target of foresters to convert the monocultures to broadleaved forests after soil conditions would have improved was not put into praxis as planned because of the financial success of plantation forestry (Heyder, 1983). Due to modern forest management systems securing a sustained high interest monocultures of fast growing conifers were planted and broadleaved species were eliminated from the 1860s onwards. The purpose of this kind of forestry was purely economic, where nature was not taken into consideration; it had to submit to the “art of forestry”.

The introduction of plantation forestry changed European forests decisively. However, the effects of reforestation on the landscape level are quite different depending on the natural conditions of the site and the method practised. Variation in climatic and site conditions, as well as cultural attitudes, especially towards woodland, had an influence on afforestation. Nevertheless, some general conclusions concerning the effects of afforestation processes can be drawn (Johann *et al.*, 2004). The historical concept of sustainability was only focused on the production and yield of the forest, and did not take ecological considerations, such as diversity, into account. One of the main characteristics of this period of afforestation was the huge increase in the proportion of forested areas in individual regions and the changes in forest structure and composition. Due to timber production, higher financial yields, afforestation of former wasteland or unproductive pastures, the transformation of coppice forests into high stands of monocultures, as well as catastrophes, spruce plantations increased dramatically, causing a rapid decrease in species diversity.

3.5 The scientific dispute about ecology and beauty

With the reduction in tree species diversity, not only did the forested landscape change, but also the entire scenery (Conwentz, 1907). In the second half of the 19th century, the precisely arranged young conifer-plantations had been the pride of all foresters. However, the treatment of large clear cut areas had brought with it very inflexible spatial planning with little thought of natural processes. As a consequence, all over Europe monocultures turned out to be less resistant to outside influences, although the progressive development of young stands was rather remarkable. This incorrect system of forest management revealed many of the offences against nature. Therefore, it was desirable from a scientific, aesthetic, and ethical point of view to turn forestry away from pure profit making and toward a focus on nature conservation.

The second half of the 19th century brought with it a general change in scientifically approved silvicultural ideas. In the Austria-Hungarian Monarchy, foresters initiated a wide-ranging discussion to clarify the different terms and silvicultural methods concerning the avoidance of clear cuts since the 1850s (Feistmantel, 1857; Österreichische Monatsschrift für Forstwesen, 1877). In Bavaria, Karl Gayer promoted the introduction of the shelterwood selection system (Femelwirtschaft) beginning in the 1880s, and in Prussia the idea of selection thinning (Plenterdurchforstung) was promoted by Borggreve (Gürth, 2003). Both aimed at the cultivation of mixed, unevenaged stands. In Württemberg, new silvicultural techniques were developed in 1865, whereby the country was divided into five natural forest regions, which were to be managed in accordance with the specific local conditions. The aim was the cultivation of mixed stands achieved through a combination of both artificial and natural regeneration. However, the economic goal was the production of timber, particularly soft wood (conifers), and this was the reason why the conversion of former beech forests into stands of spruce and fir was carried out. All silvicultural activities had to increase productivity. Nevertheless, foresters had different options on how to reach this goal. As a result, the different interpretations relied less on diverse scientific findings, but more on the technical and economic possibilities of putting these findings into practice (Gürth, 2003, pp. 77, 120).

Other examples include the introduction and development of the so-called "control method" on an area of more than 20,000 ha of fir-beech forests of the High Karst and the initiation of the system of uneven-aged forests, which was scientifically approved at that time in Postojna. This method was introduced by the Forest Director Schollmayer. However, the fear of karstification and the lack of large-diameter logs (> 50 cm) convinced the forest manager L. Hufnagel to replace the age-class system with selection cutting on an area of 22,000 ha in Kočevje by the 1890s (Mlinšek, 1996).

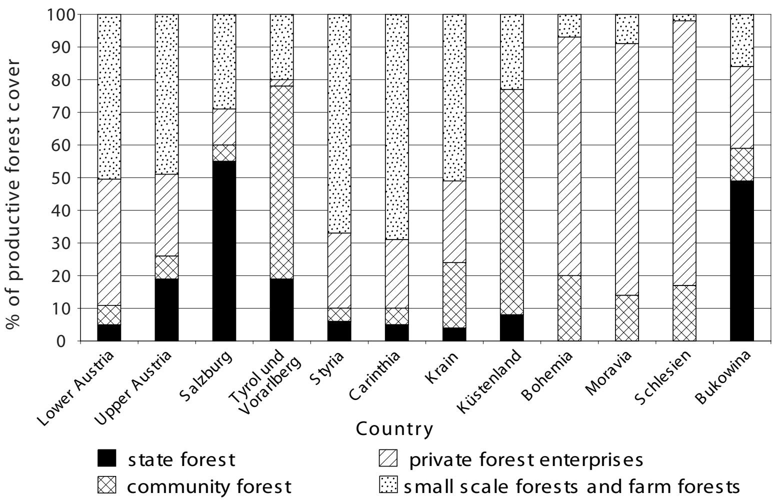


Figure 2: Categories of ownership in the Austro-Hungarian Monarchy 1890 (Sources: Wessely, 1880; Eissler, 1899)

The multiple initiatives indicated the outset of a new, more eco-friendly period in Central Europe at the transition from the 19th to the 20th century. However, the main conditions promoting the changes in management and silvicultural methods differed remarkably. In general, the intensity of forestry decreased from North to South and from West to East. The most important factors influencing the development were ownership structures, market conditions, and the formation of the landscape (see Figure 2 and Table 2). An examination of the status of European forestry in the 1880s shows that a large number of private forest enterprises, a strong industrial development, a high demand for timber, and a scarcity of forest land promoted the development of forestry and the introduction of scientific findings (see Table 3). This development was forced when site conditions were not a hindrance (steep slopes, Karst i.e.). On the contrary, development was slowed down in countries with a large amount of state owned forests with a hierarchical administration structure, sparsely populated regions combined with a low demand for wood products, a high percentage of forest area, high freight rates, and a lack of transport facilities. The high percentage of forest land often resulted in low timber prices. This was the reason forest owners had no money available to promote afforestation programmes, to cultivate the forest, and to employ a staff of educated foresters. Further restrictive conditions were the practise of forest rights, such as litter harvesting, grazing, and long-term agreements with the mining industry.

Table 2: Percentage of forest cover and market conditions in the 1880s in some countries of Central Europe

Country	Forest area in % of the productive land			Price per 1 Vienna cord (average)	Percentage of rural population (in % of the total)	Ha forest per capita
	1789	1873	1879			
Bohemia	29.8	29.97	30	0.73	28.84 (54)	0.27
Moravia	25.7	27.20	27	0.86	33.52 (55)	0.26
Silesia	29.1	32.80		1.01	28.90 (53)	0.36
Upper Austria	38.6	36.95	36	0.54	41.20 (58)	0.49
Lower Austria	28.1	33.95	34	1.23	23.03	0.29
Styria	47.0	49.06	49	0.18	50.16 (84)	0.81
Carinthia	41.0	46.13	46	0.15	47.81 (76)	1.14
Salzburg		36.75	37		36.64 (71)	1.28
Tyrol		48.06	31		40.42 (75)	0.79
Vorarlberg		29.15	31		33.43 (75)	
Krain	39.5	45.47	46	0.15	48.68 (87)	0.85
Görz/Gradisca	13.9	24.37	24	0.29	(72)	0.29
Galizien	30.5	27.90	29	0.48	46.55 (85)	0.35
Bukowina		47.10	50		50.78 (86)	0.82

Table 3: Status of Central European forestry in the middle of the 19th century

Northwest (Germany, Bohemia, Moravia, Silesia)	Northeast (Ukraine) (former Galicia Bukowina)	Alpine countries (Tyrol, Salzburg, Styria, Upper Austria, Krain)	Southeast (Unterkrain, Mittel-, Unter- steiermark)
Most developed forestry in Europe High industrial development High proportion of private forest enterprises Relatively low forest cover Forest management based on scientific findings High amount of employed foresters	Low demand Low development of forestry Low development of industry Forest rights still practised High percentage of forest cover particularly in the Carpathian mountains Small amount of educated foresters	High percentage of forests particularly in remote areas High production costs-low income Distance to the market Problems of harvesting due to the local conditions Small amount of big forest enterprises Small amount of educated foresters	Community forests (over utilization) High percentage of forests in remote areas Distance to the market Low demand: only fuelwood, potash Problematic conditions of the site Only a very few educated foresters

4 Nature-based Forestry

4.1 General development

The development of silviculture in Central Europe cannot be discussed without taking into account the renewals in the field of policy, forest policy, forest legislation and administration, and the general economy. During the 19th century the development of forest science and forestry was closely connected to the rising economy in general, particularly in regard to industry and the improvement of traffic systems, but it was also associated with remarkable structural changes in the field of agriculture and changes in timber market (the transition from fuelwood to timber production). Thus, not only was forest yield improved, but also silvicultural techniques focusing on regeneration and cultural activities in general (Johann, 1998).

The time span when the switch to more eco-friendly methods began was also characterized by remarkable changes in policy and economics. This was the time of severe conflicts, such as the civil revolution 1848/49 and several military confrontations (1866, 1870/71, 1914–1918) (Gürth, 2003, pp. 59). In the second half of the 19th century, milestones concerning economic development included the rapid growing technical progress caused by the introduction of steam power, the improvement of transport facilities (railways, steamships), the replacement of charcoal by fossil fuel, the shift from fuelwood to high class timber production, the increasing divergent development of urban and rural areas, the transformation from agrarian to industrial society, international competition in industry and agriculture, and an increasing population causing increasing demand.

However, the behaviour of human beings has always been influenced by the spirit of the contemporary society too (Otto, 1998):

- The German classical school of forestry by the Enlightenment movement;
- The theory of the highest yield by the Manchester capitalism;
- The idea of the permanent forest cover by the time of an increasing scepticism towards the benefits of civilization and growing national ideas;
- The renewing of the ideas of yield and profit by the needs of World War II;
- The implementation of the protection of nature and biodiversity in modern silviculture by an increasing sensibility of society towards the environment for safeguarding of the living space.

The question of the adequate methods of forest management and silvicultural practises were discussed divergently among foresters. The awareness of forest functions beyond timber was raised by natural hazards from the 1850s onward and gained growing priority in forest policy and legislation (protection, human health, water supply). Nature orientated forest policy and forestry also have to be considered as an answer to the doctrine of the highest returns from the forest profit (Bodenreinertragslehre). This contrast stands for an increasing ecological viewpoint of European forestry (Radkau, 2000, pp. 253)

The driving forces for this development include the demand for protection and recreation (social functions), a high demand for timber, economic development, degraded woodlands, a paradigm shift in society (i.e. urbanisation), science, forest legislation, and the abandonment of former farmland resulting from the awkward economic situation of agriculture.

4.2 Implementation in Central Europe

At the start of the 20th century, close to nature-management methods were developed by forest science and practise. European forests had been managed according to the principles of the age-class system (compartment system) for more than 200 years when a change of paradigm concerning silviculture resulted in an increasing implementation of nature-based techniques. As a response to a far-to-nature oriented forestry, which aimed at shaping even-aged, uniform monocultures, foresters stimulated by new-found loyalty to the natural diversity of species, called for turning "Back to nature" by the end of the 19th century. Careful consideration of the forest as a multi-faceted biological ecosystem came into vogue. Thereby, the maintenance and cultivation of forests became an important task of forestry beside timber production (Johann, 1981).

The „Back to nature" as proclaimed in art became apparent also in the spirit of the whole period and in the conduct of life. Although there was not a stereotypical pattern of management, a renewed adoption of natural forms of forest cultivation, as well as natural systems of regeneration and the cultivation of mixed forests, were silvicultural measures used to maintain a natural forest structure.

Already at the turn of the 20th century, uneven-aged mixed stands were important goals which were achieved by contemporary foresters, especially since they also wanted to meet the demands of nature enthusiasts. Woodlands were no longer seen and managed exclusively for the production of wood, but also with regard to the protection of the environment and to their cultural and recreational values. Educated foresters agreed with these principles. However, these ideas were often not introduced into forest management practices because of the opposition by forest owners against such considerations, especially if adequate financial compensation was not offered. Controversially, it was due to the initiative of some especially devoted forest-owners, that at the turn of the 20th century six privately owned, natural forest reservation areas already existed in the former Austro-Hungarian Monarchy.

The methods that were practised during this time were selection systems, yet counterarguments about these methods stimulated much discussion. For instance, Guttenberg (1889) favoured selection systems only in protection forests and forests with high recreational values. Also, Dimitz (1907) placed attention on the impediments of these systems in mountain forests and promoted clear cuts with a reduced size. Representatives of close to nature systems, however, generally refused clear cuts as an act of heavy destruction of the landscape and also refused uniform, even-aged stands because of instability (Siefert, 1907).

At the beginning of the 20th century, the classical silvicultural system to create continuous forest cover was single tree selection. These methods were practised in parts of Switzerland, France, Germany, Austria, and Slovenia. These traditional forest management methods became known as 'jardinage' in the French and 'Plenterwald' in the German literature. In Prussia, the permanent forest cover (Dauerwald) and a variety of selection systems based on natural principles were preferred to clear cut systems by Möller, Wiebecke, Kalitsch, von Keudell, and later Krutzsch, Lötsch and others from the beginning of the 20th century onwards. (Gürth, 2003, pp. 120–124). The continuous forest cover system includes those silvicultural systems which involve continuous and uninterrupted maintenance of forest cover and which avoid clear cutting, in clear contrast with rotation forest management. The general aim of all systems was the encouragement of structural diversity and uneven age/size-classes on a fine spatial scale.

During the beginning, the development of nature-based forestry was slowed down by several factors. Silvicultural explanations included the generalisation of methods, ignorance of the demands of the site, loss in increment and value, high costs for cultivation, low rotation periods (e.g. beech-80 years, spruce-45 years after artificial regeneration), disadvantage of fir when rotation periods were too short, strong competitiveness of beech, disadvantageous stand structure, rapid changing silvicultural methods without taking into account the demands of time (e.g. wedge shelterwood system, group selection systems, continuous forest (Dauerwald), selection systems, and strip selection cutting). Silviculture was partly regarded as a philosophy of life. Widespread afforestation activities of large clear cuts after World War II and the post-war time, bark beetle diseases, and storm catastrophes caused a renewal in conifer plantations.

The development differed with regard to space and time, often depending on varying influencing factors in the field of policy, economy, and society. The main influencing factors were World War I and II, the inflation of 1923, the obligation of forestry to contribute to the national budget, tax policy, the stock market crash of 1929, legislation, political development, and forest ownership structures.

The influence of this socioeconomic environment should not be underestimated. From the turn of the century, the legally prescribed rejection of the clear cutting economy in Switzerland led to a silviculture based on natural principles, while in Austria as well as in many other European countries, the plantation economy continued to be practised everywhere, with a few exceptions during the first decades of the 20th century (Forster, 1954). This was to a certain extent due to the world economic crisis of the 1930s and to the impacts of World War I and II. At present, the Federal Swiss Law on Forests requires that about 60% of the forest has to be managed as a near-natural biotic community. In Slovenia, since the passing of the Forestry Act in 1948, close to nature forestry became obligatory (Mlinšek, 1996). It includes, among other things, the prohibition of clear cutting for all forests and the transition from extensive silvicultural systems to selection-cutting systems and appropriate silvicultural ways of forest tending. Similar to Switzerland, forests in Slovenia, where "near to nature silviculture" has been practised since the end of World War II, have been relatively well preserved. This holds especially true for the variety of natural tree species and the structure of the stands.

The high demand for wood during of the Second World War and the post-war years caused an extreme deterioration of the forest surface. This was the reason why a considerable number of Central-European foresters promoted the cultivation and conservation of natural mixed forests, natural regeneration, thinning, cultivation of the growing stock, and in general, the cultivation of forests in harmony with nature. First of all, this method led back to natural forests and beyond it to naturally managed forests, in the course of which, particular attention was paid to the conclusions of Gayer (Plenterwald), Morosow (Wald als Lebensgemeinschaft), and Möller (Dauerwald) (Johann, 1984).

The idea of a forest living community, as it had been presented by Engler, Bühler, Flury, Biolley, and Schädelin already in the first half of the 20th century and subsequently improved and carried on by Leibundgut in Zurich was the basis for a movement called “Nature-based forestry” (“naturgemäße Waldwirtschaft”), which became increasingly well known (Leibundgut, 1949; Pockberger, 1952). The ideas were widely promoted by a working group nature-based forestry (Arbeitsgemeinschaft „Naturgemäße Waldwirtschaft“). The content of the doctrine bridged the gap of traditional forestry to the newly defined demands of nature protection. The name nature-based forestry dates back to the title of a book on permanent forest cover (Dauerwald) which was published by Krutzsch in 1932. All the conceptions and ideas were based on biological thinking, where the highest possible volume production and financial yield were to be synthesized with the idea that forests were thought of as a living community. The regulation of the sustained yield of a natural forest living community was not only the desirable aim of management during the 1950s, but became increasingly important, mainly because of the multiple requirements of the forest stands and the demanded and expected benefits, changing more from wood and timber production to conservation.

The Pro-Silva movement also initiated in Europe. This movement promotes the expansion of the goals within silviculture. The Pro-Silva movement originated from the Eastern and Central European deciduous forests in 1989 (in Slovenia), but it has also attracted supporters from the boreal forest zone. As a result of the discussions, the current concept of silviculture includes, apart from wood production, an emphasis on maintaining forest biodiversity, recreational, landscape, protective and socio-economic, as well as cultural functions. Natural forest is accepted generally as a model for the realisation of nature oriented silviculture (Leibundgut, 1978, 1986, 1989; Schütz, 1986; Schmidt-Vogt, 1991; Thomasius, 1992; Sturm, 1993; Parviainen & Seppänen, 1994). There is no uniform model for silviculture in Europe. In order to ensure biodiversity, different silvicultural and regeneration methods are needed. The choice between these methods has to be based on the climatic conditions, the soil, and the characteristics of the tree species.

5 Conclusion

The contemporary main trend of Central-European forestry is the orientation to nature-based silviculture. The general aim of all systems within the concept is the encouragement of diversity of structure and uneven age/size on a fine scale. There is considerable confusion with regard to terms and definitions and even the phrase continuous cover forestry is not universally known. Other synonyms are near natural forestry, close to nature forestry, retention, alternatives to clear felling, and many more. Continuous forest cover systems have been introduced throughout Europe and there are new forest policies in Europe that require the forestry sector to make more use of continuous forest cover techniques (Pommerening, 2002, 2004). The development, which can somehow be called a forest revolution, came into being rather unspectacularly, without drawing much public attention. The concept of nature-based forestry questions the former profit-oriented thinking of silviculture and demands a change concerning the consciousness toward woodland in general. The aim is to look at natural processes and to include them in forest management, to intervene as seldom as possible, and to implement careful techniques. Foresters should not consider themselves as producers only, but also as protectors of the ecosystem as a whole. The aesthetic of nature-based forestry is opposed to even-age forests. Dead wood and natural regeneration shape "natural forests". The natural forest is accepted generally as a model for the realisation of nature oriented silviculture in Europe. In order to ensure biodiversity, different silvicultural and regeneration methods are needed: the choice between these methods has to be based on the local characteristics of climate, soil, and tree species. The general aim of all systems within the concept is the encouragement of diversity of structure and uneven age/size on small spatial scales (Mlinšek, 1996).

6 Discussion

In the 1990s, forestry and silviculture have attracted unprecedented public attention world wide and in Europe. The following factors have contributed to this development:

- Forest sustainability discussion in international conventions and agreements (Rio-declaration) 1992;
- Ministerial Conferences for the Protection of Forests in Europe, in Strasbourg 1990, Helsinki 1993, Lisbon 1998, Vienna 2003;
- Helsinki Process since 1993, IPF-IFF United Nations Initiatives since 1994;
- Forest-certification discussions (ITTO criteria, development of FSC, ISO-14000-norms);
- Climate change forecast and agreements (Kyoto 1997, Forest as a sink in the carbon balance);
- World wide campaigns for forest protection (e.g. introduced 10% - limit of WWF-International, hot pots of protection areas) and against the deforestation of tropical forests.

Due to this development, the demands to change silvicultural practices have been particularly strong. The content of traditional silviculture has changed and the terminology has had to be reassessed. Parallel to the term silviculture, taking care of the forests can mean ecosystem management, biodiversity oriented silviculture, close to nature silviculture, continuous cover silviculture, landscape management, or landscape biological planning. The Pro-Silva movement has also initiated in Europe. Close to nature silviculture is an approach to forest management that is based on the natural development of the forest ecosystem. Under this approach, the forest is utilized and structured, however, all management activities respect its characteristics as an ecosystem. The century-lasting dispute within the extreme discrepancies of large clear cuts and permanent forest cover has at least shown the way to a valued synthesis by mutual adoption. Severe divergences between even-aged stands and clear cuts versus naturally managed forests have come to an end as far as ecological ideas have entered forest laws and forest practices.

Yet the analysis of the historical development gives evidence of the influence of some general conditions with regard to the requested silvicultural methods. Decisions concerning silvicultural practises derive from economic goals set by owners and legislators. The respective economic conditions, primarily the timber market, particularly influence the preferred silvicultural methods. Also, external pressure (nature protection and recreation) is an important determinant of the applied silvicultural methods.

What is the position of present-day silviculture? On the one hand, silviculture aspires toward management of the ecosystem as a whole and in this way receives social acceptance. On the other hand, silviculture is under threat between New-liberalism and the trendy idealism (between the dominating global market and the advancement of plantations worldwide-and the scepticism towards all users of nature in general).

References

Axelsson. A.-L., 2001. Forest Landscape Change in Boreal Sweden 1850–2000. In: Swedish University of Agricultural Sciences (Ed.) Acta Universitatis Agriculturae Sueciae, Silvestria 183, 6–44.

Bloetzer, G., 1978. Die Oberaufsicht über die Forstpolizei nach schweizerischem Bundesstaatsrecht. Zürcher Studien zum öffentlichen Recht 2.

Conwentz, H., 1907. Gesetzliche Vorkehrungen betreffend den Schutz der natürlichen Landschaft und die Erhaltung der Naturdenkmäler. Die Erhaltung ursprünglicher Waldbestände; Vorschläge zur freiwilligen, administrativen und legislativen Mitwirkung. 8. Intern. Land- und forstw. Kongress, Wien 21. – 25. Mai 1907. Referate VIII–IX, Bd. 4.

Dannecker, K. , 1952. Hochgebirgsforstwirtschat im Sinne des Plenterprinzips. Allgem. Forstzeitung, 63. Jg., Heft 9/10, 98–100.

Dasen, E., 1951. Verbauung und Aufforstung der Brienzer Wildbäche. Veröffentlichungen über Verbauungen 5, pp. 66.

Dimitz, L., 1907. Gesetzliche Vorkehrungen betreffend den Schutz der natürlichen Landschaft und die Erhaltung der Naturdenkmäler. Die Erhaltung ursprünglicher Waldbestände; Vorschläge zur freiwilligen, administrativen und legislativen Mitwirkung. 8. Intern. Land- und forstw. Kongress, Wien 21.–25. Mai 1907. Referate VIII–IX, Bd. 4.

Eissler, J., 1899. Handel und Verkehr mit Forstprodukten. In: Die Geschichte der österreichischen Land- und Forstwirtschaft und ihrer Industrien 1848–1898, Bd. 4. Wien, 316–347.

Feistmantel, R., 1857. Vereinsheft des Forstvereins für Oberösterreich. Linz, 28.

Forster, A., 1954. Betrachtungen aus der Praxis zur naturgemäßen Waldwirtschaft im Gebirge. Allgem. Forstzeitung 65. Jg., Nr. 15/16, 190–191.

Gürth, P., 2003. Geschichte des Waldbaus in Baden-Württemberg im 19. und 20. Jahrhundert. Berichte Freiburger Forstliche Forschung Heft 46, Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg 2003.

Guttenberg, A. Ritter v., 1889. Die Pflege des Waldschönen in der Land- und Forstwirtschaft. Österr. Forstzeitung, 7. Jg., Nr. 7, pp. 99.

Heyder, J. Chr., 1983. Waldbau im Wandel. Zur Geschichte des Waldbaus von 1870 bis 1950, dargestellt unter besonderer Berücksichtigung der Bestandesbegründung und der forstlichen Verhältnisse Norddeutschlands. Schriftenreihe der Sächsischen Landesanstalt für Forsten, Waldumbau. Graupa.

James, N.D.G., 1996. A history of forestry and monographic forestry literature in Germany, France and the United Kingdom. In: McDonald, P. and Lassoie, J. (Eds.) The Literature of Forestry and Agroforestry. Cornell University Press. Ithaca. New York, 15–44.

Johann, E., 1981. Die Entwicklung des Waldbaus in Österreich im 19. Jahrhundert. XII IUFRO-World-Congress Kyoto, In: Sammelband der Voluntary Paper der Subj. Group S 6.07, Zürich, 3–11.

Johann, E., 1984. The Change of Conception of Sustained Yield within the Forestry of Austria During the Last Two Hundred Years. In: History of Sustained Yield Forestry: A Symposium. Copyright 1984 by the Forest History Society, Durham, USA, 183–191.

Johann, E., 1985. Der Forstverein für Oberösterreich und Salzburg und die Entwicklung der Forstwirtschaft. Ein Rückblick auf 130 Jahre fruchtbringender Wechselbeziehungen. Hg. Forstverein für Oberösterreich und Salzburg, Linz.

Johann, E. 1998. The Impact of Industry on Mountain Forests in the History of the Eastern Alps before World War I: In: Gorski Gozd (Mountain Forest). Zbornik Referatov XIX. Gozdarski Študijski Dnevi, Juri Diaci (Hg.). Univerza v Ljubljani.

Johann, E., 2001. Zur Geschichte des Natur- und Landschaftsschutzes in Österreich. Historische „Ödflächen" und ihre Wiederbewaldung". In: Faszination Forstgeschichte. Norbert Weigl (Hg.). Schriftenreihe des Instituts für Sozioökonomik der Forst- und Holzwirtschaft, Bd. 42. Wien, 41–60.

Johann, E., 2002. Zukunft hat Vergangenheit. 150 Jahre Österreichischer Forstverein. Österr. Forstverein (Hg.) Wien.

Johann, E., 2003. More about diversity in European Forests: The interrelation between human behaviour forestry and nature conservation at the turn of the 19th century. In: Dealing with Diversity. 2nd International Conference of the European society for Environmental History, Prague 2003. Leos Jelecek *et al.* (Ed.)., Faculty of Science, Department of Social Geography and Regional Development, Charles University Prague, 202–205.

Johann, E., Mauro Agnoletti, Anna-Lena Axelsson, Matthias Bürgi, Lars Östlund, Xavier Rochel, Uwe Ernst Schmidt, Anton Schuler, Jens Peter Skovsgaard, Verena Winiwarter *et al.* 2004; History of Secondary Norway Spruce in Europe. In: Norway Spruce Conversion – Options and Consequences. Heinrich Spiecker, Jörg Hansen, Emil Klimo, Jens Peter Skovsgaard, Huber Sterba, Konstantin von Teuffel (Eds.) European Forest Institute Research Report 18. Brill Leiden-Boston, 25–62.

Kral, F., 1980. Zur Frage der natürlichen Waldgesellschaften und anthropogenen Waldveränderungen im mittleren Mühlviertel (Oberösterreich) Cbl. ges. Forstw. 97/2, 191–119.

Kral, F., 1983. Zur natürlichen Baumartenmischung im Wald- und Mühlviertel mit besonderer Berücksichtigung der Lärche. Cbl. ges. Forstwes. 100/4, 246–267.

Leibundgut, H., 1949. Grundzüge der schweizerischen Waldbaulehre. Forstw. Centralbl. 1949, 68, 257–291.

Leibundgut, H., 1978. Über die Dynamik europäischer Urwälder. Allg. Forstz. 33, 686–690

Leibundgut, H., 1986. Ziele und Wege der naturnahen Waldwirtschaft. Schweiz. Z. Forstwes. 137, 245–250.

Leibundgut, H., 1989. Naturnahe Waldwirtschaft. Wilhelm-Münker-Stiftung 23. Siegen.

Leibundgut, H., 1993. Europäische Urwälder. Wegweiser zur naturnahen Waldwirtschaft. Bern, Stuttgart, Wien.

Mantel, K., 1990. Wald und Forst in der Geschichte. Schaper Alfehld-Hannover, 451–458.

Ministrstvo za Kmetijstvo, Gozdarstvo in Prehrano Republike Slovenije, 2002. Gozd in Gozdarstvo Slovenije. Ljubljana.

Mlinšek, D., 1996. From Clear-cutting to a Close to nature Silvicultural System. In: IUFRO News Vol. 25, 1996, Issue 4, Vienna. 6.

Moriniaux, V., 2000. A History of the French Coniferous Forest. In: Forest History. International Studies on Socio-economic and Forest Ecosystem Chang*e.* M. Agnoletti and S. Anderson (Ed.), CABI Publishing in association with IUFRO, Wallingford, 363–369.

N.N., 1877. Bericht über die Wanderversammlung in Eisenerz 1877: Österr. Reichsforstverein (Ed.) In: Österreichische Monatsschrift für Forstwesen Wien 1877, Bd. 27, 635–684.

N.N., 1952. Österreichische Forst- und Holzwirtschaft, 1952 7. Jg., Heft 14, pp. 269.

Otto, H.J., 1998. Gesellschaftliche Aspekte einer modernen Forstwirtschaft. Tagungsbericht von der 58. Jahrestagung des Deutschen Forstvereins. München.

Parviainen, J., Seppänen, P., 1994. Forestry research on structure, succession and biodiversity of undisturbed and semi-natural forests and woodlands in Europe. In: Peulenka, J.&Paule; L. (Eds.). Conservation of Forests in Central Europe. Proceedings of the WWF Workshop held in Zvolen, July 7–9 1994. Autora Publishers, 23–30.

Pockberger, J.:, 1952. Die naturgemässe Waldwirtschaft als Idee und Waldgesinnung. Fromme Wien.

Pommerening, A., 2002. Approaches to quantifying forest structures. In: Forestry 75, 305–324.

Pommerening, A., Murphy, S.T., 2004. A review of the history, definitions and methods of continuous cover forestry with special attention to afforestation and restocking. In: Forestry 77, 27–44

Radkau, J., 2000. Natur und Macht. Eine Weltgeschichte der Umwelt. C.H. Beck München.

Rochel, X., Jean-Pierre Husson, Jean-Luc Dupouey, 2003. Ancient forestry practises and present landscapes in the Vosges mountains, France. An analysis of 18th century cutting records. In: History & Forest Biodiversity. Challenges for Conservation. An International Symposium 13. 14. and 15

January 2003 Katholieke Universiteit Leuven, Belgium, pp. 19.
Schmidt, U.E., 2002. Der Wald in Deutschland im 18. und 19. Jahrhundert. Conte Forst Saarbrücken.
Schmidt-Vogt, H., 1977. Die Fichte. Ein Handbuch. Bd. 1 Hamburg, Berlin.
Schmidt-Vogt, H., 1991. Naturnahe Fichtenwirtschaft. Heft 31. Wilhelm-Münker-Stiftung. pp. 55.
Schriewer, K., 1998. Die Wahrnehmung des Waldes im Wandel. In: Vokus 1998, 8. Jg.., Heft 2, 2–7.
Schuler, A., 1989. Changes of forest area and forestry in the Swiss Prealps. In: Salbitano, F. (Ed.): Human influence on forest ecosystems development in Europe. Proceedings of a workshop held in Trento, Italy, 26–29 September 1988. Bologna, 121–127.
Schuler, A., 2002. La fondation de la Société forestière suisse en l'an 1843 et son rôle dans la politique et la législation forestière helvétique. Annales des Ponts et Chaussées No. 103, 51–57.
Schuler, A., 2003. La forêt suisse et les inondations au XIXe siècle. Proceedings zur Tagung "*Forêts* d'Europe occidentale du Moyen-Âge à aujourd'hui" 24èmes Journées Internationales d'Histoire, 6, 7, 8 septembre 2002 à Flaran (Gers).
Schulz, W., 1985. Einstellungen zur Natur – Eine empirische Untersuchung – Diss. FW. Fakultät München.
Schütz, JP., 1986. Charakterisierung des naturnahen Waldbaus und Bedarf an wissenschaftlichen Grundlagen. Schweiz. Zeitschrift für Forstw.137, 747–760.
Schütz, JP. 1986. Close to nature-silviculture: is this concept compatible with species diversity? Oxford Journals *Oxford University Press* .. Online ISSN 1464-3626 - Print ISSN 0015-752X Copyright © 2005 Institute of Chartered Foresters.
Siefert, X., 1907. Gesetzliche Vorkehrungen betreffend den Schutz der natürlichen Landschaft und die Erhaltung der Naturdenkmäler. Die Erhaltung ursprünglicher Waldbestände; Vorschläge zur freiwilligen, administrativen und legislativen Mitwirkung. 8. Intern. Land- und forstw. Kongress, Wien 21. – 25. Mai 1907. Referate VIII–IX, Bd. 4.
Simpson, J., 1904. The New Forestry, or the Continental System Adapted to British Woodlands and Game Preservation. Pawson and Brailsford, Sheffield.
Smout, C., Watson, F., 1997. Exploiting Semin-natural Woods, 1600–1800. In: Scottish woodland history. Smout T.C. (Ed.), Scottish Cultural Press Edinburgh, 86–100.
Sturm, K., 1993. Prozeßschutz - ein Konzept für naturschutzgerechte Waldwirtschaft. Zeitschrift für Ökologie und Naturschutz Nr. 2. Gustav Fischer-Verlag, 181–192.
Thomasius, H., 1992. Prinzipien eines ökologisch orientierten Waldbaus. Forstw. Clb. 111, Verlag Paul Parey, Hamburg und Berlin. 141–155.
Thomasius, H., 1996. Geschichte, Anliegen und Wege des Waldumbaus in Sachsen. Landesforstverein Sachsen-Anhalt (Hg.), Ebrach.
Thomasius, H., 2001a. Beiträge des Sächsischen Forstvereins zur Entwicklung der Forstwirtschaft Sachsens bis zum Ausgang des 1. Weltkrieges – Teil 1. Sächsischer Forstverein (Hg.). Ebrach.
Thomasius, H., 2001b. Beiträge des Sächsischen Forstvereins zur Entwicklung der Forstwirtschaft Sachsens bis zum Ausgang des 1. Weltkrieges – Teil 2. Sächsischer Forstverein (Hg.). Ebrach.
Wessely, J., 1852. Die Österreichischen Alpenländer und ihre Forste. 2 Bde., Bd. 1, Braumüller Wien, 393–396.
Wessely, Josef, 1880. Österreich als Ganzes dargestellt für die Interessenten des Forstwesens nach dem Stand der Dinge und der Forschung von 1877–1879. In: Forstliches Jahrbuch für Österreich-Ungarn. Josef Wessely (Hg.), I. Jg. für 1880. Fromme Wien.

Natural management as an important factor of forest protection and survival

Slavko Matić*

Abstract

Chaotic felling in Central Europe in the manufacturing and early capitalism era had adverse ecological and commercial consequences, giving rise to a demand for organised forestry in this area. As a profession and science, forestry was born out of a need to improve forests and prevent their disappearance. Natural management based on the principle of sustainability (sustainable development) played a very important role.

The forestry service was introduced in Croatia in 1746, at a time when Croatia was a part of the Habsburg Monarchy. The service, established on military principles, included 11 regiments and covered an area of 741,907.55 ha. The "Forest Order" of Maria Theresa in the Croatian and German languages issued in 1769 made full recognition of natural management on the principles of sustainability. All forest laws, especially those of 1852, 1894 and the current law, are based on the principle of natural management. Natural management uses tending practices and natural regeneration to improve and enhance the production of commercial and non-commercial values (ecological and social). It also sustains the optimal natural stand structure and enables permanent protection and development of forest soil and site. Regrettably, in the course of time many European countries have abandoned natural management practices and replaced them with clearcutting and artificial forest establishment. The reasons for this shift may be found in economic and marketing postulates, with profit playing the dominant role.

Profit in forest management is a highly dubious category, whose values for forests and forestry have never been thoroughly and realistically explored. Changes in the global climate and ecological conditions have had catastrophic consequences for forests in the sense of their weakening, dieback and decline. In response to such trends, a large number of very active and aggressive citizen groups and political parties have sprung up. Hailed as "nature lovers", "green advocates", "environmentalists" and alike, these groups have a decisive influence on the public, and often unjustly blame the forestry profession for all the calamities. Their fierce opposition to any treatments in forests has led to the exclusion of large forest complexes from natural management. Passive or police protection that bans natural management with tending and regen-

* Acad. Prof. Dr. Dr. hc Slavko Matić, Academy of Forestry Sciences, Trg Mažuranića 11,
HR-10000 Zagreb, Croatia — Tel. +385 1 235 2450, Fax: +385 1 235 2520
E-mail: slavko.matic@zg.htnet.hr

eration jeopardizes both the site and the biocoenosis of a forest ecosystem.

Forests excluded from natural management gradually take on the features of virgin forests, whose ageing and decomposition stages may span several hundreds of years. Unfortunately, such an unfavourable trend, based on total disregard for the forestry profession, is taking alarming proportions. Thus, the total forest area in Croatia under different protection categories accounts for 610,510 ha or 29.4% of the overall natural forest area. All those who insist on passive protection of forests and who disguise their ignorance with "love" for forests should know that blind love and no knowledge, in case of forests, is a path that leads to their downfall.

Key words: natural management, sustainability, tending and regeneration of forests, passive forest protection, natural forests, even-aged forests, selection forests, virgin forests, stages of ageing and decline

1 Introduction

Organized forestry as a profession and science was established in the area of Central Europe in the 18th century for the purpose of protecting forests and preventing their disappearance. Disorganized felling and a decrease in forested areas in the period of manufacturing and the early stages of capitalism had a catastrophic ecological and economic outcome, rendering necessary the establishment of the forestry profession.

In 1702, a Military Border region (*Granica*) was established in Croatia (then a part of the Habsburg Monarchy) as a protection zone against the Turks. The forestry service based on military principles was founded for the entire Border area in 1746. There were 741,907.55 ha of forests within 11 regiments, and each regiment had a military forestry service. This is the period of organized forestry in this area. The year 1765 deserves special mention due to the construction of the first management plans and the establishment of the first forest offices (Krasno, Oštarije and Petrova Gora), of which the Krasno forest office is still active.

Organized forestry practice has always adhered to the principle of sustainability (sustainable development) in forest management. The application of this principle based on natural management ensures the survival of forests in a given area. Sustainable management has also been part of past and present forest legislations. This is seen in the Forest Order of Maria Theresa (1769), Forest Laws of 1852 and 1894, as well as the current forest laws of many European countries. In Croatia, these laws have been strictly obeyed and implemented, especially because forestry was under military administration for a time. Partly thanks to this fact, forests and forestland take up 44% of the total area of Croatia, of which forests account for 2,078,300 ha. Natural forests account for 95% and forest cultures for 5% of the above area.

2 Basic principles of natural management

Natural management retains a forest within a complex natural ecosystem. Tending and regeneration operations are aimed at influencing the site (soil, climate) and biocoenosis (phytocoenosis, zoocoenosis, micro-biocoenosis) in order to sustain and promote natural processes in a natural forest.

The goals of natural management involve the production of commercial and non-commercial values (ecological and social), the sustenance of the optimal natural stand structure, as well as the permanent protection and development of forest soil and site. A forest managed on natural principles provides a firm ecological and economic stronghold, since it lives eternally with an optimal natural structure in well developed and stable site conditions.

In selection management, forests are sustained in optimal natural structural conditions which ensure good natural regeneration, maximal increment and good quality production of commercial and non-commercial resources. In order to retain a selection forest in its optimal condition, permanent management treatments in the form of selection cutting are required. The intensity of their application should be such as to ensure the harvest of the increment and the retention of the optimal growing stock. Selection management retains forests in a selection and optimal stage. These natural stages in the development of a virgin forest, contrary to other stages in a virgin forest, provide permanent maximal production and optimal natural regeneration.

In natural management, cutting in a selection forest is performed in its optimal stage, after which the forest is brought into the selection stage. Unlike the development in a virgin forest, this method avoids both the terminal stage with the sub-stages of ageing and decline and the initial stage. If management treatments are not applied or are misapplied and if cutting is of lower than normal intensity, a selection forest gradually loses its optimal structure. This leads to the establishment of senescent and physiologically weakened trees, which eventually desiccate and decline. Natural regeneration is absent in such a forest. Its increment is reduced and so is the production of commercial and non-commercial values. Natural management in selection forests ensures their permanence in optimal structural and site conditions.

In even-aged forests of high, medium and low (coppice) silvicultural form, natural regeneration involves the application of silvicultural treatments of tending and regeneration. Tending begins after natural regeneration and lasts almost throughout the life or the rotation of a stand, or until the activities on its regeneration begin. Tending ensures the optimal natural horizontal and vertical structure. This results in a good stand climate and the development of forest soil, as well as the optimal provision of commercial and non-commercial values, biodiversity, stability and the possibility of natural regeneration. Regeneration of even-aged forests involves the replacement of an old and mature stand with a young stand using selection cutting, at the same time avoiding stresses on forest soil and young regeneration. Natural management in even-aged stands, which is based on tending treatments, retains optimal natural structural and site conditions in all age classes. Such optimal conditions in an even-aged forest may be compared with the optimal stage in the development of a virgin forest. When a stand reaches maturity, treatments are applied to promote natural regeneration. The time from the beginning to the end of natural regeneration, or the regeneration period, may be compared with the growing developmental stage occurring in a virgin forest.

Natural management treatments of tending and regeneration in even-aged forests support natural forest development similar to that occurring in a virgin forest (optimal stage and growing stage). The decline stage is thus deliberately avoided. Natural management, applied primarily in uneven-aged and even-aged forests, consistently follows all those natural processes that take place in the most natural of forests – the virgin forest. Management treatments accelerate the processes and increase the quality of stands. Such management turns forests into a permanent asset where no natural conditions, value and beauty are lost.

3 Adverse trends that threaten natural management

Despite the evident advantages of natural management and natural forests, the long history of European management has witnessed the abandonment of natural management by many countries and the introduction of the clearcutting system as a management method and artificial forest establishment. The reason for this may primarily be sought in economic and market laws, in which profit in forest management plays a role of prime importance.

Profit from forest management is a highly dubious and insufficiently clarified economic fact in the current ecological and economic conditions. In order to determine its objective value, professional indicators should be used to determine which amount of the profit should be reinvested in forests in the form of tending and regeneration treatments, the purpose being to avoid forest soil degradation, decreased quality of forests and reduction of their generally beneficial functions.

Non-commercial forest goods are reflected in the ecological or protective function (hydrological, water-protective, anti-erosive, climatic and anti-emission), and in the social function (aesthetic, health, recreational and tourist function). Society makes full use of these forest goods. Their quality increases with more intensive and better quality natural forest management. Regrettably, they are not expressed in the market value and are therefore not regarded as forestry-generated income.

The present time is characterized by globally disturbed ecological conditions with catastrophic consequences. They are caused by human activities, which, among other things, lead to the weakening, dieback and decline of forests. As a reaction to such conditions, a number of very active and aggressive associations of citizens and political parties have been established. As "nature lovers", "green groups", "environmentalists" and other forms of nature defenders, they have a profound influence on the general public. Although often lacking firm grounds, they generally accuse foresters of all the misfortunes and oppose any treatments in a forest. Despite being ignorant of forests and forestry, they insist on the protection of large natural forest complexes and demand their exclusion from normal (natural) management. Such passive or police protection that excludes natural management jeopardizes the forest ecosystem, its site and biocoenosis. Regrettably, such movements are gaining ground even in those countries which have natural forests and do not apply the clearcutting management system.

Croatia is an example of a country in which forest areas enjoying different degrees of protection that excludes normal natural management or reduces it to a minimum are constantly increasing. The total area of such protected forests is 610,510 ha, which accounts for 29.4% of the total forest area in Croatia. In some of these areas, any form of management has been strictly banned. In some other areas in which it is allowed, management is made difficult by constant supervisions and limitations imposed by the ministries, which as a rule do not employ any forestry experts.

It should be pointed out that forestry experts, whose effort of 240 years of organized management has brought these forests into the condition of the highest quality, generally have no say in this matter of crucial importance. Such passive protection excludes natural management. The forest loses its optimal natural structure and becomes degraded, while its non-commercial and commercial functions decrease significantly. The site conditions worsen, regeneration is aggravated, the number of old and physiologically weak trees increases, the vitality, stability and productivity of the forest are reduced, and the diversity of the flora, fauna and microorganisms is decreased. A combination of all the above factors is responsible for the fact that such a forest assumes the features of a virgin forest in the sub-stages of ageing and decline. Unfortunately, a forest with a disturbed structure provides minimal commercial and non-commercial benefits, let alone faces very bleak future. All forests that have been excluded from the process of natural management on grounds of protection expect similar future.

Natural regeneration has been and remains the only guaranty of forest protection, survival and longevity. All those who insist on passive forest protection and hide their ignorance behind “love” for forests, should know that they are undertaking great responsibility. In the case of forests, love not substantiated with knowledge is a sure path to ruin.

4 Conclusive remarks

Since the 18^{th} century, management on the principles of sustainability has been the principal reason for the survival of natural forests and natural management in Central Europe. The goals of natural management focus on tending and regeneration, as well as the production of commercial and non-commercial values, coupled with the maintenance of the optimal natural stand structure, permanent protection and the development of forest soil. Natural management in selection and even-aged forests is based on natural patterns taking place in a virgin forest. Silvicultural treatments are aimed at accelerating these natural processes and achieving a better quality and eternity of forests.

Clearcutting as a management method has sunk the respect of forestry as a profession on the European scale. Clearcutting is motivated with economic indicators, where profit has an increasingly dominant role at the detriment of natural forests and their non-commercial functions. Disturbed ecological conditions caused by human activities, as well as air, water and soil pollution are among the factors that affect forest weakening, dieback and decline. To counteract such a condition, a large number of very active and aggressive citizen and political associations are being established. They blame foresters for all the calamities and fiercely oppose any treatments in a forest. They insist on passive or police protection and fight any tending and regeneration treatments, which threatens the quality and survival of forests. Unfortunately, the governments of many countries indulge these groups, allowing the increasingly larger complexes of good quality natural forests to be excluded from management and putting them under protection. Forests devoid of natural management are on the path that leads to their ruin.

5 Summary

Forestry as an organised profession and science was established in Central and Western Europe in the 18th century with the goal of protecting forests and mitigating the growing fear of their disappearance. Chaotic felling and decreased forested areas had catastrophic ecological and economic consequences, giving rise to the formation of the forestry profession. Throughout history, organised forestry profession has always adhered to the principle of sustainability (sustainable development) in forest management, thus sustaining the existing and raising new forests. This principle has been incorporated in past and current forestry legislature (the Forest Order of Maria Theresa /1769/ and Forest Acts of 1852, 1894 and others).

Natural management perceives forests as complex ecosystems and applies tending and regeneration treatments to manipulate the site (soil, climate) and biocoenosis (phytocoenosis, zoocoenosis, micro-biocoenosis) by supporting the prevailing processes in a natural forest. Management goals are directed at both commercial and non-commercial values (ecological and social). Such a forest is a firm ecological and commercial stronghold in all unfavourable life conditions, because it lives eternally with an optimal natural structure and developed and stable site conditions. Advocates of forest management with clearcutting and artificial regeneration are governed exclusively by economic motives. This method results in large areas of unstable monocultures with impoverished biological diversity and reduced commercial and generally beneficial productivity, stability, vitality and capacity of regeneration. Such type of management is being increasingly criticized by both foresters and other experts.

Modern times are characterised by globally disturbed ecological conditions with frequently catastrophic consequences caused by human activities which, among other things, lead to forest weakening, dieback and decline. At the same time, in response to such a situation, a large number of very active and aggressive citizen groups and political parties have sprung up which, under the name of “nature lovers” “green”, “environmentalists” and alike, influence the public and unreasonably insist on the protection of large natural forest complexes and on their exclusion from normal (natural) management. Such passive protection excludes forests from natural management and tending and regeneration treatments. A forest loses its optimal natural structure and manifests signs of degradation and considerable loss of their socially beneficial and commercial functions. The site conditions in the forest worsen, regeneration is aggravated, the number of old and physiologically weak trees increases, tree vitality, stability and productivity declines, the diversity of the flora, fauna and micro-organisms is reduced, etc.

A combination of all these factors is responsible for the fact that forests are assuming features of a virgin forest in the stage of decomposition and growing. Unfortunately, along with the optimal virgin forest stage that lasts for about 150 years, the stages of decomposition decline and growing last for over 300 years. This is the period in which forests with a disturbed structure supply minimal commercial and non-commercial goods and have a very insecure future. Such future is shared by all forests, which have been excluded from the process of natural management on grounds of their protection.

Natural management has been and remains to be the only guarantee of forest protection and survival. All those that insist on passive protection and hide their ignorance behind "love" for forests must know that they are taking great responsibility. In the case of forests, blind love and no knowledge is a sure path towards their downfall.

References

Anić, I., Matić, S., Oršanić., M., 2005. Natural Forests of Pendunculate Oak (*Quercus robur* L.) in Croatia. In Commarmot, B.; Hamor, F. D. (Eds.): Natural Forests in Temperate Zone of Europe – Values and Utilisation. Birmensdorf, Swiss Federal Research Institute WSL; Rakhiv, Carpathian Biosphere Reserve, 135–141.

Klepac, D., 2001. Razvoj gospodarenja u jelovim šumama. U: B. Prpić (ur.), Obična jela (*Abies alba* Mill.) u Hrvatskoj, Akademija šumarskih znanosti, Zagreb, 25–89.

Korpel, Š., 1995. Die Urwaelder der Westkarpaten. Gustav Fisher Verlag, Stuttgard-Jena-Neww York, pp.310.

Korpel, Š., 1996. Razvoj i struktura bukovo-jelovih prašuma i njihova primjena kod gospodarenja prebornom šumom. Šumarski list CXX, Zagreb, (3–4), 203–209.

Matić, S., 1990. Šume i šumarstvo Hrvatske – jučer, danas, sutra. Glasnik za šumske pokuse, Zagreb, 26, 35–56.

Matić, S., 1996. Uzgojni radovi na obnovi i njezi sastojina hrasta lužnjaka. U: D. Klepac (ur.), Hrast lužnjak (*Quercus robur* L.) u Hrvatskoj, HAZU i Hrvatske šume, p.o. Zagreb, Zagreb, 167–212.

Matić, S., 1999. The forests of Croatia – country report. U: Diaci, J. (ur.), Virgin forests and forest reserves in Central and East European countries, Department of forestry and renewable forest resources, Biotechnical faculty, Ljubljana, 17–24.

Matić, S., Anić, I., Oršanić, M., 2001. Uzgojni postupci u prebornim šumama. U: B. Prpić (ur.), Obična jela (*Abies alba* Mill.) u Hrvatskoj, Akademija šumarskih znanosti, Zagreb, 407–460.

Matić, S., 2003. Neki problemi koji opterećuju hrvatsko šumarstvo u današnjim gospodarskim, društvenim i ekološkim uvjetima. Šumarski list 5–6 (CXVII), Zagreb, 211–216.

Matić, S., 2004. Održivi razvoj hrvatskih šuma ugrožen je zbog nepoštivanja Ustava i Zakona o šumama Republike Hrvatske. U: M. Maceljski (ur), Alternativna biljna proizvodnja u strukturnim promjenama hrvatske poljoprivrede. Hrvatska akademija znanosti i umjetnosti, Znasnstveno vijeće za poljoprivredu I šumarstvo, Zagreb, 82–84.

Prpić, B., 2003. Općekorisna uloga bukovih šuma. U: S. Matić (ur.), Obična bukva (*Fagus sylvatica* L.) u Hrvatskoj, Akademija šumarskih znanosti, Zagreb, 213–227.

Close to nature forestry criteria and coppice management

Pietro Piussi*

Abstract

Coppice management is the most diffused silvicultural system in Italy. Within the approximately 8,582,000 ha of Italian forests the area managed as coppice is 3,673,800 ha. Common tree species are various oaks, chestnut and beech. Coppicing is practised as a clear cut leaving standards to produce seed for stumps reproduction.

Until some 50 years ago, management criteria were different from those adopted today: short rotations, removal of all biomass, deadwood and litter, occasional introduction of agricultural crops following the coppice utilization, irregular grazing. Coppices have in the mean time undergone a crisis due to major changes in energy sources and labour costs. Some coppices have been converted to high forest. Utilizations grew again since the 70s modifying exploitation criteria: reduction in forest grazing, longer rotation age, no collection of minor products. Old forestry practices had a stronger impact on nutrient exploitation than present coppicing practices. Coexistence of forestry and pastoral activities is somewhere difficult; on the contrary in other parts of the country wildlife is heavily damaging young shoots. Coppice woods satisfy the rural economy; their use requires small investments in machinery and no special professional skills. Vegetative regeneration takes place in a very short time. Utilizations can be carried on small surfaces. During recent years new woodlots have been planted to provide fuel wood by coppicing, so as young stands deriving from secondary succession on abandoned farmland.

Coppice does not guarantee a satisfactory protection from soil erosion and organic matter losses, and water cycle is not hampered. Degraded coppices are frequently the outcome of old exploitation systems, but also of forest fires. Forest degradation is therefore the result both of bad management and of the peculiarities of a harsh environment. New and old environmental constraints and human activities can locally represent an obstacle to a sustainable management.

Coppice promotes a simplified stand composition. Stand structure diversity can be favourable to some important bird species. Vegetative propagation also causes a "genetic stagnation" useful when environmental conditions are stable, but dangerous when the environment is changing. Clear-cuts favour a herbaceous vegetation, a good

* Prof. Dr. Pietro Piussi, Dipartimento di Scienze Tecnologie Ambientali Forestali, Via San Bonaventura 13, I–50145 Firenze, Italy, Tel.:+390 55 3288647, Fax: +390 55 307263, E-mail: pietro.piussi@unifi.it

habitat to a rich fauna, especially insects. Exotics can represent a serious nuisance since they easily penetrate in degraded coppice stands.

The negative attitude toward coppice in the past was mainly motivated by how it was implemented in a different social, technical and economic frame. New exploitation criteria can support coppices as a sustainable source of energy, an environment rich in biodiversity and a relevant part of the cultural landscape.

Key words: coppice, fuel wood, sustainable management, biodiversity, Mediterranean forests

1 Italian Forests

Close to nature forestry criteria have been extensively discussed in Italy and, starting approximately 50 years ago, Trentino foresters abandoned the traditional clear cutting and artificial regeneration system and the commercial selection system, and adopted methods that had been observed in Switzerland. Nowadays, close to nature forestry has been adopted in most of the mountain forests of Italy's North-East. These forests, mainly spruce-fir-beech stands, are however scarcely representative of the Italian forestry picture. Coppice management is the most diffused silvicultural system in Italy, and coppices dominate the Italian rural landscape. Coppice covers considerable areas in some countries in Southern Europe: a total of 21 million ha, out of which 7 million ha is in France alone (Puummalainen, 2001).

The "Inventario Forestale Nazionale Italiano delle Foreste e dei Depositi di Carbonio 2000" (Italian National Forest and Carbon Sinks Inventory 2000), reports the following data regarding forest land:

Forests	ha	8,582,011
Tree plantations	ha	141,206
Other wooded lands	ha	1,662,099
Land temporarily without tree cover	ha	44,503
Total	ha	10,429,819

Unfortunately it is impossible to compare these data with the previous forest inventory carried out in 1985, since the survey criteria have changed and, in the mean time, the definition of "forest" has changed according to the criteria of the FAO Forest Resources Assessment.

The category "other wooded lands" includes stands having either a crown cover between 5 and 10%, stands with trees lower than 5 m, shrublands (the most common being the so called "macchia bassa" or evergreen Mediterranean scrubland), inaccessible stands, and also young stands deriving from secondary succession on former pastures and agricultural land. The secondary succession process is the main factor driving the increase of forest area over the course of the second half of the last century - an average of 15,000 ha per year - while artificial reforestation has had only a subordinate role. In other words, 16% of Italian wooded area is either heavily degraded or formed by young stands growing on former agricultural land.

2 Coppices: Traditional and Present Silviculture

Within the approximately 8,582,000 ha defined as “forests” (which include chestnut groves, cork oak stands, etc.) the area managed as coppice is 3,673,800 ha, or 43% of total forest land. Coppices are represented in all Italian Regions including the Alps, where they mostly occur in the foothills (Pre-Alps). The most common tree species are various oaks (Turkey oak (*Quercus cerris*), pubescent oak (*Q. pubescens*), holm oak (*Q. ilex*), Quercus frainetto (*Q. conferta*), etc.), chestnut (*Castanea sativa*) and beech (*Fagus silvatica*). Coppicing is practised as a clear cut. The reproduction of stumps is provided by new plants growing from seeds produced by standards (in Italian: *matricine*), which develop where gaps are formed by stump mortality. In the past, standards were often exploited to produce timber for railway sleepers. Various kinds of standards management were adopted according to a number of factors, such as tree species, market requirements, and other uses of acorns.

Figure 1: Traditional coppice management; notice the charcoal kiln in the foreground, which is at the final stage of burning

Coppices, precious until the 50s for the production of fuelwood, charcoal (Fig. 1) and poles used in agriculture, have in the mean time undergone a crisis due to major changes in energy sources and labour costs. Therefore, utilization decreased sharply. Some coppices, especially those of beech, have been treated with thinning to prepare the conversion to high forest, especially where silver fir was also present and it was therefore possible to favour the formation of mixed stands. An increase of utilization can be perceived since the 70s, especially on land easily accessible to machinery and on the most productive sites; coppicing has become more and more convenient also because delayed utilizations were yielding higher wood masses. Only fuelwood (approximately over 5 cm diameter) was collected, while branches, once used to heat kilns for bricks and lime, ovens, etc., were left on the ground. Thinnings and litter collection were no longer carried out. In Northern and Central Italy there was also a sharp reduction in forest grazing. The rotation age became longer. Stand structure, indicated by the crown architecture of old standards, shows these changes. Moreover, due to the different management and use of coppices, forest fires increased dramatically both in number and surface area.

Rotation age is not established considering the optimization of wood increment, but rather the possibility to obtain products with specific dimensions: in the past the production of charcoal required small shoots (2 to 5 cm, up to a maximum of 10–11 cm), whereas now different uses of the production (fuelwood and chips), mechanization introduced for cutting and handling, as well as the advantage of utilizing stands with a high standing volume are decisive in determining the time of cutting. Things are different for chestnut production, used for poles in vineyards and fruit groves in the past and present. Incidentally, longer rotation periods also offered the opportunity to improve soil conservation.

Changes also took place in forest legislation: a longer minimum rotation age is required now, and there are restrictions in surfaces undergoing utilization.

After France, Italy is the second largest consumer of wood as an energy source in Europe (Hellrigl, 2002); consumption per person is comparatively low, and similar to that of Spain, France and Germany. Fuelwood consumption has increased during the 90s: biomass consumption for domestic use is approximately 16–20 Mt (families living in rural districts provide a large part of their needs from hedges, trees scattered in fields, meadows and pastures, as well as from wood provided by pruning olive groves, fruit groves, etc.). In total, 34% of Italian families use biomass.

3 Sustainability of Coppice Management

It is interesting and useful to compare today's coppice management, in the different forms it has had in time, with the Pan European Process criteria and the Pro Silva principles (Terzuolo, 1999) regarding sustainable forest management. Coppicing has been analysed from this point of view when certification processes have been applied. This will be a rough outline serving only as base for further discussion, due to three main features: coppice utilization criteria are not uniform in various Regions of Italy; the criteria can change in a short period according to the market (costs of fuelwood and labour); and last because some criteria cannot be quantified.

Conservation and appropriate development of coppice woods and their productive function have a long history. Coppicing is recorded in the UK since 4000 b.p. and has been described in Roman agriculture treatises. More precise information regarding sites where coppicing has been practised, species composition, their management and details on the technique applied are available for the Middle Ages (Piussi & Redon, 2001). This information has been collected sometimes for forest stands still existing today, with a data continuity of 300–400 years (Piussi, 1979). In many of these cases stand composition remained unchanged, while in other cases it underwent substantial changes due to various factors (e.g. the cold winter of 1709, fires, invasion by different species during successional processes). Little can be said about productivity. These data cover in some cases a short period compared to that during which woods underwent utilizations; some of the locations occupied by these woods were settled in pre-Roman times when soil use was frequently quite heavy, as testified by ancient soil erosion records. But we also know that old forestry practices had a stronger impact on nutrient exploitation than present coppicing practices (Lucci, 1985).

Coppice woods usually satisfy local needs of the rural economy in various rural regions; their use requires small investments in machinery (usually it is the same employed in agricultural activities); no special professional skills are required. Fuelwood is usually the only product of these woods, especially for a local use, and is an energy source with a zero CO_2 budget (research is under way to study the C budget of the soil). Vegetative regeneration has various advantages; a natural process taking place in a very short time with no technical difficulties and no costs. Environmental variability (wind exposure, aspect, etc.) has no influence on cutting criteria. Utilizations can be carried out on very small surfaces, including hedges, tree rows, etc; this fact represents an advantage for small landowners.

Also, in recent times new woodlots have been planted with the purpose to provide fuelwood with traditional criteria; some sort of link with the modern short rotation forestry (Fig. 2). Furthermore, many young stands, derived from secondary succession on abandoned farmland, are managed as coppices; is it certainly a pity to see ash (*Fraxinus excelsior*) and maple (*Acer pseudoplatanus*) managed in such a way, but these woods are growing on small ownerships, where cooperation between owners is nonexistent and usually a forestry tradition is absent, while fuel wood is still required.

Figure 2: Reforestation dating back to the second half of the past century, managed as coppice

It has long been known that coppice does not guarantee satisfactory protection from soil erosion and organic matter losses; as a consequence, soil fertility is reduced. The water cycle is not hampered and therefore the danger of floods in small watersheds can increase. These are consequences of the clear-cut, which cannot be avoided with this silvicultural system; crown cover can be increased by leaving a larger amount of standards, but wood production and stump vitality would be consequently reduced due to competition. Final utilizations, and therefore, clear-cuts have a higher frequency than those in high forest. A kind of “Plenterung” or “selection” system (“*taglio a sterzo*” or “*taglio della formica*” in Italian, “*furetage”* in French) was adopted for shade tolerant species (beech and, in a few cases, holm oak); on the same stump only large shoots are felled and small, younger shoots guarantee a certain amount of soil protection while growing faster because of reduced competition; therefore on each stump shoots of two ages were growing. This “selection” system is still applied in beech woods, but many stands of this species are managed today to prepare the conversion to high forest (Fig. 3) or, because of low productivity or access difficulties, have not been utilized for many decades.

Figure 3: Beech coppices thinned since the 80s to prepare the conversion to high forest

We should not forget that most of the critical comments date to the first half of the last century or even during the 19^{th} century, and were grounded on management criteria common until a few decades ago: short rotations (officially at least 10 or 12 years, but locally sometimes only 3–4 years), collection of branches for fodder, removal of all branches, deadwood and litter, intermediate thinning at 4 or 6 years, occasional introduction of agricultural crops (equivalent to *Waldfeldbau*) during the first 2–3 years following the coppice utilization. Grazing, officially starting three years after felling, was frequently practised before. Acorn production was very important for pig rearing and, obviously, heavily contributed to the depletion of nutrients.

In most Regions the situation has totally changed: rotations are longer (18–20 years, or even more) and the collection of minor products is no longer practised.

Even though coppice management has improved there are still some critical situations, especially in the South of the country and in the big islands, caused mainly by the difficult coexistence of forestry and pastoral activities. In Central and Northern Italy, on the contrary, reduced human pressure on forest ecosystems is followed by an increase in deer populations; roe deer and fallow deer are causing damages to young shoots.

Coppice degradation is also caused by forest fires, a widespread plague in Mediterranean forests; the coppice shows an active resistance to fire since, a few weeks after burning, stumps produce new shoots so that a green cover appears after a few years. Obviously there are heavy losses of organic matter, and if summer fires are followed by intense autumn rains (September and October have the highest amount of precipitation) erosion can cause soil losses.

Forest degradation is therefore the result of both bad management and the peculiarities of the Mediterranean environment, and the final stage can be desertification. This danger has been pointed out for many forest areas in Abruzzo, Puglia, Basilicata, Calabria, Sicily and Sardinia (Corona, 2005). Areas prone to desertification are those with precipitation below 600 mm/year, summer (3 month or more) drought and strong interannual variation in the precipitation regime; these characteristics are typical of large areas of the Italian peninsula (52% of Italy is "exposed to the risk of potential degradation processes"). Another vulnerable feature of the Mediterranean environment is soils prone to erosion, especially where they are formed on limestone and where they have been created through terracing no longer maintained because of land abandonment.

This picture is worsened by the trend - already established by the end of the 19th century - of increasing temperature and decreasing precipitation. New and old environmental constraints and human activities can represent a serious obstacle to sustainable management. Both fire and grazing are factors typical of the Mediterranean environment in which vegetation has evolved: vegetative propagation, low flammability, corklike barks, active pyrophytic seed regeneration, thorny shrubs, etc, are examples of adaptation. Anthropogenic activities have nevertheless modified the frequency and intensity of these factors so that their action frequently reaches a pathological level. As a consequence, if Italian forest area is globally increasing thanks to secondary succession in abandoned farmland, in the Mediterranean regions, degradation processes are reducing forest cover.

Coppice regeneration is provided by vegetative propagation: Thanks to their fast growth (Turkey oak and chestnut shoots can reach 2 m in the first growing season) crown cover can be reached in 2–3 years. Since nowadays branches are usually left on the ground, nutrient depletion is lower than in the past. Furthermore, these branches increase the forest fire danger, but protect the soil against erosion; they are also a mechanical obstacle to deer movement and therefore protect the new shoots and reduce browsing damage. But longer rotations also mean stronger competition between shoots of the same stump and between different stumps. As a result, some of these die and therefore, after cutting, stump density is reduced and the formation of cover takes longer (Lucci, 1985).

The relation between coppice management and biodiversity has been frequently discussed. Coppice promotes a simplified stand composition, since only some tree species can use vegetative propagation and fast growing species benefit from short rotations. Vegetative propagation also causes a "genetic stagnation" (some stumps, especially those of chestnut, can be centuries old) which is an advantage when environmental conditions are stable, but could become a negative factor as the climate conditions change.

Genetic diversity within dominant species should be promoted by seedling regeneration from standards, whereas species diversity can be fostered by favouring the usually few individuals of *Sorbus, Acer,* and *Fraxinus* (Pelleri & Ferretti, 2003). A richer diversity can be obtained by leaving standards in small groups, so that also herbaceous and shrub species can be preserved from disturbances.

Exotics can represent a serious nuisance: *Robinia pseudoacacia*, introduced in forestry since the 19th century, and *Prunus serotina*, introduced from experimental plots, easily invade coppices and are rather aggressive in degraded stands where reduced density cannot be an obstacle.

In coppices old trees and deadwood are obviously missing. This fact can be partially overcome by avoiding the utilization of some standards independently from their wood or seed production. This criterion is required, for instance, in the Regione Toscana.

Clear-cuts favour herbaceous vegetation which, in turn, offers good habitat to a rich diversity fauna, especially insects. Very few are nevertheless empirical data.

Using landscape ecology criteria, an attempt has been made to estimate the virtual impact of coppice management, as it is practised at the moment, on the conservation of some endangered bird species. These have been chosen between sedentary and migrants according to their requirements in terms of habitat for reproduction and for foraging. The impact is different, and sometimes opposite, for the different species. A general rule for bird diversity could not be established even if areas with high compositional and structural heterogeneity (that is areas where utilizations are still practised) have a higher index of ornithological importance and of environmental quality (Mairota *et al*., 2005).

4 Conclusions

Coppice is a silvicultural system, which has been applied in different ways over the course of time in different parts of Italy; the soil occupied by these woods has frequently been used contemporaneously for wood, fodder and grain production. A general comparison with the criteria expressed by the Pan European Process is therefore impossible, nevertheless useful observations can spring from the analysis of individual case studies.

It is however possible to draw some general conclusion.

The negative attitude toward this system frequently expressed in the past was motivated by how it was implemented in a different social, technical and economic frame. This situation has changed, but the ecological history of coppices - an extreme exploitation of primary production - is reflected in many cases by degraded stand structures and impoverished soils. This story must not be forgotten now that the progress in mechanization and the request of biomasses for clean energy exert a new pressure on these woods. The process of recovery which has taken place in the recent decades must not be reverted. Unfortunately, very little - or nothing - can be done to mitigate climate changes and the invasion of other species acting as competitors, predators or parasites endangering indigenous tree species.

During the last fifty years the attitude toward coppice management has changed;

the suggestion to transform coppices into high forests, if necessary by eradicating the stumps and planting conifers, was followed by attempts to develop animal husbandry in old coppice stands (luckily both attempts failed) and, more recently, by the revival of their use for energy. The cultural values of forests are not explicitly mentioned among the Pan European Process requirements. Forest history is now acknowledged as a cultural value (and perhaps can be included in other socio-economic functions and conditions) and we are all aware of the interest for old and majestic trees. Large dimensions, curious shapes, old age, are all features of the landscape and elements which draw attention, but usually these cannot be detected in coppices.

Coppice management is an important part of the Italian heritage, it is related to many aspects of our culture, in the techniques developed to exploit and to preserve these woods. The lore of woodmanship (Rackham, 1993) has certainly in part disappeared. The energy of wood and charcoal flowing from the mountains and hills has been an indispensable element in urban development. New exploitation criteria, supported by ecological knowledge, appropriate mechanization and integrated land planning can support coppices as a sustainable source of energy, an environment rich in biodiversity, and a relevant part of the cultural landscape.

5 Summary

Close to nature forestry criteria have been adopted in most of the mountain forests of Italy's North-East. These forests are scarcely representative of Italian forestry. Coppice management is the most diffused silvicultural system in Italy. Within the approximately 8,582,000 ha of forests the area managed as coppice is 3,673,800 ha. The most common tree species are *Quercus cerris*, *Q. pubescens*, *Q. ilex*, *Q. conferta*, *Castanea sativa,* and *Fagus silvatica*. Coppicing is practised as a clear cut. The reproduction of stumps is provided by new plants growing from seeds produced by standards which used to be also exploited to produce timber for railway sleepers and acorns for pigs.

Coppices, precious until the 50s for the production of fuel wood, have in the mean time undergone a crisis due to major changes in energy sources and labour costs. Therefore, utilization decreased sharply. Some coppices have been converted to high forest. An increase in utilization started in the 70s with criteria usually different from those of the past.

We try to compare today's coppice management with the Pan European Process criteria and the Pro Silva principles regarding sustainable forest management, even if coppice utilization criteria are not uniform in various Regions. However, they can change in a short period and some of them cannot be quantified.

Coppicing has been practised since prehistory. More precise information regarding sites and techniques are available since the Middle Ages and show how old forestry practices had a stronger impact on nutrient exploitation than present coppicing practices.

Coppice woods satisfy local needs of rural economy; their use requires small investments in machinery, and no special professional skills are required. Vegetative regeneration takes place in a very short time with no technical difficulties and no

costs. Environmental variability has little or no influence on cutting criteria. Utilizations can be carried on very small areas, including hedges, tree rows, etc, which is an advantage for small landowners.

In recent times new woodlots have been planted and many young stands developed from secondary succession on abandoned farmland are managed as coppice to provide fuel wood.

Because of clearcutting coppice does not guarantee a satisfactory protection from soil erosion and organic matter losses. The water cycle is not hampered and therefore the danger of floods in small watersheds can increase. Final utilizations, and therefore, clear-cuts have a higher frequency than those in high forest. A kind of "selection" system was adopted for shade tolerant species and can sometimes be seen in beech stands.

Most of the critical comments date to the first half of the last century or even during the XIX century, and were grounded in management criteria common until a few decades ago: short rotations (officially 10 or 12 years, but sometimes 3–4 years), collection of branches for fodder, removal of all woody material, deadwood and litter, intermediate thinning at 4 or 6 years, and occasional introduction of agricultural crops during the first 2–3 years following the coppice utilization. Grazing, officially starting three years after felling, was frequently practised before.

Today rotations are 18–20 years or more, and the collection of minor products is no longer practised reducing nutrient depletion but increasing forest fire danger.

In the South of Italy and in the big islands the coexistence of forestry and pastoral activities is difficult, whereas in Central and Northern Italy, the increase in deer populations is followed by damage to young shoots. Coppice degradation is also caused by forest fires; stumps can survive but fire causes losses of organic matter and frequently erosion. Forest degradation is therefore the result of both bad management and the peculiarities of the Mediterranean environment, and the final stage can be desertification, which is more likely on soils formed by limestone. This situation is worsened by increasing temperature and decreasing precipitation. A harsh climate, fire and grazing are factors typical of the Mediterranean environment in which vegetation has evolved, but anthropogenic activities have modified the frequency and intensity of some of these factors up to a pathological level. As a consequence, if Italian forest area is globally increasing thanks to secondary succession in abandoned farmland, in the Mediterranean regions, degradation processes are reducing forest cover.

Coppice promotes a simplified stand composition, since only some tree species can use vegetative propagation and fast growing species benefit from short rotations. Vegetative propagation causes a "genetic stagnation" useful when environmental conditions are stable, but dangerous when climate is changing. Species diversity can be fostered by favouring the usually few individuals of *Sorbus, Acer,* and *Fraxinus*. Exotics can represent a serious nuisance: *Robinia pseudoacacia* and *Prunus serotina* easily invade in degraded coppices. In coppices old trees and deadwood are obviously missing. Clear-cuts favour herbaceous vegetation, a good habitat to a rich diversity of fauna. An attempt has been made to estimate, using landscape ecology criteria, the virtual impact of coppice management on the conservation of some endangered bird species. The impact is different, and sometimes opposite, for the different species.

Coppice is a silvicultural system, which has been applied in different ways over the course of time in different areas of Italy. The negative attitude toward this system expressed frequently in the past was motivated by how it was implemented in a different social, technical and economic frame. The ecological history of coppices is reflected in many cases by degraded stand structures and impoverished soils; this story must not be forgotten now that progress in mechanization and the request of biomass exert a new pressure on these woods.

During the last fifty years the attitude toward coppice management has changed many times and recently by the revival of their use for energy and, sometimes, by their historical value even if cultural values of forests are not explicitly mentioned among the Pan European Process requirements. Coppice management has been related to many aspects of Italian culture, including the techniques developed to exploit and preserve these woods, which have been an indispensable element in urban development. Finally, coppice woodlands may provide a valuable source of energy.

References

Corona, P., 2005. Desertificazione, siccità, foreste e ricerca. Forest@ 2 (3), 256–257. [online] URL: http://www.sisef.it/

Hellrigl, B., 2002. L'uso energetico del legno nelle abitazioni di alcuni Paesi europei. Sherwood 76, 15–21.

Lucci, S., 1985. Nutrient distribution in a Turkey oak (*Quercus cerris* L.) coppice stand in Southern Italy. In: Current perspectives in Environmental Biogeochemistry, C.N.R. – I.P.R.A. Roma. Giovannozzi G. Sermanni, Nannipieri P. eds., 341–351.

Mairota, P., Tellini Florenzano G., Piussi P., 2006. Gestione del bosco e conservazione della biodiversità: l'analisi eco-paesistica applicata a territori boscati della Toscana meridionale. (In press)

Pelleri, F., Ferretti F., 2003. Valorizzazione delle latifoglie nobili nei cedui. Sherwood 93, 31–34.

Piussi, P., 1979. Le traitement en taillis de certaines forêts de la Toscane du XVIème au XXème siècle. Actes du Symposium International d'Histoire Forestiere, Nancy, 24–28 Septembre 1979. E.N.G.R.E.F., Tome I, 50–57.

Piussi, P., Redon, O., 2001. Storia agraria e selvicoltura. In: Medievistica italiana e storia agraria (A. Cortonesi e M. Montanari eds.) CLUEB, Bologna, 179–209.

Puummalainen, J., 2001. Structural, compositional and functional aspects of forest biodiversity in Europe. ECE/TIM/DP/22, United Nations.

Rackham, O., 1993. The last forest. Dent, London, pp. 302.

Terzuolo, P., 1999. I cedui italiani ed i principi di Pro Silva. Primo contributi. Pro Silva informa. 2, 6–12.

Opportunities and strategies of biorationalisation of forest tending within nature-based management

Jean-Philippe Schütz*

Abstract

The positive effects of working with natural processes are now well known for close to nature silviculture, using so called nature-automation. The general wisdom is that they apply especially for whole silviculture systems like the plenter forest system or for other regeneration forms under cover using shade as a cheap nurturing factor. Much less is known about the possibilities of applying nature-automation to tending operations, even though the costs for this important feature are currently prohibitive for young stands with plethoric stem numbers. Because natural processes lead to social differentiation they also lead to a natural reduction in stem number, and so they work similar as our goals, in so far as they favour the trees with the best self differentiation. We presently know that the social dominating trees in regular stands show properties to maintain their social dominance and do not need as much crown deliverance as previously thought. Inexpensive tending operations aim to let work the social differentiation process up to a certain limit. This allows substantial cost reductions in a manifold extent. The strengths and limits of this so called situative tending operation are presented and discussed.

Keywords: rationalisation, close to nature silviculture, tending, social position, thinning

1 Introduction

The great challenge in modern forest management considering sustainability as defined in the 1992 Rio conference is to harmonize the needs for a sound economy while maintaining a correct ecological demeanour and be socially compliant. The common denominator for such a challenge is the multiple use strategy, which tries to fulfil every need at the same place. Thus, the multiple use concept is on the mend to become the main goal for modern forest policies. The characteristic trends for the frame conditions in the last decades include the general awareness for a sound ecology which has gained favour since the different international conferences (Rio, Helsinki), the emergence of societal needs and the role of forest as a legacy or patrimonium (Siegwalt, 1994), and a dramatic decline of economic return from timber selling as a

* Prof. em. Jean-Philippe Schütz, Brüggliäcker 37, CH-8050 Zürich, Switzerland
Tel. 0041 44 321 1989, E-mail: jph.s@bluewin.ch

consequence of globalisation. As a consequence, the discrepancy between the three main pillars for sustainability (economy, ecology, social) widened tremendously, and thereafter the necessity for reducing the costs by different forms of rationalisation gained importance.

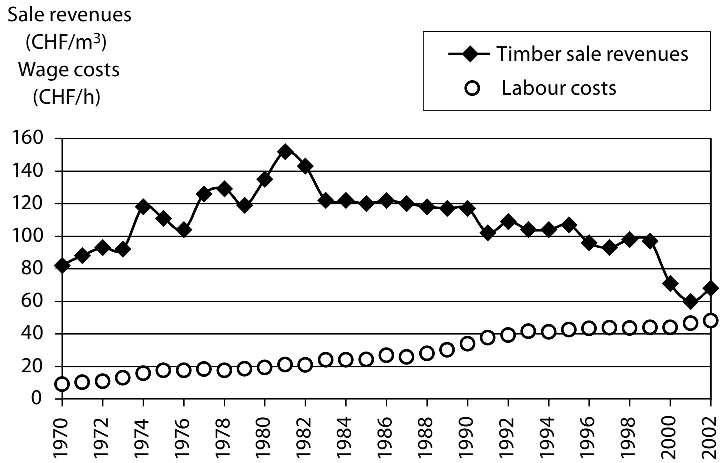


Figure 1: Depicts the dramatic decline, in a ratio 1 to 2 of the timber sale revenues since 1982 and increasing of forest labour costs. So the cost-benefit scissors became tightened.

2 Biorationalisation

Close to nature management is one of the responses to this dilemma because this way of managing forest compliant with nature works with gratuitous forces or so called **nature automation**. This concept is compatible with economic efficiency and at the same time provides unrestrictive use of other benefits. An important question then is which natural forces or processes do bolster the production goals, such as a good added value of timber without loss of stability? So called biorationalisation steers a valuable timber production at low cost, according to the aphorism after the British philosopher Francis Bacon (1620) "nature to be commanded must be obeyed". The two principles of the biorationalisation are **nature automation** like gratuitous natural regeneration and **concentration on essential**, such as on a few trees with high quality or with large dimensions (Schütz, 1996, 1999a, 199b). One of the silvicultural systems fully in line with such principles is the plenter system (or selection system) because it works with natural regeneration, with not too many tree numbers in the juvenile phase, uses shading as a nurturing force (i.e. maintaining branchiness), and concentrates yield on a few large trees with high quality. Another rationalisation lies in the single tree decision of cutting according to different considerations, like the best achievement of value increment as well as silvicultural benefits to surrounding stand parts.

3 Selfdifferentiation after natural socialisation

The other main forests like the plenter forests are constituted of collectives (or cohorts), whichever their scale, with mostly high tree numbers and lateral competition, which provide the natural pruning, nurturing, and adequate stem shape. Here, the mosaic of stands and its pattern ensure the horizontal structuring, instead of the vertical one in the case of the plenter forest, and fulfil the needs for structured habitats important for biodiversity. Patch work structuring is possible at a larger scale with a small mosaic of versatile stands. Structure can be achieved for instance with an irregular group shelter wood system (Femelschlag). The question arises of reducing the costs for the tending operations, where the main aim lies in reducing the competition from a plethoric number of trees and favouring the best ones. The clue here is to let nature create social differentiation and thus, self-structuring. In fact, in the first stages of the life cycle up to pole stage the competition forces lead to a socialisation of the collective in different social classes (leading, dominant, codominant dominated and suppressed) (Fig. 2). The consequence of this socialisation process is natural dying of the social suppressed trees and consequently a tremendous stem number reduction.

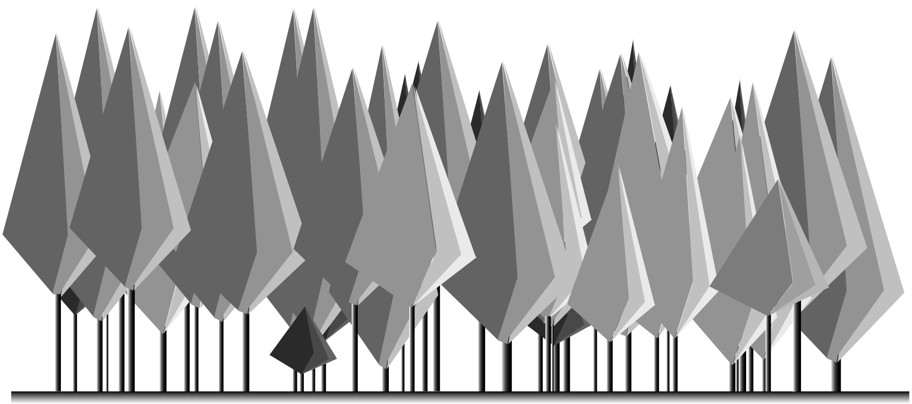


Figure 2: Natural social structuring in a 34 year old spruce stand without interventions. After Ammann (2004)

Figure 3 depicts for the same untreated spruce stand in Fig. 2, the important differences in crowning between the stand constituents. The socially leading trees (hyper dominant) have a crown grade of about 40 to 50%, which is sufficient for good stability and provides good growth, and in turn maintains their social position. Otherwise, the dominated are less crowned at about 20% of the height or less, indicating a loss of stability and vitality, which leads to mortality.

Classical tending operations within high interventionist silviculture aims to reduce competition relatively early (i.e. in the stage of thicket or small pole), combined with a selective effect of favouring the best individuals (so called qualifying or favouring value increment). This results in some homogenisation of the social collective and this leads paradoxically to increase the competition within the level of dominants in the long run, because tending operations aim to boost growth of less dominant trees or of the codominant trees, which after a while become more competitive to the best social trees. Thus, early tending could have a reverse effect as expected, at least on growth. Otherwise, if we let nature work alone the socialisation leads to more structure in the crown layer and lets the socially best trees continue to dominate.

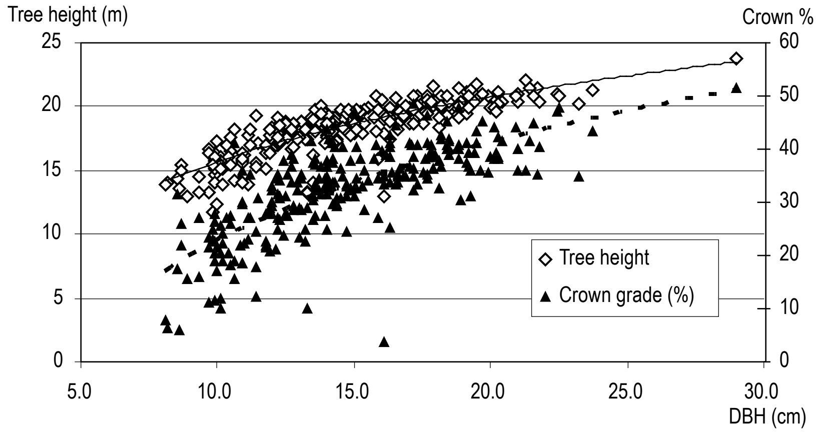


Figure 3: Tree height and crown % in an untreated 34 year old spruce stand

So it seems interesting from the point of view of cost reduction to let nature work alone, at least until a certain point. Another question is to determine if allowing nature to work alone has an influence on stem quality. Here, it is interesting to examine the group of trees with potential to attain production characteristics (so called candidates) and the number of candidates present at the end (so called crop trees or Z-trees). Fig. 4 depicts the natural decrease in the number of candidates in untouched broad-leaved stands in Switzerland, after Ammann (2004, 2005) in relation to top height (height of the 100 largest per ha). It shows the important natural stem number reduction up to 15 m top height. Considering that the goal in terms of crop tree number at the end lies between 100 to 120/ha, we see that even at a height of 20 m there are enough valuable crop trees, even when accounting for losses during the entire production cycle.

The question of when to begin the first thinning operation is more dependent on other criteria than the number of crop trees. It depends more, for instance, on the capacity of recovering from delayed thinning in relation to the expected final diameter. For tree species like ash or beech, for which the production goal is to attain large dimensions (about 60 cm in diameter) free from red coloured heartwood, it is important not to wait too long, because the development of facultative heartwood increases with aging (von Büren, 1998, 2002; Knoke and Schulz-Wenderoth, 2001) and because of the poor recovery after delayed thinning in the case of ash. For ash, the compression phase where high competition is accepted should not last more than up to a top height of 15 m. For beech, which recovers substantially better, the compression phase can last much longer. For spruce or fir the question of stability against snow load is more decisive for determining the first thinning, but this depends more on the way of liberating the crop trees. Currently, there exists a kind of thinning (situative thinning) less traumatic for favoured trees and especially the stand canopy. It is therefore clear that the beginning of thinning varies greatly within tree species. It should also be emphasised that delayed thinning represents a way to spare labour costs, but represents in fact a suboptimal solution. From a biological point of view, early thinning is appropriate because young stands recover much better than older ones. It should bear in mind that in the case of fine tree species mixtures, the start of silvicultural intervention is needed much earlier (in the thicket stage) or else more competitive species may overtop less competitive species leading to elimination of these species (Schütz, 1999b, 2003).

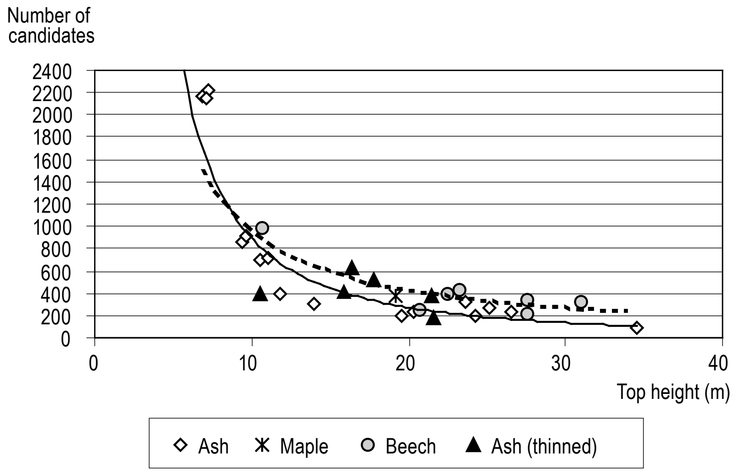


Figure 4: Natural reduction of candidates (putative crop trees) in untreated broad-leaved stands. After Ammann (2004)

4 The concept of situative thinning

In addition to using self social differentiation as a natural stand structuring process, there are other ways of saving costs. They rely on the effect of concentration on the essentials. Only the best crop trees should be improved by silvicultural measures and with only the crown clearance they need according to their social status. Self dominant trees are able to maintain themselves without great help, while others need more crown clearance. In other words, the less dominant the crop tree, the more crown clearance they need. Fig. 5 shows this effect by example of the individual thinning intensity in terms of basal area of the competitors in relation to that of the considered crop tree in a 24 year old spruce stand at the first thinning.

The so called **situative thinning** aims to differentiate the thinning operation according to a minimal number of crop trees (i.e. 100 to 120/ha at most in the final distribution) with crown liberation only if needed. The leading motto by which to implement such interventions is: appreciate first what is not necessary before deciding what is essentially necessary to eliminate. Such situative thinning ensures the goals of the thinning with reduction of the stand basal area of about 5% to less than 10% and thus allows substantial cost reduction. In addition, but not less important, it does not allow the canopy to become unstable.

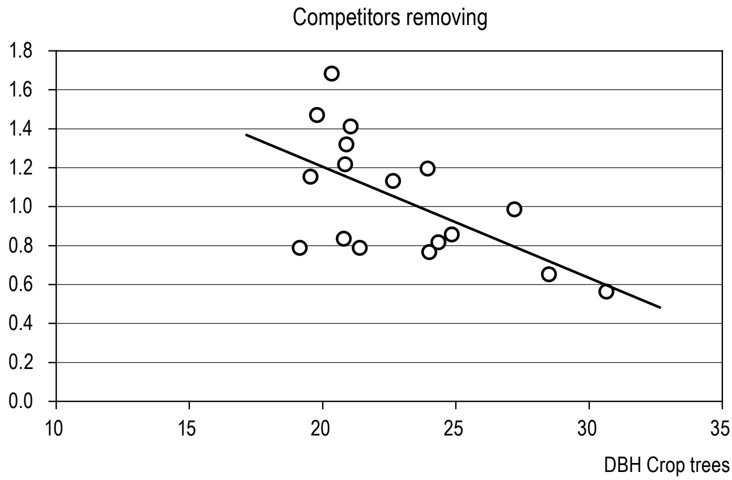


Figure 5: Individual removing competitors as dependent on the social position in the case of the situative thinning, exemplified at the first thinning of a 24 year old spruce stand. Reduction of competition measured in terms of relative basal area of the competitors in relation to the favoured crop trees. After Ammann (2004)

5 Biological reduction of competition: an alternative to mechanisation

The differentiate method like situative thinning aims to minimise the removal of competitors to only what is absolutely necessary. Such operations are not efficiently completed by a harvester for two reasons: First, because of the minimal number of eliminated trees and second, because harvesters need wide working tracks which unstabilize the stand and making it vulnerable to snow or even storm damage.

Instead, there exists very simple ways of controlling competition without extracting the trees from the stand, including girdling or simple slant cutting with a chain saw leaving treated competitors standing. Aptly applied girdling with a special gauge or a brush hook (Fig. 6) leads to a slow death within one to three years, depending on the tree species (Roth *et al*., 2001). This permits the elimination of many more competitors, up to 4 to 6 per crop tree (Fig. 7) if necessary, because the effect of clearance is not too instant and the standing dead competitors produce some shade as well as support (scaffolding). Bear in mind that for successful girdling it is necessary to completely eliminate the cambium, otherwise a cambium bridge may allow the treated trees to recover. Such simple methods apply especially well to broad-leaved tree species. Finally, these methods produce substantial cost reduction, about 5 to 10 fold less than the classical tending costs (see Table 1).

Figure 6: Simple methods of suppressing the competition, such as slant cutting with a chain saw letting only the stem section standing and girdling

Figure 7: Effect of natural devitalisation of the competitors after girdling

Table 1: Productivity gain of new ways of suppressing competitors in comparison to classical tending methods

Method	Hours/ha	%
Classic tending, stem cut and debranched	80	100
Stem simple on the floor	28	35
Slant cutting	5–10	9
Girdling	15	19

6 Conclusions

The use of natural processes compatible with the goals of multiple forest use allows substantial cost reductions. The power of so called biorationalisation is even higher than technical ones, especially for young stands. For their implementation it requires high skills in silviculture, especially aptitude to anticipate the favourable natural stand development. The concept is more opportunistic in the sense of letting nature do what it realises for free, than deterministic like in the classical operations. To be savvy, lazy is a way of thinking but needs special skills.

References

Ammann, P.L., 2004. Untersuchung der natürlichen Entwicklungsdynamik in Jungwaldbeständen; biologische Rationalisierung der waldbaulichen Produktion bei Fichte, Esche, Bergahorn und Buche. Diss. ETH, Zürich 2004.

Ammann, P.L., 2005. Biologische Rationalisierung; Teil I: Einleitung und ökonomische Grundlagen. Wald und Holz 85, 1/2005, 42–45.

Bacon, F., 1620. Aphorism concerning the interpretation of nature. In: Ellis & Heath (Eds.), Novum Organum Vol. 4 Instauration magna. Longman & Co, London.

Büren, S.v., 1998. Buchenrotkern; Erkennung, Verbreitung und wirtschaftliche Bedeutung. Schweiz. Z. Forstwes. 149, 955–970.

Büren, S.v., 2002. Der Farbkern der Buche (*Fagus sylvatica* L.) in der Schweiz nördlich der Alpen. Untersuchungen über die Verbreitung, die Erkennung am stehenden Baum und die ökonomischen Auswirkungen. Beih. Schweiz. Z. Forstwes. Nr. 86.

Knoke, T., Schulz-Wenderoth, S., 2001. Ein Ansatz zur Beschreibung von Wahrscheinlichkeit und Ausmass der Farbkernbildung bei Buche (*Fagus sylvatica* L.). Forstwiss. Cbl. 120, 154,172.

Roth, B., Bucher, H.U., Schütz, J.P., Ammann, P., 2001. Ringeln; Alte Methode neu angewendet. Wald und Holz. 82 (5/01), 30–31 and 38–41.

Schütz, J. P., 1996. Bedeutung und Möglichkeiten der biologischen Rationalisierung im Forstbetrieb. Schweiz. Z. Forstwes. 147, 315–349.

Schütz, J.-Ph., 1999a. Close to nature silviculture: is this concept compatible with species diversity? Forestry 72, 359–366.

Schütz, J.P., 1999b. Neue Waldbehandlungskonzepte in Zeiten der Mittelknappheit; Prinzipien einer biologisch rationellen und kostenbewussten Waldpflege. Schweiz. Z. Forstwes 150, 451–459.

Schütz, J.P., 2000. Kosteneffiziente Waldpflege. I. Teil. Grundsätzliche Überlegungen. Wald und Holz. 81,11/2000, 47–50.

Schütz, J.P., 2000. Kosteneffiziente Waldpflege. II. Teil. Praktisches Vorgehen. Wald und Holz 81,12/2000, 23–25.

Schütz, J.P., 2003. Die Situative Durchforstung: ein an der Extensivierung der Kosten orientiertes Durchforstungskonzept. In: P. Brang (Ed.), Biologische Rationalisierung im Waldbau. Tagungsband Jahrestagung der Sektion Waldbau im Deutschen Verband forstl. Forschungsanst., Birmensdorf 10.–12. September 2003, 4–13.

Schütz, J.P., 2005. Intensität der Waldpflege und Baumartendiversität im Wald; oder: Naturautomation contra Entmischung. Schweiz. Z Forstwes. 156, 200–206.

Siegwalt, G., 1994. La gestion des forêts; Réflexions éthiques sur un défi de notre temps. In: Union. des forestiers aux conceptions de gestion proches de la nature (Ed.), Pour une vraie forêt productive et belle. Actes du 1er congrès européen PRO SILVA, du 21 au 24 juin 1993 à Besançon. PRO SILVA, 35–44.

Minority tree species – a challenge for multi-purpose forestry

Heinrich Spiecker*

Abstract

After many decades of forest degradation productive forests have been established. These activities led to a shift to non site adapted coniferous tree species and a reduction in tree species diversity. High labor costs and low prices for medium quality timber weakened the economic conditions of forestry. At the same time the interest in ecosystem services of forests increased. Today's society is asking for sustainable forestry emphasizing biodiversity and close to nature forest management. Changing demands require a widened scope and new ways of forest management.

*Minority tree species such as Wild cherry (*Prunus avium *L.), European ash (*Fraxinus excelsior *L.), and Sycamore maple (*Acer pseudoplatanus *L.), as well as other species from the genera* Alnus, Carpinus, Castanea, Juglans, Malus, Pyrus, Sorbus, Tilia *and* Ulmus *may help to achieve the changing objectives. These species became comparatively rare as they are often light demanding, grow best on highly productive sites and are often rather short-lived. Therefore, they eventually need more intensive release and different scales and patterns of canopy disturbance in the regeneration phase. In most European countries, they typically make up less than 5% of the forest cover and produce less than 5% of the timber. They usually grow individually or in small groups in mixed forests. As these species contribute to the heterogeneity and diversity of forests and also have the potential to produce high quality timber within a relatively short time, they are of high ecological and economic interest today.*

Economic results of management of these minority tree species depend on the timber quality, dimension, and branchiness. In order to improve management, efficiency interventions have to be limited to actions that increase the value of the product. Naturally regenerated minority tree species in mixed forests offer an often underestimated potential for growing valuable timber. When planting, only a small number of genetically well selected and site adapted trees are needed. A two-phase management system is recommended, forcing pruning in the first phase and stem diameter increment in the second phase. The advantages of such a system are described.

The high diversity in sites, ownership, economic and socio-cultural conditions in Europe require different strategies adapted to the local needs. Minority tree species

* Prof. Dr. Heinrich Spiecker, Institute for Forest Growth, Albert-Ludwigs-University Freiburg, Faculty of Forest and Environmental Sciences, Tennenbacherstr. 4, D-79085 Freiburg, Germany
Tel. +49 761 203 3737, Fax: +49 761 203 3740, E-mail: instww@uni-freiburg.de

offer options for increasing ecological, economic and social values and may contribute to sustainability of forestry in Europe and other parts of the world.

Keywords: minority tree species, forest management, valuable timber, pruning, thinning

1 Introduction

By definition, minority tree species make up only a small proportion of the forest cover. They are usually light demanding, grow best on highly productive sites and are often rather short-lived. They usually grow individually or in small groups. Mixed with other tree species, they generally need more intensive release and in the phase of regeneration they need different intensities of canopy disturbance.

Such minority species include Wild cherry (*Prunus avium* L.), European ash (*Fraxinus excelsior* L.), Sycamore maple (*Acer pseudoplatanus* L.), as well as species from the genera *Alnus, Carpinus, Castanea, Juglans, Malus, Pyrus, Sorbus, Tilia, Ulmus* and others. This list may be extended by other broadleaved and coniferous species.

For centuries, European forests have been affected by exploitation, devastation and soil degradation. Wood was cut not only for local uses, but it was even rafted from remote locations for all kinds of purposes, such as for charcoal production, construction, or mining. Litter collecting was also extensively applied. In the end, forests in Central Europe were exploited and devastated. Applying great efforts to eliminate the severe wood shortage, countermeasures were taken by regenerating and tending highly productive forests. Forest management had a major effect on stand structure and tree species composition. While starting at the end of the thirteenth century and continuing even more extensively during the last 200 years, conifers have been introduced on sites naturally dominated by broadleaved species. The current composition of European temperate forests is the result of centuries of vast human activities. Today, only a small part of formerly forested areas is still covered with forest, even though recently, the forest area in Europe is increasing. As site conditions, ownership and cultural, economic and social conditions vary over short distances in Europe, so does forest management.

High growth rates and an increasing growing stock indicate that former efforts have been successfully accomplished. Broadleaves such as beech (*Fagus sylvatica*) and oak (*Quercus sp.*), as well as other broadleaved species were the dominant species naturally covering about two third of the forest area in Central Europe. In former times, Norway spruce covered naturally only Northern and Eastern parts of Europe and some mountainous areas in Central Europe. The area of *Fagus*, *Quercus* and minority tree species has decreased, while the area of Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*) has drastically increased. Today, coniferous forests cover large areas for instance in Germany, parts of France and other countries far beyond their natural limits. During the last 120 years, the percentage of high forest consisting of coniferous species increased continuously, while forest consisting of broadleaved species decreased. Especially the area of broadleaved forest consisting of coppice forests, and coppice with standard forests decreased on many sites. For instance, in Germany, today's forests consist of 99% of more or less even-aged forests, while selection forests cover only 0.3% and coppice with standards and coppice forests cover 0.7% of the total forest land.

At the same time, the interest in ecosystem services of forests increased. Today's society is asking for sustainable multi-purpose forestry emphasizing biodiversity and close to nature forest management. As our ecological, economic, social and cultural values have changed, the aims of forest management have changed, too. A widened scope and new ways of forest management are required.

2 Ecological importance of minority tree species

Cuts caused by storms are the most common type of salvage cuts in Europe. Ice and snow have caused a considerable amount of salvage cuts in the past as well. In addition, high air temperature has induced considerable salvage cuts caused by bark beetles and to some extends also by fungi. The combination of impacts of storms and droughts may have increased the volume of salvage cuts even more. The salvage cuts of desiccated trees and trees killed by insects and fungi increased in recent decades. This is especially remarkable during the 1970s and 1980s, as discussions about the "forest decline" were popular. At that time, the volume of desiccated trees and trees killed by insects and fungi was far lower than in most recent years.

New ecological aspects became apparent, such as climate change, which led to an increase in air temperature during the last 100 years. It is predicted that air temperature will increase even more in the future. Favouring site adapted tree species and increasing tree species diversity strengthen forest resilience. Minority species help to improve resilience of forests and reduce ecological risks.

3 Economic importance of minority tree species

While labour costs have increased considerably, the value of wood decreased in the last 50 years. Even though the total productivity per man hour increased during this time, the net income from forestry decreased. Due to this difficult economic situation, new ways of management have to be found. In addition, a globalisation of markets has to be acknowledged. The recent expansion of the EU led to an increase in the forest area by 53 million ha in 1995, by 24 million ha in 2004, and a further increase by 10 million ha is expected in 2007.

As a consequence of these changes, costs have to be reduced, labour productivity has to be raised, wood quality has to be improved, forest stability and resilience has to be enforced, and the ecological services of forests have to be enhanced. High quality timber from minority tree species may contribute to higher revenue without increasing costs. The improvement of the economic conditions primarily depends on the quality of wood. Low quality timber of broadleaves produces low value, not even covering the harvesting costs, whereas high quality timber is many times more valuable. Thus, quality decides on the economic result. Even though the price of high quality timber may depend on fashions - so some species are preferred at some time while other species are preferred in other times - high quality timber from broadleaved trees was highly valued in the last years.

4 Social importance of minority tree species

Values and perceptions of people are changing. Commodity values have decreased, while ecological values such as habitats, water quality, and climate protection have increased. Recreational values have increased as well. Environmental values and ecosystem services are emphasized and close to nature forest management is promoted. These changes led to a higher emphasis on environmental services and to a preference of close to nature forest management which encourages an increase in the proportion of minority species. Minority species such as Wild cherry may add to the beauty of the landscape through its flowering in the spring. They may as well provide pollen for bees and in summer fruits for birds.

There are new challenges, today. Besides traditional economic criteria, such as net present value, cash flow, and risks, new aims become more important, such as flexibility to adapt to new ecological, economic and social conditions. On sites naturally dominated by broadleaves, conifers forests are less favourable from the ecological point of view. As society is not satisfied with the existing forests, forest conversion has to be considered. To provide a solid base for analysing the costs and benefits of conversion of forests towards other types of forests with respect to species composition and stand structure, various aspects need to be taken into account (Spiecker *et al.*, 2004). There is no one single optimal forest! The best option depends on site conditions, the state of the forest, economic conditions, such as forest size and location, and the aims of the forest owner. Aims are changing fast when compared to the slow changes of forests. So, forests have to be established which can be adjusted to changing aims more easily. On sites naturally dominated by broadleaves, conifer forests are less favourable from the ecological point of view, while economically, conifer forests may still be preferable on many sites. Minority tree species offer options for increasing ecological, economic and social values and therefore contribute to multi-purpose forestry. Minority species produce ecological values and contribute to diversity of habitats; they may also produce economic values by producing high quality timber and this within a relatively short time. They should be managed in a highly efficient way by restricting interventions to actions that have a direct impact on the value production.

5 Forest policies promoting minority tree species

There is no legal obligation to change tree species composition towards more minority tree species. However, it is acknowledged that water quality, soil fertility, genetic diversity, and landscape beauty are of high relevance for the society, and a balance between private and public interest has to be found. Forest ecosystems should be stable and elastic and they have to serve multiple purposes. They should provide protection, recreation, as well as sustainable production of valuable timber. A substantial proportion of various site-adapted tree species should be accomplished, which means an increase in broadleaved species including minority species on many sites. In Germany for example, different states offer varying ways for federal subsidies, such as subsidy for regeneration of broadleaved and mixed forests.

Looking at forest statistics we can see that forest conversion is already taking place. For instance, the tree species composition of the state of Baden-Wuerttemberg in south-western Germany has changed considerably. In 800 B.C.E., European beech covered 60% of the forest area, oak about 20% and Silver fir about 15%, while Norway spruce covered only 1.0 to 2.5%. Up to 1975, the area of Norway spruce continuously increased to 40% and the area of Silver fir decreased slightly; the relatively small area of Scots pine in this region increased during the first decades, but then stayed more or less constant or decreased even slightly. The percentage of European beech was drastically reduced from 60% to 21%. The area of oak and the other broadleaved tree species decreased as well. But from 1975 on, this development has ended and changed in the opposite direction.

6 Aiming towards more broadleaved tree species

Species composition in Germany has changed recently quite considerably towards more broadleaves. The last two inventories covering all categories of forest ownership in Baden-Wuerttemberg in 1987 and 2002 indicate an increase of European beech from 19 to 21%, as well as a decrease of Norway spruce from 44 to 38% (BML, 1993; BMVEL, 2004). This conversion process already started in about 1975. The conversion was accelerated right after the heavy storm in 1999, which affected Norway spruce forests most heavily. It is planned that the area of Norway spruce in the public forest of Baden-Wuerttemberg should decrease still further to 29%, while the area of broadleaved tree species should drastically increase.

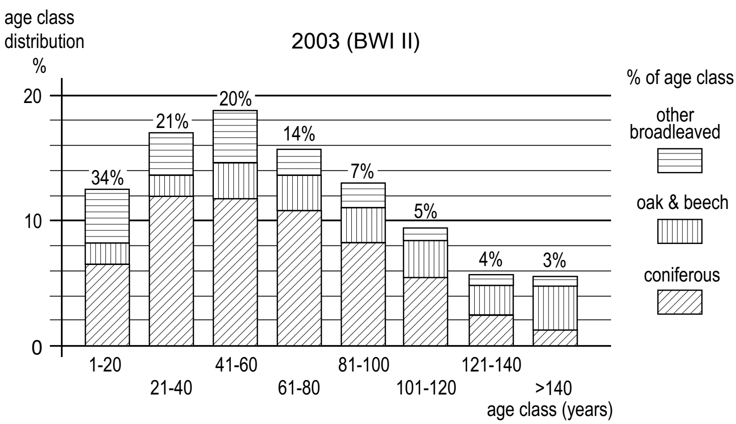


Figure 1: Age classes and species composition in German forests

The area occupied by "other broadleaved" tree species in younger age classes is relatively large (data source: BMVEL, 2004).

The age composition of the forests in Germany is not equally distributed over the age classes; the younger ages are especially underrepresented. However, the area covered by broadleaved species, especially broadleaved species other than beech and oak, is rather large in the younger forests (Fig. 1).

7 How to improve timber quality?

To improve the economic outcome of management results the costs have to be reduced, while timber quality and therefore timber price has to be raised. In addition, forest stability and resilience has to be strengthened, and the ecological quality has to be improved. There is a big price difference between low quality timber (quality class "D"), which amounts to a price of less than 10 Euro per m^3 and high quality veneer (quality class "A", "TF" or "F"), which amounts to a price of between 200 and more than 1,000 Euro per m^3. Even though the price of high quality timber varies over time, its prices were always significant higher than those of medium or low quality timber.

Higher timber quality can be reached by adequate management of valuable broadleaves. Economically sound activities have to be linked to the economically relevant, value-producing trees. Growth potential of the site should be concentrated on these future crop trees. When dealing with fast growing broadleaves the number of final crop trees per ha is relatively small. This is due to the fact that valuable trees need to have a large diameter, which can only be produced by a large crown.

In order to reduce management costs the number of trees to be planted, released and pruned should be reduced to the minimum number needed. Only a small number of genetically well selected and site-adapted trees are essential. The risk of losses of once well selected and well treated crop trees is very low, as can be observed on plots where trees have been planted and tended in a rather wide spacing. The option of selection and releasing of a small number of already existing, naturally regenerated trees is often not used sufficiently. How many future crop trees should be selected and adequately treated? The value-generating future crop trees are generally less than thought in practice. Should it be 100 trees, 200 trees, or 50 trees per ha? At the end of the production, only 40 to 50 trees with a dbh larger than 60 cm can grow on an area of one hectare resulting in a distance between the crop trees of more than 15 meter. We have to ask, whether we should grow less crop trees with larger crowns or more crop trees with smaller crowns accepting smaller dimensions with respect to diameter, but reaching a higher crown base (Fig. 2).

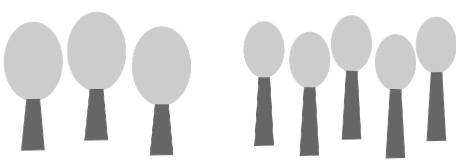


Figure 2: How many future crop trees should be selected?

For accelerating diameter growth the number of crop trees per ha has to be reduced; the crown base will be lower.

The decision on the number of future crop trees has an impact on the rigour of the selection criteria: When the number is small the selection process can be more rigorous. Better selected crop trees with larger crowns may produce higher quality, and larger diameters; harvesting costs may be reduced, and forest stability increased. However, the clear bowl timber volume per ha will be smaller. There may also be some impact on biodiversity and aesthetic values.

Figure 3 summarizes the impact of the height of the crown base on the physical and economic outcome: With decreasing crown base the stem diameter and the timber price per m³ will increase, but the total volume of clear bowl per ha will decrease. Management costs per ha including planting, pruning and harvesting will also decrease if the number of crop trees is lower. The optimum depends on the economic conditions, especially on the impact of tree diameter on price. The space occupation of those crop trees is at the early stage very small and increases slowly. This means that only a small proportion of the area needs to be tended at this stage.

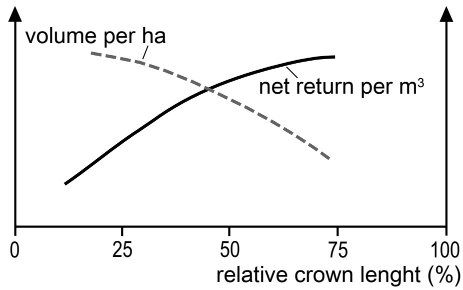


Figure 3: Where should be the crown base?

With decreasing crown base (increasing crown length) the stem diameter and the timber price per m³ will increase, while the volume of clear bowl per ha will decrease.

A further argument for selecting fewer crop trees is the danger of die-back of branches at the lower part of the crown when trees are growing to close to each other (Fig. 4). Dead branches not only have a direct negative impact on timber properties, they provide an entrance for destructive fungi into the trunk, as well. Another draw back of such a die-back is the unfavourable reduction in diameter growth when crown expansion of future crop trees is limited by competitor trees. When crop trees are well selected and adequately treated the argument of maintaining "reserve" crop trees does not hold. Various examples show that high quality trees can be planted with large spacing (Fig. 8) with low risk of mortality, provided that the planting is done correctly and the planting material is well chosen.

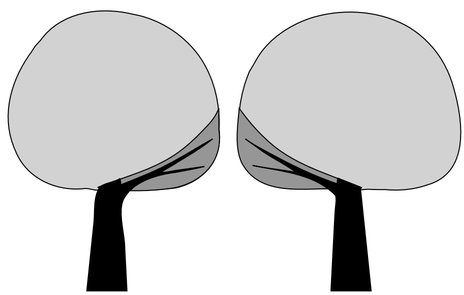


Figure 4: Distance between crop trees

When crop trees grow close to each other, lower branches die. Distance between crop trees should be at least $d_{1.3}$ x 25 (Spiecker & Spiecker, 1988).

Tending, thinning, and pruning have to start early. Management activities should concentrate on a few future crop trees and necessary measures have to be repeated in time.

8 The two-phase management system; Phase 1: Pruning

Management activities for producing valuable timber can be divided in two phases: Phase 1 emphasizing pruning - either natural or artificial pruning - and phase 2 emphasizing diameter growth by allowing continuous crown expansion (Spiecker, 1991). Artificial pruning is required particularly, when tree species, such as Wild cherry, retain their dead branches. On the other hand tree species like European ash lose their branches rather quickly when they do not grow in full light. Here natural pruning is appropriated in closed forests. Artificial pruning should be applied for all minority tree species when trees are spaced at large distances (Fig. 8). Artificial pruning has to start early in order to minimize the size of wounding and to maximize the volume of branchless timber in the long run (Fig. 5). Artificial pruning activities may not just proceed to the height of a certain whorl; it is advantageous to first prune the largest branches of the tree and those branches showing a steep angle even further up in the tree crown, as they have the potential to grow bigger than horizontal oriented branches. On the other hand small and horizontal oriented branches may remain longer. Natural pruning caused by heavy competition of neighbouring trees as well has to be initiated at a rather early phase of development. Natural pruning requires little input when combined with natural differentiation (see chapter 9). However, depending on the species specific natural pruning dynamics, the stand structure and the quality of the most vital trees, the aim of producing high quality timber may not always be reached. When thinning is required thinning costs have to be compared with the option of wide spacing and artificial pruning.

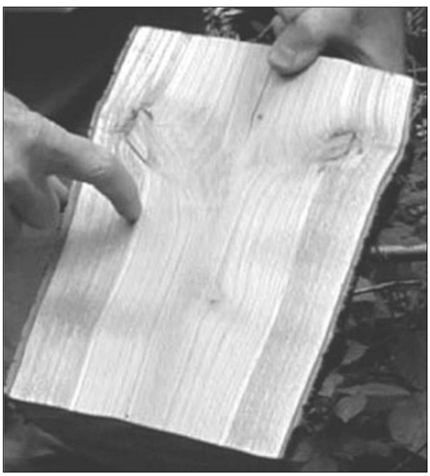


Figure 5: Artificial pruning

By early pruning - here at a cambial age of 8 years - the size of wounding is still small, and the volume of branchless timber can get large.

Applying traditional management the crown base moves higher with age and the lowest branches continue to die until the end of the tree's life. Applying the two-phase management system intense pruning takes place only in the first phase, whereas in the second phase, the crown base stays constant without any die-back of branches (Fig. 6). By early pruning not only timber quality is improved, but also the speed of recovering from wounding is higher (Fig. 5). Correct pruning is essential for vitality and quality.

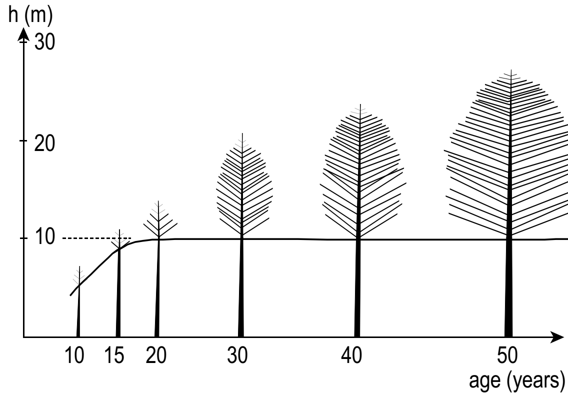


Figure 6: The two-phase management system

In order to improve the quality a two-phase management system is applied. In the first phase, pruning is stimulated, while in the second phase, diameter growth is stimulated by allowing the crown to expand (Spiecker & Spiecker, 1988).

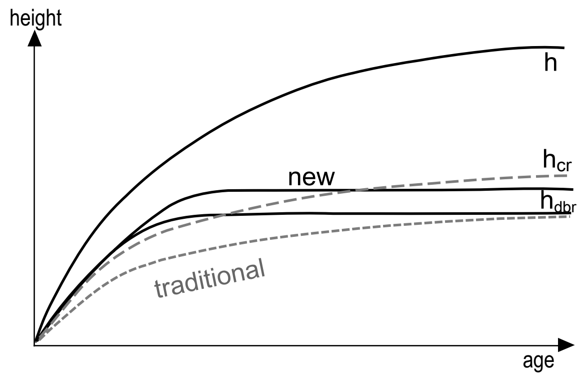


Figure 7: The pruning phase

Traditional natural pruning is a long lasting process (dashed lines). According to the procedure recommended here the pruning phase starts early and lasts only a short period (solid lines). Afterwards the crown base stays at a constant height (Spiecker, 2003).

Pruning should take place when the branches are still young and thin, and the stem diameter is small. Repeated artificial pruning or natural pruning by shading of neighbour trees is essential for producing high quality timber. This leads to an early development of a clear bowl, while in the second phase branches in the crown grow larger and stay alive. This kind of management accelerates pruning in the early phase and prohibits further pruning in the second phase (Fig. 7). Looking inside the stem of a tree, a totally different shape of the clear bowl appears. The branchy core of the bowl is much smaller, especially in the higher part of the stem (Fig. 9), while applying traditional management the proportion of branchy wood, especially in the higher part of the trunk is much larger because branches die rather late.

Figure 8: Pruning of widely spaced minority species

Trees may be planted at wide distance when artificial pruning is applied.

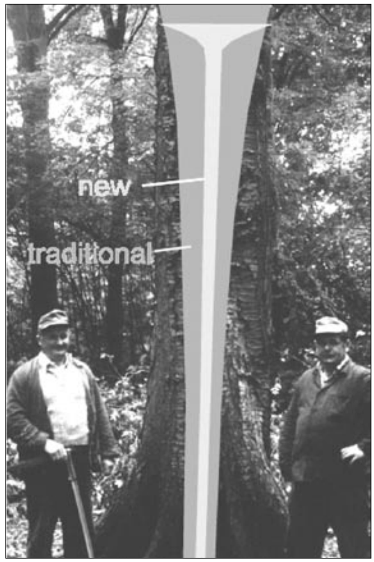


Figure 9: Proportion of timber without branches

The two-phase management system (new) reduces the size of the branches containing part of the stem (Spiecker, 2003).

9 The two-phase management system; Phase 2: Accelerating diameter growth

In tree ring research, generally, an age related change of ring width is known as an "age trend". This trend shows that young trees produce wide rings while with increasing age tree rings get narrower. This growth trend is common in traditionally managed forests. The two-phase management system slows down initial diameter increment in the pruning phase and accelerates later increment so that increment stays over many years more or less constant until the time of harvest is reached (Fig. 10). As a result not only a more homogeneous ring structure is achieved, but also a larger proportion of branchless timber, as well as larger diameter and higher value timber. The acceleration should start as early as possible, constrained only by the desired height of the crown base. The diameter growth of traditionally treated trees deviates substantially from this growth pattern. Applying traditional treatment the diameter growth reaches its maximum at a rather early stage of 10 to 20 years, and later decreases with age (Fig. 10).

Stem diameter is closely, almost linearly related to crown width. This means that diameter growth can be controlled through crown competition of neighbouring trees. The less the competition, the faster the crown can expand and the faster the stem diameter increases. However, a reduced diameter increment in the very early phase of intensive pruning has to be accepted. Later, the diameter increment stays at a high level until the end of the tree's life (Fig. 10).

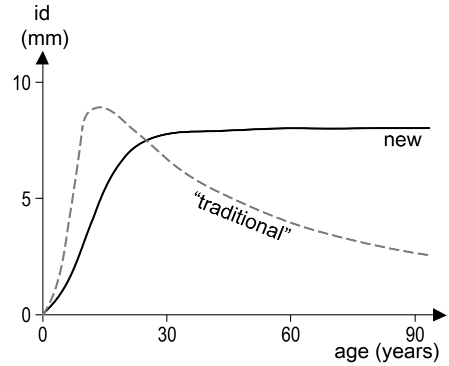


Figure 10: Stem diameter increment (id) - a comparison of traditional with the two-phase management

While traditionally, the diameter increment slows down after an initial fast increment ("age trend"), the two-phase management system provides a long lasting diameter increment on a high level (Spiecker, 2003).

10 Natural differentiation or thinning?

In unmanaged conditions the thickest trees in even aged stands have the fastest current growth rate and the highest probability of survival, while dominated trees slow down in their growth and finally die (Spiecker, 1989). The larger the diameter variance the faster this differentiation process happens. The natural differentiation process can be employed to reduce management costs when dominant trees produce high quality (Spiecker, 1995). If less dominant trees show better quality and produce higher value, early release is required to strengthen their competitiveness and to allow possible natural differentiation at a later stage. Selection and release of a rather small number of future crop trees favour the later differentiation process. However, the risk of unwanted die-back of branches at the crown base increases when the desired crown base is low and no thinning takes place. By steady release, the best growing trees can reach a diameter increment of almost 1 cm per year in the long run on good sites. Some Wild cherries near Freiburg have reached a diameter of more than 60 cm at an age of 80 years.

An active release is needed if minority tree species should be favoured growing in mixture with more vigorous species. In contrast to the natural differentiation, this management is a process which requires continuous efforts and has to be carefully judged against other options before being applied.

11 How should the forest of tomorrow look like?

The forest of tomorrow should be adaptive to ecological changes; it should be able to reduce risks, to maintain site productivity, and to maintain cultural values. The forest of tomorrow should also be adaptive to economic and social changes. Should it be a multi-purpose forest providing various goods and services or a specialized forest providing the industry with raw material or specific environmental services? As in the future more arable and grazing land may be available for forestry, and energy wood may become more valuable, old systems such as coppice with standards may experience a renaissance and favor the minority species again. Also, options of innovative agro-forestry systems need to be further explored in a creative way. Furthermore, we may find diverse ways of forest management in Europe in the future. This is due to the high diversity of forest sites, varying forestry conditions, the diverse ownership structure, as well as the cultural diversity.

Tending, thinning and pruning have to start early concentrating on a few trees, and they have to be repeated in time to guarantee tree survival and value production. The criteria for controlling management have to relate to the production aims. Such parameters are the number of crop trees per ha, the height of crown base, the desired trunk diameter and the anticipated production time.

Minority tree species offer the opportunity for increased ecological, economic and social values, and may contribute to multi-purpose forestry. Minority tree species are relevant not only in Europe. In secondary tropical forests, the promotion of minority trees species is also important and challenging. In the long run, this will be possible only when economically feasible, sustainable ways of management of minority tree species can be found.

12 Summary

European forests play a prominent role in timber production, nature protection, water conservation, erosion control and recreation. After many decades of forest degradation productive forests have been established. These activities led to a shift to non site adapted coniferous tree species and a reduction in tree species diversity. High labour costs and low prices for medium quality timber weakened the economic conditions of forestry. At the same time the interest in ecosystem services of forests increased. Today's society is asking for sustainable forestry emphasizing biodiversity and close to nature forest management. Changing demands require a widened scope and new ways of forest management.

Minority tree species such as Wild cherry (*Prunus avium* L.), European ash (*Fraxinus excelsior* L.), and Sycamore maple (*Acer pseudoplatanus* L.), as well as other species from the genera *Alnus*, *Carpinus*, *Castanea*, *Juglans*, *Malus*, *Pyrus*, *Sorbus*, *Tilia* and *Ulmus* may help to achieve the changing objectives. These species became comparatively rare as they are often light demanding, grow best on highly productive sites and are often rather short-lived. Therefore, they eventually need more intensive release and different scales and patterns of canopy disturbance in the phase of regeneration. In most European countries, they typically make up less than 5% of the forest cover and produce less than 5% of the timber. They usually grow individually or in small groups in mixed forests. As these species contribute to the heterogeneity and diversity of forests and increase their stability and resilience they are of high ecological value. They also contribute to social needs. Because of their potential to produce high quality timber within a relatively short time, these species are also of economic interest today. In recent years the proportion of the minority species already has increased in some parts of Europe.

Economic results of management of these minority tree species depend on the quality of the timber, dimension, and branchiness. In order to improve management efficiency, interventions have to be limited to actions that increase the value of the product. Naturally regenerated minority tree species in mixed forests offer an often

underestimated potential for growing valuable timber. When planting, only a small number of genetically well selected and site adapted trees are needed. The number of crop trees has to be limited in order to avoid die-back of branches at the crown base.

A two-phase management system is recommended, forcing pruning in the first phase and stem diameter increment in the second phase. Either natural pruning or artificial pruning can be applied. An early start of the pruning activity is recommended. By this system the knotty core in the stem will be reduced and the proportion of clear wood will be increased. In the second phase diameter growth is accelerated. Natural differentiation may be used as a tool if the most vital trees are the wanted future crop trees and if a fast differentiation process can be anticipated. However, crop tree oriented selective thinning often accelerates the diameter growth and reduces the risk of die-back of the lower branches in the second phase.

The high diversity in sites, ownership, economic and socio-cultural conditions in Europe require different strategies adapted to local needs. Minority tree species offer options for increasing ecological, economic and social values and may contribute to sustainability of forestry in Europe and other parts of the world.

References

BML, 1993. Bundeswaldinventur 1986–1990: Volume I: Inventurbericht und Übersichtstabellen für das Bundesgebiet nach dem Gebietsstand vor dem 03.10.1990 einschließlich Berlin (West) 118 p., Volume II: Grundtabellen für das Bundesgebiet nach dem Gebietsstand vor dem 03.10.1990 einschließlich Berlin (West), pp. 366.

BMVEL, 2004. Die zweite Bundeswaldinventur: Das wichtigste in Kürze. Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft (BMVEL), Referat 533, pp. 87.

Spiecker, M. and Spiecker, H., 1988. Erziehung von Kirschenwertholz. *AFZ* (20), 562–565.

Spiecker, H., 1989. Wachstumsdifferenzierung auf langfristig beobachteten Buchen-Versuchsflächen. DVFFA-Sektion Ertragskunde, Tagungsbericht, Attendorn/Olpe, 11/1–11/10.

Spiecker, H., 1991. Zur Steuerung des Dickenwachstums und der Astreinigung von Trauben- und Stieleichen (*Quercus petraea* (Matt.) Liebl. und *Quercus robur* L.). *Schriftenreihe der Landesforstverwaltung* Bd. 72, pp. 150.

Spiecker, H., 1995. Ein Vergleich natürlicher und pflegebedingter Selektionsprozesse. *Mitteilungen aus der Forstlichen Versuchsanstalt Rheinland-Pfalz* 34, 161–179.

Spiecker, H., 2003. Laubholzerziehung und Wertleistungsgrundsätze. *Österreichische Forstzeitung* 114, 10–11.

Spiecker, H., Hansen, J., Klimo, E., Skovsgaard, J.P., Sterba, H., von Teuffel, K., 2004. Norway spruce conversion: Options and Consequences. *European Forest Institute Research Report* 18. Brill Academic Publishers, Leiden, Boston, pp. 269.

Economic aspects of irregular, continuous and close to nature silviculture (SICPN)

Examples about private forests in France

Brice de Turckheim*

Abstract

The purpose of this paper is to address economic aspects of irregular, continuous and close to nature silviculture, or SICPN (la sylviculture irrégulière, continue et proche de la nature). Of course, the economic and financial objectives of silviculture are not the only ones to be taken into account; others are also important, including:

- *Ethical objectives: conservation of nature for the wellbeing of future generations.*
- *Objectives of protection.*
- *Esthetic objectives corresponding to both landscape management and leisure activities.*

All of these objectives are important, but what will follow only deals with profitability. Furthermore, while numerous forestry owners have incomes which do not come from timber selling, this paper only deals with timber. However, before examining a few concrete examples, we must be reminded of a few general principles:

- *This paper will deal with the net profitability of forests from the annual result of exploitation – receipts minus expenditures – plus or minus the difference of value of standing timber compared to the value of the capital.*
- *To assess the long-term performance of a forest, the use of calculations with compound interests must be refused. What results from these calculations is absurd: the exponential curve is very close to the S curve for the first years, but quickly in SICPN the investment has neither loss nor gain (Figure 1).*

Applying calculations with composed interests to forest management and researching maximal income are part of the worst nuisances in the forest. How can a forester improve the profitability of the forest he has to deal with? How to increase the receipts and decrease the expenditures?

The whole volume of yield cannot really be increased or so little of it and the future of the yield produced today is not known and can only be obtained through the improvement of the products value: and there, the opportunities are tremendous, due to:

* Brice de Turckheim, F-67140 Truttenhausen, France
Tel. 0033 (0)388089604, Fax. 0033 (0)388085725, E-mail: brice.deturckheim@worldonline.fr

- *the yield of precious and expensive species;*
- *an increase in the diameter of timber produced: all the large diameters are not expensive, but all the expensive timber has large diameters;*
- *an increase in the timber quality whose criteria are stable and known.*

Those very general criteria are the following: lack of knots (or big knots), cylindricity, regularity of the rings, and lack of defects. It is not worth producing common timber quality, the price of which – determined by the world market and the tropical countries – with low labour cost – is not really going to increase.

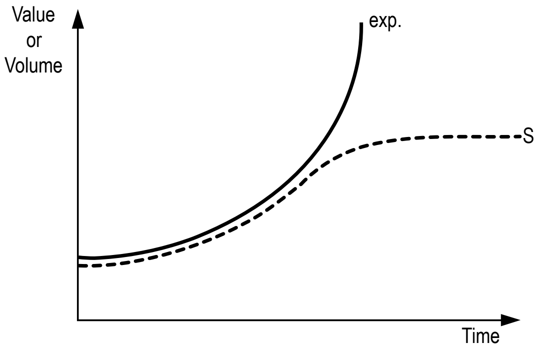


Figure 1: *Exponential or sigmoid curves*

Key words: close to nature silviculture, cost reduction, forest company returns, constraints and solutions of future management

1 How can the SICPN answer those challenges?

We are used to defining the SICPN according to two fundamental principles (Table 1):

1. The continuous improvement and lasting conservation, in the long run, of forestry ecosystem health and their good functionality, including the continuing of all life processes.
2. The respect of tree as an individual and its particular treatment, according to the place it uses in the ecosystem and the way management schemes are realised.

Table 1: Principles of SICPN

• Health, functionality and continuity of ecosystems	1. Good choice of the species, and of the mixture 2. Permanence of the cover, volume of standing trees, growth, and cuttings (a clear-cut being exceptional) 3. Careful harvesting (cutting, skidding) (soil, remaining stand) 4. Conservation of large diameter trees 5. Regeneration under the cover of high trees 6. Conservation of dead trees, with cavities and defects 7. Good management of the game
• Management of the tree itself	Its functions: production, protection, stability Its health and vitality Its place in the forest (The age is not a priority)

The SICPN, thanks to a continuous selection of valuable trees, the opportunity to harvest them at the best moment, and the opportunity to produce very precious timber, enables the increase in the percentage of high value timber in the total yield, and as such the present and future sales turnover. Figure 2 shows that in irregular, broad-leaved stands, there is - as far as large diameter trees are concerned – only high quality timber (but some mediocre and dead trees have to be left for birds, ants and bats).

The possibility to adapt harvests to the common timber market is also a very efficient means to increase the sales turn over: felling more timber when the market prices are high; making financial reserves and on the contrary reducing felling; living on financial reserves and developing high diameters reserves without generating further important cost in reconstitution. This is a clever strategy to earn money. And it is possible to do so with the SICPN without any difficulty.

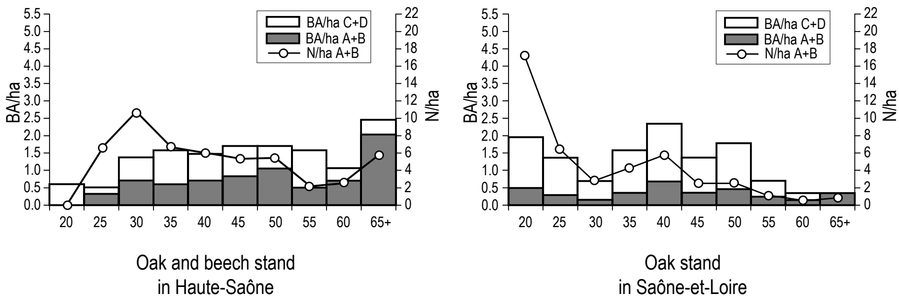


Figure 2: Quality distribution according to EU standards - network AFI (BA = basal area, N = quantity)

The means to reduce the company costs exist, though they are less efficient than those of the sale turn over increase. Four cost categories can be distinguished (Table 2):

1. The silviculture cost or timber yield cost.
2. The harvesting and selling costs or timber mobilization.
3. The equipment costs: paths, ditches, boundary stones, forestry houses.
4. Management costs. The know-how must not be reduced to the detriment of the turn over.

Using largely biological automation, the SICPN enables reduced costs in silviculture. It is the same for tree harvesting. The volume of an average harvested tree is higher in SICPN than with other treatments, so the felling and harvesting time output are increased and their costs decreased.

The stability and flexibility of stands are also important criteria of profitability. They were proven during the storm catastrophes of 1990 and 1999. In case of wind damage, large diameter trees in irregular stands are rather uprooted than snapped. The financial loss is then weaker.

Table 2: Improving profit

The timber volume is more or less stable	
Increasing the receipts	Choice of precious tree species Timber quality (economic maturity according to the quality) Size of the stems Management flexibility - adapting to the market
Improving stability and flexibility of stands	
Decreasing the expenses	Silviculture: natural regeneration, natural processes Harvesting: decreasing the volume of small diameter trees, increasing the volume of the average tree Equipment: little difference Management: simplification of management

2 Examples

Practical examples of these principles and their results are shown in a few cases located in France (Figure 3). The evolution of the prices and the costs are very variable as years go by, so it seems more useful to compare volumes, cubic metres, and working hours rather than money in the following examples. The global value of forests will not be discussed, as these important data are not within the scope of this paper.

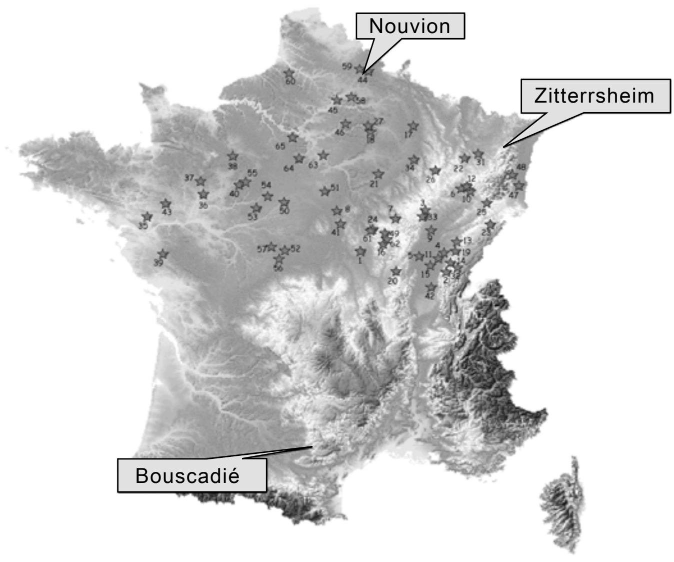


Figure 3: AFI Network

2.1 La Thierache

The first example is a former coppice with standards on extra rich soil in Picardie (North of France), including 10 main tree species. Its area is about 2,500 ha. The cutting rotation usually took place between 30 to 34 years, and spruce and poplar plantation were made between 1961 and 1984.

The SICPN was introduced all over the area in 1984/85 with intelligent, interested and motivated partners who accepted overnight to revolutionize silvicultural practices.

The landmarks of that revolution were the following:

1. Stopping the former way of cutting the coppice with standards and its replacement by selection cutting, with an 8 years rotation.
2. Stopping artificial planting of spruce and poplars.
3. Intermediate light cuttings in the coppice every 4 years.
4. Light tending but multifunctional, with 4 years rotation; selecting of beautiful young trees or saplings. A few prunings, and a few enriching plantings.
5. Selling of timber at the road side, classified and grouped in species, sizes, and qualities.
6. Pressure upon the hunters to increase deer shooting, sometimes compensated by a reduction in hunting fees.

The result of the treatment is given in Table 3. The volumes are determined by a statistical inventory.

Table 3: Development of stand parameters in Nouvion and Regnaval

	NOUVION		**REGNAVAL**	
	1993	2003	1992	2002
Volume (m^3/ha)	159	216	169	201
Number of trees (N/ha)	416	446	423	434
Volume of mean trees (m^3)	0.4	0.48	0.4	0.46
Volume partial (m^3/ha)				
Oak	46	52	35	39
Ash	22	23	41	44
Maple	27	32	24	29
Wild cherry	1	1	3	3
Alder	16	17	13	12
Hornbeam	11	15	22	28
Beech	3	2	9	9
Birch	6	9	6	6
Broad-leaved trees	3	5	4	6
Coniferous trees	25	59	7	19
Poplars			5	6
Total broad-leaved trees only	134	156	162	182
Large DBH trees - 53 cm	46 m^3/ha = 29%	58 m^3/ha = 27%	49 m^3/ha = 29%	63 m^3/ha = 31%
Medium DBH trees (33/52 cm)	44 m^3/ha = 28%	69 m^3/ha = 32%	58 m^3/ha = 34%	63 m^3/ha = 31%
Small DBH trees (18/32 cm)	49 m^3/ha = 31%	71 m^3/ha = 33%	43 m^3/ha = 25%	58 m^3/ha = 29%
Poles (10/17 cm)	18 m^3/ha = 12%	16 m^3/ha = 8%	19 m^3/ha = 11%	17 m^3/ha = 9%
Basal area (BA/ha)	16 m^2/ha	20 m^2/ha	16.3 m^2/ha	18.8 m^2/ha
Quality timber	67 m^3/ha = 37%	80 m^3/ha	48 m^3/ha = 29%	60 m^3/ha = 30%
Snags & logs		0.4 m^3/ha = 0.2%		0.94 m^3/ha = 0.5%
Regeneration		1.4% of area	9% of area	6% of area
Ground vegetation	Absent on 27% of area, dense on 30%		Absent on 12% of area, dense on 39%	
Increment for 10 years		11.28 m^3/ha/year		9.48 m^3/ha/year
Harvesting volume for 10 years		3.9 m^3/ha/year		5.05 m^3/ha/year

The global result of that management can be summarized as the following:

	1983	1993	2003	Evolution (%)
Total standing timber volume	328,000 m^3	406,000 m^3	526,000 m^3	+ 60%
Large diameter timber (DBH > 52,5 cm)	113,000 m^3	120,000 m^3	151,000 m^3	+ 34%
Large diameter oaks	69,000 m^3	82,000 m^3	99,000 m^3	+ 44%

During the period until 2004, 310 000 m^3 were sold, so nearly the whole initial volume. It means that the initial volume was obtained in 22 years with a 60% increase.

The proportion of timber sold which was about 22% of the total harvest wood increased by 34% (Figure 4) and that proportion could increase to 50% even 55% when the producing volume is balanced, not only in total volume but mainly in the percentage of high diameter trees of a high quality.

Two points also deserve a closer examination.

1. Thanks to a fast turnover of the harvest on the total estate area, large ash trees could be harvested between 1988 and 1995. They were mostly brown, but brought back a good financial return. Since then their price fell by 50%. The drop in price was taken up by alder, sycamore, and now oak.
2. The productivity in money concerning precious woods is extraordinary. Here are the results of the 7.12.2004 sale concerning high quality stems (Table 4).

The value increase in precious large diameter tree is impressive.

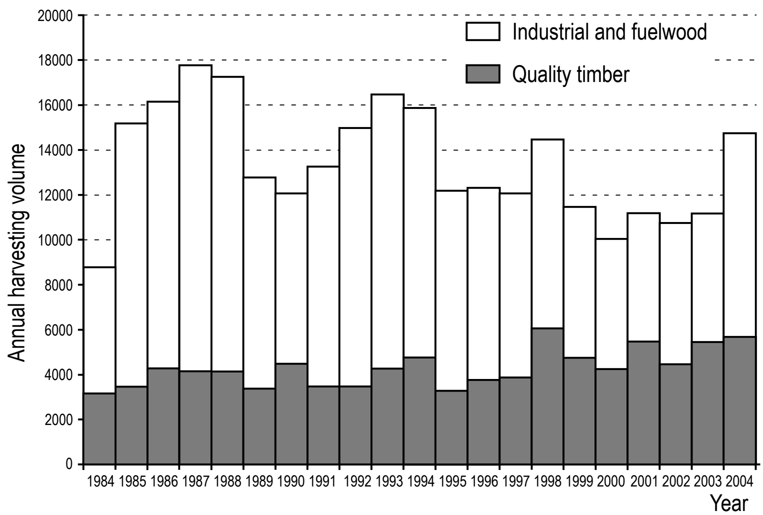


Figure 4: GF Thiérache : 2,500 ha - annual harvesting

Table 4: GF Thiérache - Example of sale 07/12/04 - Price at roadside

Species	Volume	Average price	Quality A/AB/B			
			Volume	%	Average price	% of total price
Oak	548 m³	141 €/m³	48 m³	9	418 €/m³	26
Beech	451 m³	75 €/m³	39 m³	9	154 €/m³	18
Sycamore	230 m³	136 €/m³	2 m³	1	2,768 €/m³	18

Table 5 gives examples of exceptional trees. My best result in 50 years of timber selling was the case of a 130 year-old wavy-wood sycamore of 3.32 m^3 with a 8.4 m stem. The selling price was 20,580 €. That tree had gained from the time it was a seedling, 158 €/year. During its first 100 years, it produced 4,600 to 5,000 €, but in the last 30 years 15,000 €, or 500 € a year.

Table 5: Examples of prices - measurements were taken for a selected tree after felling (bark included)

Sycamore maple - Régnaval forest (near Vervins) Measured by Jochem H.

Age	Average diameter	Volume	Increment volume	Price per unit €/m³	Value €	Increment in €/year	Relative increment per value
60	32	0.79		61	48	1	
70	38	1.12	0.33	91	102	5	11%
80	44	1.50	0.38	152	229	13	12%
90	50	1.95	0.45	457	892	66	29%
100	56	2.39	0.44	1,067	2,550	166	19%

Oak - Forest of Enghien (near Epernay) Measured by Augier S.

Age	Average diameter	Volume	Price per unit €/m³	Value €	Increment in €/year	Relative increment per value
90	40	1	61	61		
110	55	2	152	305	12	20%
130	66	3	229	686	19	6.25%
150	78	4	381	1,524	42	6.11%
164	90	5	579	2,897	98	6.43%

These examples show the extraordinary and unsuspected possibilities of increasing the rentability of beautiful forests.

In some very poor forest of Champagne or west Lorraine, it sometimes occurs that 2 or 3% of the sold volume brings back 50 or 60% of the sold value.

During tree marking, when we have such figures in mind, we hesitate before harvesting a beautiful tree – even a big one – if it is healthy. The people working in even-aged forests don't have such moral dilemmas but they don't know the economic sacrifices that they impose on the owners either when cutting trees that could bring a lot of money too early, or when cutting trees which have no more value too late.

We can also add that the forests mentioned above brought back a comfortable income to the owners, including the improvement in producing material and all the large investment in roads (20 km built) which were constructed.

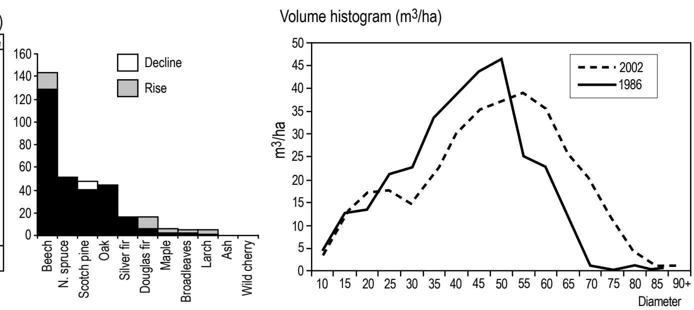
2.2 Zittersheim

The Zittersheim forest spreads out on 460 ha in the Basses Vosges Greseuses, along the Plateau Lorrain. Managed as a regular forest, but with a somewhat useful imagination, until 1970, it was then converted into an irregular forest.

Several inventories and studies were performed there witch show a positive evolution. Figure 5 shows the management results between 1986 and 2002. The volume of the standing timber has increased by 9% from 299 to 326 m³/ha, whereas the cuttings including the wind fallen wood of 1990 and 1999 took about 113 m³/ha, or 38% of the initial material, or 2.4% /year. The turnover of capital in volume is 32 years but only 25 years in value: the standing capital has gone up from 15,526 to 19,672 €/ha while the harvest rose to 4,146 €/ha in constant value. The composition and the value of standing timber capital are given in Figure 6.

Species volume (m³/ha)

	1986	2005	Difference
Beech	129	143	11%
N. spruce	51	52	2%
Scotch pine	48	40	- 15%
Oak	44	44	1%
Silver fir	16	15	- 6%
Douglas fir	6	16	172%
Maple	2	5	142%
Broadleaves	2	5	203%
Larch	1	5	509%
Ash			
Wild cherry		0	
Total	299	326	9%



Present value (EUR/ha)

	1986	2005	Difference
Beech	6,145	9,560	56%
N. spruce	2,082	2,403	15%
Scotch pine	4,645	4,202	- 10%
Oak	1,671	2,117	27%
Silver fir	748	823	10%
Douglas fir	186	351	89%
Maple	23	68	199%
Broadleaves	16	70	342%
Larch	10	77	673%
Ash			
Wild cherry		1	
Total	15,526	19,672	27%

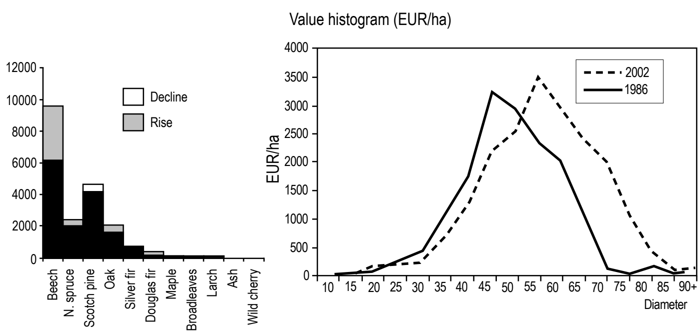
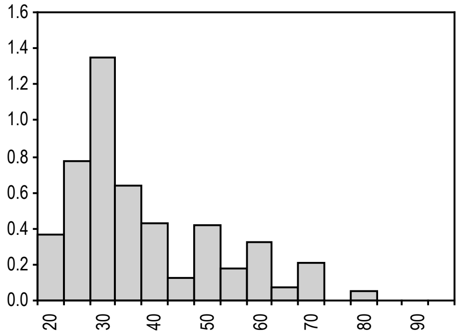


Figure 5: Zittersheim - Evolution of growing stock in volume and Euro

Ecological score		Coarse woody debris (m³/ha)
Beech	97	1.1
N. spruce	30	2.0
Scotch pine	34	0.7
Oak	51	0.9
Silver fir	1	0.2
Douglas fir	1	0.0
Maple	6	
Broadleaves	6	0.1
Larch	1	
Ash		
Wild cherry		
Total	228	4.9



Revenue

Cash return	4.0%
Volume	3.1%

Rotation

Cash return	25 yrs
Volume	32 yrs

Everage stumpage value (EUR/m³)

1986	52
2002	60

Structure (in volume)

	1986	2002	Difference
PER	17	16	-8%
PB	35	35	0%
BM	139	101	-28%
GB	108	175	62%
Total	299	326	9%

Distribution

Ecological score

PER	15
PB	31
BM	96
GB	86
Total	228

Quality volume

	1986 m³/ha	2002 m³/ha	Difference	Increment m³/ha/year
Quality - A	78	79	2%	2.0
Quality - B	146	200	36%	4.3
Quality - C	15	25	71%	0.7
Quality - D	60	22	-63%	2.7
Total	299	326	Total	9.7

Figure 6: Zittersheim forest (Legend: PER = poles 10–15 cm, PB = small trees 20–30 cm, BM = medium trees 35–50 cm, GB = large trees ≥ 55 cm)

Figure 7 reveals that stems with a weak economic interest represent 40% in number but less than 10% in volume and less than 2% in value. A study examining the ecological value of the trees on this site was also carried out. Trees were sorted according to ecological interest (Max Bruciamacchie, 2003). Trees having both an economic and ecological value represent 10% in number, 15% in volume and 12% in value. The economic sacrifice which could be made in favour of a better ecological functioning can be calculated with the method adopted here. It is weaker than what is usually considered. With a small number of large diameter trees with an important economic value, the system can operate on a profitable level leaving room for ecologically interesting trees. And this because with the same volume, large diameter trees use less space than small trees. The windthrow of 26.12.1999 damaged 15% of the growing stock, while at the same time in the neighbouring age class forest of N. spruce was 80%.

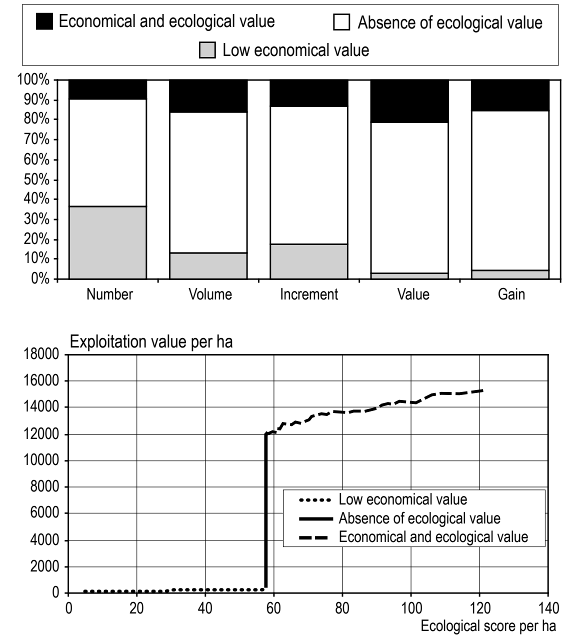


Figure 7: Conflict between economical and ecological point of view - Zittersheim forest (de Turckheim and Bruciamacchie, 2005)

2.3 Bouscadié

Another case, completely different, is that of the Bouscadié private forest located in the mountains in the south of the Massif Central, on granitic soils, at 700 m high, with 1,500 mm of rain per year. The forest developed artificially between 1870 and 1974 by plantation on fields. After somewhat simplistic cuttings, it then underwent substantial storm damage between 1960 and 1964, which destroyed about 25% of the standing volume. After 1965 the owner completely changed his management scheme to transform his even-aged into uneven-aged stands.

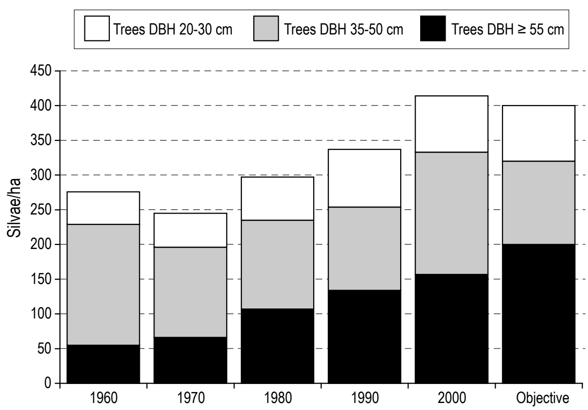


Figure 8: Bouscadié forest - Evolution of growing stock

Following experiments made by Schaeffer, Gazin d'Alverny (1930) on the one hand and by Gurnaud and Biolley on the other hand, he defined – at that time – the target volume at 400 m^3/ha since big trees were 40 m high.

The evolution of standing volume from 1960 to 2000 is shown in Figure 8. The objective being to obtain 50% in volume for large trees, 30% for average trees, and 20% for small trees.

Table 6: GF Bouscadié

Blocks		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Average
Marking of trees for felling	Year	2005	2002	2005	2003	2004	2002	2003	2001	2005	2004	2003	2003	2004	2002	2005	2001	2004	
	sv/ha	49	85	71	62	84	59	72	56	72	81	66	59	71	40	59	84	63	67 (13.4 sv/ha/y)
Stumpage volume (sv/ha) (inventory 2000)		376	479	429	423	435	371	441	415	451	416	409	481	432	337	355	396	357	414 sv/ha
Harvest % of volume per 2000		13	18	16	14.7	19	16	16.2	13	16	19.5	16.1	12.4	16	12	17	21	18	16
	Harvest	1.67	3.38	2.04	1.74	2.17	2.04	1.76	2.15	3.70	2.31	2.02	1.88	2.06	2.00	2.31	3.34	1.65	
Medium trunk	Inventory 2000	1.07	2.08	1.33	1.13	1.24	1.22	1.12	1.30	1.33	1.25	1.16	1.21	1.32	0.99	1.27	1.82	0.85	
sv/trunk	K=PT/inv	1.56	1.63	1.53	1.54	1.75	1.67	1.57	1.65	2.12	1.85	1.74	1.55	1.56	2.02	1.82	1.84	1.94	
	Harvest	20	68	33	19.4	51	32	33.6	30	49	53	33.7	23	32	23	39	68	32	39
Large DBH trees	Inventory 2000	117	344	146	106	151	128	101	128	201	186	136	116	103	121	164	246	85	157
Diameter >55 cm	% of harvest	17	20	22	18	34	25	33	23	24	28	32	20	31	19	24	28	38	
Previous felling	Year	2000	1997	2000	1998	1999	1997	1998	1996	2000	1999	1998	1998	1999	1997	2000	1996	1999	
	sv/ha	63	73	66	49	66	43	36.7	46	66	74	42.3	18.7	64	35	58	57	53	
Harvest	decade	00/05	97/02	00/05	98/03	99/04	97/02	98/03	96/01	00/05	99/04	98/03	98/03	99/04	97/02	00/05	96/01	99/04	00/05
per decade		112	158	137	111	150	102	108.2	102	138	155	108.2	78.2	135	75	118	141	116	124

Total standing rotation: 414/13.4 = 30.9 years
Large trees standing rotation: 157/39 = 19.9 years

As for the previous examples, the improvement of tree quality doesn't appear but it is real. The current increment of that forest is about 16 m^3/ha/year. Cuttings take 13 to 18 m^3/ha/year as it is no longer planned to enrich the standing volume. It is interesting to study the harvested volumes, comparing them to standing timber (Table 6).

These results are interesting in many ways. The turnover of the standing volume is 30.9 years, which can be expressed differently: to produce 1 m^3/ha/year you need to immobilize 30.9 m^3. But if you make the same calculation with large diameter trees (more than 52.5 cm), this ratio falls to 19.9 = 20 years or m^3. Another interesting figure is: the volume of the average harvested tree is situated at about 1.6 to 1.8 times the average volume of the standing tree. That explains the reason why the financial return in Euro is faster than the turnover in volume.

Thanks to biological automation which is quite generalized, the cost of silvicultural treatments has gone down to a very reduced level and is almost limited to quality pruning on Douglas fir. Tree marking also has a somewhat low cost. In 2005 we marked 2,400 m^3 on 1,042 stems, or 800 m^3/day with 4 people only. That is to say 10 stems/hour/person, but nearly 24 m^3/hour. That also represents rationalization.

2.4 A study by Julien Bouillie

The comparison of the management and working costs in two forests was studied by Julien Bouillie and published in the French Forestry Review No. 2, 2001. Figure 9 shows the working sharing cost according to different types of intervention.

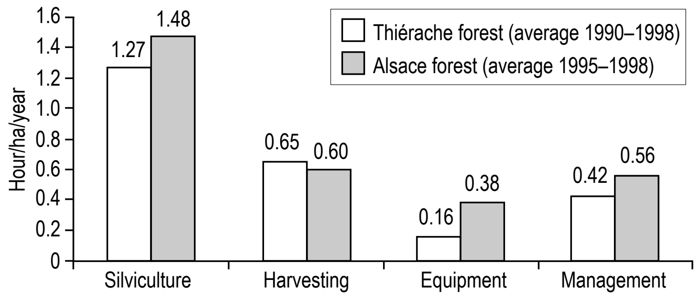


Figure 9: Time distribution in two forests (without logging and skidding)

It must be mentioned that the high sum of seedling care in the forest of northern Alsace is still what remains of previous even-aged forest with clear-cuttings, which have left very important areas of thicket and pole forest requiring many interventions (Figure 10).

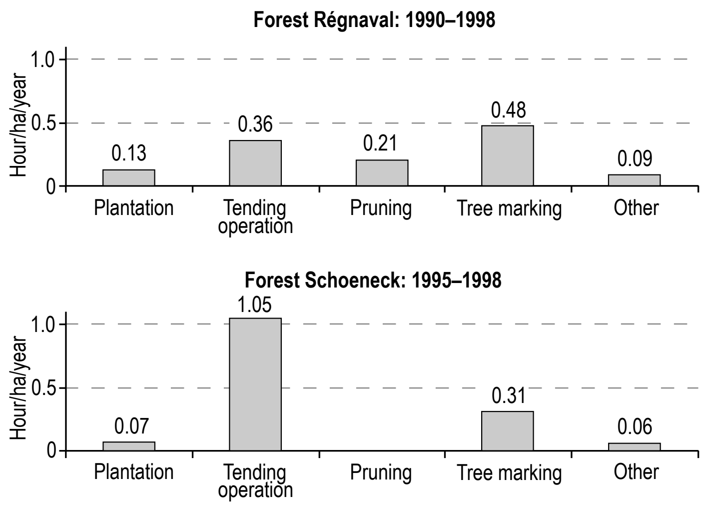


Figure 10: Time distribution in silviculture

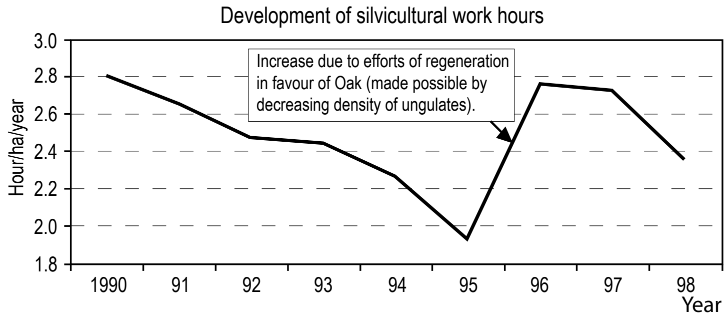


Figure 11: Régnaval forest

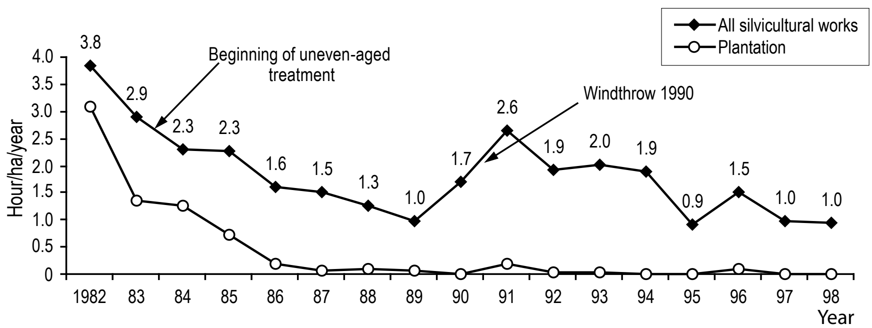


Figure 12: Schoeneck forest

Figure 11 indicates the evolution of the working time between 1990 and 1998 for the Thiérache and in between 1982 and 1998 for the forest in Alsace (Figure 12). It shows the slow decrease in global time as well as in silvicultural time during the observation period, while leaving little by little coppice with standard in Thiérache and even-aged forest in Alsace.

The evolution of the producing material was previously evoked for the Thiérache. For the forest in Alsace, located on very poor soils, the volume remained somewhat stable but:

1. the portion of large diameter trees went from 8 to 18% of standing volume;
2. that of small diameter trees has decreased from 40 to 30%;
3. the volume of timber has slightly increased;
4. the volume of high quality trees has slightly increased.

2.5 The AFI network

The association for the irregular forest AFI is an organization like Pro Silva France with the same people. It was made in 1991 to study – with public money – the functioning of irregular forest and their economic efficiency. Under the direction of Professor Bruciamacchie, 60 plots spread out in the North of France mainly in plains and former coppice with standards (Figure 3). The main results deal with the volume of standing timber to be maintained, enabling both a regeneration and a sufficient yield, as well as an increase in diameter of high quality trees.

When summing up the main results, it is possible to draw the following conclusions:

1. In the former coppice with standards a good functioning involves rather moderate volumes per ha with a basal area of 14 to 22 m^2/ha and 12 to 20 m^2/ha for upper storey (Figures 13 and 14).
2. The financial return is obtained thanks to a few precious trees with short stems and large diameters, without defects and topped by huge crowns.
3. The study of financial account reveals that tending and the marking of trees are the main expenses for companies selling principally standing timber. Tending requires an average of 0.5 working hours per ha and per year, rarely reaching 1 h/ha/year.
4. The marking of trees represents a cost situated between 5 and 20 €/ha/year but usually less than 15 €. Planting, pruning, thinning, are practically null thanks to biological automation.
5. The costs take into account the yearly result plus the value evolution of the stands including the evolution of standing timber cubic meters, but also that of the quality timber percentage and the recruitment of young quality trees. Figure 15.
6. All the forests studied earn money with an excess of receipt on expenses ranging from 25 to 480 €/ha/year. According to the forests the standing timber value has increased since 1991 from 115 to 360 €/ha/year.

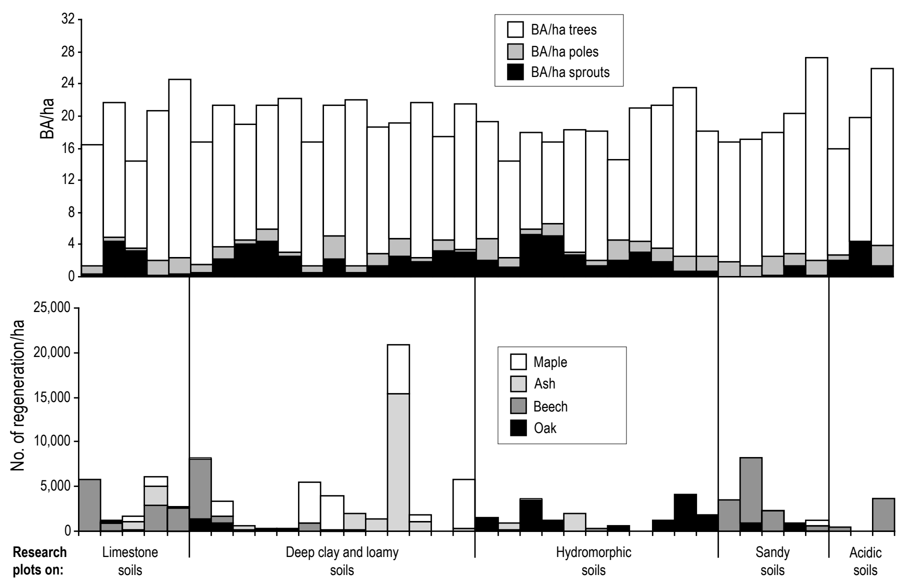


Figure 13: Correlation between basal area and regeneration. Each bar represents a specific forest stand.

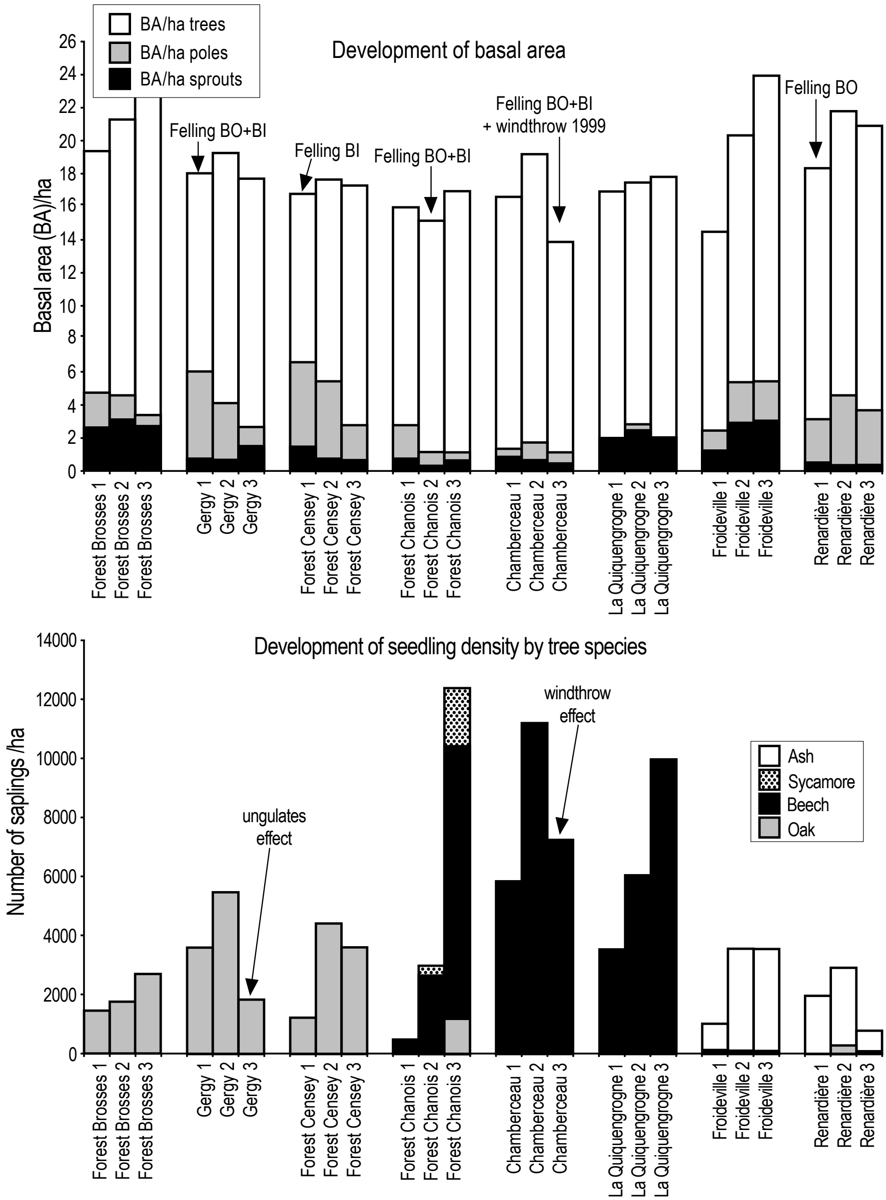
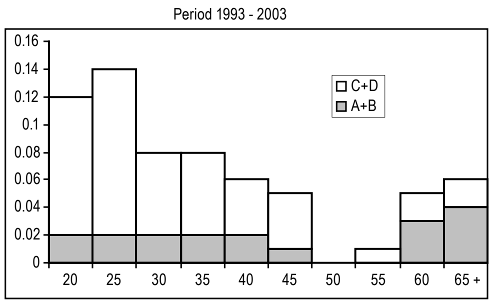


Figure 14: Evolution of basal area and regeneration. 1, 2, 3 represent successive measurements on the same research plot. (BO = quality timber, BI = industrial and fuel wood)

	1993	1998	2003
Stumpage substance (BA/ha)			
BA trees	14.9	14.6	15.7
Coverage trees	86%	93%	84%
Quality			
% A+B	46%	45%	38%
BA/ha beech A+B	6.5	6.0	5.5
Regeneration			
Regeneration coverage - beech	10%	17%	27%
Regeneration coverage - total	23%	33%	38%
N/ha seedlings - beech	3536	6036	9950
BA/ha poles - beech	1.2	0.6	0.4
Structure			
% PB	21%	23%	15%
% BM	36%	51%	52%
% GB	43%	27%	32%



Harvest rates : felling repartition

	1993-1998		
	PB	BM	GB
A+B	0.1		2.1
C+D	0.5		1.3

	1998-2003		
	PB	BM	GB
A+B	0.1	0.2	
C+D	0.9	0.4	0.1

	1993-1998		1998-2003	
Felling :	4.0	m²/ha	1.7	m²/ha
Basal area increment :	0.74	m²/ha/year	0.56	m²/ha/year
Share of trees reaching timber DBH by increment on BA :	0.24	m²/ha/year	0.08	m²/ha/year
Transformation to timber trees - total :	10	stems/ha/year	3.3	stems/ha/y
Transformation to timber trees - beech :	7.5	stems/ha/year	0.0	stems/ha/y

Felling statement for 10 years :	**0.57**	**m²/ha/year**		
Basal area increment for 10 years :	**0.65**	**m²/ha/year**	Rates :	4.4%
Basal area increment for 10 years (A+B):	**0.17**	**m²/ha/year**	Rates :	2.5%
Quality loss for 10 years :	0.89	m²/ha, "recovered" in 5.2 years.		

Synthesis :

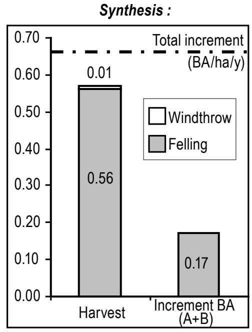


Figure 15: AFI research object No. 6: Quiquengrongne forest (Legend: PB = small trees 20–30 cm, BM = medium trees 35–50 cm, GB = large trees ≥ 55 cm) (de Turckheim and Bruciamacchie, 2005)

2.6 Other forests

In a forest located in northern Alsace, the evolution in standing volumes is shown in Table 7. The average quality of standing volume increased since poor large diameter trees were systematically harvested.

Table 7: Evolution of growing stock - Vosges du Nord (m³/ha)

	Windstein		Schoeneck II		Grossenwald	
	1971	1993	1964	1992	1975	2002
Growing stock	174	286	230	301	229	266
Broad-leaved (DBH >52.5)	8	22	5	31	26	65
Conifer (DBH >52.5)	1	11	4	17		

In another forest, on 1,000 ha situated in eastern Lorraine, cuttings have taken 25% of the initial material in 9 years. During this period capital increased by 16% in volume and 17% in constant money. Notice that the total is 33%!

The IDF (Institute for Forestry Development), whose aim is to send forestry techniques to private owners, has made up a working group with Pro Silva France concerning uneven-aged forests. They collected data in various regions in France.

The Pro Silva France groups meet regularly to talk about their experiences. These working groups gather representatives of the private forests, of the administrations of the French Forestry Commission, and are very interesting for the professionals who always work on their own and have practically no other occasions to meet and communicate.

3 Drawbacks and obstacles

In order to generalize SICPN in France, drawbacks and obstacles are very numerous, but not insurmountable (Table 8).

Table 8: Drawbacks and obstacles

1.	Training of the different foresters.
2.	Numerous people in charge are worried about this silviculture: fear of losing control, power ?
3.	Excess of game.
4.	Heterogeneity of harvesting products.
5.	Mechanical progress - arrival of big processors.
6.	Industry (especially those sawing white conifers) prefers small and average diameter.

1. Training of all the people, whatever their levels is an essential condition to develop SICPN in good conditions. Moreover, a continuity in staff, which is easier in private than in public forest.
2. Numerous people in charge – rather aged – have not understood the SICPN and are worried about it. They fear they might lose power and control. Unfortunately, we have to wait for their departure.
3. The excess of game is preventing the generalisation of SICPN and the increase of the hunting fees lead the manager to overestimate the hunting capital neglecting the patrimony in general.
4. The heterogeneity of harvesting products makes cutting and selling more difficult, and this is damaging in places where the selling of standing timber is a tradition, but also in mixed broad-leaved stands.
5. Mechanical progress and the arrival of big processors leads to a homogenization of stands and to the return of clear-cutting. The machines can be very useful but one shouldn't renounce the numerous advantages of SICPN for a very limited return. If the advantages of mechanization can be "bought", with less stable stands, the increase in silvicultural costs, damage of the site, and the loss of multifunctionality, where is the profit? Let's not pay short term earnings or advantages with losses over the average or long term.
6. Some industries, especially those sawing white conifers, prefer small and average diameter trees because of the evolution of their equipment. The sawyers often reject the large diameter wood because they are said to have defects. However, the SICPN works correctly when producing large diameter wood and then we should define the frontier between average and large di-

ameter trees. For the industry, the large diameter wood, if of a good quality, is not a problem. So let's produce quality timber, which is easier in SICPN than in even-aged stands. Let's trust the technological improvement to buy our products.

4 Conclusion

As a conclusion and to answer the excellent question of the symposium organizers ”Industrial forests, protected forests, or close to nature managed forests?”, the response given by Pro Silva France on the economic level is clear: while assuming the best functions of biodiversity, landscape care, and protection, the continuous, uneven-aged forest with close to nature management is profitable and financially efficient. The obstacles and difficulties in these types of treatments can be solved and avoided and there should not be an implacable opposition to its universal development. However, we won't change nature laws. We have to stick to that task and we have to congratulate the organizers of that symposium who contribute in making people know and defend the SICPN.

Combination of economic and ecological aspects by close to nature forestry

A contribution to the economic crisis of forestry

Hermann Wobst*

Abstract

Close to nature forestry has many opportunities for a useful combination of economic and ecological aspects. This is effective not only after having reached optimal forest conditions with regard to site-adaptation, choice of species, mixture and structure, but also on the way towards this aim. This way is normally a transformation of forests, which result from the classical type of forestry. Examples from the State Forest District Stauffenburg, where close to nature forestry already began in 1943, and the State Forest Administration of Lower Saxony, beginning about 45 years later, will show some of the results.

Especially considered are the efforts to optimize the congruence between the different site-qualities and the growing-stock objectives, to change pure stands into mixed stands, to acquire the next generation from natural regeneration and to produce higher amounts of large timber by a single-tree system. Some economic benefits, connected with ecological reasons and effects, are described. Considering the present unsatisfactory prices, the chances and the conditions for producing large timber are discussed.

The present economic crisis of the Central European forestry also concerns close to nature forestry. The reasons and present-day ideas and measures to master the crisis are presented. Some of these suggestions, mostly directed to improve the situation in the short run, have undesirable consequences, at least from a close to nature point of view. These are confronted with, on the long run, better effects and higher importance of long term strategies. Consequent use of all possibilities coming from outside and the concentration of its own efforts can help forestry – in the form of close to nature forestry, of course – to regain better chances in the future.

Key words: Choice of tree species according to site conditions; mixed stands, lower costs by natural regeneration and planting under shelter; production of valuable large timber; structure of standing volume, annual cut and increment; present-day problems of large timber; current crisis of forestry; critical assessment of suggestions and hopes

* Dr. Hermann Wobst, Fuchswinkel 21, D-37581 Bad Gandersheim, Germany
Tel./Fax 0049-(0)5382-907885, /-907887, E-mail: hermann.wobst@t-online.de

1 Introduction

In 1950 the „Arbeitsgemeinschaft naturgemäße Waldwirtschaft“ **(ANW),** a working group for close to nature forestry, was founded in Germany. The number of members, then 21, amounts to 3,300 today. The ANW views forests as holistic, complex, permanent, dynamic ecosystems. Natural processes that occur in the forest can be used for various economic purposes. Therefore, the ANW made two demands: to renounce the methods of the age-class high forest and to establish a sufficiently large number of model enterprises for close to nature forestry. The first demand along with the ANW-principles (Wobst, W., 1954) were refused for a long time. The second demand was more successful. One example is the State Forest District Stauffenburg in Lower Saxony. Here the author´s father, Dr. Willy Wobst, started close to nature forestry practices in 1943. In 1948 a separate part of the district called „Landteil“ was conceded as an experimental object. In 1967 the trial area was extended to the whole state forest of Stauffenburg. Since 1950 the development has been well documented by sample inventories repeated every ten years, including normal forest management plans, the last of which is from 2001. The following examples and results mostly have their origin in Stauffenburg; some of them relate to the entire state forests of Lower Saxony.

Around 1990 the economic success of Stauffenburg and other model enterprises, together with other influences, caused German forestry to adapt the (lightly modified) ANW-principles. The author was head of the Stauffenburg Forest District from 1966 to 2000. The district was “liquidated” at the end of 2004.

2 Combination of economic aims with ecology

In Central Europe, close to nature forestry typically begins in classical age-class high forests. As a result, one is well advised to slowly convert the existing standing volume through the following measures: 1) replace clearcutting with individual tree tending and felling on the whole area; 2) use natural regeneration instead of planting or sowing; 3) let the next generation grow under shelter; 4) retain the climate within the stand; 5) carefully deal with the site-potential; 6) convert pure stands into mixed stands; and 7) choose site-adapted tree species and produce more large timber.

If these practices are carried out for a long time, this will lead to characteristic changes of important natural, economic and ecological parameters for a forestry enterprise. In the following some of them will be considered more closely.

2.1 Site-adapted choice of species and establishing mixed stands

Choosing site-adapted tree species and establishing mixed stands may at first seem to be economically driven aims, as optimally site-adapted species yield high vitality and performance, they regenerate naturally, and they have lower risk.

However, in time these aims will also maintain site quality and soil fertility, thus ensuring the basis of the sustainable ecosystem. In mixed stands of site- adapted species the indigenous species should be dominant. The natural interactions between site and standing volume will then be only slightly disturbed. The capacity of nutrients and water are optimally used and renewed by corresponding root development, litter decomposition and humus form. Ground vegetation and further flora and fauna correspond to a large extent with the inventory of species of the natural plant association.

Figure 1 shows a remarkable increase in site-adapted mixed stands in the Landteil between 1946 and 2001 from 47% to 82%. The stands once dominated by beech (*Fagus sylvatica* L.) and Norway spruce (*Picea abies* Karst.) clearly decreased.

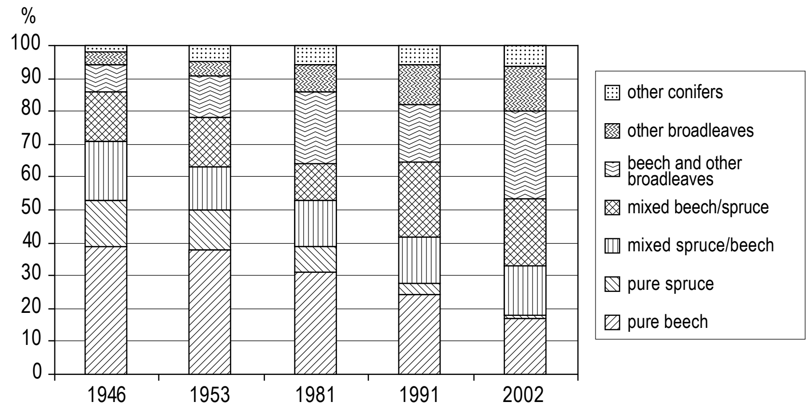


Figure 1: Increase in mixed stands, Landteil, 1946–2002

The long-term growing stock objective on limestone sites (Landteil) are mixed stands comprised of beech (50%) and many other species, including ash (*Fraxinus excelsior* L.), sycamore (*Acer pseudoplatanus* L.), cherry (*Prunus avium* L.), and lime (*Tilia cordata* Mill.). Figure 2 shows the development of the percentage of standing volume between 1950 and 2002. While beech and spruce continuously decreased, the other more valuable broadleaves increased from 6% to 33%.

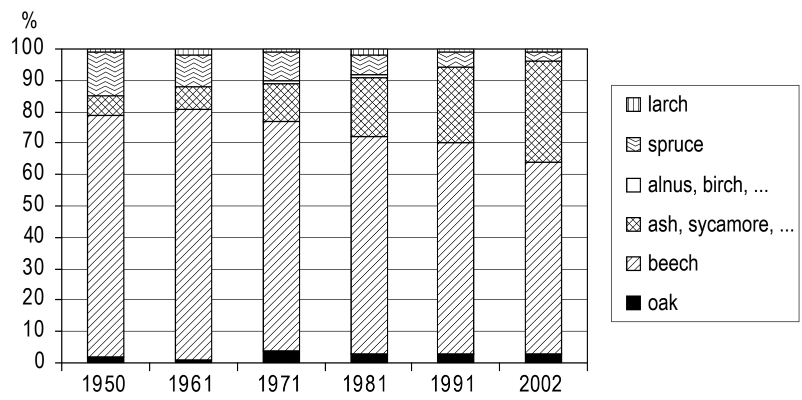


Figure 2: Changed composition of tree species on limestone-sites, Landteil, 1950–2002

2.2 Renewal of forests by natural regeneration

Close to nature forestry is intended to lower costs with priority on silvicultural means. Abandoning clear cuts and focusing on more natural regeneration and planting under shelter may substantially lower the costs of forest regeneration and development. Under shelter, fewer plants per hectare and less tending are required. Furthermore, much of the work required in clear cuts, such as removal of logging debris, soil cultivation, and weed control, will become almost unnecessary.

This has some ecological advantages too: the climate inside the forest and the nutrient balance are only slightly disturbed; there is no need to use chemicals; natural regeneration maintains genetic potential; it offers a rich choice of plants; and it ensures unharmed root development.

In 1991 the State Forest Administration of Lower Saxony officially started with close to nature forestry on its total forested area (345,000 hectares). In the following years this had considerable effect in lowering costs (Wollborn, 2004).

Figure 3 shows how the costs for renewal of forests developed between 1986 and 2001. From the maximum of 120 DM per hectare (ha) of lumber producing area in 1989 the costs could be reduced to 36 DM/ha in 2001. As Figure 4 shows, the yearly planted area decreased from about 3,500 ha before 1991 to about 1,300 ha in 2001. At the same time the costs per ha (planted area) fell from about 12,000 DM to 9,000 DM.

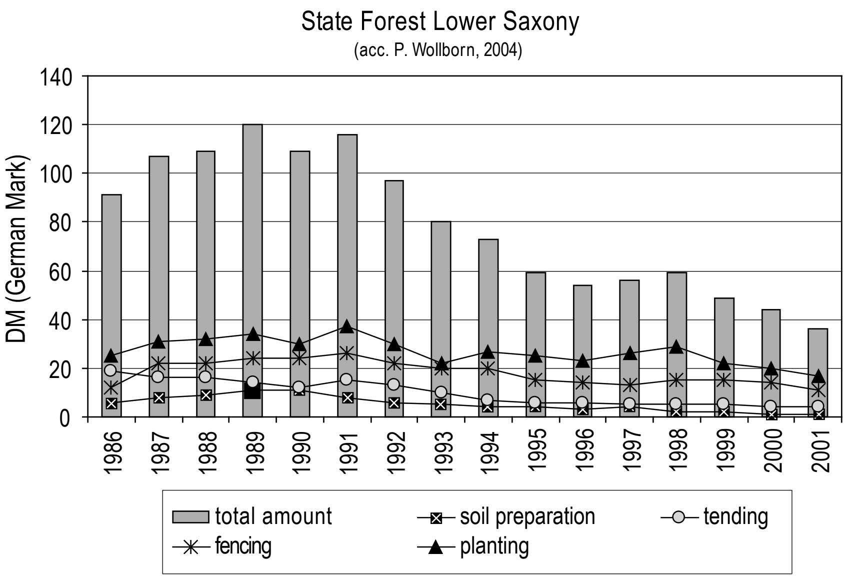


Figure 3: Costs of renewal of forests, 1986–2001 - State forest Lower Saxony

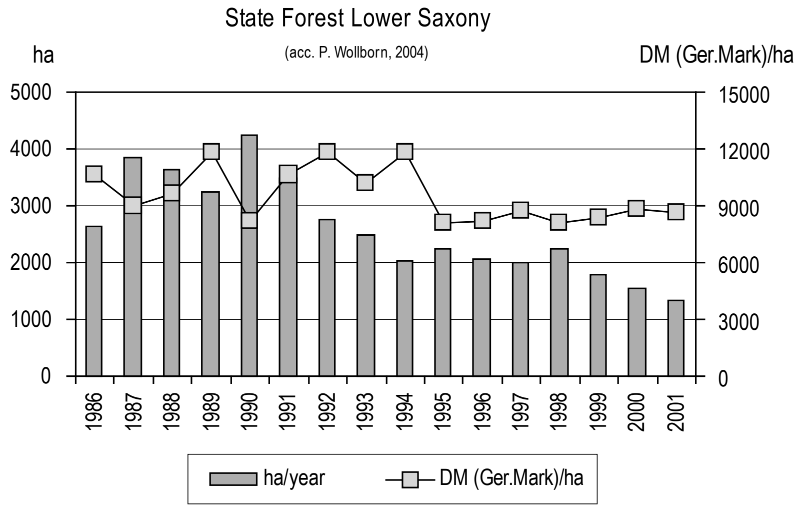


Figure 4: Reduction of planting area & costs per ha, 1986-2001 - State forest Lower Saxony

2.3 Production of valuable large timber

From the beginning the ANW wanted to use natural processes not only to reduce costs but also to increase yield. Consequently, a higher production of large timber was an important economic aim. Large timber reduced harvesting costs and reached (with normal quality) the highest prices for both conifers and broadleaves alike. Simultaneously, the quality of growing stock should be constantly improved by permanent individual-tree cutting on the whole area. Within the Landteil this aim was followed for more than 60 years. The diameters at breast height (DBH) should reach > 65 cm for broadleaves and > 55 cm for conifers. Some examples follow (Landteil).

2.3.1 Amount and size structure of standing volume

The average standing volume remained relatively constant between 1943 and 2001. The planned cut and real cut however could be raised remarkably; see Table 1.

Table 1: The development of standing volume, planned harvest, and real cut (Landteil 1950–2002)

Period	Standing volume	Commercial volume	
		Planned harvest	Real cut
	m^3/ha	m^3/ha	m^3/ha
1950–1961	341	5.2	6.2
1962–1971	326	6.2	7.7
1972–1981	337	8.1	10.4
1982–1991	304	9.1	9.0
1992–2001	329	8.9	8.4
2002	338	8.2	

On the contrary, the size structure of the standing volume changed very much between 1950 and 2002. Figure 5 shows the distribution of standing volume (m^3) into DBH-classes (5 cm), divided into broadleaves and conifers. The development is especially obvious with the broadleaves. In 2002 the largest part of the standing volume is located in the highest DBH-class (>65 cm), followed by smaller amounts in the lower diameter classes. This guarantees a sustainable cut of large timber. In regard to the conifers, four heavy windthrows between 1962 and 1976 disturbed a similar development, but since 1981 large timber increased visibly too.

Figure 5: Size structure of standing volume (DBH-classes) 1950–2002

2.3.2 Development of size structure of harvested large beech stemwood

The increase in large diameter parts of the standing volume made it possible – with a certain interval in time – to cut increasing amounts of large timber. Figure 6 shows the continually rising quantities of harvested beech stemwood in the higher diameter classes 5 and 6 between 1986 and 2002.

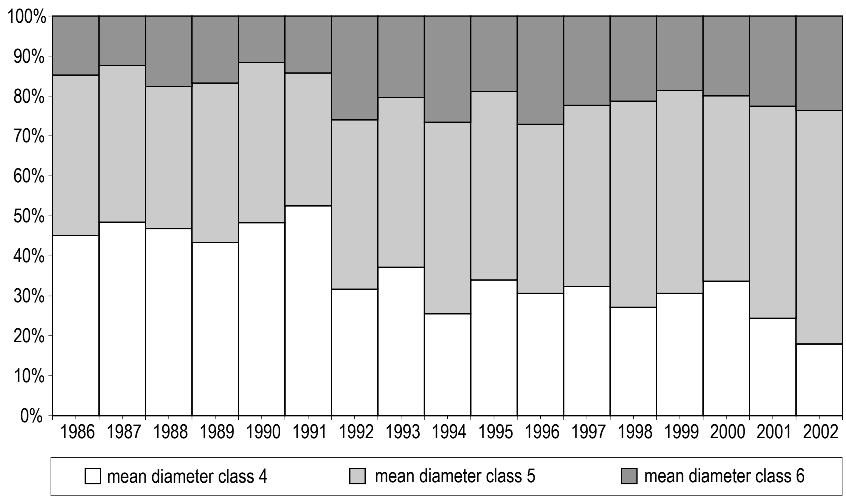


Figure 6: Size structure of harvested large beech-stemwood, 1986–2002

2.3.3 Quality of harvested large beech stemwood

Besides dimension, of course, the quality of large timber is decisive for economic success when producing large timber. As beech trees become older and larger, they tend to develop a red heart, which is considered to be a quality fault. Thus, the production of large beech timber is a certain risk. As a result, this aspect was observed carefully in Stauffenburg. The percentage of higher quality classes of the total beech stemwood – separated into the diameter classes 4, 5 and 6 – was determined yearly. Figure 7 shows that between 1986 and 2001 the average quality of the diameter classes 5 and 6 does not differ remarkably.

To produce large beech timber was therefore economically useful. For this it was very important to realize that a large beech tree with a standing volume of already 5 m^3 can produce the 6^{th} m^3 within the next ten years.

2.3.4 Aspects of standing volume – increment – real cut

A high percentage of large timber in the standing volume also produces a high increment in large dimensions. This connection becomes obvious in Table 2. Standing volume (1991 and 2001), increment (1991–2001) and real cut (1991–2001) are divided into three groups: small-sized timber (7–25 cm DBH), medium-sized timber (26–50 cm DBH) and large timber (>50cm DBH). Large timber had 41.2% of the standing volume in 1991, produced 49.6% of the total increment, reached 54.8% of the real cut, and had again 42.4% of standing volume in 2001.

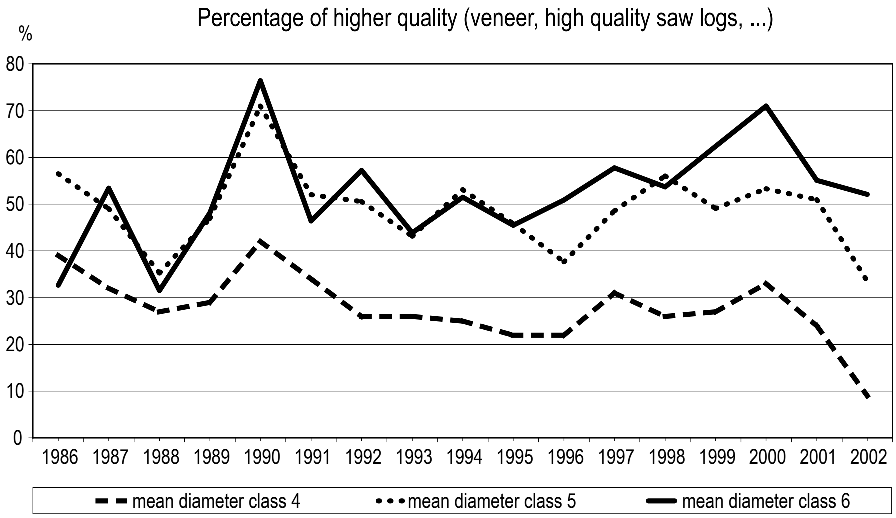


Figure 7: Quality of harvested large beech-stemwood 1986–2002

Table 2: Standing volume (1991 and 2001), increment (1991–2001) and real cut (1991–2001)

DBH	Standing volume 1991 m³	%	Increment 1991–2001 m³	%
7–25 cm	35,500	13.8%	15,000	19.4%
26–50 cm	116,000	45.0%	23,900	31.0%
>50 cm	106,000	**41.2%**	38,300	**49.6%**
Total	257,500	100.0%	77,200	100.0%

DBH	Real cut 1991–2001 m³	%	Standing volume 2001 m³	%
7–25 cm	8,000	10.7%	35,000	13.4%
26–50 cm	25,700	34.5%	115,500	44.2%
>50 cm	40,800	**54.8%**	111,000	**42.4%**
Total	74,500	100.0%	261,500	100.0%

2.3.5 Economic success of producing large timber

In Stauffenburg (about 80% broadleaves, mostly beech), the amount, size, quality and price of beech stemwood became decisive for economic success. Due to the described treatment this narrow natural basis was enough to make a small average profit even in the period from 1970 to 2000. The Landteil had an over proportional share in this result. For instance, the average net revenue of the Landteil from 1972 to 1981 was about 400 DM higher (per ha and year) than in the other state forest parts of Stauffenburg. During the whole time considerable investments into converting the forest were paid from the yield.

2.3.6 Ecological aspects of producing large timber

The conversion of an originally even-aged stand may last many decades. This allows you to orientate further silvicultural measures by the natural dynamic of the forest.

The first aspect is natural regeneration. Normally, a single-tree system disperses the canopy irregularly. In developing gaps natural regeneration may take place. Gaps can also be used to plant additional tree species. Each of these possibilities, but also combinations of both, can be extended to longer periods. A higher light requirement of light-demanding tree species can be filled by varying the gap size or by using open places caused by windthrow or other disturbances.

As another aspect, a canopy of older trees protects young trees from frost, heat, drought and weeds. A canopy also means intensified competition. Thus, shelter differentiates the young trees, forms good quality (self-pruning, slender branched, fine ringed) and reduces their number. Depending on the moment of arrival and degree of light the young generation may develop a more or less uneven-aged structure.

Thirdly, additional tree species and changing structure will result in a higher variety of ecological niches for flora and fauna. This will give important impulses to keep or renew the site typical biodiversity. This aspect can be intensified by groups of habitat-trees, which are left to die in old age. In Stauffenburg, such trees already existed at an average amount of 15 m^3/ha in 2001.

Finally, an entry into continuous-cover-forestry („Dauerwald“) will result from the developing new structure. Here, in principle, all forest functions exist without interruption on the whole forested area. In Stauffenburg, 75% of all stands are already two- or multi-storied (Hennecke, 2004).

2.3.7 Production of large timber – also in the future?

Since about 1990 harvester-machines in the forest and highly mechanized sawmill techniques have promoted small-sized timber, so that at present large timber of conifers reaches only slightly better prices than small-sized timber. Only above average quality, for instance veneer, will achieve higher prices, so part of the “large timber problem“ is a “quality problem“.

On the other hand, in Germany, Austria, Switzerland and parts of France the percentage of large conifer timber is continuously increasing, whereas the growing stock of small-sized timber is decreasing. By establishing some sawmills with a new technique for larger dimensions, the sawmill industry has shown its ability to react to the changed supply.

With the broadleaves the situation is different according to various species. Depending on changing fashions within the furniture industry, demand and prices often fluctuate considerably. By adapting supply to demand, large timber of good quality will mostly find corresponding prices.

Especially with large beech stemwood, however, higher shares of red heart have caused clear price reductions. Therefore, a certain recognizable tendency to avoid the "red heart problem" is by simply lowering the target diameter. However, all further positive aspects of producing large timber will be faded out. This connection may not be carelessly given up, but has to be advocated more aggressively. To find better uses of red heart beech timber in cooperation with the timber industry is equally possible and necessary.

Summing up, there is no reason to leave the aim of producing large timber with its many economic and ecological advantages. Not only the highest possible amount, but also the highest possible quality of large timber has to be produced.

3 The economic crisis of forestry

3.1 Reasons

For about 50 years now timber prices have stagnated in middle Europe, whereas the costs have increased continuously. Including the inflation rate present-day prices are on an average less than 20% of the prices in 1955. In spite of its many advantages the real cut of timber is still below the increment. Certification has hardly changed that. Very many and very different owners of forests prevent an optimal marketing of timber and in fact an effective representation of their interests in forest policy. Compared with agriculture, forestry is hardly supported by the European Union. The various protective and recreational functions of forests are insufficiently paid.

3.2 Countermeasures and suggestions to master the crisis

Especially in the last 20 to 25 years – in ever decreasing intervals – public and private forestry enterprises enlarged their districts and management units, changed their status and structure, decreased their staff, outsourced services and performances to contractors, delegated tasks to subordinate personnel, distributed the comprehensive responsibility for all tasks in the area to specialists, and others.

At the same time, suggestions were and are still being made – and maybe are even practised – to change silvicultural methods, including practices that: shorten the production cycle, reduce target diameters and thinning intensity, support only a few elite trees per hectare, prolong intervals of harvesting and achieve a higher quantity per cut, plant pure spruce after pure spruce, replace an intensive mixture distribution by mixing (small) pure stands, invest in biological production only from one's own yield and after judging the financial consequences.

3.3 Critical assessment of countermeasures and suggestions

Recently, reduction and fluctuation of personnel show alarming consequences. An almost unchanged volume of work must be done by continuously diminishing company-owned personnel. Long-term experience, local knowledge and being familiar with one´s "own" forest gradually disappear. In close to nature forests – and also in the phase of conversion – regeneration, tending and harvesting are going on at the same time and in the same area. If parts of the work are done by different, partly not company-owned people a close observance of the consequences of measurements and the "dialogue with the forest" will be lost. Necessary and important feedback for the further management of the enterprise will be missing.

The above mentioned silvicultural suggestions will have more disadvantages than benefits: shorter production cycles break off the development of forests at a more juvenile stage, they shorten the periods of regeneration, harvesting and conversion and – with that – will produce more even-aged and less mixed stands. To support only a few stems per hectare will provoke a solitaire-like growth and less reserve of elite trees. Mixing small pure stands lowers the number of options with regard to the fact that the site factors are no longer constant. High wood quantities per cut disturb a continuous treatment of forest and run high risks: They may cause windthrow, sunburn and unacceptable damage to the next generation; overgrowing of grass and weeds may lower the chances for natural regeneration.

I believe the administrative countermeasures and the silvicultural suggestions too, are short-sighted temporary solutions. I fear the pace and the present-day extent of their realization no longer do justice to our long-lived economic object.

3.4 Are there ways out of the crisis?

Besides internal rationalization, which should also be possible in the future, changing base conditions may improve the situation as well.

We can observe some rapid worldwide developments: The world population is still exploding. Many raw materials are running short. Prices for fossil fuels are rising. In wide areas deforestation is still happening. China and India are booming. These global trends may increase the demand for, and prices of, timber and will improve the competitiveness of timber as opposed to energy demanding materials (steel, aluminium, glass, concrete) and fossil fuels.

But forestry has to strengthen its own efforts too. A European forest policy offensive should promote the use of timber and more active marketing, should emphasize the excellent features and further benefits (ecological balance, CO_2) of timber and the economic importance of the "Cluster forestry and wood based industries", should ask for a fair payment of protective and recreational functions and for a higher support of close to nature forestry.

Last but not least, an increased use of close to nature forestry can help to master the crisis. On the one hand, with short-term solutions, and on the other hand, with more possibilities in the long run to convert classical age-class forests into site-adapted, mixed and unevenaged forests. Economic and ecological aspects will complement and intensify one another the longer this way is followed. Such a long-term strategy is the essence of forestry. It includes, however, being ready to invest in the – always unknown – future, on the basis of our present-day knowledge. Especially in economically hard times forestry has to categorically advocate – on every occasion – its historic obligation to sustainability in its broadest sense.

References

Hennecke, W., 2004. 60 Jahre naturgemäße Waldwirtschaft im Niedersächsischen Forstamt Stauffenburg, Ergebnisse-Einblicke-Möglichkeiten. Forst und Holz 59, 1.

Unterberger, W., Wobst, H., 1985. 40 Jahre naturgemäße Waldwirtschaft im Landteil des Staatlichen Forstamts Stauffenburg. In : „Aus dem Walde“, Mitteilungen aus der Niedersächsischen Landesforstverwaltung, Heft 39.

Wobst, H., 2000. Silviculture in conformity with nature in the hill and mountain country of Lower Saxony. In : 3rd International Congress of Pro Silva Europa in Fallingbostel/Germany, Congress Report, 204–220.

Wobst, H., Wobst, J., 2004. Langfristige Ergebnisse naturgemäßer Waldwirtschaft im Landteil des Niedersächsischen Forstamts Stauffenburg. Forst und Holz 59, 1.

Wobst, W., 1954. Zur Klarstellung über die Grundsätze naturgemäßer Waldwirt-schaft. Der Forst- und Holzwirt 9, 13.

Wobst, W., Wobst, H., 1975. Ergebnisse aus drei Holzvorratsinventuren im Landteil des Niedersächsischen Forstamts Stauffenburg. Allgemeine Forstzeitschrift 30, 17.

Wollborn, P., 2004. Vorteile naturgemäßer Waldwirtschaft für die Niedersächsische Landesforstverwaltung. Forst und Holz 59, 1.

Close to nature forestry as the only true culture of a man's activity

Dušan Mlinšek*

Abstract

During his development, man was always destroying the natural environment and nature was all the time warning him with different catastrophes. It was to no purpose. He was, at all times, trying to control nature with his "technoid" thinking in many different ways, but he was not successful. A destroyed and sick environment amounted to a sick life. The more natural the environment is, the more natural is life (i.e. more successful and healthier). All the cultural activities of man are only a thin plaster over the hurt human spirit, which has gone far away from nature.

There is cognition arising: Nature and forest as a classroom for man (including science) saying "BACK TO THE NATURE". In other words, this means a radical change in the development of the relationship between man and the environment, and a birth of true - real culture.

The true real culture is fighting against and slowing down entropic processes in nature. These processes can't be changed but healthy life is slowing them down. This means a new foundation for future management and change from highly entropic concepts (material development at all costs) to a low entropic philosophy and practice as the only successful solution for preserving life.

Forestry in Slovenia started with success, focusing on nature and site (environment) adapted forest management. There were some similar tendencies in Slovenian forestry in the past, but they were only locally present. After WWII, a fundamental change happened in Slovenia. A more close to nature management was applied in all forests, away from wild high productivity trends of modern society and towards seeking the answers and advice in undisturbed natural – virgin forest.

This path led to the discovery of nature-based forest management with all its positive effects. The biogeographical position of Slovenia with four large units (Dinaric, Alpine, Mediterranean and Pannonic) also helped with the idea: respect local, so you can benefit from global. Consequently, Slovenia can be used as a case study of a diverse European environment where nature-based forestry should be supported as a CULTURA NOVA (the only real and true culture).

* Prof. Dr. Dr. hc Dušan Mlinšek, University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources, P.O. Box 2995, 1001 Ljubljana, Slovenia
Tel. +386 1 423 1161, Fax: +386 1 257 1169

Remark: *It's logical! But still, with no regard to success of described concepts, different "civilization" diseases like haste, stress, genetic modification and "agricultural illnesses" are appearing. We shouldn't forget – forest remains a classroom for gaining not only knowledge, but wisdom too.*

Key words: culture – a thin plaster on hurt human spirit, close to nature forestry – true and real culture of a human being, forest ecosystem – new university, forestry – cultura nova, multifunctional forest – green assignment of forest

1 Post WW II revitalisation of Slovene forests

Let's present how the Slovene forests recovered during 50 years after WWII. In this way we should comprehend a forest, which is an integral part of a landscape, and as such it is effectively multifunctional. Multifunctional forest is Nature's property, and therefore 'the property' should be subordinated to Nature.

Only those who saw our forests before the year 1945 know how to appreciate:

1. the present state of forests;
2. the efforts put into achieving this 'organic turn', and the positive revival of forests.

Remark: The economic welfare of forest owners, especially farmers, was catastrophic before WWII. The proofs of this situation are: diameter-limit cuttings, leaf litter collecting 'to bare ground', forest pasturing, 'inheritance cutting', etc.

Already the first forest inventory in Slovenia, and the immediate forest management planning for all forests (full callipering) which started in 1953, disclosed catastrophic condition of forests, and this pointed out an integral economic crisis.

Let's list some evidence: in the 19th century the Pohorje region had only 25% of forest land where felling could be carried out. Not only the Alpine region, but also the Goričko region (the hilly countryside of Prekmurje) was well-known for its torrents. Deforested hills of the Kozjansko region, named after goats (koza = goat), where only goats could survive out of all domestic animals. Not to mention the Karst and Bela krajina region (i.e. a birch region), the impoverished Slovenske gorice region, the deforested Savinja valley region, and the deforestation of the Koroška region in order to gain farm land. Another such example was a suggestion to remove forests of Pedunculate Oak on clay soils in the region of Slovenj Gradec in order to create farm land. We listed only some occurrences to prove how wood-depleted and exploited the Slovene forest landscape was.

To the present-day inhabitants of Slovenia the existing situation is quite normal. But visitors from abroad cannot hide their admiration for our success in creating such a unique forested country, unlike the sceneries of clear-cut forests throughout Europe. A foundation was established to promote further successful development of Slovene forest, and at the same time it is a guarantee that committing a forest robbery won't happen again. This should not happen, and if it did, then such doing would give proof that man definitely took the wrong road, and is listed in 'THE NATURE'S BOOK OF

SPECIES TO BE EXTERMINATED'.

But, let's not give up: **the final disillusionment is an unconditional imperative!** This article was written because of that, and to present a rough draft of man's history, which embodies a constant destruction of environment, and further his search for solutions like:

- bringing forth various new religions;
- bringing forth diversified cultural activities;
- bringing forth sciences (at one time Greek);
- bringing forth science of today;
- ….

A solution is in restoration of wisdom as an argument to examine the science, and only this is a genuine culture and an assurance for saving the mankind.

To articulate this we demonstrate the following:

Unbearable ecological ratio

(A forest ecosystem display, and its volume of biomass per hectare.)

Total biomass per hectare	out of this: animal biomass per hectare
A) In undisturbed nature:	
NATURAL ↗1,000–1,500 metric ton/ha	**↓ 5–10 metric ton/ha**
= 100%	**= 5–10‰ (of total)**
B) In the 'economy-landscape' of the present day	
TODAY'S ↓forest 200–300 metric ton/ha	**↑ !**
	= 5–10% (of total)
	= 6 billion people **= 2 billion livestock** **= ? billion the rest**
A warning for presented situation: **1. The end of wild liberalism** **2. Sobering up and development of true culture**	

Some additional explanations regarding natural conditions.

Relation VEGETATION BIOMASS **:** ANIMAL AND HUMAN PROTEINS is unprecedented and greatly modified, and as such is causing unpredictable disturbances. This can be avoided by a systematic development of true culture, such as the development of close to nature forestry.

Remark: A wise Greek proverb: "There is none who would not lick one's fingers if stuck in honey." (This is a human being.)

These kinds of occurrences are evident in nature. But nature has secret remedies to cure such incidents. In contrast to a phoney human society, which has gone savage, nature has 'decided' to eliminate the present human being.

2 The future development of discovering paths of close to nature forestry, and 'infectious' entireness

A glance to the past history was necessary in order to comprehend successes of the present day situation, and to outline future creation and development of a 'healthier' approach towards man's cohabitation with the natural environment.

There would be no present state of restored Slovene forests if there were no fundamental turning in the field of forest management in the second half of the 20th century. In this period a cognition matured (i.e. how a man has transformed into an alien body – 'detached' from the Earth), and what is the meaning of this? A development of modern science led to piracy of nature's 'patents', or to not-verified discoveries! The discoveries, that ought to be thoroughly verified in order to obtain the wisdom, which is the only assurance for a rewarding development of **man in harmony with nature**. But this is not happening, and therefore the distance between man and nature is becoming larger and larger, and man is more and more an endangered being. Because of this there is not too much to say: "Back to nature, otherwise we shall perish!" To successfully avoid this critical state, among other things, we need a forest in our environment – a real fundamental nature, a true third University. The Slovene forestry is taking the right direction, which was already stipulated, although there still are some devious steps (e.g. corn-fields and similar plundering manifestations in agriculture); a cocky human on the Earth stripped of forests, etc.

Remark: In Europe there are only 30% of forests of some sort left.

Experiences we have obtained on this long way of understanding the laws of nature, particularly "nature's unpredictability", are necessary for continued communication with nature. All further steps should be carefully thought of and constantly verified; described as a cognitive way which should be developed in all fields of man's activity. Therefore, the nature's forest should be used as an educational institution, a 'University nova'!

The point is to accept common philosophical foundations acquired while communicating with nature in Slovenia, with its unique ecological diversity, including the landscape from barren Karst lands up to a mountain upper tree line. This philosophy is based on old and bitter experiences obtained over hundreds of years, and on the last 50 years of a successful forest shift – back to nature.

During this period, recognition of the importance and strength of the local vs. global matured, and in this case the global is helping a lot. Therefore, let's respect the unique and rich Slovene biodiversity so that the globalisation trends will be an advantage, and not a disadvantage that is very common in the World today. Hence, promoting strength of local vs. worldwide trends of nature destruction by modern society.

Examples for this declaration in the field of forestry in Slovenia are present everywhere. Let me list some:

- the sick Norway spruce forest of Pohorje and its successful curative treatment;
- the forests of Pahernik estate and others on Pohorje alike, and their vital management;

- the forests of Postojna and Kočevje region;
- the Norway spruce forests of Pokljuka;
- the greening of the Goričko region with forests, and strengthening the region;
- the runaway from clear cutting and strip felling in the Upper Savinja valley and Koroška region;
- Kozjek and Kozjansko landscape don't need to be called this way any more (koza = goat);
- the Dolomite region with appeased torrents;
- Bela krajina region (white country after white bark of birch) transferred to green country;
- the greening of the Šaleška valley;
- etc.

Therefore, Slovenia doesn't need to repeat its history; but if it will, then it is doomed because it chooses to remain ignorant.

If we continue to manage forests successfully, we shall prosper on the whole (i.e. in revitalisation), in the strengthening and preservation of our motherland. This means that we shall grasp our forest, our homeland, and from there our total wellbeing.

How to achieve this? Within Nature's utmost creation – the forest and in the comprehension of it – lies the assurance for our successful coming down to earth (i.e. forest site sanctity).

This is a matter of real and feasible 'optimism', and away from slavery. Let us apprehend the meaning of our birth cradle – our 'vital site' with assistance of our supreme ancestor, the forest (the one, which is unique, inscrutable, modest, efficient, etc.). In 1950, we ultimately stopped plundering it entirely.

At this point, it is interesting to know how our homeland became pleasant to reside, thanks to forests, and how a forest is coming back to towns in order to cure them. Fortunately, forestry overcame agricultural diseases, like poplar and spruce plantations. However, the disease is breaking out in different forms, like excessive machine use, etc. At the same time we are talking about reforestation as a damaging factor (i.e. the process of restoring of woodlands or forests that once existed but were deforested), and an introduction of weeds as something negative, but in fact it is quite the opposite; weeds are land remedies.

Slowly a fundamental cognition is leaking out: a forest as a unique, absolute and vital education; old and everlasting wisdoms are coming back as new awareness. Among others, wood as a genuine matter of nature, etc.

Therefore, let's halt the "GREEN MISSION" and let's help the forest. The Iranians have a saying: "If I help someone, this one will help me." In this manner, a forest will help us also.

Accordingly, with forest assistance let's be optimistic – even if everything is ruined (see the Iranian saying). Stealing is a sickness that we are not conscious of. For that reason, we need more cognizant foresters; **to be conscious of forest and lecturing for the change of mankind**; in other words, beware of mankind. In our country, the privilege to reside is given to forests. A sick site has sick people, and the more preserved a natural site is, the more fulfilled life we live in.

The perception should be: Environment protection as a true culture. This requires that man's needs should be within ecological boundaries. This means, a successful road to a prospering existence of mankind on the Earth, i.e. "SIMULATING CLOSE TO NATURE FORESTRY".

And tools for this are:

We should imitate processes of natural ecosystems; e.g. forest, and should apprehend its boundaries, amplifications, flexibilities in time and space. In addition, what does it mean in other words? Let's comprehend:

- a man, a devastator;
- a man, a troublemaker;
- a man, a slayer;
- a man, a destructor, etc., or
- a man, as a true cultured being is the only guarantee for his successful and respectable survival.

What does this mean in other words?

It means, to speed up environment protection, to cultivate and direct Slovenia, with its forests, to be the model.

Let us realize that:

1. the basic global environment question should be tackled at a local management of natural values;
2. the present economy is an open system within a **closed** final ecological ecosystem. In other words, the Slovene forestry is heading to be in harmony with nature; it is the beginning of true culture, and soothing the entropy crises. In other words, a new orientation for forest management foundations, and utterly towards the philosophy of low entropy.

The techno-optimists will still follow the old ways, asking themselves: "How many sins can I commit, and still be eligible to go to Heaven?" Disputable humankind evolution triggered some consequences that produced appeasing activities, including our culture, which in fact is just a soothing bandage on man's altered psycho. The humankind alienated or removed from nature; in other words, emergence of false culture.

There is only one way to follow the law of entropy, which is to economize energy by adapting to existing natural environment conditions; in other words, becoming fused to its site. This means, we should practice low consumption, not more and faster than nature could reproduce. The genetic engineering of renewable resources should be rejected. Let us enter the natural forest, and start learning how nature is working in a minimal entropy mode.

Close to nature forestry should serve as a model for true culture, as its modest entropy is dictating close to nature development as a course of action in order to save the humankind. Slovenia is posing as a classroom in the European diversified site region. Hence, it is a forest as an ecological uniqueness, and an assurance for healthy life, and consequently a necessity to start a new upbringing and education.

The society has to think profoundly about what was told, and at the same time should recognize the unexpected events that accompany life – and moreover the responsibilities of the 6 billion human inhabitants. Then we shall understand the 'Nature's University of a Close to Nature Forest Ecosystem', which is fully equipped to face the unpredictable. On the overcrowded Earth, life in all forms is demanding that the human society understands how to be prepared for unpredictability of life, which nature's ecosystems are mastering uniquely (e.g. natural forest). Therefore, let us not be disillusioned, and make a demonstration that we are in realty a culturally grown-up society.

3 Contemplation in place of Summary

On its historic path, Slovenia was always a terribly affected country; its forests heavily plundered (with some rare exceptions). The country is situated on an interesting biogeographical – uniquely diversified – transient territory. The plundering of forests, an historically, ever present occurrence worldwide, is a result of depredatory 'entropic policies', and also affects heavily on Slovenia even today.

Some enlightening examples (e.g. Rog, Postojna, individuals, …) and similar reflections led to the discovery and development of close to nature comprehension and handling of forests, with totally positive outcomes. Particularly, with a possibility to survive efficiently, using a bio-centric philosophy and applying advancement of forestry as a symbol of true culture, which is characterized by explicit modest entropy. All said is a dictation of the close to nature path of development, and Slovenia as a school in 'the European site-variegated biosphere'. The man's demands should be aligned only within permitted ecological boundaries, as a security for man's survival on the Earth. Thus, a man as a cultured being – a true and unique guarantee for his fair survival.

What was said is drawing attention to agricultural illnesses, like different artificial plantations, 'hasty machinery', genetic engineering, etc., along with various wrong comprehensions, like reforestation of ”weeds” that are actuality not weeds. In a forest, we are attaining worldly wisdom and knowledge on ecology influencing a long-term thinking in economy and science. This is asking for healthy products, for environment friendly technology, for energy efficiency, etc. The awareness of this leads to a notion that environment protection should be managed by 'producers' and not by public servants. Today's environment protection is globally ineffective compared to global destruction, which is a global tragedy. All this is asking for a reform of taxation (ecology taxation). In short, a culture based on close to nature environment. This is an obligation, not only for Slovenia but also for the whole World.

Slovenia would be narrow-minded not to understand what forestry has done for the time yet to come, such as its first-rate contribution for the future. The future needs us, because plastics are only 'transitional trash'. A forest is a multi-functional uniqueness on an altar! Everyone should recognize this, and a new school of education should be introduced. In other words: ”healthy environment – healthy mankind – healthy creativeness”, a truthful culture as a motto and fundamental guidance.

Such considerations and conclusions bring a spontaneous need to comprehend the essence, strength and fortification of a local that automatically attracts positive influence of globalisation.

It is even more important to understand the meaning of ‘Slovene high diversity on the bio-graphical chessboard’. Therefore, understand the local in order to succeed at the global level. Inversely, disrespecting the local brings intensification of negative strength and effects of globalisation.

Therefore, attention politicians: a forest is neither a mine nor a sick farm field; but it is an elixir or life, it is a Slovene temple, our residence, our salvation, etc.

50 years of post war sobriety, and an escape from entropy of the past time deluge towards a healthy nature, or better said: on a close to nature path (i.e. nature-kind path) that demands thorough thinking and is a prerequisite for a healthy development. That is how a true culture comes into existence as a saviour for those of ‘false-culture illusions’ that are far away from nature, and are only a thin plaster on a deeply hurt human spirit.

We should follow this path with ‘a forest educator’ as an essential to new conceptions of life. No more plundering the woods and nature, but back to the forest for instructions – back to the natural formation, and a close to nature composition. In this establishment a unique and diverse life is flourishing on the humankind continent, where we live and dwell, and where we must not destroy the natural environment and its natural resources.

According to our experiences, a caution is essential when implementing scientific and technological findings, because knowledge and technology is not enough. They should be replaced by wisdom and adapted technology that acknowledge nature’s uniqueness, what is so fascinating in a forest ecosystem. This is leading us towards understanding of nature’s priorities, such as putting an end to looting nature, and to reformation of the economy. This course of action is changing today’s bureaucratic environment protection in order to take an organic waveband. Consequently, the 21st century should be a century of environment, opposing the savage economy of the previous centuries. The Slovenian forestry is ready to take these new steps. For 50 years, it has been confronting the destruction of environment, and established a friendly communication with a forest landscape. A close to nature forestry is capable of saying NO in a society filled with lies, tolerance and opportunism. Bio-strategy means a successful survival of our civilisation, because it not only considers ecology and technology, but also sociology – in other words, it ponders true culture.

4 Some concluding remarks for consideration

The society should thoroughly consider the presented views. At the same time it should envision the unpredictable that is always accompanying life, and foresee the responsibilities of 6 billion human inhabitants. Then we shall apprehend the Nature’s University, provided by the forest ecosystem that is invariably equipped to overcome the unpredictable. Therefore, let us sober up and manifest that we are a cultured and adult society of a truthful and not false culture.

At this point some statements and warnings again

- Do we want to throw away half a century of formation? No! If yes, than the responsible should appear before the Court of Law on criminal charges.
- Forestry is facing a unique, ideal and at the same time a pretentious assignment: To care for a healthy forest ..., and by that to care for our healthy environment; for further development of a real and true culture with a forest and its wood that is an indispensable part of our surroundings.
- We should understand the Virgin forest, and the facts of healthy life on Earth.
- Attention! Apprehend that unchecked patents, inaccurately copied from nature, are most disastrous!
- The awesome picture of Slovenia of yesterday should be a permanent reminder!
- There is a request for new education and tutoring.

At one time Slovene landscape was in tatters, and today it is stricken by machinery, chemicals, etc., and only naturally formed forest resists such shocks successfully. Being aware of this, some fundamental knowledge turns up – revealed by a natural forest, e.g.:

- Forestry is in a crossfire zone between ECONOMY : ECOLOGY, and who is reasonable now? Probably the Nature and its Economy.
- Priority should be given to Biological Depreciation over mechanistic forestry.
- Favouring close to nature operations will bring a fair future, and forestry can provide instructions.
- There should be a change of the exploiting economy towards a eco-social economy, i.e. abandoning maximalistic conception, and taking an optimal path towards a polifunctional forest ecosystem.
- The state officials should advocate forestry, and by this means restore water supplies, soil conditions, atmosphere, etc., and through this revitalization of health.
- Let's stop government subsidies to 'catastrophic economy'!
- Should machinery be used by forest management? YES, but only for purposes of close to nature forest management. Therefore, NO to forests that are convenient for machines, and YES to machines that are adequate for close to nature forests (= a clear call to come to our senses).
- Let's promote ecological accountancy that was applied in the past, which yielded a perfect experience, and we shall solve a series of organisational problems.
- Close to nature forestry will bring hope to solve the conflict between ecology and economy, and a discovery of multifunctional character of forests.
- Close to nature forestry over the whole surface, extended to residential area, therefore putting an end to ”fake democratic tendencies”.

- Attention! Wood, a unique Natural product, is coming back to our vigorous environment, and we should make use of it again.

Suggestion: The society should meticulously think over what was written here, considering also indicated favorable results of Slovene forestry, and additionally about unpredictability of events that accompany life – living conditions of 6 billion people on our Earth. Then we shall understand the Nature's University – the Forest Ecosystem – equipped to overcome life's unpredictability, and we should start to honour and transcribe natural values of forests; confirming this notion with our practice. The essence of this argumentation must be followed by a thorough **re-education of the Earth's human inhabitant**.

In Europe for some time, this topic is successfully emerging as a new endeavour, i.e. forest pedagogy. It is bringing forth fundamental facts about life; it is forming a completely new delivering and nature-satisfying path for the human society living close to nature. Respectively, embarking on close to nature living is a true culture. Hence, the human being in cooperation with nature and not in defiance of nature, i.e. opposing the law of entropy, since the high culture of close to nature forestry depends on the Law of **highly moderate entropy**.

Let us summarize and recapitulate

The great fundamental revolution in Slovene forestry demands cooperation with the public, and this is an essential duty of the profession and society in general. For this purpose forestry has developed special styles of planning, i.e. a footpath of small steps, and constant observation and examination.

Honouring the nature leads to the real true culture of human society. We have established a comprehension of the multifunctional forest, and an aspiration for putting it into effect. We are not conscious enough of wood functions in forests and in our residential areas, where we are constantly returning.

The profession needs its own inspectors – persons who can comprehend the essence of forest management that is a unique culture.

In Slovene forests, during the 50 years, we have studied approximately 70% of forest area (Phytoceonology) to figure out the laws of harmony between a forest stand and forest vegetation, in order to understand the uniqueness of this cohabitation, and this should be simulated by other endeavours of society.

In forestry, the transition of taking new paths necessitates a shift in each professional, and this means a fundamental personal metamorphosis – no more plundering of nature, but taking true cultured ways. A healthy forest and healthy nature lead to a healthy mind, and consequently a development of true culture and qualitative living.

The maladies forestry has contracted by mimicking agriculture and wild economy are hard to get rid of. Nevertheless, a deflection is clear and should be continued radically.

We are preparing not to lavish everything. Attention! Slovene material and intellectual investments into our forests and environment should be preserved and additionally developed at all costs, despite increasing savage civilization's 'filth'.

Moreover, all that was said and done will bring benefit in the future, and the proof is evident in the existing experiences.

Additional warnings should not bring discouragement. European forestry is experiencing already known disturbances, and this is confirming the significance of Slovene achievements. In any case, there is always a danger of disregarding the achieved, and behind this threat, there can only be a corrupt person or narrow-mindedness. The wise and sensible will follow and continue the unveiled path. The articulated and described is not a matter of theorization, but an attested practical work of experiences in Slovene forestry.

All over Slovenia, in nature and in education, there are proofs of what was said, and this is admired over all Europe. It should become a signpost for Slovene politicians, and not for political careerists with no principles, because the latter are maleficent, they strive after continuation of anthropocentric treatment of nature.

For the conclusion, a flaming parable: We should follow the represented sensitive path, otherwise we shall experience the fate of over-reproduced Norway lemmings (*Lemmus lemmus*) that are drowned in rivers and seas by Nature's own way.

And now to conclude

1. The human society is rushing towards calamity when promoting entropy that was never before as dreadful as it is today.
2. The plundering in the human society is repeating (hands in foreign pockets). Let's present how to avoid this situation with the pedagogic help of a tetrahedron. Not a triangle of two dimensions (research, education and practice) but of tree dimensions, i.e. research, education, practice and public relations.
3. Let's announce the truth on true culture (cultura nova) – putting it on the altar assisted by close to nature forest.
4. A development of a low entropy culture is the only salvation for the human being – respectively, it is a New University.
5. An interdisciplinary contact with nature should be taken as a new pedagogy.
6. In what situation we would be if we didn't start 50 years ago (or even before, e.g. in forests of Postojna region)? A scandalous Slovene desertificated landscape! Today, a model for a forest landscape that is envied by all Europe.
7. A transfer of forest wisdom also to other fields of activity.
8. An abuse of discovered and unchecked nature's patents is demanding a thorough examination on a wise man's level – otherwise scientific work will be considered as a criminal act.
9. Therefore, a cognitive approach to nature, as it was done in prehistoric times.
10. And forest tending, not as a technology, but as a paradigm (alive and dead tree as an indivisible unity) = the soul of ecology; i.e. of economy and a patent of wholeness.

5 The growing public, economists' and politicians' concern over Slovene forest, and forest landscape

The Slovene forest has never seen such revitalization before. The public is not aware of what this means. We are talking about an ecological and economical uniqueness of close to nature condition that should be admired by the whole Europe.

Let us explain the situation.

Did we ask ourselves, why nature is producing from 1,000 to 1,500 tons of biosubstance per ha in an intact forest. Is this a luxury, or is it life's necessity? Furthermore, are we aware how a forest stand and its biosubstance are uniquely and seamlessly connected and interweaved in a genuine form of successful life. The more this process is disturbed, the more the Earth is becoming denaturised, and to a greater extent nature is claiming back a forest with its rich biosubstance.

What are tons of biosubstance in a forest revealing?

- Healthy life.
- Refreshed air.
- Pure water.
- Living ground.
- In short, healthy environment, etc.

In Slovene forests, after the WWII, we put an immense care to render beck wood substance to forests. The growing stock has risen from 150 m^3/ha to 300 m^3/ha, i.e. 100% increase in forests that were cut out all over Slovenia 50 years before. At the same time, with forest tending, we took care to conform forest structure and tree species mixture to natural conditions. We place great care on forest tending to achieve better wood quality, greater stem thickness, greater structure mix of forest stands – all this to achieve an as close to nature forest as possible; a forest that is more vital and yield appealing.

Augmented tons, or better said, rendered tons of biosubstance in woods suggest an essentially better life quality of environment. In other words: a favourable impact on climate; absorption of CO_2 into wood; more effective multifunctional forest; and there are even more benefits.

A ”miracle” occurred. Throughout the history of forest plundering, there was a radical spin after the WWII, after 1951 exactly, a direction towards a sound economy that is in harmony with ”nature's economy”. Therefore, let's search for a permanent understanding between the two economies, i.e. man's and nature's economy, and there should be a notion that without a strong nature's economy there cannot be a proper man's economy.

We are asking ourselves why a man has such mistaken attitude towards forests. There are many reasons; among others, man's plundering motives, and because of forest's persistence to drive away the man from deforested land. The mankind and Nature have a constant conflict because a forest is claiming back domains that were stolen and used for man's sick civilisation. However, without a forest we cannot achieve a successful life. The presented is a ripe result of biocentric thinking that is essential for man's future prosperous existence. It is this small Slovenia and its large contribution, serving as a close to nature signpost, directing the human society that went astray. We should diminish energy squandering which is the most sinful doing of human society.

Forestry should be acknowledged for its assistance, because without a good conditioned environment there cannot be a vigorous life. The nature has created forests to fit these conditions, and such forest is not the Earth's luxurious rubbish, but it is life's necessity that was abused all along the man's evolution (i.e. plundering), and consequently was always punished by nature (worldwide).

In Slovenia a miracle occurred, i.e. a fundamental shift back to the framework of natural forest. In ecological point of view, it is quite self-evident, but it is not so looking from the perspective of man's wild economy. We do not realise what achievement it is to say "Back to a sound Slovene forest – means: something said and accomplished."

The origins of this change of direction in man's behaviour and taking a new path of harmony with nature, what must be supported systematically, constantly, universally, educationally, operationally, etc., and most of all the nature's forest and forest landscape should be discovered as a New University of Mankind, e.g.:

- Domain;
- Environment;
- Educational institution;
- Health resort;
- 'El Dorado' of residence environment.

That is why we need to present forests of Slovenia, and its 50 years of forestry, to the Slovene and European public, to point out:

- a warning;
- information;
- an instruction;
- a model;
- a diversion towards a new true quality of life, and
- a sobriety of the 'galloping technology'.

Protected forest management in Slovenia

Andrej Bončina*

Abstract

Protected forests were mostly determined by legal regulations and forest management plans. Different objectives caused forest protection (e.g. wood supply, protection functions, and military purposes). Presently, reasons for forest protection are much more related to nature conservation. In Slovenia, protection forests and special purpose forests and the forests included in national, regional or landscape parks are treated as protected forests. Protected forests in Slovenia amount to 14.1% of the total forest area. The concept of forest management planning in the protected forest areas is similar to that in multi-purpose forests. Protected forests are a classic tool in nature conservation management. However, more than the segregation approach to nature conservation, the aggregation (integral) model should be preferred, in which nature protection is built into the concept of multi-purpose management.

Key words: protected forests, protection forests, special purpose forests, forest reserves, forest management planning, multi purpose management, Slovenia

1 Introduction

Much attention has been focused on protected forests in Europe. One of the reasons for this is biodiversity conservation, which is becoming an important criterion of sustainable forest management (Anonymus, 1997; Hlad and Skoberne, 2001). Protected forests as an indicator of sustainable forest management are also the topic of discussion in Ministerial conferences on protection of forests (Dokumenti…1998; MCPFE, 2002, 2003). Within the framework of COST (European intergovernmental framework for scientific and technical co-operation), the analysis and harmonisation of the project *Protected forest areas in Europe* will be completed this year (Latham and Frank, 2005). One of the simple but important findings of the project is that categories of protected forests in Europe are extremely diverse and the reasons for protection are changing (Latham *et al*., 2005). Protected forests should not be evaluated separately from non-protected forests, which raises many questions related to protected forests: Is the division into protected and unprotected forests appropriate? Is the concept of forest reserves appropriate for nature conservation objectives? What is

* Prof. Dr. Andrej Bončina, University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources, P.O. Box 2995, 1001 Ljubljana, Slovenia
Tel. +386 1 423 1161, Fax: +386 1 257 1169, E-mail: andrej.boncina@bf.uni-lj.si

the role of protected forests for multi-purpose management? What is their importance for sustainable forest management? Why protect forests at all - for whom or against whom? How many forests should be protected?

The importance and size of protected forests in Europe varies between countries because of different natural conditions, forest area, management, as well as the political, social, and economic situation. There is a long tradition of forest management in Slovenia. One of the characteristics of Slovenian forestry compared to many other countries is the fact that foresters were some of the first nature conservationists who established the first protected forest areas. Nature conservation planning became an integral part of forest management planning (FMP, 1892).

In this paper, the history of protected forests in Slovenia is briefly presented and the current state is compared to other European countries. Further, some dilemmas concerning protected areas in general, as well the management and planning in protected areas are described.

2 Defining protected forests

The definition of protected forests or protected forest areas is not completely clear. Considering the current legislation in Slovenia, protected areas are explicitly mentioned in the Nature Conservation Act (Anonymus, 1997; Hlad and Skoberne, 2001). If such an approach is adopted, than forest reserves cannot be understood as protected forest areas at all.

The current definition of protected forests refers to forest areas with special (additional) legislative regulation adding some additional restrictions, so that forest management significantly differs from non-protected forest areas. To define protected forests in the past, a broader definition of protected forest areas was needed; some forests might be "protected" in other ways, by management plans for instance. At that time, forest and nature conservation legislation as we understand it today was absent.

3 Forest use regulation- legal acts and forest management planning

Protected forests should be evaluated in the context of the forest use management. Forest use has mostly been regulated by:

- Different legislative regulations.
- Forest management plans.

Legislative regulations are much older than forest management planning. From the beginning of forest use regulation until the present, it is evident that forest use regulation appears *mostly* in circumstances of scarcity of forest resources and willingness to conserve and improve the availability of forest resources at the same time. Wood shortage was most often the reason for forest regulation. However, it was not the only one; protection functions of forests, pasture, and water were also important reasons to regulate forests. In the cases mentioned, there were no ethical but only existential reasons for forest regulations. Forest use was regulated and some of the forests were even protected in different ways, including agreements, legal regulations and later, by forest management plans.

3.1 Legal regulations

Examples of regular forest use in Europe and Slovenia are much older than regular forest management. For instance, sacred forests from ancient Greece were a type of forest reserve where the management regime and use were regulated for religious purposes (Hughes, 1983). At the same time, some forests were protected due to their strategic value for shipbuilding. Similar examples can be found in the Roman Empire (Hughes, 1983).

A common way of regulating forest use in the Middle Ages was by agreements in small communities, where members of the community regulated the rights of forest use in community forests (Johann, 1994a). An interesting example of such regulation is the "Bannbriefen", which served as an instrument for temporary forest protection emphasising the protection role against avalanches (Shuler, 2002).

During the Middle Ages intense deforestation took place. However, in some cases, especially nearby mining operations, ironworks and larger settlements, forest use became regulated, which included protection against deforestation in some areas. Such cases are known for the Trieste region (1159, 1350, 1411), where deforestation and goat grazing were strongly prohibited (Gašperšič, 1995). Similar regulations occurred in the Tolmin and Bovec regions in Slovenia (Blaznik *et al*., 1970; Gašperšič, 1995).

From the early 15th to the beginning of the 19th century, the governing body regulated forest use in the area of present day Slovenia by declaring forest and mining orders that would ensure a permanent wood supply; the first one was the Ortenburg Order (1406). By Orders for the Istrian region (1452 and 1475), all timber was confiscated for the Venice navy, pastures were strongly restricted, and the forestry service was organized. Later, other forest orders were issued for the following regions: Istria, Furlania, and Karst (1541); Styria and Carinthia (15th and 16th cent.); the well known Teresian Order (1771); and in the time of Napoleon, the Order for the Illyrian Province (1810) was declared (Anko, 1985; Gašperšič, 1995).

Forest inquirers (Ger. Waldbereiters) were a further step from forest use governed by legal regulations toward an active and regular forest management (Johann, 1994b); they also prevented deforestation of the forest area.

3.2 Regular forest management

Regular forest management includes active forest management. The beginning of active management was largely dependent on natural sciences and the advancement of science and the education system, and predominantly by the changing economic situation. The first management plans, such as those for the Idrija mining forests in the 18th and 19th century, were not obligatory, but were simply introduced by the need to ensure a sustainable and economical wood supply for the mine. Similar examples are known from the end of the 19th century for larger private properties, where regular forest management was spontaneously organized. Forest management planning was later influenced by forest policy. Between World War I and II, forest management plans were obligatory for all private forest properties larger than 300 ha. Presently, forest management plans are made for the whole forest area in Slovenia and are financed by state. The management plans are an instrument for guiding the three fundamental principles of forest management in Slovenia: sustainability, multi-purpose management, and nature-based forestry.

4 Some characteristics of protected forest areas in Slovenia

Regulations of forest use differ between Slovenian regions due to various natural, political, and economic factors. The Primorje region was deforested around 1000 C.E., whereas in the nearby Dinaric mountain forest region, virgin forests existed for as long as only 50 years ago. At the beginning of forest use regulation, several acts tried to protect forests, and later forest policy and forest management planning were developed. Several important milestones are worthy of attention during the development of forest protection.

4.1 Some milestones in the development of forest protection in Slovenia:

- Several documents (i.e. Annex to Ortenburg Forest Order from 1614) show that some forests were legally protected because of their defence role against Turkish attacks (Mohorič, 1958). "*The Commission sentence about protection forests was of special importance. Cutting was strongly prohibited in those forests. Such important forests were located near Prerigelj, Knežja Lipa, Nemška Loka, Svetli potok, Kumrova vas, Hrib and Tanča Gorica. Protected forests were also situated near Rajhenav, Novi Breg, Trnovec, Šalka vas, Cvišlerji, Oneška gmajna. The priest in Mozelj draw the servants' attention to not forget the prohibition of cutting from the pulpit, reading the regulation every Ember days. On the 12th of January 1614, Commission prohibited cutting trees in Skorten forest, where only guards against Turks were eligible to cut trees for signal-fires.*"
- The Forest Act from 1852 introduced the category of protection forest. Criteria for designation of protection forests have been changing up until the present (Bončina, 2005), and so has the total area of protection forests (Žumer, 1976; Anko *et al*., 1985; Anko, 1987).
- In 1892 Leopold Hufnagl, known as the pioneer of uneven-aged forest management (*Plenterung*) in Slovenia, decided that some sub-compartments should be preserved as virgin forest. These writings are found in the part of the management plans called "Stand descriptions", where the site and stand characteristics were described. The reasons for his decision are not quite clear, but likely had to do with nature conservation; this hypothesis is later confirmed by management plans issued in the next decades, where original virgin forest remnants remained untouched once more.
- In some older FMPs, such as the FMP Friedrichstein made by Hufnagel (1892), "protection forests" were mentioned. No measures were planned for these forests.
- Heinrich Schollmayer is known as the author of the "Postojna control method" (Mlinšek, 1972; Gašperšič, 1995). In his forest management plan a management class for protection forests was determined (FMP, 1906).

- In 1920, the Memorandum of The Section for Nature Monuments Conservation was issued (Skoberne, 1995), giving the proposals to conserve natural heritage. It suggested that new parks are to be established, endangered species are to be protected, and to make the public aware of nature conservation. Larger forest areas and special trees should be protected.
- In 1944, during WW II the inventory of natural heritage conservation was made, where protected forests were mentioned in connection to proposed parks, virgin forests, monument trees, and mountain pine vegetation, etc. (Šivic, 1944).
- After WW II, nature conservation areas were regulated through numerous legislative regulations. In 1962, the first Survey of natural heritage was published, which also included some forests as forest natural heritage, tree natural heritage, and parks.
- In the late 1970s, the forest reserves network was improved by the action of the Forest Faculty and Forest Institute. Many new reserves were established with respect to particular factors, such as forest associations, secondly naturalness, and research goals. The total number of 173 forest reserves encompassing approx. 9,000 ha was protected.
- In 1985 the Forest Act divided protected forests into two categories: protection forests and special purpose forests (e.g. urban forests, hydrologically important forest areas, research areas, etc.).
- The Environment Protection Act (1993) and Nature Conservation Act (1999) were passed. In 2001, the Strategy of conservation of biodiversity in Slovenia was published, thus affirming nature-based forestry in Slovenia. In 2004, full transposition and implementation of the Habitats Directive and the Birds Directive was achieved.

5 Protected forests in Slovenia: the situation and comparison to Europe

Some forest areas defined by the Forest Act and the Nature Conservation Act are treated as protected forests in Slovenia.

Table 1: Land areas of the main forest categories in Slovenia (according to Decree, 2005)

Forest categories	Forest area (ha)	% of total forest area
Total forest area[1]	1,169,196	100.0%
Protection forests[2]	100,570	8.6%
Special purpose forests	60,752	5.2%
- with interventions[3]	(50,960)*	(4.4%)
- no interventions[2]	**9,792**	(0.8%)

[1] ZGS 2006

[2] Uredba…(Ur.l.RS št. 88/2005)

[3] Data from 2001 (ZGS, Veselič and Matijašič, 2002)

5.1 Protection forests

All forests fulfil some protection functions, but there are particular differences between them according to vulnerability, scarcity, ecological importance, and site conditions. Legally, forests are classified as protection forests mostly where extreme site conditions are present or when extraordinary environment values are present (habitats, etc.). Among the current protection forests, those with extreme site conditions prevail (Uredba…2005). When compared with other countries, one might wonder about the concept of protection forest designation in Slovenia. In the majority of others countries (FAO, 2000; Latham *et al*., 2005), forests are classified as protection forests when protecting infrastructure and settlements. In Slovenia, forests with such a protection function cover only 0.3% of the total forest area.

Protection forests cover around 9% of the total forest area (Table 1). However, because of different criteria used in defining protection forests, it was difficult to compare data between countries. For example, in Austria 19% and 8% are mentioned, in Switzerland 25%, and in Norway 13% (FAO, 2000; Latham *et al*., 2005).

Because of the important function of protection forest, as well as the extreme natural conditions in these areas, active intervention in protection forests is quite limited. When carrying out planning and management in the protection forests, one should respect the concept of multi-purpose management; three main possibilities of forest management are possible:

- It is necessary to implement some measures which conserve and / or improve the desired forest functions.
- It is allowable to carry out some measures which support some forest use (e.g. wood supply, hunting, habitats) and do not endanger protection functions.
- No active intervention is allowed.

Protection forests are in most cases protected in the sense of spatial land use categories; no deforestation is allowed. Despite the current criteria, many declared protection forests have not been endangered because they are inaccessible or far away from human activity. Then again, many forests with higher environmental values, which are potentially endangered due to human activities, are not declared as protection forests.

5.2 Special purpose forests

There are two categories of the special purpose forests (SPF).

- SPF with no intervention (forest reserves).
- SPF where interventions are allowed.

Forest reserves are ecosystems left to natural development. The first reserves were established in 1892 (FMP, 1892; Hartman, 1999; Bončina, 2005), and in the 1970s the forests reserve network was expanded to a total number of 173 reserves equalling an area of 9040 ha (Anko *et al*., 1976; Mlinšek, 1980; Diaci, 1999a,b). In 2005, another regulation concerning forest reserves was passed, increasing their number to 186 reserves totalling 9,762 ha, which represents around 1% of the total forest area in Slovenia (Table 1).

A stricter regime of management compared to protection forests is typical for this category. No measures that could hinder natural development of forest vegetation are permitted.

Compared to other European countries, the area of strict forest reserves in general is quite small in Slovenia, amounting to around 1% of total forest area (Table 2). Data from 2005 indicate an enlargement of forest reserve areas in some European countries. However, the difference could be explained by different categories – strict and non-strict reserves (Table 2).

Table 2: The area of forests reserves in other European countries

Country	The area of strict forest reserves (% of total forest area)[1]	The area of forest reserves (% of total forest area)[2]
Austria	0.2	3.6
Belgium	0.3	0.9
Bulgaria		2.3
Croatia	0.2	
Czech Republic	1.0	1.0
Denmark	1.1	
Finland	5.9	0.3
France	0.1	0.3
Germany	0.2	0.3
Greece	4.2	
Hungary	0.2	
Lithuania		1.6
Nederlands	0.6	1.0
Norway	1.7	0.6
Poland		0.7
Slovakia	0.8	
Slovenia	0.9	0.9
Sweden		3.9
Switzerland	0.1	2.2

[1] Strict forest reserves according to Parviainen *et al.* (1999)
[2] Forest reserves (Latham *et al.*, 2005)

The following issues are relevant to the forest reserve network in Slovenia:

- The problem of representativeness; there are more reserves in the mountain vegetation belt, while sites from the sub-mountain and hill belts are fewer in number.
- Forest reserves are important reference objects for close to nature management; therefore more research is needed. Most research was carried out by the Chair of Silviculture, and virgin forest reserves received the most attention. However, there are many reserves that have not yet been included into research.
- Forest reserves are also an important tool to promote sustainable forest man-

agement and to cooperate with the public. Thus far, infrastructure in the reserves is deficient, and publications concerning forest reserves are lacking.

- Forest reserves should be suitably included in the content of new forest management plans; adapted forest inventories and monitoring of forest reserves is needed.
- The forest reserve network should be analysed and enlarged.

The SPF where measures are allowed can also be treated as protected forest areas. In that case they are protected as land use categories. Urban forests are a typical example of such forests (Hostnik, 2003).

5.3 Forests and protected areas according to the Nature Protection Act

The nature conservation Act defines *smaller* and *larger protected areas*. The following areas are included within smaller protected areas: natural monuments, strict nature reserves, and nature reserves. National, regional, and landscape parks belong to the larger protected areas (Table 3). Within Slovenia, there is one national park, two regional parks, and 40 landscape parks, which make up 4,1%, 1%, and 5,5% of the total land area, respectively (Table 3). Forests included within these parks can be additionally separated into categories, such as special purpose forest with intervention, protection forests, and forest reserves (Figure 1).

Table 3: Protected areas in Slovenia - situation in 2005 (http://www.sigov.si/mop/)

Category	IUCN	Number	Area (ha)
National park	II / V	1	83,808
Regional park	V / III	2	21,166
Landscape park	V	40	111,533
Nature reserve	I / IV	49	*
Natural monument	III	623	*
Sum			216,507

*no accurate data available

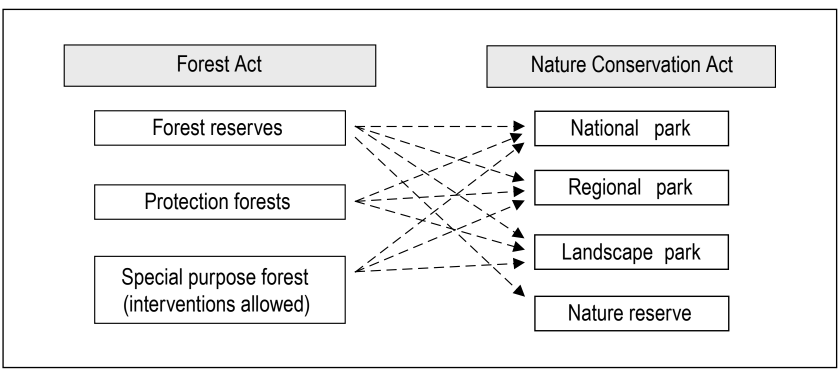


Figure 1: Categories of protected forests and possible overlapping between them

6 Comparison of the extent of protected forests to other European countries

With the aforementioned categories in mind, 14.1% of the total forest area in Slovenia are protected forests (Bončina, 2005). There are significant differences in the amount of protected forests between various European countries. However, data concerning protected forest areas in different countries are very diverse (Figure 2); they would be even more diverse if some of the following references were taken into account (e.g. Parviainen *et al*., 1991; Latham *et al*., 2005). Reasons for variation in the reported data are due to differences in the following factors:

- criteria of definition of protected forests;
- data sources;
- period of the reporting;
- definition of forests, influencing the share of protected forests;
- reporters;
- understanding of protected forest areas.

Data on protected forests between countries cannot be compared without restraints. IUCN and MCPFE categories attempt to harmonize different categories of protected forests, although an understanding of these categories is subject to interpretation. The Cost Action E27 brings some suggestions to harmonize categories of protected forest areas.

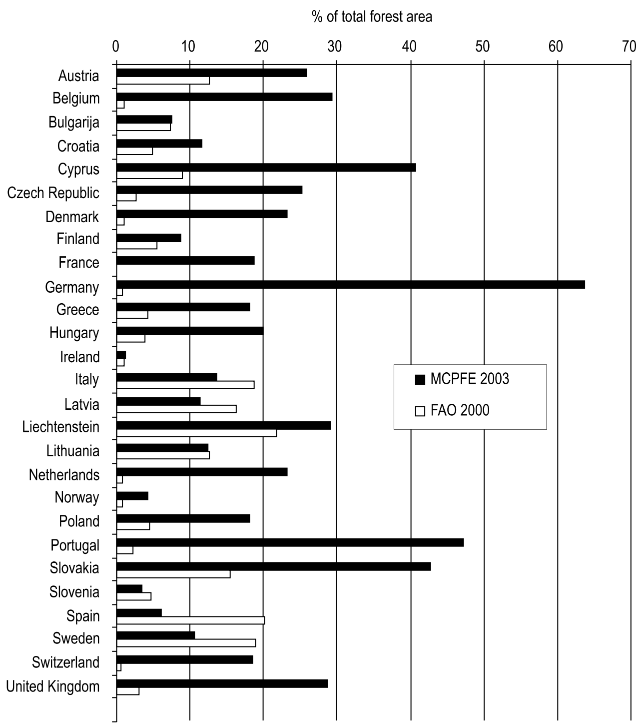


Figure 2: Protected forest areas in some European countries (source: MCPFE 2003 and FAO 2000)

7 Criteria of definition of protected forests

The criteria for defining categories of protected forests vary. They are partially related to the characteristics of forest ecosystems, but in most cases human values were also present. They differ among individuals; therefore, opinions concerning protected forests along with criteria for their designation differ among members of society.

Criteria are not absolute categories; protected forests areas are always evaluated in regard to something. What is common, rare, or preserved depends on a broader area. For example, a species might be rare in one area could be common in another.

Most of the criteria are related to sustainable forest management, especially to its ecological components. Management goals can also be important as criteria for designation of protected forest area; the local community can recognize protected forests as an important part (advantage) of sustainable development of their region.

Table 4: Expert assessment of criteria for definition of protected forests and areas (● = very important, o = important, - = less important)

Criteria	PF	FR	SPFi	NP	RP	LP	NR
Representation	-	●	-	o	●	●	o
Rarity	-	●	o	●	o	o	●
The level of preservation	o	●	●	●	●	o	●
Typicalness	o	o	o	o	o	●	o
Complexity	-	-	o	●	●	o	o
Diversity of natural phenomena	o	●	o	●	●	o	●
Intactness of forest sites and stands	o	●	o	o	-	-	●
Endangerdness	o	o	o	o	o	o	●
Vulnerability	●	o	o	●	o	o	●
Special goals	●	o	●	o	●	●	o
Interests of local community	o	-	●	o	●	●	o
Characteristic	-	o	o	o	●	●	o
Exceptionality	-	o	o	●	o	o	●

Abbreviations: Protection forest (PF), Forest Reserve (FR), Special purpose forest with intervention (SPFi), National Park (NP), Regional Park (RP), Landscape Park (LP), Nature Reserve (NR).

Why protect the forests at all? The reasons for forest protection have changed throughout history (Chap. 3 and 4). In recent times, protected areas are understood as an important instrument of nature protection (Table 4). However, some different reasons and impulses can be important:

- The concept of forest management (e.g. nature based forestry vs. clear-cutting forestry) in general influences the extent of protected forests.
- The important background for forest protection could be the fear of the future – the fear of social and economic development. In general, people do not trust in the future, capital, and institutions.
- An important impulse for forest protection can be private initiative and inter-

ests of target groups, which become recognized through protected areas; they promote and assert themselves by protection of the forest areas. Professional advantages of individuals, groups, and institutions could also be an important reason; they can assure themselves the employment and revenues when taking new responsibilities and/or competence concerning management of protected areas.

8 Planning and management in protected areas

The concept of forests management planning in protected forest areas is similar to that in multi-purpose forests (Figure 3), for there are always more management goals in the protected forests. The planning process has to be adapted to management goals, which define the purpose of the forest and influence the selection of operational goals (e.g. silviculture) and measures. The management goals (protected areas) influence on the inventory concept, management controlling, and assessment of efficiency.

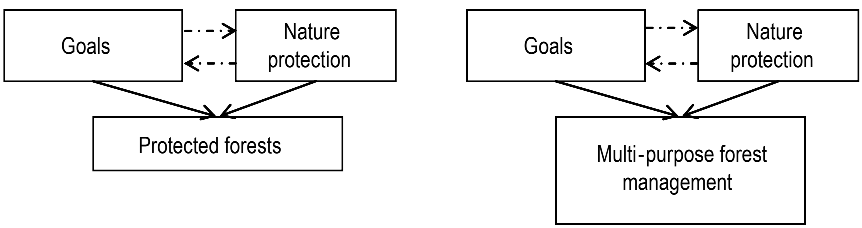


Figure 3: Protected forests in multi-purpose forest management

There are three different possibilities when selecting management measures in accordance to goals of the protected forests:

- Changed management goals do not require additional special measures nor modification of the current close to nature management.
- Additional measures are required.
- Restrictions are needed.

Besides planned activities, other instruments are necessary for supporting the implementation, (e.g. subsidies, compensations and other financial tools) enabling realization of additional measures or restrictions in private forests. In protected forests, measures are determined for conservation and improving those forest services, which were the reason for protection in the first place. Additionally, various other measures, which support some other management goals, are allowed in the protected forests. In forest reserves, question concerning research, access and informing are important. These objects are important for the promotion of forests and forestry. In SPF with intervention (e.g. urban forests), intense management is usually needed. When planning in protected areas, elements of multi-purpose management should be emphasized (Bončina, 2005), such as integral planning, modern planning concept, participatory approach and cooperation with forest owners.

9 Discussion: segregation or aggregation?

To understand protected forests the following statements are important:

- The role and definition of protected forests depends on the time period and actual economic and political situation.
- The definition of protected forests in a particular country depends on the concept of forest management in general. The management regime in protected forests in one country might be less restrictive than in "unprotected forests" in another country.
- When evaluating protected forest in different time periods, we notice that reasons and purposes for forest preservation were different.

Different examples of protected forests from the past show that different objectives were the reasons for protection (e.g. wood supply, protection function, and military purposes). Therefore, they represented an example of multi-purpose forest management. Contemporary reasons for forest protection are much more related to nature protection, which is a constituent part of sustainable forest management. Close to nature forest management is one of the most appropriate approaches for active nature conservation.

Protected forests are a classic tool in nature conservation management. Protected forests may be more important in the case when forest management outside of protected forests is not nature-friendly. On the contrary, the importance of protected forests is relatively lower for nature conservation issues when close to nature management is adopted in non-protected forests.

In Slovenian forestry, the elements of close to nature management are present from the beginning of regular forest management. Although the management goal of maximum forest profit in Auersperg's forest estate, the well known forester Leopold Hufnagl (1892, 1893), tried to reach the goal more then hundred years ago by uneven-aged forest management, which is much closer to natural processes compared to the clear-cut system, which prevailed at that time. There is a dilemma about the importance of Hufnagl's work for nature conservation. Was he more important for nature protection because he established forest reserves, or was his decision to use uneven-aged forest management in a huge forest area more important? Clearly, a combination of both is the most suitable approach. In my opinion, however, close to nature forest management is even more important because it includes aspects of nature conservation into forest management activities on the whole area. Without a doubt, forest reserves are still needed, but they are not compensation for poor management decisions made in managed forests. They are an important part of close to nature forestry, serving as research sites to study reference conditions and natural processes, and also as special habitats. Therefore, the forest reserve network in Slovenia should be enlarged.

In general, the aggregation model should be preferred in forestry (Bončina, 2005), which considers the ecological, economic, and social components of sustainable forest management at the same time and place. This approach is more challenging because finding suitable measures in the same forest area, reaching compromises, and consulting forest owners present many difficulties. The segregation approach is more simple; in some forests the economic functions are maximized, while in others the social or ecological functions are stressed. In many countries, the segregation concept is established, where nature protection is limited mostly to protected areas, mostly in public forest areas.

According to some predictions, the area of protected forests in Europe will probably increase (Naaburs *et al*., 2003). Current trends show that an integral approach in which nature protection is built into the concept of multi-purpose management is needed.

The concept of nature-based forestry is an important part of Slovenia. Many foresters have contributed to this; among them Prof. Mlinšek considerably. Forestry should be a synonym for active nature conservation. The current state of Slovenian forests if compared to other European forests confirms this (FAO, 2000).

References

Anko, B., Mlinšek, D., Robič, D., 1976. Instructions for formation, equipment and maintenance of forest reserves in Slovenia, Yugoslavia. XVI IUFRO World Congress, Oslo, pp. 24.

Anko, B., (Ed.) 1985. Pomen zgodovinske perspektive v gozdarstvu, BF, Oddelek za gozdarstvo, Ljubljana.

Anko, B., 1987. (Ed.) Varovalnost gozda v Sloveniji. Zbornik republiškega seminarja. BF, Oddelek za gozdarstvo, Ljubljana.

Anko, B., 1993. Development of the idea of sustained yield in Slovenia. An outline. News of forest history, 18/19, 2–11.

Anko, B., Golob, A., Smole, I., 1985. Varovalni gozdovi v Sloveniji. Stanje po popisu 1980. BF, Oddelek za gozdarstvo, Ljubljana, pp. 117.

Anonymus, 1997. Convention of biological diversity. National report of the Republic of Slovenia. Ministry of the Environment and Physical Planning. State Authority for Nature Conservation, Ljubljana.

Blaznik, P., Grafenauer B., Vilfan, P., 1970. (Eds.) Gospodarska in družbena zgodovina Slovencev. Zgodovina agrarnih panog. Slovenska akademija znanosti in umetnosti. Državna založba Slovenije, pp. 651.

Bončina, A., 2005. Country Report Slovenia. Protected Forest Areas in Europe – Analyses and Harmonisation (PROFOR): Reports of Signatory States. Federal Research and Training Centre for Forests, Natural Hazards and Landscape, BFW, Vienna, Austria, 325–337.

Bončina, A., 2005. Nekateri vidiki načrtovanja mnogonamenskega gospodarjenja z gozdovi. GozdV 63, pp. 299–312.

Diaci, J., 1999a. (Ed.) Virgin forests and forest reserves in Central and East European countries. Department of Forestry and Renewable Forest Resources, Biotechnical Faculty, Ljubljana, pp. 171.

Diaci, J., 1999b. Slovenia. In: research in forest reserves and natural forests in European countries. Country reports for the Cost Action E4: forest reserves research network (Eds.: Parviainen, J., Little, J., Doyle, M., O'Sullivan, A., Kettunen, M., Korhonen, M.) Efi Proceedings 16, 225–231.

FAO 2000. Forest Resources of Europe, Cis, North America, Australia, Japan and New Zealand. UN-ECE/FAO Contribution to the Global Forest Resources Assessment 2000. Geneva timber and forest study papers 17, United nations, Geneva, New York, pp. 445.

FMP 1912. Betriebseinrichtung für das Dezennium 1912–1921. Reviere Schneeberg, Leskova dolina, Masun, Georgstal. Fideikomissherrschaft Schneeberg.

FMP 1892. Wirtschaftsplan der Betriebsklasse I, Göttenitzer Gebirge. Kocevje.

FMP 1893a. Wirtschaftsplan der Betriebsklasse II, Fridriechstein. Kocevje.

Gašperšič, F., 1995. Gozdnogospodarsko načrtovanje v sonaravnem ravnanju z gozdovi. BF, Oddelek za gozdarstvo, pp. 403.

Hartman, T., 1992. Sto let varovanja pragozdov na Slovenskem (*100 Year Anniversary of Virgin Forest Protection in Slovenia*). Dolenjski zbornik, Novo Mesto, pp. 109–116.

Hlad, B., Skoberne, P., 2001. (Eds.) Pregled stanja biotske raznovrstnosti in krajinske pestrosti v Sloveniji, Ministrstvo za okolje in prostor, Agencija Republike Slovenije za okolje, Ljubljana.

Hostnik, R., 2004. Izkušnje z javnostmi na primeru celjskih primestnih gozdov - dosedanje delo, stanje, perspektive. V: Participacija v gozdarskem načrtovanju. Bončina A. (Ur.). Ljubljana, Biotehniška fakulteta, Oddelek za gozdarstvo in obnovljive gozdne vire.

Hughes, J.D., 1983. Sacred groves: the groves, forest protection, and sustained yield in the ancient world. History of sustained-yield forestry: a symposium (Steen, H.K., ed.). Western Forestry Center, Portland, Oregon. IUFRO (S6.07), pp. 331–343.

Johann, E., 1994a. Weistümer. In: Österreichs Wald. Von Urwald zur Waldwirtschaft. Österreichischer Forstverein, Wien, pp. 157–162.

Johann, E., 1994b. Waldbereitungen - Vorläufer der Forsteinrichtung. In: Österreichs Wald. Von Urwald zur Waldwirtschaft. Österreichischer Forstverein, Wien, pp. 208–222.

Latham, J., Frank, G., 2005. Cost Action E27, Protected Forest Areas in Europe – Analyses and Harmonisation (PROFOR): Reports of Signatory States – An Introduction. Federal Research and Training Centre for Forests, Natural Hazards and Landscape, BFW, Vienna, Austria, pp. 1–5.

Latham, J., Frank, G., Fahy, O., Kirby, K., Miller, H., Stiven, R., 2005. (Eds.) Protected Forest Areas in Europe – Analyses and Harmonisation (PROFOR): Reports of Signatory States. Federal Research and Training Centre for Forests, Natural Hazards and Landscape, BFW, Vienna, Austria, pp. 413.

MCPFE 2002. Improved Pan European Indicators of Sustainable Forest Management as adopted by the MCPFE Expert level meeting 7–8. Vienna. Liaison Unit, pp. 7.

MCPFE 2003. State of Europe's Forests 2003. The MCPFE report on Sustainable Forest Management in Europe. MCPFE Liaison Unit Vienna and UN-ECE/FAO. Vienna, pp. 126.

Mlinšek, D., 1972. Ein Beitrag zur Entdeckung der Postojna Kontrollmethode in Slowenien. Forstwissenschaftliches Centralblat 4, pp. 291–296.

Mlinšek, D., 1980. Gozdni rezervati v Sloveniji, Ljubljana, BF-IGLG, pp. 414.

Mohorič, I., 1958. Industrijsko odpiranje in izkoriščanje kočevskih gozdov. Mscr, pp. 147.

Mop 2002. Biodiversity conservation strategy of Slovenia. Ministry of the Environment and Spatial Planning, Ljubljana.

Nabuurs, *et al*., 2003. Development of European forests until 2050 : a projection of forest resources and forest management in thirty countries. - Leiden, Boston : Brill. European forest institute research report 15, pp. 242.

Schuler, A., 2002. Historični vidiki gozdarskega načrtovanja na primeru Švice. ZbGL 66, 203–219.

Šivic, A., 1944. Domovinski prirodni spomeniki. Prirodoslovna izvestja 1, 189–197.

Skoberne, P., 1995. (Ed.) 75 let Spomenice Odseka za varstvo prirode in prirodnih spomenikov v Sloveniji. (Seventy-five Years after the Memorandum of the Section for Nature and Natural Monuments Conservation at the Slovene Museum Society), Ljubljana.

Uredba o varovalnih gozdovih in gozdovih s posebnim namenom, Ur.l.RS št. 88/2005.

Veselič, Z., Matijašič, D., 2002. Gozdnogospodarski načrti gozdnogospodarskih območij za obdobje 2001–2010. Gozdarski Vestnik 10, 461–489.

ZGS, 2006. Poročilo Zavoda za gozdove Slovenije o gozdovih za leto 2005. Ljubljana.

Žumer, L., 1976. Delež gozdov v slovenskem prostoru. Strokovna in znanstvena dela 50.

Direktiva o habitatih »Directive in the Conservation of Natural Habitats and of Wild Fauna and Flora – the Habitat Directive – 92/43/EEC, 1992.

Direktiva o pticah »Directive on the Conservation of Wild Birds – The Bird Directive« – 79/409/EEC, 1979.

Dokumenti 1998. Dokumenti vseevropskega procesa o varovanju gozdov v Evropi. Ministrstvo za kmetijstvo, gozdarstvo in prehrano. Ljubljana.

Krajčič, D., Tomažič, M., 2005. Mesto gozdarskega načrtovanja v okviru prostorskih in naravovarstvenih direktiv EU. GozdV 7–8, 291–298.

Zakon o gozdovih (ZG), Ur.l. RS, št. 30/93.

Zakon o ohranjanju narave (ZON-UPB2), Ur.l. RS, št. 96/2004.

http://www.arso.gov.si

http://www.zgs.gov.si/

http://www.sigov.si/tnp/

Nature-based silviculture in Slovenia: origins, development and future trends

Jurij Diaci*

Abstract

Nature-based silviculture commenced in different locations around Europe at the same time as traditional silviculture. However, it was only practised in scattered regions until the present time, although it experienced some periods of prosperity. Currently, we are facing a general support for sustainable forest management by European societies. Nevertheless, nature-based silviculture is endangered more than ever by the global market and a trend toward total preservation of large forest areas in Europe. Forestry in Slovenia significantly contributed to the European movement of nature-based silviculture, as it shares similar history. The purpose of this paper is to explore the origins and development of nature-based silviculture in Slovenia, to expose contemporary silvicultural problems, to anticipate future development, and to underline the needed counter-measures and guidelines for successful development and expansion.

The historical impulses for development of nature-based forestry in Slovenia are: (1) negative experiences, such as the bare Karst area, deforested Alpine regions with frequent natural catastrophes, degraded private forests, and also (2) positive experiences, including the successful afforestation of the Karst, and selection forestry practised by some farmers and landowners of large estates. The man success was achieved after the second world war with the prohibition of the clear cut system and introduction of the control-method with a selection system for all forests. Later, the irregular shelterwood system and silvicultural planning were implemented, and finally the original free style silvicultural technique was developed.

The main contemporary problems of silviculture in Slovenia, such as the decrease in forest tending and decreased interest in regular management, are similar to those in neighbouring countries. Still, the problems in Slovenia are partially also due to the abrupt organisational changes in the forestry sector during the last decade. To overcome these problems, action in the following fields of silviculture are needed: (1) more research on natural processes and their application in silviculture; (2) optimisation and rationalisation of silvicultural models; (3) a greater flexibility and adaptation to the market, with an increased number of products; introduction of a Central European forest products trademark; and (4) diversification of silvicultural aims and measures,

* Prof. Dr. Jurij Diaci, University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources, P.O. Box 2995, 1001 Ljubljana, Slovenia
Tel. +386 1 256 7991, Fax: +386 1 257 1169, E-mail: jurij.diaci@bf.uni-lj.si

which would enable adaptation to the shift in general interactions between forest and society, such as in urban, recreational, and protection forests. Yet the main change has to be done in the art of thinking. In both education and practice foresters have to supplement well developed forest surveillance patterns with entrepreneurial spirit in managing forest ecosystems for producing environmental friendly goods and healthy supporting services.

Key words: nature-based silviculture, origins, contemporary silvicultural problems, forest tending, future silvicultural models

1 Origins of nature-based silviculture in Slovenia

The origins and further development of nature-based silviculture in Slovenia can be divided into four periods: (1) the preparatory period, which lasted until the late 19th century; (2) the period from the late 19th century until the end of the second world war; (3) the period after the second world war and until the beginning of 90s; and (4) the period from the beginning of the 90s until the present.

In the first - preparatory period, negative as well as positive impulses, which initiated the development of nature-based silviculture, can be found. The negative impulses include a completely bare and degraded Karst area above the Adriatic coast, deforested Alps with Norway spruce plantations along with recurring natural catastrophes, and degraded overcut private forests. Still, there were also many positive incentives, such as the first successful afforestation of the Karst, the first important management plans (e.g. for Trnovski gozd), and the conservative single tree selection management practised by some farmers and landowners of larger estates (Mlinšek, 1965, 1993). Within the first period we will focus on the farmers conservative selection management, which has often been neglected. This type of management was often disregarded by the administration and the official forestry, since it produced many overcut forests with regeneration - the so called green "scenery". If practised in the long term it could also lead to genetic degradation of tree populations (Mlinšek, 1981). It was characterized by periods of growing stock accumulation and periods of heavy cutting, sometimes even diameter harvest of everything below e.g. 7 inches (17.8 cm) in dbh. However, there were also many examples of conservative, careful management that created interesting forest structures, which were admired by foresters and the general public. We can demonstrate this with a closer examination of selected important silviculturists from Europe and Slovenia from the same and following periods. It is very likely that Gournaud and deLiocourt were favourably impressed by unevenaged, selection forests in the French region of Franche-Comte when they developed, first the control (permanent monitoring) method, and second the method of constructing the normal diameter distribution in a selection forest (the reverse J shaped curve). The same is true for Biolley or Balsiger in Switzerland (Schütz, 1986), and some decades later for Pahernik (Sušek, 2005) or Pogačnik (Gašperšič, 1995) in Slovenia. For example, Pahernik studied in Austria and acquired practical experiences in the Czech part of the Austro-Hungarian monarchy, both in countries with a pronounced tradition of the German forestry school, yet he decided after returning to his home estate to continue and upgrade the selection system of management. It can be presumed that his decision was influenced by the forest images he was surrounded with in his youth. The story from Mislinja, on south side of the Pohorje Mountains is considerably different (Fig. 1). Farmer selection forests probably also influenced Schollmayer and Hufnagl in Slovenia.

Figure 1: Sharp difference in forest management between the south and north slopes of the Pohorje Mountains at the beginning of the twentieth century. Left: A regular clear cur system with planting in large ownership forests in Mislinja. Right: A single tree selection system as practised at the same time in small family forests and some mid-sized owners on the north slopes of Pohorje (e.g. Pahernik, Pogačnik). Photo: archive of Slovenian Forest Service - Regional Unit Slovenj Gradec

Besides selection forestry in farm and family forests, we should also bring up the role of single tree selection in the first management plans for large estates. These plans introduced, in spite of the prevalent German forestry school, varied management within forests, such as even-age management in production forests and a single tree selection system in forests with important protection functions in the Tolmin and Nazarje forest regions.

The second period (late 19th century until the end of the second world war) was initiated by the decree of the Austro-Hungarian government concerning the obligatory management plans for forests of all large property owners. The forest management plans for the Kočevje and Postojna forests introduced selection management on large forest areas, an autochthonous control method in Postojna was developed (Mlinšek, 1972), and the first statements about protection of virgin forests were written (Hartman, 1999). Also, on the Pohorje Mountains, Pogačnik developed a model of the control method and Pahernik applied selection management. Between both World Wars, the first Yugoslavian government issued a decree prohibiting large-scale clear-cut management.

However, the main success was achieved by the generation of foresters of the third period - after the second World War until the beginning of the 90s. They were successful in the total prohibition of the clear-cut system by the law from 1948/49. Furthermore, regular inventories and management plans for all the forests in Slovenia were introduced. The selection system with natural regeneration was implemented on the entire forest area and the control method was applied as the fundamental forest management tool. With the decree concerning the underplanting of noble hardwoods issued by the Ministry for Agriculture and Forestry in the beginning of fifties, an era of active transformation of Norway spruce monocultures started. Three important works followed: the management plan for the Mislinja forests (Mlinšek, 1955), the management plan for Gornji Grad and Luče (Knez, 1955), and three years later the final report about the conversion of Norway spruce monocultures on Pohorje, elaborated by Miklavžič's team from the Institute for forest and wood management (1958). The most successful were Mlinšek's ideas of gradual conversion, which were practised in Mislinja. The main reasons for this were Mlinšek's personal involvement in the field, a steady but continuous approach and an lucrative combination of exploitation and restoration of plantations in both an ecological and economic sense.

In the meantime, single tree selection management showed many deficiencies. The reasons were partly silvicultural. For example, individual management of broadleaves was followed by a decrease in quality, non-regulated farmer selection management with sporadic overcuts was still operational, and trees that already lost their social position due to competition were favoured (Mlinšek, 1959, 1963). However, there were also other important reasons which were outside the field of silviculture, including poor forest roads and skidding trail networks, large damages caused by harvesting, excessive browsing of regeneration by red and roe deer, and especially silver fir die-back, which started in the late 50s (Mlinšek, 1964).

During the search for a solution from the schematic, non-regulated selection system, the irregular shelterwood system was recognized as a ideal replacement. It gradually became the prevalent silvicultural system in Slovenia, especially in combination with detailed silvicultural planning. The first seminar in Slovenia on this topic was organized by Professor Mlinšek in Dobrna in 1960. In this period Professor Leibundgut form Switzerland profoundly influenced silviculture in Slovenia and the former Yugoslavia. He was in a close contact with the practice as the FAO expert for east and south-east Europe.

The practice of selection and irregular shelterwood systems showed that conditions were not appropriate for their application everywhere. Moreover, there was a sense of a missing link, which would enable a smooth connection or alteration of both systems in time and space, as well as enable further development of silvicultural systems. Backed up with the experience on forest structure and dynamics from undergoing old-growth research (1967a, b) Mlinšek developed a paradigm of commitment to the unique combinations of forest sites, stands, and social environments, which require absolute silvicultural freedom. Those ideas ripened in his freestyle silvicultural technique, which was concisely described in his book of the same name from 1968.

The ideas were further developed, and the silvicultural practise has constantly profited from old-growth research. Because of a need for a better representation of all forest sites Mlinšek and collaborators (1980) managed to establish a network of new forest reserves in Slovenia. The network encompassed 173 forest reserves totalling 9,040 ha. At the time of creation the network was one of the largest in Europe (in %), and also one of the most organized in regard to maintenance, data collection, and research. The following years were marked by the preparation for a IUFRO World Congress, which was successfully held in 1986 in Ljubljana. A few years later in Ljubljana, Pro-Silva, a European federation of foresters who advocate forest management based on natural processes, was founded.

The fourth period (from the beginning of the 90s until present) was initiated by the formation of the Slovene independent state. The forest sector faced substantial changes. Many rights, but also responsibilities for forest management were transferred from the former forest enterprises to forest owners. The forest products marked opened completely. Many feared that this would lead to the erosion and reorientation of silviculture in the direction of clear-cut management, and that private forests would be closed for general public access. However, once again the Slovene public opinion steered the forest policy in the right direction and the Slovenian Forest Service was organised, covering both private and state owned forests. Beside this, forest enterprises were successfully reorganised. In this way the forestry sector also had to face unfavourable results of the reorganisation, namely the separation of silviculture from the forest exploitation. This last period is discussed at a greater length in the paper of Veselič in this book.

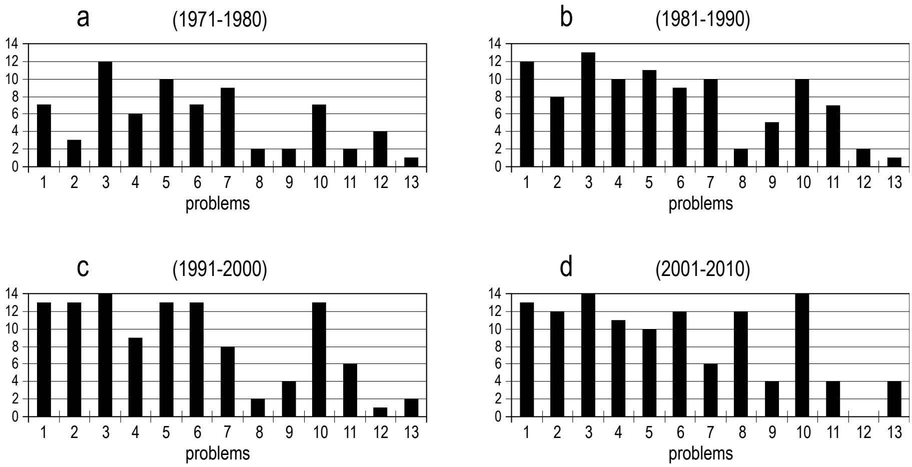
2 Contemporary silvicultural problems

The second part of this paper is concerned with an analysis of the main silvicultural problems and forest threats in Slovenia. The problems are also compared with other Central European (CE) countries, possible consequences are discussed, and finally, some ideas and solutions are presented (Diaci and Grecs, 2003). For the problems, we analysed forest management plans for four decades (1971–1980, 1981–1990, 1991–2000, 2001–2010) for all 14 management regions in Slovenia.

From the figure 2 we can see the appearance of the problems and threats in 14 management regions of Slovenia. We can roughly classify them in four groups (A, B, C, D) according to their time dynamics – the legend is below the figure:

- group A are problems, present through all four decades, having a high and increased frequency (e.g. deer browsing, unbalanced developmental phases, decrease of forest health, problems with natural regeneration, delay in tending);
- group B are problems, infrequent in the past, while increasing in present (e.g. increase of forest cover and increasing costs for forest management;
- group C are problems with minor trends in time (altered tree species composition, low growing stock, lack of experts and technological deficiency);
- and group D are problems with negative trends in time including: degraded forests, lack of site analyses and a poor transportation network.

The analysis exposed that: (1) the structure of problems was changing with time; (2) the frequency of problems increased over time – this was partially a result of more complex conditions and partially due to higher sensitivity (education) of forestry experts; (3) the majority of problems was present for four decades, which indicated their endurance; (4) group D pointed out problems, where plenty of work was invested. The problems with high and increasing frequency indicated the most important silvicultural problems in Slovenia – these were groups A and B.



Label	Problem description	Label	Problem description
1 A	Deer browsing	7 D	Degraded forests (coppice, grazing)
2 A	Unbalanced developmental phases	8 B	Unregulated increase of forest cover
3 A	Decrease of forest health	9 C	Lack of experts, technological deficiency
4 C	Low growing stock	10 A	Problems with natural regeneration
5 C	Altered tree species composition	11 D	Poor transportation network
6 A	Delay in tending (thinning ...)	12 D	Lack of site analyses
		13 B	Increasing costs for management

Figure 2: The main silvicultural problems and forest threats in Slovenia derived from forest management plans for four decades

The comparison with neighbouring countries showed that most problems were similar, such as excessive browsing of regeneration or a decrease in general forest health (Table 1). The problems that were less important in other countries comprise unbalanced developmental phases and deficient forest site analyses (Sterle, 2005). However, we also found problems and trends abroad, which were not stressed in Slovenia, or which were only emerging. For example:

- small and sub-divided private property;
- increasing importance of social functions, protection of extensive forest areas;
- many organizations and ministries in charge of the forestry sector;
- decrease of subventions for forest tending;
- decrease of interest for regular forest management;
- price decrease of large diameter timber.

In continuation, we will focus on the group of interconnected problems, which are significantly endangering further development of nature-based silviculture, namely: increasing costs of forest management, delay of forest tending operations, price decrease of large diameter timber, and decreasing interest for regular forest management. Similar trends can be found in other more developed CE countries. They are mostly a result of an unfavourable economic situation. In Slovenia this is partially due to organisational changes in the forestry sector, where the responsibility for realisation was given to forest owner. Many of them were unprepared, as they lack forestry skills and management interest. Beside this the system of state subventions proved to be rather unstable.

Table 1: Comparison of main silvicultural problems, forest threats and trends among CE countries. Legend: X - presence of a problem, **o** - presence of a process, but not considered as a problem. The legend for the problems is the same as in the Fig. 2

Countries	Problems												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Austria	X		X	X	X	X	X	o		X	X		X
Czech R.	X		X	X	X	X	X	o	X	X	X		X
Croatia	X		X	X		X	X	o		X	X		X
Italy	X		X	X	X	X	X	o		X			X
Germany	X		X	X	X	X	X	o		X			X
Slovakia	X		X	X	X	X	X	o	X	X			X
Slovenia	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Switzerland	X	X	X	X		X	X	X	X	X			X

Label	Problem description	Label	Problem description
1 A	Deer browsing	7 D	Degraded forests (coppice, grazing)
2 A	Unbalanced developmental phases	8 B	Unregulated increase of forest cover
3 A	Decrease of forest health	9 C	Lack of experts, technological deficiency
4 C	Low growing stock	10 A	Problems with natural regeneration
5 C	Altered tree species composition	11 D	Poor transportation network
6 A	Delay in tending (thinning ...)	12 D	Lack of site analyses
		13 B	Increasing costs for management

Before we analyse possible countermeasures and solutions we should also discuss probable consequences of the above mentioned problems and trends which result in a more extensive forest management or even complete abandonment of management practices (Diaci, 2004). First, we will consider the forests with important protection functions. Younger and lower trees and stands have a greater mechanical stability, and younger forest are also more resilient. Many forest in the Slovenian Alps are aging, facing senescence, and a decrease of stability and increase of risks. Similar conditions can be found throughout the Alps.

In urban forests and other forests with important social functions the non-management alternative is frequently applied, yet it results after few decades in senescence of trees and decreased vitality and mechanical stability of trees and stands. Forest health can be at risk, especially to climate change. Large insect, fungus, or abiotic calamities limit accessibility of forests for recreation, change the forest climate, are aesthetically unattractive, and provoke negative reaction of the public. Moreover, they endanger the forest work safety and increase forest operation costs. Therefore, the non-intervention has to be associated with regular sanitary cuttings, and this makes it economically even less attractive. The risk and the costs can be decreased by combining the non-intervention with low impact management, and by carefully planning the installation of non-intervention stands.

In forests with prevalent production functions, non-management initiates a decrease of commercial quality and stability of stands. The owners also often replace regular management with sporadic interventions of extreme intensity. Also here non-management puts forest worker safety at risk and increases the forest operation costs. All this can result in further decline of economical efficiency, further decrease of management interest, and poorer functioning of multipurpose forests. The above mentioned development is not economically, socially or ecologically in the interest of the state, and forest and its renewable resources can not be sealed or stored up for long periods of time.

3 Future trends and strategies

The third part of this paper is focused on countermeasures and solutions to prevent a further decrease of forest tending and increase the interest for regular, nature-based forest management. The above mentioned problems, developmental constraints and threats require activation of a broader knowledge in society in the fields of policy, legislation and organization, including: education for private owners, stable subventions and other instruments (e.g. silvicultural projects), advocating CE multipurpose and sustainable forestry to the public, promoting the use of wood as a material and energy source (within policy and public), and cooperation within the whole wood chain and architects. Finally, the forestry profession should take a more active part in the future organizational changes inside the sector.

While within silviculture, activities in the following four fields could be promising: (1) more research on natural processes and their application in silviculture; (2) optimization and rationalization of silvicultural models; (3) a greater flexibility and adaptation to the market; and (4) adapted silviculture to special demands of society, such as in urban and protection forests.

3.1 More research on natural processes and their application in silviculture

Adaptation of forest management for protection of rare and endangered species is necessary, yet this cannot represent the main doctrine of nature-based management. Different species often have different, even contrasting requirements. Therefore a better option would be mimicking natural processes, including the natural disturbance regime. Of course, a prerequisite for this is a deeper understanding of natural disturbances, such as gaps dynamics and processes within gaps. In spite of much research, there are many reasons which indicate that our knowledge is biased. Namely, natural forest are very rare in Europe, amounting to about 1.7% of the forest cover (Parviainen and Frank, 2003). Therefore, our knowledge is founded mainly on the information from managed forests. But in these forests, natural disturbance may take different directions: (1) it is mixed with management; (2) in managed forest with natural species composition, natural disturbance is less likely to happen, since managed forest are relatively young compared to old-growth forests; beside this, European forest preventive sanitary cuts are carried out on a yearly basis; (3) if the managed forests are changed, than natural disturbance can be more common (for example in Norway spruce monocultures).

Finally, not all forest sites are equally represented. The majority of natural forest are mainly in the Fenoscandia and European part of Russia. In CE Europe the majority of old-growth forest are in the mountain vegetation zone, especially in silver-fir beech and beech forests. Here, tree fall gaps are a common regeneration pattern. This is backed by numerous inventories of developmental phases (Leibundgut, 1982; Prusa, 1985; Korpel, 1995). As a result, we often think that natural disturbance is an important feature only in managed and altered forests, and that all CE forest are driven by endogenous regeneration. This is not true, as we have limited data from forests other than mountain beech and beech-silver fir forests. Also, recent studies in old-growth, beech-fir forests of Slovenia show the importance of intermediate wind disturbance (Nagel and Diaci, 2006; Nagel *et al*., 2006).

On the other hand, the research of gap regeneration following intermediate disturbances shows that gaps are being filled with waves of seedling and sapling generations, and the key role is often played by the shade tolerant (beech) advanced regeneration (Diaci and Marinšek, 2004). Furthermore, we found unfavourable plagiotropic growth of beech only in extremely low light environments, which is hard to achieve in managed forests during regeneration (Diaci and Kozjek, 2005).

In the future in Central and South Eastern Europe more research on disturbance dynamics of bottomland, high mountain, Mediterranean and Pannonian forest is needed. Here, large-scale disturbances, such as snow and ice damage, insect attack, windstorms, and fire are likely to be important driving forces of natural forest development. For example, we should clarify what is the natural disturbance regime of the floodplain bottomland hardwoods, especially regarding high light demand of pedunculate oak (Accetto, 1974, 1975). Further, fire is thought not to play a significant role in Central European forest owing to abundant precipitation. Still, in areas with retarded decomposition of debris due to low temperatures (e.g. high elevation forests) or low precipitation (e.g. Mediterranean and Pannonian forest) it surely has played an important role in the pristine landscape. Nowadays, fire has a negative connotation. This is a result of: (1) changed - degraded ecosystems, with small forest coverage (forest protection and climatic function are important) and (2) a high share of early successional conifers (e.g. Black pine, Norway spruce, Mountain pine), therefore fire has a more devastating effect as it would have in the pristine landscape.

After answering the above stated questions we will be able to develop new silvicultural models based on natural processes. However, the preliminary results already point out one interesting contrast. The broader palette of gap sizes within natural disturbance regime is suggesting to be even more flexible with combined silvicultural systems. Yet, according to the research on gap regeneration, light still remains relatively low, and the light demanding species are scarce. Moreover, there is a dominance of shade tolerant advance regeneration and their architecture is rarely plagiotropic. This suggests a great possibility to use shading as a management tool also in broadleaves.

3.2 Optimization of silvicultural models

The solutions to the mentioned problems within silviculture include: (1) improvement of traditional tending and (2) development of new silvicultural models. The existing silvicultural models can be improved with consistent use of all processes compatible with our aims, and the so called employment of “natural automation”. The systems based on natural selection and indirect management of regeneration with canopies are favoured (e.g. selection forest, irregular forest and indirect tending in general), natural structures are respected (e.g. thinning of groups, use of advance regeneration), natural competition is employed (e.g. delayed first thinning if stability and quality are not endangered), associative species are favoured, and secondary stands are utilized. Some interesting Swiss experiences in this field are discussed in the contribution of J.-Ph. Schütz in this book.

During the renewal of stands, natural generation is favoured, spontaneous mixtures are respected, and successional development of vegetation is taken into account. An exceptional tool for indirect management of seedlings and saplings is appropriate canopy cover. Here, optimal openness influences the mixture, architecture, stability and vitality of regeneration, as well as that of the remaining stand. More knowledge on gap regeneration ecology should be transferred to the practising forester (e.g. Mlinšek, 1967a, 1967b; Gašperšič, 1974; Diaci *et al*., 2005). The circumstances in the field namely reveal a high share of sanitary and salvation cuttings and this suggests that current regeneration practices do not enable regular steering of forest ecosystems any more.

More opportunities to overcome the lag of forest tending and decrease of regular management are in the field of new silvicultural, especially tending models. For example, the principle of concentration, which was developed in Switzerland (Schütz, 1996, 1999), assumes that intensive education is reasonable only for a part of the tree population with the highest potential commercial quality and stability. While the remaining stand stays untreated, or is treated only for stability if necessary. In Slovenia, there are still considerable reserves in the field of selection. From comparisons with countries like Switzerland and Germany, it is evident that our density of crop trees is relatively high. Furthermore, the density of crop trees is often not adapted to the existing mixture of stands. New tending models also allow improvements of forest operations and their organisation, especially in the aspect of mechanized logging (Diaci, 2004).

3.3 Greater flexibility and adaptation to the market

New management circumstances and large differences in the price of quality classes require a greater adaptability to the market. During renewal of stands for example, the market conditions should be respected as one of the factors influencing the spatiotemporal dynamic of regeneration cuts. It is understandable that this is easier to achieve with long lived species. Especially, the local forester has to be well informed about the current market conditions. He should well understand the ecological role and economical value of trees, and he has to be familiar with the general economic and ecological success of the silvicultural treatments from the past.

The experiences from abroad show a significant trend toward diversification of the palette of forest products or even introduction of non-forest services, including tourism in successful forest administrations. Perhaps CE forestry could profit from new a certification scheme, or at least a common wood trademark, in particular as a countermeasure to the certification of plantations of fast growing conifers.

3.4 Adapted silviculture to special demands of society

The changing interactions between forest and society demand adaptations of silvicultural aims and measures, as in high mountain or urban forests. As an example, we can mention thinning for stability, which was developed in Switzerland (Wasser and Frehner, 1996; Zeller, 1996).

Also, in urban and recreational forests a development of new adapted silvicultural models is needed. In some urban forests of Slovenia interesting steps have already been made, which prove that adapted nature-based management could present a more favourable alternative to non-management with sanitary cuts, or any kind of park management. Silviculture of urban forest includes tending for forest health and restoration, accessibility, aesthetics and nature conservation. Some forest administrations abroad already acquire part of the income for a special level of maintenance of forest roads and trails, for tending of forest borders, for projecting new or restoring degraded habitats of rare and endangered species, for installing small islands of strict reserves, and protecting old and large diameter trees.

4 Conclusions

More than 100 years of fascinating history of nature-based forestry in Slovenia demands a serious monographic study. The analysis of fundamental silvicultural problems and developmental constraints in the last four decades revealed time changes in their structure, and a steady increase in their abundance. This points also to the increasing complexity of future forest management. Some regard the overall future of nature-based forestry as cumbersome, because of decreasing value of large diameter timber, open markets, trends toward industrialisation, demands for strict protection of large forest areas, and a higher risk of management due to increasing frequency of natural catastrophes. Furthermore, the decreasing political weight of forestry due to it diminishing share in Gross National Product, and the unstable subventions system for forestry sector should be taken into account.

However, there are also many trends favouring the use of nature-based forestry, such as recurrent energy crises, and a rising consumption of wood with increasing demand for other forest goods and services. Moreover, the recent emphasis on nature protection is coherent with nature-based management. And finally, there are many possibilities to favour and adapt nature-based management to the coming situation. First of all, an activation and support from a broader public and policy are needed. Further, there are many needed actions in the field of silviculture: like improvement of traditional models and development of alternative models. To increase the weight of nature-based management, old-growth forests and forest reserve research should be accelerated again, and the results incorporated in forest management plans. Yet, above all there is a necessity to change the art of thinking. In education and practice the well established surveillance tradition should be supplemented with entrepreneurial spirit in managing forest ecosystems, which would help to advertise production of environmental friendly goods and healthy supporting services.

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References

Accetto, M., 1975. Naravna obnova in razvoj doba in belega gabra v pragozdnem rezervatu Krakovo. GozdV 33, 67–85.

Diaci, J., 2004. Nazadovanje nege gozdov v Sloveniji: vzroki, posledice, protiukrepi. GozdV 62, 76–84.

Diaci, J., Grecs, Z., 2003. Uspešnost gojenja gozdov v zadnjem desetletju in priložnosti za prihodnost. In: Bončina, A. (ed.), Območni gozdnogospodarski načrti in razvojne perspektive slovenskega gozdarstva. Zbornik referatov, Ljubljana, Biotehniška fakulteta, Oddelek za gozdarstvo in obnovljive gozdne vire, pp. 81–102.

Diaci, J., Kozjek, L., 2005. Beech sapling architecture following small and medium gap disturbances in silver fir-beech old-growth forests in Slovenia. Schweiz. Z. Forstwes. 156, 481–486.

Diaci, J., Pisek, R., Bončina, A., 2005. Regeneration in experimental gaps of subalpine *Picea abies* forest in Slovenian Alps. European journal of forest research 124, 29–36.

Gašperšič, F., 1974. Zakonitosti naravnega pomlajevanja jelovo-bukovih gozdov na visokem krasu Snežniško-Javorniškega masiva. Strokovna in znanstvena dela, Biotehniška fakulteta, Ljubljana.

Gašperšič, F., 1995. Gozdnogospodarsko načrtovanje v sonaravnem ravnanju z gozdovi. Biotehniška fakulteta, Oddelek za gozdarstvo.

Hartman, T., 1999. Hundred years of virgin forest conservation in Slovenia. In: Diaci, J. (ed.), Virgin forests and forest reserves in Central and East European countries: history, present status and future development. Proceedings of the COST E4 meeting in Ljubljana, Slovenia, Ljubljana, 111–120.

Knez, A., 1955. Ureditveni načrt za gospodarski enoti Gornji Grad I in Luče I. Gozdno gospodarstvo Nazarje.

Korpel, Š., 1995. Die Urwälder der Westkarpaten. Gustav Fischer Verlag, Stuttgart, Jena, New York.

Leibundgut, H., 1982. Europäische Urwälder der Bergstufe. Paul Haupt, Bern, Stuttgart.

Marinšek, A., Diaci, J., 2004. Razvoj inicialne faze na vetrolomni površini v pragozdnem ostanku Ravna gora. Zb. gozd. lesar. 73, 31–50.

Miklavžič, J., 1958. Melioracija smrekovih monokultur na Pohorju na gozdno-ekoloških in gojitvenotehničnih osnovah. Inštitut za gozdno in lesno gospodarstvo Slovenije, Ljubljana.

Mlinšek, D., 1955. Ureditveni načrt za gospodarsko enoto Mislinja. Gozdno gospodarstvo Slovenj Gradec.

Mlinšek, D., 1959. Untersuchungen über den Zustand und die Pflege der Bauernwälder in Pohorsko Podravje (Slowenien). ČP Celjski tisk, Celje.

Mlinšek, D., 1963. Gradivo za republiški seminar o prebiralnem gozdu, Lovrenc na Pohorju, mscr.

Mlinšek, D., 1964. Sušenje jelke v Sloveniji - prvi izsledki. GozdV 22, 145–159.

Mlinšek, D., 1965. Betrachtungen über den Waldbau und seine Stellung in der Forstwirtschaft Sloweniens. Schweiz. Z. Forstwes. 116, 753–758.

Mlinšek, D., 1967a. Pomlajevanje in nekatere razvojne značilnosti bukovega in jelovega mladovja v pragozdu na Rogu. Zbornik Biotehniške fakultete 15, 7–32.

Mlinšek, D., 1967b. Rast in sposobnost reagiranja pragozdne bukve. Zbornik Biotehniške fakultete 15, 63–79.

Mlinšek, D., 1968. Sproščena tehnika gojenja gozdov na osnovi nege. Poslovno združenje gozdnogospodarskih organizacij, Ljubljana.

Mlinšek, D., 1972. Ein Beitrag zur Entdeckung der Postojna Kontrollmethode in Slowenien. Forstw. Cbl. 91, 291–296.

Mlinšek, D., 1981. Nevarnost populacijsko-genetske osiromašitve pri drevesnih vrstah v gozdnih sestojih. GozdV 39, 167–171.

Mlinšek, D., 1993. Življenjski prostor “nizki kras”, primer človekove destruktivnosti, energije življenja, upanja v človeka in trajen raziskovalni laboratorij. GozdV 51, 280–293.

Mlinšek, D., Accetto, M., Anko, B., Piskernik, M., Robič, D., Smolej, I., Zupančič, M., 1980. Gozdni rezervati v Sloveniji. BF - IGLG, Ljubljana.

Nagel, T. A., Diaci, J., 2006. Intermediate wind disturbance in an old-growth beech-fir forest in south eastern Slovenia. Can. j. for. res. 36, 629–638.

Nagel, T. A., Svoboda, M., Diaci, J., 2006. Regeneration patterns after intermediate wind disturbance in an old-growth *Fagus-Abies* forest in south eastern Slovenia. For. Ecol. Manage. 226, 268–278.

Parviainen, J., Frank, G., 2003. Protected forests in Europe approaches-harmonising the definitions for international comparison and forest policy making. Journal of Environmental Management 67, 27–36.

Pruša, E., 1985. Die böhmischen und mährischen Urwälder – ihre Struktur und Ökologie. Academia Verlag der Wissenschaften, Praha.
Schütz, J.-Ph., 1986. Carakterisierung des naturnahen Waldbaus und Bedarf an wissenschaftlichen Grundlagen. Schweiz. Z. Forstwes. 137, 747–760.
Schütz, J.-Ph., 1996. Bedeutung und Moeglichkeiten der biologischen Rationalisierung im Forstbetrieb. Schweiz. Z. Forstwes. 147, 315–349.
Schütz, J.-Ph., 1999. Neue Waldbehandlungskonzepte in Zeiten der Mittelknappheit: Prinzipien einer biologisch rationellen un kostenbewusten Waldpflege. Schweiz. Z. Forstwes. 150, 451–459.
Sterle, N., 2005. Razvoj gozdno gojitvenih problemov v Sloveniji ter primerjava z Evropo in svetom. Diplomsko delo, visokošolski strokovni študij, Biotehniška fakulteta.
Sušek, M., 2005. Pahernikovi gozdovi: biografija rodbine Pahernik. Pahernikov sklad, Radlje.
Wasser, B., Frehner, M., 1996. Minimale Pflegemassnahmen für Wälder mit Schutzfunktion. - BUWAL, Bern.
Zeller, E., 1996. Probleme im Gebirgswald lösen: Wiederbewalden, Stabilisieren, Verjüngen, Sanieren. Bericht Gebirgswaldprojekt II, Nr. 5A, Interkantonale Försterschule Maienfeld.

Development of forest monitoring methods for sustainable forest management in Slovenia

Milan Hočevar*, David Hladnik**

Abstract

Forest inventory data serves as the basic source of information on forest conditions. Its application must be adapted to forest management, structure of forest stands, multifunctional goals of sustainable management, and basic concepts of geographical information systems, which means the use of digital, qualitative, and spatial data. In this paper, the development of forest inventory techniques in Slovenia is described, and a complete scheme of a forest inventory, based on rational use of different techniques of terrestrial measurements (sampling and stand inventories), remote data collection and external databases, is presented. The Control Sampling Method is the most important part of the forest inventory on the level of forest management units and regional levels. It gives reliable and objective data on present conditions and future trends in development of forests and can be applied on different levels of forest management. The implementation of permanent sampling plots for forest management planning was also influenced by the beginning of the systematic monitoring of forest health in Slovenia in 1985 when a 4x4 km sampling grid (tract method) was established on the state level for the estimation of health conditions in the forests. With the development of monitoring and the Control Sampling Method in field inventories, different techniques of remote sensing data collection were introduced into the forest inventory.

Key words: forest monitoring, forest inventory, control sampling method, remote sensing, GIS

1 Introduction

Over the last decades, the role of forests and forestry has become broader. Since the United Nations Conference on Environment and Development in 1992, a number of international initiatives have promoted new monitoring programmes for sustainable forest management. In the framework of the Ministerial Conference for Protection the Forests of Europe (MCPFE), European countries have agreed on quantitative indicators, describing the sustainability of forest management. The information needs

* Prof. Dr. Milan Hočevar, Slovenian Forestry Institute, Večna pot 2, SI-1000 Ljubljana, Slovenia
Tel.: +386 1 200 7800, Fax: +386 1 257 3589, E-mail: milanh@gozdis.si
** Doc. Dr. David Hladnik, University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources, P.O. Box 2995, 1001 Ljubljana, Slovenia
Tel. +386 1 423 1161, Fax: +386 1 257 1169, E-mail: david.hladnik@bf.uni-lj.si

on forests and the scope of forest inventories have widened, which concerns both the national needs and the needs for reporting at the international level.

The EU continues to develop forest monitoring by integrating previous regulations on the protection of the Community's forests against atmospheric pollution and fire. At the European level, ICP Forests (International Cooperative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests) was launched in 1985. Forest Focus is a new EU scheme for harmonised, comprehensive and long term monitoring of European forest ecosystems. In European countries, seeking sinergies between new monitoring programmes and national forest inventories is an important issue for ensuring coordinated and cost effective assessment of forest status (COST E43). New information needs also emerged from the Kyoto protocol addressing climate change.

At the national level, the Forestry Act of 1993 regulates the protection, cultivation, exploitation and use of forests in order to secure sustainable and multipurpose management, permanent and optimal functioning of forests as ecosystems and implementation of their ecological, social and economic functions on a permanent basis. The Slovenian Forest Service conducts regional forest management plans, plans for forest management units, and silvicultural plans. Forest management systems require information about complex forest structures in both space and time. The concept of the forest inventory should be adapted to forest management practices and silvicultural treatments, forest conditions and the diversity of stand structures, and sustainable and multifunctional use of forests. Updated information on forest resources is an essential prerequisite to improve the ecological, economic and societal benefits from forests.

2 Information needs in Slovenian forestry

Slovenian forests are characterized by great natural diversity, a fine-grained range of ecological conditions, and a selective harvest management system with natural regeneration, resulting in a predominantly uneven-aged, multi layer and multi species structure of forest stands. Forests cover 12,644 km^2 or 62% of the total land area (Hočevar *et al*., 2005). According to the UN-FAO Global Forest Resources Assessment 2005, the average growing stock in Slovenia is 270 m^3 per hectare, while the annual increment reaches 6.3 m^3/ha. Broadleaves, mainly beech and oak, occupy about 39 % of the forest area; similar to the extent of mixed forest stands (39%). Conifers, mainly spruce and silver fir, encompass 22% of the forest area. Slovenian forests have been relatively well preserved, since they account for 70% of the Natura 2000 sites.

Human influence has been less detrimental to forests than in most Central European countries due to the mountainous character of the country and the difficult access of a Karst region. The forests have mainly been preserved in higher and steeper locations. The high population pressure and the need for subsistence caused a diversified use of forests surrounding the small holdings, settlements and agricultural areas. The structure and composition of forests in the lowlands and on hillsides was highly influenced by coppice management, grazing and litter gathering. In the 18th century, the proportion of agricultural land in Slovenia was the highest, due to the fact that the settlement of alpine world lasted until the very end of that century. At the end of the 19th century urbanisation commenced, a process still under way today. The abandoned agricultural land reverted to forest in western and central Slovenia, so that the country's forest cover has increased by 20% over the last 200 years (Hladnik, 2005).

A high diversity of natural conditions, historical development in the past centuries, and close to nature silvicultural techniques in forest management in the last 50 years, favouring mixed uneven-aged stands, site adapted tree species, and selective harvesting, have created a great variability of forest structures. Other processes affecting the complexity of the forest inventory and management continue. It is expected that after the process of denationalization about 80% of the forests will belong to private property. Nowadays there are about 300,000 forest owners, consisting of many small forest estates, with an average area of only 3 ha, commonly characterized by many separate parcels.

Along with the development of society the interests regarding forests are becoming more diverse and multi-purpose forest management is becoming more relevant (Hočevar, 1991). This kind of management enables the use of various forest resources. Foresters have been required to manage for other resources and demands of the society, including biodiversity, water quality, protective functions, and productive, economic and socio-cultural functions of forest ecosystems and forest landscapes. Traditional forest inventories focused mainly on the assessment of the sustainability of the productive forest functions. Similar to forest inventories in Europe, they have developed over more than 200 years and have strongly been influenced by forest management planning procedures, optimised for the assessment of homogeneous, even-aged stands (Koehl, 2001) or former silver fir and beech selection forests (Hladnik, 2006).

3 Historical background of forest inventories in Slovenia

The present concept of forest inventories in Slovenia can be assessed only if, like elsewhere in Europe, the more than two hundred years of forest management planning development is also taken into account. Among the beginnings of forest management planning are the regulation of wood yields in the forests of Idrija from the years 1724 and 1759 and the first management plan for the Trnovo Forest, drawn up by Flamek in 1771. From the first management plans on, the monitoring of the development of forests is mentioned, which provided the basis for a control method of management like elsewhere in Europe. In the Kočevje region in the 1892, the forester Hufnagel introduced the original concept of the control method into forest management.

Despite the long tradition in forest management, at the time when the first general inventory was taken in Slovenia (1946–47), a mere one-fifth of Slovenian forests were managed. During the first inventory the average growing stock was estimated at 133 m^3 per hectare and annual volume increment at 3.2 m^3/ha. In 1952 a systematic management of state-owned forests was introduced, along with plans for management units, and the management of private forests began in 1954. A management system for the entire Slovenian forests was introduced, irrespective of ownership. By 1968 the first regulation of all forests had been performed and revisions had been elaborated for a number of management units. Thus far, four regional forest management plans have been elaborated for all Slovenian regions.

As to forest inventories, tariffs for the determination of the growing stock of stands were introduced in the fifties, from which methods for estimating the increment of the growing stock were then designed (Mlinšek, 1955; Čokl, 1959). Up to the end of the seventies, total tallies of forests prevailed in forest management according to the control method, while sampling methods were rarely used, and ocular estimates were employed in forests of minor economic importance. At that period, the collection of data and information in forest inventories was focused only on the production role of forests.

The permanent sampling plots and interpretation of aerial photographs were first used in a forest inventory in Slovenia thirty years ago (Grilc, 1972). In the selected forest management unit about 2,000 sampling plots were systematically placed on a sampling grid of 200x100 m. The spatial position of each tree in a plot was recorded, so that sampling plots and trees had been measured on future occasions. However, the sampling intensity in the forest management unit was too low to adequately characterise individual compartments or even individual forest stands. At that time, the concept of the forest inventory was stand-based. Similar to the tradition in Eastern Europe the stand-based inventories had been designed for management planning purposes and the national data had been gathered by aggregating data of individual stands or compartments.

In 1980 inventory methods were a combination of sample surveys, total tallies, and ocular assessment of individual stands. Despite the comprehensive field inventory, foresters have been faced with many new tasks. The outbreak of forest decline was an extensive problem demanding new inventory and monitoring procedures. At the same time the application of multi-purpose management was not well recognized in the forest management.

3.1 Traditional forest resource assessment

An efficient forest management, which comprises planning and executing, is based on a reliable and continuous information system and monitoring. A valuable information system is even more important for the forests that are far from being in a stable condition and when there are extra harsh environmental conditions (forest deterioration phenomenon). Without an efficient information system and supervision, we cannot envision a ‘free style’ silviculture (Slovene silvicultural doctrine) to work (Mlinšek, 1968). In essence, this ‘free style’ silviculture means: experimenting and conforming to micro-site and forest stands conditions all the time.

The traditional monitoring system did not take into account these principles. Although a multifunctional purpose of forests was declared, the bulk of the efforts (and costs) were set to gathering information on wood production and partially on commercial data, which usually cannot be compared neither in space nor in content.

The main weaknesses of the traditional system of data collection are:

- not conforming to the system of close to nature and ‘free style’ silvicultural methods;
- frequently not a satisfactory and reliable data (subjective judgments);
- data not worthy of comparison, unknown prediction error, lack of statistically sound information;

- incomplete use of information on collected data;
- unreliable predictions of future developments and information on changes;
- lack of integration between field assessment (growing stock, increment) and spatial information in mapped format, not taking into consideration the very heterogeneous stand structures, avoiding small-scale heterogeneity.

In forestry, there were many reasons for doubting the sense and rationality of collecting, processing and dissemination of data and information in the traditional way. The obvious ineffectiveness of the system appeared when for important assignments (e.g. forest deterioration follow-up, making of regional forest plans) a special data collection had to be organized, whilst much of the existing data was not used. The concept of economic efficiency of information (a ratio between usefulness and costs) obviously was not considered adequately. Too often, the quality of information was matched with quantity of data, and desk drawers were stuffed with data and estimates with unknown confidence. Only a small portion of information content was fully utilized from the surveys.

In spite of some progress in the field of computer data processing, it was clear that a technology of data collection, data processing, data analysis and dissemination has to be modernized and reorganized. This process can employ some new contemporary technologies of data collection, data processing and information presentation like aerial and satellite imaging, GIS methods, graphic and cartographic presentations.

3.2 Requirements of an integrated information system in forestry

A contemporary spatial information system should incorporate the multifunctional purpose of forests and close to nature forestry, which is characteristic for Slovenia. It should reflect spatially very diverse forest management practices, small-surface forests structures that are specific in Slovenia, and forest stand structures with largely diversified tree species. Forest inventory and management has to conform to the ‘free style’ silviculture that rejects the classic ties of felling plans. This new information system needs more reliable data then was available up till now, data of better quality in many ways (e.g. an insight into tree response to different silvicultural measures), and dependable guidelines. Also, it should be noticed that much of the traditional knowledge (in the field of silviculture and forest growth) and informational resources (stand tables) are becoming unreliable or are even useless when applied to afflicted environment and deteriorating forests. Growth and yield models are not fully representative for updating regional forest surveys. Recent research suggests that vegetation productivity may have increased in central and Northern Europe.

The multipurpose-derived data is diminishing the importance of a forest section as a principal cell of information, and a transition to larger bio-ecological spatial units is evident, e.g. a stratum, a forest as an ecosystem. This means that in the future we need more information, but of a different kind. Stand-type-related information is essential for the planning and management decision at the stand and landscape level. Most of all we need reliable data on trends of forest stand development, on qualitative and structural changes of forest landscape (i.e. good information for sound decision-making), planning, and monitoring.

Much progress has been achieved in this way by the development and advances in computer systems, remote sensing, and geographical information systems. These developments have made an important step toward a broader integrative concept of forest inventory. Following the principles of hierarchical structure, four levels of research into forest ecosystems and forest landscapes were connected: from the level of the region, the landscape, the ecotope or forest stand, and the level of the individual tree. For each of this levels technologies were selected and methodological foundations for collection, storage, search, links-up, redesigning, analysis and representation of spatial data were formulated. The framework for this collection of technological tools was provided by the geographical information system.

Three main information sources were determined for the concept, from which the spatial data was collected with the aid of primary methods, and observations were made of changes at the regional and landscape levels and at the levels of forest ecotopes and forest stands. The primary methods of data collecting include field surveys and continuous forest inventory, photo interpretation of aerial photographs, digital orthophoto technology, and interpretation of multispectral satellite imagery.

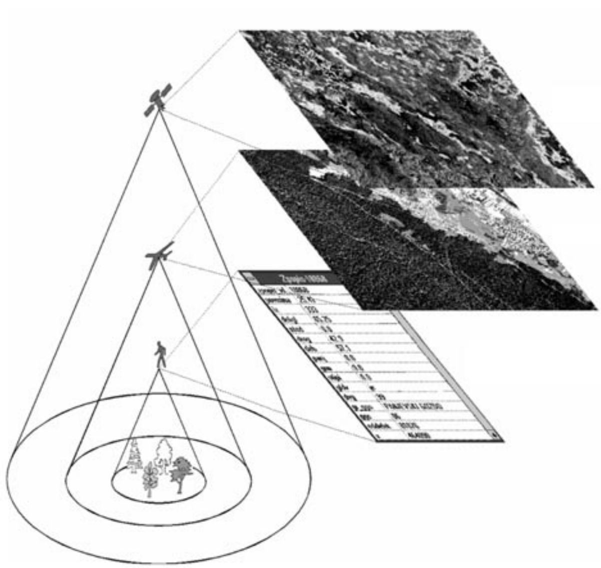


Figure 1: Hierarchical structure of the monitoring system

By adopting this hierarchical structure, we can recognize forest stands as the basic units of forest inventory. In contrast to the concept of forest compartments, the stands are more or less homogeneous and should be well-defined in space and time. The information level was expanded upwards into the level of forest stands strata. Such forest inventory would become a central part of a spatial information system in forestry. Reliable information would be available on separate stratum levels, such as forest stand types, forest management units, forest management regions, and on the state level.

4 Continuous forest inventory

The idea of continuous recording (data collection) of forest stand development, known as the Control Method, was born in Central Europe at the end of the 19th century (in France: Gurnaud, 1878; in Switzerland: Biolley, 1921). The method was highly regarded by selection forest management in connection with full callipering, and as such is known in Slovenia (Hufnagel in Kočevje region and Schollmayer in Postojna region). The idea of the classic Control Method was transmitted to a Control Sampling Method, which passes on the concept of control from a forest department, considered as a permanent monitoring surface, to a sample plot or a sample tree. This shift from an entire surface to partial plots, from full callipering to sampling, means to focus on chosen plots that are only a part of a whole forest surface. This is associated with a sampling error, but on the other hand, the Control Sampling Method enables an intensive follow-up of each tree growth, and a possibility to gather large quantities of data for different forest stands and sites, forest management measures, and environmental impacts. In this way, it is possible to assess some other spatial indicators, including increment Iv(m^3/ha), growing stock V(m^3/ha), felling C(m^3/ha), ingrowth, mortality, etc., which could otherwise be assessed only on scientific research plots.

The Control Sampling Method took root in the USA, while for Slovenia the development in Switzerland (in 1960s) was important (Schmid-Haas, 1963). From the start, the Swiss Control Sampling Method was designed as a complete forest management system, which incorporated inventory and data analysis, application of photogrammetric methods, and all aspects of rationale planning based on sample data. As such, the method was tested in Slovenia in the early 1970s. Already in 1972 the forests of Jelovica, and few years later the forests of Pokljuka were measured using the original Swiss method (Grilc, 1972). In spite of the lacking support of a broader group of forestry professionals, the method was retained in the Bled region, and found some followers elsewhere, such as the Forest Management Enterprise in Slovenj Gradec, as well as some trials in the Forest Management Enterprise in Celje. Such conditions lasted up to the late 1980s, when intensive research and development of Control Sampling Method started at the Department of Forestry of the Biotechnical Faculty (Hočevar, 1988, 1990, 1991). At the same time a development of photogrammetric methods began, and spatial information system (GIS) was implemented. The Control Sampling was disseminated to a wide range of forestry professionals through seminars and through cooperation with Forest Management Enterprises on pilot projects in the form of diploma theses. Forestry professionals needed a method, which would ensure a reliable assessment of changes in forests, besides providing other traditional indicators about timber production and the production function of the forests. Afterwards, the Regulation on forest management and forest silviculture plans (Ministry of Agriculture, Forestry and Food, 1998) confirmed the course that the forestry praxis had already chosen.

In order to provide a continuous supervision of the forests, the Slovenian Forest Service launched the continuous forest inventory. The continuous forest inventory is carried out in a 10-year cycle and is staggered, with different management units completed in different years. In the period between 1991 and 2000, about 71,500 permanent sampling plots were remeasured by the Slovenian Forest Service (Matijašič and Pisek, 2004). These permanent plots represent 70% of the total forest area according to the regional plan 2001–2010. The Regulation on forest management and forest silviculture plans (1998) prescribed the establishment of a complete cycle of measurements on permanent sampling plots in 2007.

Particularities of the Control Sampling Method in Slovenian forest inventory:

- Control sampling plots are installed at all sample locations where the forest site productivity, described in terms of annual volume increment is 4 m^3/ha or greater.
- The sampling framework is based upon terrestrial sample plots on a 250x250 m or 250x200 m grid.
- The sample plot centre is permanently marked in the ground and spatially defined by Gauss-Krueger coordinates, determined on topographical maps. The position of each tree on the sample plot is determined by the azimuth and distance from the plot centre.
- A sample plot consists of two concentric circular plots of 200 m^2 and 500 m^2.
- All trees with a dbh of more than 10 cm are measured within the inner circular plot (r_1 = 7.98 m), those with a dbh of more than 30 cm within the outer circular plot (r_2 = 12.61 m). The circular plots, established on a slope should have enlarged radius, so that horizontal plot area is identical for the corrected plot size.
- Field measurements include plot description pertaining to site and stand structure and remeasurement of individual trees.

Procedure and preparation of the plot level notes on the first survey:

- Forest plot establishment (transfer of sampling net from maps to the terrain);
- Geodetic measurement using a compass and tape, following the azimuth and distance from the starting point to plot center;
- GPS and orthophoto maps (position control and stratification based on a stand map);
- Plot level notes and tree data:
  - Plot identification, stand and site condition classification;
  - Tree data (azimuth and distance from the plot centre, species, dbh).

Procedure on second and next successive remeasurements:

- Finding of plots with the aid of topographical maps from the first survey, ortho photographs and GPS; detection of the sample plot center, based on azimuth and distances from the trees measured on the first survey;
- Remeasurement and assessment of plot-level data, remeasurement of trees;
- Remeasurement of dbh; data and procedure in exactly the same way as in the first survey;

- Checking and identifying any irregularities in dbh measurements of the previous survey;
- Tree history coding.

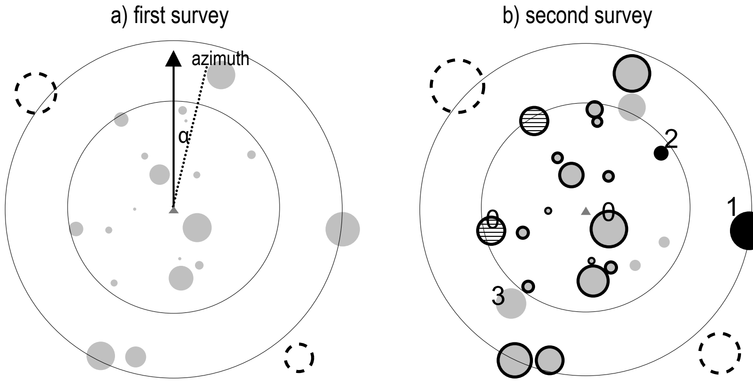


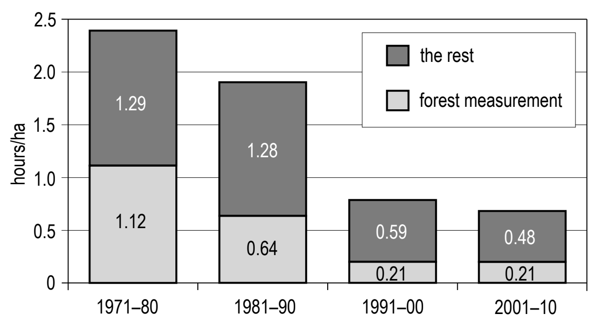
Figure 2: Layout sketch with tree positions and detected changes on permanent sampling plot of the Control Sampling Method in Slovenian forest inventory

In the second inventory and for future measurements tree history codes represent and track the status of the sample trees:

- live / survivor tree (Code 0);
- cut tree (1);
- dead tree, natural mortality (2);
- ingrowth tree (3);
- missed tree, downloaded# tree.

By introduction of new methods into forest inventory and forest management planning, substantial achievements were accomplished, and especially rationalization of forest management planning. The data in Figure 3 refer only to Forest Management Enterprise of Tolmin region, but the same trends prevail over Slovenia (Kozorog, 2003). In the first examined period of ten years, the mensuration of forests had taken almost half of total time needed to renew forest management plans, in the last twenty-year period, it took only one third of it.

Figure 3: The amount of time needed for the renewal of forest management plans in the last decades (Slovenian Forestry Service, Tolmin regional unit)



Tree tallied at the previous survey but should not have been.

4.1 Forest health monitoring (ICP Forests)

The implementation of permanent sampling plots for forest management planning had been influenced by the beginning of the systematic monitoring of forest health in Slovenia in 1985. Its main features are annual inventorying of permanent plots on a 16x16 km grid and occasional inventorying of plots on a grid of 4x4 km. Since its early implementation, the inventory method has been continuously improved. Recently it has been estimated that visibly marked plots were treated differently from the rest of the population and became unrepresentative (Hočevar *et al*., 2002). Unlike the previous inventory system based on four 6-tree sample plots, the new concept required the newly established circular permanent sample plot and two (of four) existent 6-tree sample plots.

5 Stand mapping

Simultaneously, with the development of Control Sampling Method in field inventories, different techniques of remote data collection were introduced.

In the 1980s, a compilation of forest stand maps started to emerge, but geometrically correct delineation of forest stands represented an obstacle in the mapping process due to the central projection of photographs and displacements due to terrain relief. Simple instruments designed for the transfer of stand delineation from aerial photographs were not accurate enough in mountainous regions, therefore we looked for new solutions. We started with digital monorestitution and concluded with an orthophoto map that was produced with an assistance of digital photogrammetry (Desktop Mapping System, Welch 1992) in 1993 (Figure 4). Ten years later, orthomaps became a standard tool also used by forest management enterprises.

In Slovenia, remote sensing methods have been implemented in forest inventories to a greater extent since the outbreak of the forest decline, when both panchromatic and colour infrared photographs were acquired. In 1985 the decline of trees and forest stands was studied by photointerpretation and field survey. At the level of forest management unit an integral analysis based on photo interpretation of CIR aerial photographs and field sampling plots was conducted to assess the forest structure, growing stock, productivity and decline of forest stands (Hočevar and Hladnik, 1988). The aerial survey with CIR photographs was in part repeated in 1988 and a method for the evaluation of silver fir and spruce decline was designed. In that period the basic methods of visual photo-interpretation were developed, interpretation keys for the most important tree species in Slovenia (beech, silver fir, Norway spruce) were prepared, and structural elements of tree crowns and their reproduction on aerial photographs were used for identifying different damage classes.

It has been shown that the information content of forest stand maps can be increased by combining field assessment and aerial photographs. Combined surveys aimed at increasing the cost-efficiency of survey systems by providing statistical key parameters with a reduced sampling error. By stratifying areas into homogeneous stands the efficiency of the forest inventory was increased.

The advent of technology of the digital orthophoto and digital photogrammetry provided a rather new concept for production of forest stand maps. Previously, aerial photographs were used mostly for orientation on the terrain, delineation of forests from the neighbouring land uses and for rough assessment of the forest stands structure. In 1985 the Slovenian Forestry Institute and the Department of Forestry of Biotechnical Faculty started to develop a computer based system for monorestitution of aerial photographs. Both institutions have been continuing the development of mapping procedures in forestry by using the simple analytical stereo plotter and monoplotting systems. At the beginning of the nineties we started to produce digital orthophotos for forest stand mapping (Hočevar *et al.*, 1994). Since then, digital ortho photographs have been increasingly used to rationalise stand mapping, to conduct continuous forest inventories, and to stratify the forest stands.

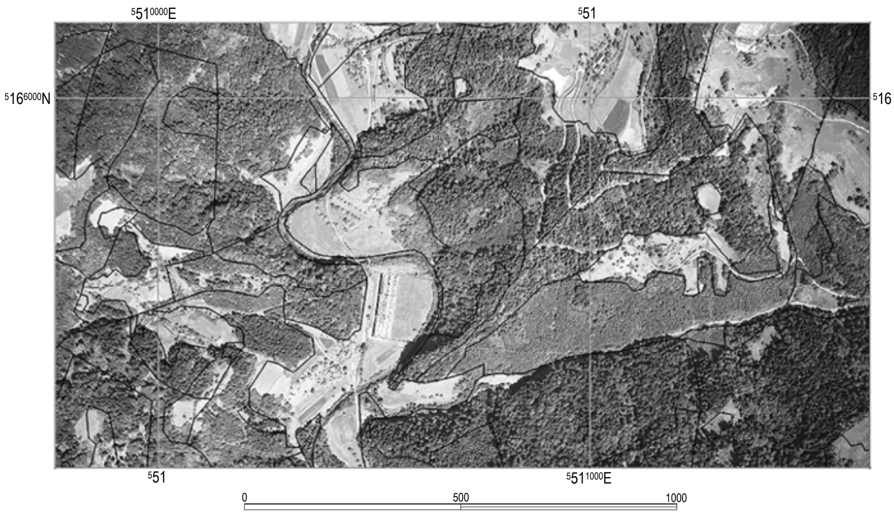


Figure 4: Subset of an orthoimage map, based on colour infrared aerial photography and delineation of forest sections and compartments in the forest management unit in Slovenia (Muta area 1993)

More recently, the development of digital photogrammetry and the use of geographic information systems have widened the scope of remote sensing technology for forest monitoring. In recent studies, the two-phase photo-terrestrial inventory was tested. A stereo model of forest was set up on a digital analytical stereo plotter. Photo samples were chosen on a grid of 50x50 meters in the first phase. The dominant tree height was measured and shares of conifers, crown cover percentage and stand ages were estimated in the sample. Terrestrial samples were chosen from photo samples where timber volume was estimated by the terrestrial control sampling method in the second phase. Terrestrial assessment of growing stock was highly correlated with photogrammetric measurements of additional stand variables. The combination of photogrammetrical and terrestrial measurements improved the estimation of growing stock and reduced sampling error (Kušar and Hočevar, 2000).

6 Application of remote sensing

As to interpretation of satellite imagery in Slovenian forestry (Hočevar *et al.*, 1996), research work has made it possible for satellite imagery to become a basis for stratification of inventory data and for their coordination with planners from other fields of spatial planning at the regional level. In the forest landscapes of the Slovenian regions landscape structure was assessed using supervised classification of a Landsat TM image. With the advent of GIS and digital photogrammetry the use of satellite and aerial images is about to become even more attractive to forestry professionals. These techniques have also been tested at an operational level in a case study of the Kočevska region, where the forest enterprise map based on SPOT and Landsat TM images was prepared.

Various options for streamlining forest cover change detection for the period between 1975–1995 were tested (Kobler *et al.*, 2002, Hočevar *et al.*, 2004), based on Landsat TM data and on existing maps and GIS layers. Using a spatial regression model, spontaneous afforestation was forecasted for the next 20 years. Machine learning was used in some steps of the classification in order to streamline the procedure as much as possible.

The small-scale heterogeneity of Slovenian landscapes results in a limited number of forest and land use classes that can be derived by multispectral satellite imagery. The major disadvantage of satellite remote sensing for forest management planning purposes on the operational level remains insufficient classification accuracy.

7 Development of forest inventories in future

In the next decade, we do not anticipate any essential changes concerning the established forest inventory system in Slovenia. If the forest health monitoring program and other EU programs of intensive monitoring of forest ecosystems will expand to a national inventory, depends on political decisions and on the concept of the future forest planning on the state and regional levels. Of great importance for further development are international conventions (e.g. the Kyoto Protocol), which set high standards concerning quality of data. The set of attributes to be assessed increases, monitoring structural changes, and predictions of future development become major issues of forest monitoring for sustainable forest management.

References

Čokl, M., 1959. O poenostavljenih metodah za meritev prirastka. Gozdarski vestnik 17, 65–82.

Grilc, J., 1972. Gozdno gospodarstvo Bled urejuje gozdove po metodi stalnih vzorčnih ploskev. Gozdarski vestnik 30, 63–65.

Hladnik, D., 2005. Spatial structure of disturbed landscapes in Slovenia. Ecological Engineering 24, 17–27.

Hladnik, D., 2006. Monitoring of the development of stands in uneven-aged beech and silver fir forest in Slovenia. Proceedings of the international conference Sustainable Forestry in Theory and Practice, Edinburgh, Scotland, 5th–8th April, 2005 (In press).

Hočevar, M., Hladnik, D., 1988. Integralna fototerestrična inventura kot osnova smotrnega odločanja in gospodarjenja z gozdom. Zbornik gozdarstva in lesarstva 31, 93–120.

Hočevar, M. (Ed.), 1988. Gozdna inventura. Seminarsko gradivo, Ljubljana, 11. in 24. maj, 1988. Ljubljana, Biotehniška fakulteta, Oddelek za gozdarstvo, 60 pp.

Hočevar, M., 1990. Anforderungen an die Forstinventur als Bestandteil des forstlichen Informationssystems. Oestr. Forstztg. 101, 4, 75–76.
Hočevar, M. (Ed.), 1990. Ugotavljanje stanja in razvoja gozdov s kontrolno vzorčno metodo. Zbirka referatov in navodila za pripravo in snemanje na stalnih vzorčnih ploskvah, Ljubljana, 22. maj, 1990. Ljubljana, Biotehniška fakulteta, Oddelek za gozdarstvo, 48 pp.
Hočevar, M. (Ed.), 1991. Obdelava in analiza podatkov kontrolne vzorčne inventure. Seminarsko gradivo, Ljubljana, 25. junij, 1991. Ljubljana, Biotehniška fakulteta, Oddelek za gozdarstvo, 45 pp.
Hočevar, M., 1991. Značilnosti celostne gozdne inventure v sistemu sonaravnega upravljanja z gozdovi. Zbornik gozdarstva in lesarstva 38, 41–54.
Hočevar, M., 1992. Waldzustandserfassung in naturnahen Waeldern Sloweniens. Oest. Forstztg. 1, 9–12.
Hočevar, M., Hladnik, D., Kovač, M., 1994. Verwendung digitaler Orthophotokarten fuer die forstliche Bestandeskartierung. In: Photogrammetrie & Forst - Stand der Forschung und Anwendungen in der Praxis. Freiburg iBR. Albert-Ludwigs-Universitatet Freiburg, Forstwissenschaftliche Fakultatet, Abt. Luftbildmessung und Fernerkundung, 155–168.
Hočevar, M., Hladnik, D., Kovač, M., 1996. Ecological monitoring of preserved forested lanscapes in Slovenia by means of remote sensing and GIS. In: Saramäki, J., (Ed.). Remote sensing and computer technology for natural resource assessment. Proceedings of the Subject Group S4.02-00 ”Forest Resource Inventory and monitoring” and Subject Group S4.12-00 ”Remote Sensing Technology”. Vol. 2, (Research notes, 48). Joensuu, The University of Joensuu, Faculty of Forestry, 95–118.
Hočevar, M., Kovač, M., Kobler, A., 1996. Application of remote sensing and GIS from landscape to forest stand level. In: Kennedy, P.J. (Ed.). Application of remote sensing in European forest monitoring, Proceedings of the international workshop. Vienna, Austria, 14th–16th October, 1996. Vienna, Universität für Bodenkultur, Joint research centre European Commission, Joanneum Research, 33–45.
Hočevar, M., Kušar, G., Cunder, T., 2004. Monitoring in analiza zaraščanja kraške krajine v GIS okolju. Zbornik gozdarstva in lesarstva 75, 21–52.
Hočevar, M., Kušar, G., Japelj, A., 2005. Gozdni viri Slovenije – stanje in razvoj 1990–2000–200. GFRA Forest resource assessment for Slovenia. Ljubljana, Gozdarski inštitut Slovenije, 120 pp.
Kobler, A., Hočevar, M., Kušar, G., 2002. Uporaba multispektralnih satelitskih posnetkov in metod GIS za zaznavanje ter napoved zaraščanja. Zbornik gozdarstva in lesarstva 69, 277–308.
Koehl, M., 2001. Resource assessment techniques for Continuous Cover Forest systems. In: von Gadow, K., Nagel, J., Saborowski, J. (Eds.). Continuous Cover Forestry, Assessment, Analysis, Scenarios. Proceedings of the international conference. Goettingen, Germany, 19th–21th September, 1996. Goettingen, Georg-August University, 13–25.
Kušar, G., Hočevar, M., 2000. Fototerestrična inventura gozda. Zbornik gozdarstva in lesarstva 62, 117–148.
Matjašič, D., Pisek, R., 2004. Debelinska struktura slovenskih gozdov. In: Brus, R. (Ed.). Staro in debelo drevje v gozdu. Zbornik referatov XXII. gozdarskih študijskih dni. Ljubljana, 25–26 marec, 2004. Ljubljana, Biotehniška fakulteta, Oddelek za gozdarstvo in obnovljive gozdne vire, 33–46.
Mlinšek, D., 1955. Poskus uporabe francoskih tarif v naših gozdovih. Gozdarski vestnik 13, 161–167.
Mlinšek, D., 1968. Sproščena tehnika gojenja gozdov na osnovi nege. Poslovno združenje gozdnogospodarskih organizacij v Ljubljani. Jugoslovenski poljoprivredno šumarski centar, Beograd. pp. 117.
Pravilnik o gozdnogospodarskih in gojitvenih načrtih. Ur.l.RS št. 5–242/98.
Schmid-Haas, P., 1963. Vergleich von Vollkluppung und Stichprobenaufnahme. Schweiz. Z. Forstwes. 114, 7, 412–425.

Practising Mlinšek's nature-based forest tending under contemporary circumstances in Slovenia

Živan Veselič*

Abstract

After the Second World War, the forestry profession in Slovenia started to form its basis for future work. Different views on the forests were present among forest professionals during that time. Prof. D. Mlinšek undertook the formation and realization of the vision of work with the forest on a global level and also in his own country. His contribution was crucial for the close to nature orientation of Slovenian forestry.

Modern professional work with Slovenian forests through many decades was not only reflected in Slovenian forests but was of exceptional importance for the reputation of the forestry profession in Slovenia. During times of transition, when the roles and organization of the profession were being determined anew in Slovenia (similar to all others countries of the former eastern social system), Slovenian forestry had a very good starting point based on its heritage.

Under new circumstances, with more rights and responsibilities of forest owners, it is much more difficult to realize forest management goals than it used to be in the past. However, in these new circumstances Slovenian foresters strive to continue the work with Slovenian forests in a way that is congruent with the practices introduced by professor Mlinšek .

Keywords: close to nature forestry, Slovenia, Slovenian Forest Service, Mlinšek

1 Foundation and introduction of the contemporary way of forest management in Slovenia

In the past centuries, there have been many examples of poor forest management practices across the world. One such example is the Karst landscape in Slovenia, which at a certain time in history became almost entirely bare.

While the Karst degradation was certainly an example of poor forest management, there have also been some success stories in the area of forest management in Slovenia's past. The first known regulation in Slovenia, the Ortenburg forest order, was issued in 1406. This was followed by the first forest-management plan made in 1771, and in the 19th century the original selection method of forest management was

* MSc. Živan Veselič, Slovenian Forest Service (SFS), Večna pot 2, SI-1000 Ljubljana, Slovenia
Tel. +386 1 200 7800, Fax: +386 1 257 3589, E-mail: zivan.veselic@zgs.gov.si

developed in Slovenia (in both the high Karst and Pohorje regions). In the middle of the19th century, well known attempts for reforestation of the Karst began, which proved successful towards the end of the 19th century. All these events contributed to the development of forest management and the protection of Slovenian forests against their transformation into pure spruce forests, which was common in Europe at that time.

As mentioned above, the efforts made to reforest the Karst region proved successful by the end of the 19th century. During the World exhibition in Paris in 1900, much praise was given for reforestation of the Karst. Thus, the Karst became not only a symbol of bare lands, but also a symbol of successful reforestation of such lands.

After the Second World War, forests in Slovenia went through a very turbulent period. Slovenian forests contributed to the restoration of the State relatively more than the forests of other Yugoslav republics. In several years, the quantity of wood cut was a few times higher than the annual increment, which strongly activated forestry professionals in Slovenia. Professional arguments prevailed and cuttings were decreased. In 1953 and 1954, a complete inventory was done in the forests of Slovenia (by parcels). Under the Federal Forest Act, forest management plans became obligatory for all forests, and both goat grazing and clear-cuts were forbidden.

These decisions showed that the period following the Second World War, when State forests were focused on wood supply, was coming to a close, so that the forestry profession could focus on a more progressive future. A review of forestry literature from this time period revealed that different views on forests were present among forest professionals, and the forestry profession in Slovenia only started to form its basis for future forest work. Further development of Slovenian forestry could follow a different way.

The richness of negative and positive experiences of forest management in Europe, as well as in our country, mainly associated with the severe consequences of poor management, motivated professor D. Mlinšek to start synthesizing all these experiences, including both domestic and especially foreign views of forests and forest-management, which at that time were making an important contribution to the formation of a vision of work with the forest, nature and environment. Such a vision was advanced on a global level then and remains such until today.

Professor Mlinšek developed and practised his vision of forest management in forests on a global level and of course in his own country. Undoubtedly, his contribution left important traces on forest management practices elsewhere in the world, while in Slovenia forest management has followed Mlinšek's vision with practical work experience in the forest since the 1960s. Such a long period of systematic management following Mlinšek's ideas substantially improved Slovenian forests in all respects.

In the last fifty years, Slovenian forests recovered in many ways. Their surface, growing stock, and increment have increased, while at the same time forests preserved their natural stand structure and composition, giving them the characteristics of a naturally preserved ecosystem.

Professor Mlinšek's contribution was crucial for the close to nature orientation of Slovenian forestry and closeness-to-nature of Slovenian forests. Thanks to the efforts of may forestry professionals over the past several decades who followed these guidelines until the present time, the forests of Slovenia exhibit a close to nature stand structure and composition.

It is no coincidence that the designers of Natura 2000 had difficulty in deciding what to include in the Natura network. In the end, 35.5% of the Slovenian territory was included and almost half of all the forests. Of course, many other forests (almost all of them) should have been included among natural areas of special value, but only those species habitats and habitat types endangered or important in the European Union were included.

Modern professional work within Slovenian forests over many decades was not only reflected in Slovenian forests, but was of exceptional importance for the reputation of the forestry profession in Slovenia, both with the public and politicians, state bodies, and institutions. During times of transition, when the roles and organization of the profession were being determined anew in Slovenia (similar to all others countries of the former eastern social system), Slovenian forestry had a very good starting point based on its heritage.

2 Forest management in Slovenia under new circumstances (after 1993)

Debates concerning provisions of the new Forest Act of 1993 and about the formulation of the public forestry service in regard to its tasks were not easy on the reputation of the forestry profession. A few unnecessary restraints of property rights over forests and over traffic with wood, which were in power until the social changes and were the consequence of the past social system, most certainly contributed to this. Perhaps in these public debates and in all types of negotiations forestry hasn’t achieved everything that would have been possible or someone might have wanted. It most certainly has achieved more than it would have if Slovenian foresters wouldn’t have had the described heritage of work within Slovenian forests, which couldn’t be overlooked by all impartial critics in the past and cannot be overlooked today. Among the achieved, there is also the foundation of Slovenia Forest Service and the extent of tasks that it is entrusted with.

- recent tasks of Slovenian Forest Service, with regard to the field of forestry work in the past:
    - formulation of forest-management plans; collect data about forests and keep a data base about forests;
    - creation of detailed silvicultural plans; determine silvicultural and protection works and mark trees for cutting (together with the forest owner);
    - on the basis of legal mandate, the Forest Service cooperates in spatial management and issues certificates of approval for interventions in the forest and in the forest area;
    - creation of plans for maintenance of forest roads and takeover the finished works;

- counselling of forest owners and educate them for work in forests;
- education of the public about the relation with forest and timber.

- new tasks of Slovenia Forest Service:
  - creation of management plans of hunting management areas;
  - management of special-purpose hunting districts - based on Forest Act from 1993 with four hunting grounds (106,000 ha), based on Wild Game and Hunting Act from 2004 with six new ones (their common surface is 154,000 ha), altogether 10 hunting special-purpose hunting districts with a common surface of 260,000 ha;
  - preparation for execution of direct control in nature (control of events in nature from the preservation and protection of nature point of view) - based on Nature Conservation Act;
  - according to the law from the finances area (from 2004), the Slovenia Forest Service is authorized for evaluation of damage in forests after natural disasters;
  - evidence suggests that forest management plans will be given the role of management plans for the areas of Natura 2000.

In the area of professional consulting of work with forests, changes in organization and the way of forestry funding in Slovenia as a consequence of deep social changes, didn't result as negative. Integrating the activities from the areas of managing forest stand development and the personnel who carry them out, including district foresters, into one joint public forestry service for all forests in Slovenia, as well as the inclusion of some new activities under the control of the Slovenia Forest Service (especially the area of game and of hunting) would enable even new possibilities and a higher work efficiency.

Some achievements of the Slovenia Forest Service:

- as a basis for all stand and other thematic maps, orthophotos have been used since 1998;
- growing stock and increment are measured with a unified methodology on permanent sample plots;
- the ecological (4), social (9) and production (3) functions of all forests were defined in detail;
- on this basis, the Slovenian Forest Service actively participated in developing the Slovenian Strategy of spatial development;
- detailed silvicultural plans for all forests were made (before that they hadn't been made for all forests);
- for the first time district wild game management plans were made (annual and 10-year plans);
- in all forests systematic monitoring of browsing young trees by herbivores was introduced;
- The Forestry Service leads or participates in numerous national and international projects (Life, Interreg, Phare, FAO).

However, there is also a negative side of the transition in Slovenian forestry:

- in state forests (25% of forests), professional management of forest development and the staff conducting the management in the field were separated from the production branch of forestry;
- funding of silvicultural and protection works in forests, as well as funding of building and maintenance of forest roads and skidding trails were cancelled;
- the already large share of private forests (62%) continued to grow with denationalization (to 75%).

In conditions with, on average, very small private forest properties (2.6 ha) and with totally unorganized (unconnected) forest owners, it is very hard to achieve effective forest management.

In such circumstances, it is much more difficult to realize forest management goals than it used to be in the past when all urgent forest works were done by forest enterprises and paid through income gained as a tax for sold wood. Nowadays, the forest owner is responsible for realizing all forest works, co-financed by the State. In regard to private property, its present condition is more similar to the condition in developed countries.

However, Slovenian foresters strive to continue the work with Slovenian forests in a way that is congruent with the practices introduced by professor Mlinšek in these new circumstances. We are more successful in the fields where the results of the work are not strongly affected by unfavourable objective circumstances for forest management. But much was done also in these fields and we try to find ways and proposals in the legislation for further improvement of our work.

The Forest Service also continues with the promotion of close to nature forestry, as the ideas of Prof. Mlinšek, Prof. Leibundgut, and other men of vision are still thriving. For instance, we sent the following statement among some other remarks concerning the Draft of the Action Plan for implementing EU Forest Strategy some weeks ago to the Standing Forestry Committee of the EU:

The objective "to promote close to nature forestry" should be mentioned as one of the first among environmental objectives. In fact close to nature forestry is the only efficient way to protect the biodiversity of the forests and the whole landscape. All other measures (i.e. Natura 2000 network, fully protected areas etc. are insufficient without general orientation of forestry towards the close to nature forestry. We are sure that close to nature forestry should be quoted even amongst guiding principles for the EU Forest Action Plan. It is too bashful or timid to admit that it is already included in the words "sustainability" and "multifunctionality".

Under the present circumstances we strive to work actively and professionally in all fields. The most important for the Slovenian Forest Service is to have a clear vision of how to manage forests. Prof. Mlinšek showed us this vision a long time ago. Thanks to him for the exceptional contribution to the development of Slovenian forestry, we wish him even more contacts with forests, good health and a lot of contentment.

References

Gašperšič, F., 1995. Gozdnogospodarsko načrtovanje v sonaravnem ravnanju z gozdovi. Univerza v Ljubljani. Ljubljana. pp. 403.
Mlinšek, D., 1968. Sproščena tehnika gojenja gozdov na osnovi nege. PZGGO. Ljubljana. pp. 117.
Perko, F., 2005. Trpeli so naši gozdovi. Založništvo Jutro. Ljubljana. pp. 327.
Letna poročila o delu Zavoda za gozdove Slovenije 1994–2004.

Sustainable and multipurpose forest management with production of high quality timber

Marijan Kotar*

Abstract

This paper deals with definitions of sustainable forest management, multipurpose forest use, and nature-based forestry. In the last decades, sustainable forest management has evolved into sustainable forest ecosystem management. The prerequisite for sustainable forest ecosystem management and multiple use of forests is forestry as it is understood under the paradigm of nature-based forestry. Multipurpose forest use will be fulfilled optimally if forest production is aimed toward the production of high quality timber and if the tree composition of the forest is suitable to the site conditions. A large share of high quality timber can be achieved by well designed forest regeneration and forest tending. The possibility of increasing the quantity of timber production in Slovenia is relatively small, while opportunities to increase the production of high quality timber are considerable. This can be achieved by site appropriate tree composition and by better assortment structure in tree stems.

Key words: sustainable forest ecosystem management, multipurpose use of forest, nature-based forestry, high quality timber, increment according to value

1 Introduction

1.1 Definitions of basic terms

Precise and intelligible definitions of basic terms are necessary for successful research work, expert knowledge, as well as prolific discussion. In the heading of the given article are three terms, which need clear definitions; they are: sustainable forest management, multipurpose forest use, and production of high quality timber. The first and second terms (i.e. sustainability and multipurpose use) are considered as principles or axioms, and the production of high quality timber as a management goal (objective).

* Prof. Dr. Marijan Kotar, University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources, P.O. Box 2995, SI-1001 Ljubljana, Slovenia
Tel. +386 1 423 1161, Fax: +386 1 257 1169, E-mail: marijan.kotar@bf.uni-lj.si

1.2 The principle of sustainable development in forestry

The principle of sustainable forestry has a requirement or tendency towards continuous and optimal fulfilment of material goods and other services, which can be maintained for the benefit of owners and society for present and future generations (Peters, 1983; Gašperšič, 1995). This definition is rather anthropocentric, and it had prevailed until the 80s in the last century. During the last decades, however, the definition of sustainable forestry has been widened to encompass the functioning of the entire forest ecosystem. Gašperšič defines sustainable forestry as a permanent tendency to stabilize the functioning of forestry in general, as well its subsystems, especially forest ecosystems. Thomasius (1994) defines sustainable forestry as a tendency towards stable functioning of forest ecosystems and permanent and stable effects (material goods and nonmaterial benefits) on the smallest forest surface possible. In these definitions of sustainability, both anthropocentric and ecological viewpoints are included.

Both the sustainable use of natural resources and the sustainable development of forests were discussed on the conference in Rio de Janeiro in the 1992 (UNCED: United Nations Conference of Environmental and Economic Development). Four ministerial conferences on the protection of forest in Europe were important for the definition of sustainable forestry (MCPFE); the first one took place in 1991 in Strasbourg, the second in 1993 in Helsinki, the third in 1998 in Lisbon, and the forth one in Vienna in 2003. The documents that were drafted at these Conferences or by the MCPFE Expert level meeting have been signed by 41 European countries, including Slovenia.

The conference in Helsinki was particularly important for the progression of sustainable forestry, where 6 criteria and many indicators were adopted for monitoring of sustainable forest management at the regional and national levels. In addition, the definition of sustainable forest management was also outlined at the Inter Ministerial Conference (IMC) in Helsinki (1993): "Sustainable forest management is stewardship and use of forest and forest land in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality, and their potential to fulfil, now and in the future, relevant ecological, economic, and social functions, at local, national, and global levels and that does not cause damage to other ecosystems".

Six criteria and 50 indicators were adopted in Helsinki, which have later been changed. In 2002, the experts group from MCPFE prepared a new array of indicators, which were adopted at the Vienna MCPFE in 2003. This document provides 6 criteria, 35 quantitative indicators, and 12 descriptive indicators (Requardt *et al*., 2004). Criteria are (measurable) facets or features that must be considered in setting objectives or policy. All criteria involve an element of change. Indicators are designed to measure quantitative evaluation of progress in meeting policy and management objectives (goals) (Schneider, 1995).

Further progress was made in Europe by expert groups and conferences with the aim of forming criteria and indicators for sustainable development of forestry. On the seminar of experts on sustainable development of boreal and temperate forests in Montreal (1993), additional criteria and indicators for such development and management were formed.

The criteria formed in Montreal were similar to those criteria outlined in Helsinki, but there were differences among the indicators. The indicators from Montreal were based on integrity of forests (i.e. holistic treatment of forest), and on forest ecosystem management. The Pan-European indicators were adopted on the following principles: they have to be scientifically faultless, technically realizable, financially possible, and they should assess whether sustainable forest development and management are functioning appropriately.

This means that it is possible to directly ascertain on the basis of forest surveys, forest inventories, and statistics about the forest condition, if sustainable development is guaranteed, but it is not directly possible to determine the changes in conditions. This is possible in Europe because the terms and practice of sustainability are deeply rooted in many centuries. In North America (USA and Canada) indicators are the consequence of new strategies in forest management and forest ecosystem management respectively, which were adopted under strong influences of various environmental associations and societies (e.g. Greenpeace, Save the rain forest, etc.).

The criteria which were adapted in Montreal and the Pan-European criteria for sustainable forest management are given in Table 1.

Table 1: Criteria for sustainable forest management (Schlaepfer, 1993; MCPFE, 2000)

Criteria from Montreal	Pan-European criteria
1. Biodiversity (species diversity, landscape diversity)	1. Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles
2. Productivity (of the ecosystem)	2. Maintenance of forest ecosystem health and vitality
3. Soil conservation (including erosion and natural hazards)	3. Maintenance and encouragement of productive forest functions (wood and non-wood)
4. Water conservation (including water quantity and quality)	4. Maintenance conservation and appropriate enhancement of biological diversity of forest ecosystems
5. Forest ecosystem health and vitality (ecosystem functioning)	5. Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)
6. Contribution to global ecological cycles	6. Maintenance of other socio-economic functions and conditions
7. Ability of the forest ecosystem to fulfil socio-economic functions	

It is evident from both definitions of sustainable forestry and the criteria used for sustainability, that the present understanding of this concept includes the sustainable and optimal management of forest ecosystems as a whole. In the past, sustainability assured sustainable yield, beginning with forest goods, such as wood, fruits, litter, and pasturing. Later, sustainability was widened to include maintenance of productive and non productive forest functions (goods and benefits), but still from a human viewpoint to fulfil basic needs and demands from the forest. The former criteria of sustainability had been carried into effect by forest management, nowadays criteria are brought to effect by forest ecosystem management. Within the old definition, sustainability was aimed at controlling nature. Under the modern principles of sustainable forest ecosystem management, a more cognitive and holistic comprehension of forests is considered, which does not diminish its complexity, but serves to maintain and enhance natural diversity in the ecosystem, which further increases its stability (Gašperšič, 2005).

1.3 The principle of multipurpose use in forestry

Multipurpose use of forests or multifunctional forests is the second term which has to be clarified and defined. The former use of forests was above all oriented to its productive function, although the forest had to fulfil the other nonproductive functions as well. However, the situation in the forests has been changing in the last decades, the causes of which not well known. For instance, we do not know exactly why biodiversity has been reduced on the species and ecosystem level in relation to acidification and entrophication with nitrogen. Similarly, we were until now without a satisfactory answer on the question of why site productivity has changed (increased) in the last decades in different parts of Europe. One possible explanation, but not very reliable is an increased concentration of CO_2, a higher concentration of nitrogen in forms accessible for plants (trees), changes in the climate (i.e. higher temperatures), etc. We also cannot determine the main causes for disturbances in the biogeochemical cycles of substances in forest ecosystems, which is reflected in neighbouring ecosystems as critical loads. Because of these reasons we have to redefine the multifunctionality of forests. Beese (1996) considers multipurpose or multifunctional forest use as forest ecosystem management in which the intrinsic control, habitat production, as well as cultural and socioeconomic functions should be developed to achieve the goal of an integrated assessment. Forest management should be sustainable, suitable for the site, and friendly to the environment (also for adjacent ecosystems). Multipurpose use of forests has to respect the four above mentioned main functions, which have equal rights. These functions are: regulating, habitat function, production and cultural-social function.

If these conditions are fulfilled, the maintenance or re-establishment of basic abiotic and biotic conditions for forest ecosystem functioning are assured, and at the same time the economical use of forest is warranted (Beese, 1996).

The multiple use of forest maintains the internal cycles of substances in the ecosystem and therefore leads to diminishing the loads of substances (pollutants) in neighbouring ecosystems, as it reduces the number of processes which bind and set energy and substances free. Thus, the processes of composition and decomposition as well as the processes of transformation of living and dead biomass run more organized, which minimizes soil degradation processes.

All the above mentioned processes maintain or re-establish the function of self-regulation and self-organization of forest ecosystems (i.e. regulation function). The forest ecosystem acts and runs as a self-renewable and self-organizing structure.

The multifunctional forest use leads to maintaining biodiversity on the species and biotope level, what leads to higher stability and resilience of the forest ecosystem. This is coupled with:

- higher diversity of forest stands in their arrangement in space and time;
- formation of mixed stands and mixed structural units;

- maintenance or re-establishment of soil structure;
- maintenance or re-establishment of stable chemical properties in the soil;
- formation of protected and peaceful zones;
- reduction of the input of toxic substances.

The consequences result in maintenance or re-establishment of the habitat function or function of living space.

Multifunctional forest use leads to higher efficiency for production needed resources by:

- diminishing the energy and substances losses;
- reactivation and acceleration of self-regulation processes;
- economical use of resources (economical husbandry).

All of which assures the long-term maintenance and encouragement of productive functions of forest, taking into account economical, ecological, social, and cultural conditions.

The multipurpose use of forest leads to social stability of the rural human population and serves to increase public wealth and prosperity by:

- production of renewable goods;
- assurance of income and places of employment;
- preservation of the cultural rural landscape;
- maintenance of social functions of the forest;
- maintenance of cultural heritage.

All these measures maintain or re-establish socio-cultural functions of the forest.

For verification of multipurpose forest use, we have to use indicators similar to those used for certification of sustainability. If we compare the indicators used for verifying sustainable forest development (Montreal and Pan-European indicators) and multipurpose forest use, it is evident that most of them are the same.

The indicators which are used by multipurpose forestry are divided in four groups (Beese, 1996):

- analytical indicators;
- composed (combined) indicators;
- systematic indicators;
- normative (standard-setting) indicators.

Analytical indicators are used to show us the state of the forest ecosystem and its functions. They give us values of single variables (characteristics and traits), such as: tree species composition, wildlife, growing stock (data about stands and animals), concentration of nitrogen, sulphur in leaves or soil, concentration of toxic substances in precipitation, and all data obtained by forest surveys. Composed indicators are obtained by a combination of system variables and they give us additional information about the ecosystem. Such indicators include: quantity of different acids which are set free in ecosystem processes, reactions of organisms to toxic substances in the ecosystem, and the quantity of available nutrients.

Systematic indicators show the properties of the forest ecosystem, such as their complexity, diversity, stability, resilience, elasticity, developmental potential, etc. These indicators are obtained by connecting analytical with composed indicators.

Aside from the above mentioned indicators, normative indicators or standards are also used for evaluating the forest ecosystem in terms of ethical, economical, social or political reasons.

These indicators provide information about the quality of individual component systems or about "conforming to standard development" of a system (i.e. development from human viewpoint).

By means of the objectives of society (by forming a common scale for evaluation) the analytical indicators change to normative indicators. It is not necessarily harmful for ecosystem functioning if the set boundary value for a certain analytical indicator is considered bad from a human perspective. Therefore, by multipurpose use of forests are required normative indicators which are not "natural constants" but indicators which serve for verifying how human demands and expectations are fulfilled (Beese, 1996).

A thorough review of the criteria for sustainable forestry and multipurpose use of forests shows that sustainable management can be assured if forests are treated (managed) in a particular way, which in Slovenia is known as nature-based forestry. The term nature-based forestry is not precisely defined and has in different countries different interpretations. Because of the different conditions in different countries the aims in forestry are not equal, so that the term nature based forestry is not possible to embody in a concrete form; it is paradigm (Bončina, 1997). In the fundamental document of ANW (Arbeitsgemeischaft Naturgemäße Waldwirschaft) are given the aims of silvicultural principles of nature-based forestry (Greuther, 1993).

The summarized contents of this document are as follows:

The basic idea of nature-based forestry is the holistic approach to forests, which are considered as sustainable, complex and dynamic ecosystems. Nature-based silviculture in forestry is a paradigm which is defined by principles of how to use the intrinsic processes and inherent characteristics of forests, and management goals have been achieved in the highest degree in the most rational way.

The basic silvicultural principles of nature-based forestry are:

1. Maintenance and appropriate enhancement of site productivity, which is attainable through the following measures:
    - preventing clear-cuts;
    - preventing whole tree exploitation (whole tree biomass);
    - preventing the transport of timber in the forest with devices and machines which cause a negative impact on soil conditions;
    - harvesting should be focused on single trees or small groups (by regenerating processes).
2. The tree species and provenances have to be suitable to the site. Tree species that are adapted to a certain site pose less yield risks. According to the share of tree species in mixed stands, consideration should be given to the composition

of natural phytoceonoses (natural plant communities), as well as oscillation (amplitude) in the portions of individual tree species. It is not necessary to reject a small admixture of non-native tree species, which grow well in similar site conditions.

3. The form in which tree species are mixed in the stand (individually, in groups, nests, etc.) should resemble the form which is common in naturally regenerated forests and which also assures high productivity and high richness in structure.
4. Harvesting and tending should be focused on individual trees (plenter principle), which leads to “Dauerwald” (i.e. constantly overgrown forest-without clearings) (Bončina, 1997). Depending on the site and tree species composition, as well as their requirements for light, a mixed, uneven-aged stand gradually develops, which has a structure very unlike a homogeneous forest. Exploitation, tending, and regeneration are done on the same area at the same time. Measurements and interventions are moderate, they succeed one after another in short time intervals, and follow the economic and functional value of the tree. The economic value depends on the stem quality, which is defined by the trunk form, tree dimension, current annual volume increment, and tree health. The functional value of the tree depends on its role as a structural constituent of the forest and on its ecological role. As a result, each tree has its own cut maturity.

In Slovenia, the paradigm of nature-based forestry was introduced to a lesser degree by Schollmayer in the Snežnik forests (Gašperšič, 1995) and to a higher degree by Mlinšek with his freestyle techniques in silviculture (Mlinšek, 1968, 1987). In Slovenia nature-based forestry is considered forest management that is in accordance with natural processes and natural structures in the forest. Nature-based forestry according to the definition given by Bončina (1997), defines the principles of how to manage the forest, how to use forest goods and benefits in a rational way, and how to maintain its sustainability at the same time. The key idea of nature-based forestry is cognitive access, which recognizes the natural processes in the forest, and controls them (to turn them to goals) in such a way that management goals are achieved in the most rational way, which means with the least possible financial means and the least possible risk. A deficiency of nature-based forestry is that it does not have fixed and valid indicators among various countries, as it is a paradigm of how to manage the forest. But if you examine sustainable forest management and multipurpose forest use, you can easily determine that forest ecosystem management, which is considered nature-based forestry, is a prerequisite for sustainable forest management and multipurpose forest use.

Nature based forestry that is guided by criteria and indicators, which are given for sustainable forestry and multipurpose forest use, will assure that forest management aims will be achieved in the most rational way and that forest ecosystem functioning will be sustained. To only use criteria for nature-based forestry without indicators can lead toward unexpected results. For example, in forest tending operations, many foresters would be tempted to under-manage under the pretence the forest development in nature-based forests has to be left to nature. In this case, the development of forests would be more true to nature, but the management goals according to the multipurpose use of the forest would not be achieved.

2 Multipurpose use of forests and production of high quality timber

The definition of multipurpose forest stressed that all of four forest functions are equal, two of which encompass timber quality (i.e. function of production and the group in which are arrayed socio-cultural functions). It is explicitly stressed that fulfilment of these functions should lead to social stability of the country's inhabitants and serve the welfare of the whole human population.

The same intentions were in the criteria from Helsinki and Montreal. The 7th criterion from Montreal is the ability of the forest ecosystem to fulfil socio-economic functions, and the 3rd criterion from Helsinki requires maintenance and encouragement of productive functions of the forest (wood and non-wood). As you can see, sustainable forest management as well as multipurpose forest use require considerable yield according to biomass.

The founders of nature-based forestry have not refused or denied the importance of timber production, but have equalled this production with others functions of the forest (Mlinšek, 1968, 1987). Up-to-date forest management tends to assure such timber quantity production in forest stands with natural structure and suitable site conditions for native tree species. It is aimed that the level of timber production in a stand should approach the site productivity, but this holds only for timber quantity. According to criteria, the highest possible timber production according to value has to be assured – only in this way the management goals will be fulfilled. As a result, the maximal share of high quality timber must be achieved in a given forest structure. Such an objective is achieved by goal oriented regeneration and forest tending. With proper regeneration and tending, the forest development should be oriented such that maximal sustainable production according to value will be reached. This production depends on site and tree species, and therefore should be tended inside the same site unit. The share of tree species with wood that reaches higher prices on the market will approach the upper border (limit) (i.e. the allowed share), and the share of tree species with low wood prices will approach to the lower border (i.e. the necessary share) (Kotar, 2005). If you speak about the "natural share" of individual tree species, it means the share of the species on a given site (site unit) in the forest, where development has been left to nature. An examination of these stands shows that these shares vary in intervals; they have lower and upper borders. The lower border is considered as a necessary border and the upper as the allowed border.

Timber production according to value also depends on the assortment composition, and not only on tree species composition. Some tree species have assortments with little price differences, where the ratio between the most expensive and the cheapest assortment is small. These include European hornbeam, Hop-hornbeam, Trembling poplar. In contrast, tree species with large differences in prices between their assortments, where the ratio between the best paid and the worst paid assortment is very high, include Sessile and Common oak, Wild service tree, Witty pear tree, Wild pear, etc. With these species, the ratio can exceed 200.

Realization of multipurpose forest use requires that timber production according to value approaches the upper border. Therefore, it is necessary in forest ecosystem management to introduce indicators that will show on the level of the least territorial units how successful timber production is according to value, and how the aims of multipurpose forestry are realized. Perhaps it would be convenient to mark with durable sign all of the future-trees which have in the lower part (for example lower quarter) of the stem the timber quality which can give at target diameter veneer logs. Each tree of Whitty pear, Wild service tree, and Common oak, which has approached target diameter and has in the lower part of the stem veneer quality reaches the price of one car. Only a little less in value includes high quality timber from Wild cherry, Sycamore, and Wild pear, etc. There is a relatively small chance to increase timber production according to quantity in Slovenia. The current annual volume increment (CAI) is 6.4 m^3/ha (ZGS 2005), and according to the estimate given by GIS, it amounts to 6.8 m^3/ha (GIS 2005), while site productivity is estimated at about 7.5 m^3/ha/year. If the current annual increment would happen to increase to the upper border (i.e. up to 7.5 m^3/ha/yr), the enhancement would amount to a 17% increase, but this would be connected with a large increase in forest work (tending) because the law of diminishing return is applicable to timber production. Much larger are the possibilities for increase production of value, but this is connected with forest tending and more professional and specialized work.

In Slovenia, the growing stock and current annual increment has increased in the last decades, and more or less intensive forest tending has been carried out for more than forty years. Yet the share of wood assortments of the best quality on the market has not increased. This is partially a consequence of stronger criteria (standards) for classification in the assortment classes (criteria have been less and less tolerant). This could also be related to the fact that stands treated with intensive tending during the last decades are not yet in the regeneration phase (they are to young). A further cause is that the regeneration phase has been postponed in old stands that should be regenerated. In these stands, the quality of timber has decreased and is decreasing still, as the trees are becoming older and defects in the stem are more and more frequent. The reason for postponing the regeneration is a fear to meet with failure due to high population densities of herbivores. Lately, different motives advocating postponement of regeneration have appeared, and these new motives are a result of misinterpretation of nature-based forestry. Some foresters favour large diameter trees, and therefore a felling cycle that is prolonged to an excessive extent, far beyond the optimal tree age. The production of large diameter timber is reasonable if it leads to higher value production, and that is the case if healthy trees with high quality timber grow in the forest. The production of trees with low quality timber and large diameter is not in accordance with multipurpose use of forests, especially in cases when rotation periods are increased to very long intervals, which is connected with reduction in value (i.e. with diminishing timber quality). This is quite common with Common beech (red heart), Black alder, Wild cherry (rottenness), Common ash, Narrow-leaved ash, and Sycamore (brown heart).

The amount and share of trees which have in the first or second lower quarter of the stem (first quarter is the lowest, second quarter is next to first) wood (logs) of the highest quality from Common beech (veneer and logs for peeling) and Norway spruce (sawn wood I. and II. class) is given on Tables 2a and 2b. The analyses were carried out in mature stands older than 100 years. On each site unit, five sample plots 30 x 30 m (900 m^2) in size were analysed. The numbers show the arithmetical mean for the five plots. The tables show that the share of trees with the highest wood quality in the lower part of the stem depend on the site unit. The analysed stands represent the best stands in Slovenia according to timber quality, but these stands have been treated by forest tending during the last 20 to 30 years (before they were analysed). Forests that will be treated with forest tending during their whole life span (rotation) will have similar timber quality to the stands given in Table 2a and 2b.

Table 2a: The number and share of trees per ha in the best stands in Slovenia, which have wood of veneer quality or wood for peeling in the first or second quarter from the bottom to the top of the tree for Common beech (Kotar, 1989).

Site unity	Number of trees per ha with the highest quality in the first or second quarter	Percent of trees with the highest quality-calculated on the total number of trees in the stand canopy
Castaneo-Fagetum; Dletvo – Ilirska Bistrica	227	73%
Luzulo-Fagetum; Velika Kopa - Haloze	193	71%
Vicio oroboidi-Fagetum, Log – Tisovec	169	51%
Blechno-Fagetum, Mamolj – Litija	180	76%
Hedero-Fagetum, Bukov vrh – Straža	216	70%
Hacquetio-Fagetum, Peščenik – Novo mesto	118	37%
Lamio orvalae-Fagetum, Šoštanj	169	55%
Seslerio-Fagetum, Starod – Kras	93	29%
Lamio orvalae-Fagetum, Ogence – Idrija	142	36%
Lamio orvalae-Fagetum, Gače – Črmošnjice	180	38%
Anemone-Fagetum, Krma – Bled	164	42%
Omphalodo-Fagetum, Loški potok - Kočevje	149	52%
Omphalodo-Fagetum maianthem., Jurjeva dolina - Mašun	160	60%
Luzulo-Fagetum abiet. Polamanek – Zg. Savinjska dolina	160	59%
Ranunculo platanifolii-Fagetum Črni Dol – Mašun	251	44%
Anemone-Fagetum var.geogr. *Luzula nivea*, Gozdec – Bovec	41	9%

Table 2b: The number and share of trees per ha in the best stands in Slovenia which have wood of the highest quality in the first or second quarter from the bottom to the top of the stem for Norway Spruce (Kotar, 1980)

Site unity	Number of trees per ha with the highest quality in the first or second quarter	Percent of trees with the highest quality-calculated on the total number of trees in the stand canopy
Rhytidiadelpho lorei-Piceetum abiet., Pokljuka	149	33%
Rhytidiadelpho lorei-Piceetum, Pokljuka	187	43%
Homogyno sylvestris-Fagetum, Jelovica	327	64%
Avenello flexuosae-Piceetum, Kaštni vrh – Zg. Savinjska dol.	96	29%
Adenostylo glabrae-Piceetum, Podvežak – Zg. Savinjska dol.	184	27%
Luzulo sylvaticae-Piceetum calam.ar., Glažuta - Pohorje	62	15%
Adenostylo glabreae-Piceetum, var.g.Card.trif., Uršlja gora	91	26%
Lonicero caeruleae-Piceetum, Smr. Draga – Trnovski gozd	82	25%
Hacquetio-Piceetum lycopod., Črni dol - Mašun	102	20%

The number of trees that have wood of the best quality in the lower part of the stem depends on the site unit, tree species, and silvicultural measures (i.e. from the input of work – quantity of work). As site productivity increases, the share of the highest quality timber also increases. If you compare the share of logs (sawn wood) for all quality classes – which is less than 40% for broad-leaved species in Slovenia – with the data given in the Tables 2a and 2b, it is evident that there are many possibilities to enlarge the value production (i.e. to increase the share of high quality timber). With tending, it is possible to enlarge the value production by increasing the share of minority tree species and by increasing the share of high quality timber inside these tree species. High quality timber from minority tree species is typically very valuable and reaches very high prices, but these tree species are usually less competitive than other more common tree species. Therefore, in forests which have not be tended, they usually have poor architecture, with crooked stems, asymmetric crowns, and timber with many defects, resulting in low quality timber and very low prices. The amount of labour needed for forest tending is relatively small. The analysis which was carried out in the beech forest shows that it is necessary to input only 152 working hours from a forest worker and 28 hours for a forester (i.e. in total, 180 hours per ha for the whole rotation – living span of a stand). This work includes the following activities: tending of young growth (twice), tending of thickets (twice), and precommercial thinning (twice) (Kotar, 1997). The enlarged yield (harvest) from tending must compensate a little more than one salary per month of a forest worker (if the costs are not prolonged). Tending also increases the other benefits of the forest, which are assured in a higher degree if tending has been done. Large differences in the prices between assortments of low quality and the best quality show that forest tending is profitable.

The price of veneer logs is several times higher than the price of sawn logs for Common beech, and the differences are even larger for Wild cherry, Sycamore, Oaks, Wild service tree, Whitty pear, Wild pear, Nut trees, and so forth.

If the tree composition in the present forest and rotations of stands would be determined on the basis of timber prices from this moment, and on the basis of the maximal land annuity (financial rotation) – which was the main reason 150 years ago for planting pure spruce and even-aged pine stands on sites where broadleaved trees prevail – we would have the forests in which the tree composition would be similar as in the forests which have natural forest tree composition.

The orientation in the production according to value (i.e. into production of high quality timber) is a prerequisite for multipurpose forestry and sustainable forest ecosystem management. With such an orientation there is no risk of insufficient dead biomass (i.e. snags because of tending in the forest). If regeneration is carried out successfully, the forest will have enough so called "sterile cells", or the cells without (kernel) a core (i.e. without a future tree, which is promoted (advanced)). The cell in the case of thinning is the group of trees that are in narrow contact and have a future tree. The cells without future trees have to be left to natural development. On such cells the process of natural mortality of trees is the conducting factor within forest development. The dead trees in sterile cells have to remain and they serve as habitats for many animal species in the forest.

3 Conclusions

Forest management that had in the past the task to meet the needs of the human population and forest owners (i.e. to assure the foods and benefits from the forest in a sustainable way) has changed in last decades to forest ecosystem management. The main properties of the forest ecosystem are that it is self organizing and self-regulating, and both of these processes will be preserved if managed forests are similar to forests which have natural structure. This means that managed forests also contain processes that are characteristic of natural forests. Within forest ecosystem management, these processes have to be directed in such way that the system functions as a forest and at the same time it fulfils the forest management goals on the highest degree.

Because the production function (wood and non-wood) in the forest ecosystem is equal to other functions, the ecosystem management has to be lead in such way that the production of timber and other forest goods is optimal. The production function encompasses the whole biomass production (phytoceonoses and zoocenoses) and all of the renewable resources in the forest. This also includes water, which is today a very important natural resource, and which quality is only good in catchment areas covered by forests. The production function of forests will be fulfilled on an optimal level if the growth developmental processes will be oriented to high quality timber production. The share of high quality timber depends on the site, forest structure, tree species, provenances, efficiency of regeneration, and tending measures. Tending is a prerequisite for successful forest ecosystem management. Successful sustainable forest ecosystem management and multipurpose use of forest require treatment in the forest known as nature-based forestry. This means that the use of forests has to be: sustainable, suitable to the site, and friendly to the environment. The paradigm nature-based forestry is in accordance with the statement of Davidova: nature has to be treated on a creative and cultural way; only in such a way will its vital force be saved (Gašperšič, 2005).

By forest ecosystem management is necessary to introduce indicators which show us how much management is really close or far from nature-based forestry and to what extent the forest works as an ecosystem.

A large part of the indicators that were accepted on the national levels has to be turned to lower management units. Besides the successfully asserted indicators, such as: tree species composition, forest health and vitality, growing stock, forest damage, volume increment, age and developmental phase structure, annual cut, quality of timber, defoliation, tending input, and volume of dead-wood (snags), it will be necessary to introduce and monitor the following indicators: biodiversity (plant an animal species), quality and quantity of water, content of heavy metals in the biomass, the quantity of Cd, Cr, Pb, Cu, Zn and the soil, CO_2 balance, annual value increment, finding places of trees with extra valuable timber (Maple species with curly wood etc.), the site units for Common beech where the odds of red heart appearance are very high, the places with nests of endangered birds, habitats of other endangered animals, and many others, which are important for undisturbed functioning of forest ecosystems.

4 Summary

In the last decades, sustainable forest management, which assured a sustainable forest yield, shifted to sustainable forest ecosystem management. The basic characteristics of a forest ecosystem are that it is self-regulating and self organizing (i.e. intrinsic control). These characteristics will be maintained if the structure of a managed forest resembles that of a natural forest, where forest development has been influenced by site conditions only. Therefore, under sustainable forest management, efforts tend to respect all of the processes which are inherent to a forest ecosystem in such a way that sustainable ecosystem functioning (control function) is assured, but the relevant economic and social functions of forest are also supported by so called extrinsic control. Both controls together form organic control.

As multipurpose forest management or multifunctional forest use is considered, such a forest ecosystem management in which the intrinsic control, habitat, production, as well as cultural and socioeconomic functions should be developed to achieve the goal of an integrated assessment. The timber production is only one part of socioeconomic functions and includes sustaining the harvest of timber from forests over time, taking into consideration the ecological constraints on harvesting. Timber production will be well fulfilled only if the growth processes will be led in such way that the forest will produce the wood of the highest quality. The share of high quality wood depends on site conditions, forest structure, tree species composition, provenances, successfulness of regeneration of stands, and tending. Forest tending is a prerequisite for successful sustainable management of forest ecosystems and simultaneous achievement of forest management goals.

Sustainable forest ecosystem management and multipurpose forest use need management that has been promoted by the paradigm of nature-based forestry and nature-based silviculture. In other words, forest management should be sustainable, suitable for the site, and friendly (harmless) to the environment. For monitoring sustainable forest ecosystem management and multipurpose use of forest, some new indicators should be implemented, which will provide indicators of successful management and forest ecosystem functioning. Beside the common indicators, such as tree composition, growing stock, current annual increment, stand structure, developmental phases, health conditions, damage, general quality, and the quantity of snags, some new ones have to be introduced, such as CO_2 balance, quality and quantity of water sources in the forest catchment area, quantity of heavy metals in leaves, herbs and herbivorous, annual increment according to value, and many others which inform us about forest system functioning.

In Slovenian forests, the current annual increment has almost achieved 80% of the site productivity, but the annual increment according to value is lower than half, which could certainly be increased through tending. Proper socioeconomic forest functioning will only be achieved if Slovenian forests will be treated properly, meaning tending should be carried out on the whole area.

References

Beese, F.O., 1996. Indikatoren für eine multifunktionelle Waldnutzung. Forstw. Cbl. 115, 65–79.

Bončina, A., 1997. Naravne strukture gozda in njihove funkcije v sonaravnem gospodarjenju z gozdom. Doktorska disertacija, Odd. za gozdarstvo, BF, Univerza v Ljubljani, pp. 210.

FAO, The Pan-European Forest Process on Criteria and Indicators for Sustainable Forest Management. http://www.fao.org./DOCREP/004/AC135E/ac135e09.htm

Gašperšič, F., 1995. Gozdnogospodarsko načrtovanje v sonaravnem ravnanju z gozdovi. Odd. za gozdarstvo, BF, Univerza v Ljubljani, Ljubljana, pp. 403.

Gašperšič, F., 2005. Teoretske osnove kontrolne metode v gozdnogospodarskem načrtovanju. Odd. za gozdarstvo in obnovljive gozdne vire, BF, UL, Ljubljana, pp. 167, in press.

Greuther, W., 1993. Naturgemäße Waldwirtschaft-Ziele, Grundsätze und Erfahrungen. Dauerwald 8, 3–5.

Kotar, M., 1980. Rast smreke *Picea abies* (L.) Karst na njenih naravnih rastiščih v Sloveniji. Strokovna in znanstvena dela 67, Inštitut za gozdno in lesno gospodarstvo, Ljubljana, pp. 250.

Kotar, M., 1989. Prirastoslovni kazalci rasti in razvoja bukovih gozdov v Sloveniji. Zbornik gozdarstva in lesarstva, Ljubljana, 33, 59–80.

Kotar, M., 1997. Donos gozda v povezavi z nego gozda. Ali moramo načela nege gozda spremeniti? GozdV. 55, 130–163.

Kotar, M., 2005. Zgradba, rast in donos gozda na ekoloških in fizioloških osnovah. Zveza gozdarskih društev Slovenije in Zavod za gozdove Slovenije, Ljubljana, pp. 500.

Köhl, M., Haussmann, T., Larson, T-B., Päivinen, R., Peare, D., Prins, C., 2002. Improved Pan-European Indicators for Sustainable Forest Management. Adapted by the MCPFE Expert Level Meeting 7–8 Oct. 2002, Vienna, Austria, pp. 6.

Mlinšek, D., 1968. Sproščena tehnika gojenja gozdov na osnovi nege. Ljubljana, Jugoslavenski poljoprivredno šumarski centar Beograd, pp. 117.

Mlinšek, D., 1987. Naravoslovne in gozdarske znanosti jutri. Zbornik gozdarstva in lesarstva, Ljubljana, 30, 77–84.

Schlaepfer, R., Innes, J., Steward, R., 1994. Workshop on enviromental criteria/indicators for the sustainable development of boreal and temperate forests. CSCE, Seminar of experts on sustainable development of boreal and temperate forests. Technical report. Natural Resources Canada, Canadian Forest Service, Ottawa, 2–11.

Schneider, T.W., 1995. Kriterien und Indikatoren für eine nachhaltige Bewirtschaftung der Wälder. AFZ 4, 105–108.

Requardt, A., Köhl, M., Näscher, F., 2004. Ist Nachhaltigkeit messbar und dokumentierbar AFZ-Der Wald 9, 494–498.
Thomasius, H., 1992. Grundlagen eines ökologisch orientierten Waldbaus. Dauerwald, 7, 2–21.

Nature-based management started in Central Europe as a response to forest overexploitation in fragile mountain landscapes. Despite declared support for sustainable forest management by European societies, nature-based management is endangered by many circumstances. However, there are also many tendencies favourable for it's future development. Utilising favourable trends, while overcoming the developmental constraints, may for the first time in history result in an important expansion of nature-based forestry, and consequently significantly raise the quality of life in Europe.

This book contains contributions from thirteen experts in the field of nature-based forestry and covers fields as: historical development; criteria, terms and definitions; monitoring; contemporary problems; developmental constraints and forest threats; consequences of decreasing forest tending and increasing of non-management; answers and solutions to the problems; possibilities for rationalisation and adaptation; future opportunities; reasons for continual nature- based management of forests; management of protected forests and areas; practical examples of best practices; and possible professional and political alliances to promote nature-based forest management in Europe and the World. The book can be used by practising foresters, forest owners, researchers, landscape ecologists and planners, forestry students, nature conservation experts, as well as the broader forest interested public.

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