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Protected forests in Europe approaches-harmonising the definitions for international comparison and forest policy making

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Abstract

Comparison of forest protection between regions in Europe is extremely difficult, because there is such wide variation of strategies, procedures and constraints; the way forests have been used historically and their present closeness to nature also varies, and furthermore so does the definition of what constitutes a forest. For the European Ministerial Conference on the Protection of Forests in Europe (MCPFE) in 2003, forest protection has been harmonised into three categories for the sake of comparison: protection to safeguard biodiversity, protection of landscape and specific natural features, and protective forest functions.

There is no single, uniform and universal model and no internationally agreed target with respect to the percentage of forests which should be protected. What is more important than a fixed percentage level of forested area (e.g. 5 or 10%) is that the protection network should be biogeographically and ecologically representative and accordingly distributed on a regional basis. Long-term practical experience and research have proved that conservation of different species of organisms can be assured by appropriate silvicultural management of multifunctional production forests. Consequently, the focus of debate in Europe appears to shift more and more from total protection in segregated areas to 'precision protection' and to combining protection and timber production in the holistic, integrated concept of modern management of forest areas.

Advances in regional ecological planning and the growing adoption of naturalistic forest management practices have slowed the decline of the biological diversity in the multifunctional production forests. However, this fact is not yet widely and sufficiently acknowledged and appreciated. There is consequently a political and scientific need for continued study of the effects of naturalistic silvicultural management on the biodiversity of forests. Information from such research is crucially needed before new and additional protection networks and schemes are set up on a large-scale. Protection by voluntary contracts between parties is a workable model concept for European forestry based on private forest ownership. In small private forests, patches of forest worth protecting are often small and located within production forests.

Forest certification can contribute to the efforts of maintaining biodiversity in multifunctional production forests and offers an instrument of independently monitoring and verifying that forests are managed according to the agreed criteria. Forest certification is not an alternative or a means of increasing forest protection, because as a voluntary process it cannot guarantee the permanence of protected areas or deal with issues of finance and compensation.

Keywords: Protected forests; Strict protection; Classification of protection; Naturalistic silviculture; Biodiversity

1. Situation

Forest protection is an important tool to conserve, preserve and generally maintain and enrich biodiversity. In the Helsinki process in 1993–1995, the components of biodiversity in the forest ecosystem were defined in a European context (Ministerial Conference on the Protection of Forests in Europe, 1993, 1994). Based on these definitions there are two approaches to conserve and preserve, or generally to maintain biodiversity in forests.

At a regional level, each country, for example, must take care of the protection of rare and valuable forest ecosystems. In this case, a protection area network is created in each region. The density, representativeness, size and total number of protection areas in the network clearly depend

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on the variation in the forest stands, vegetation zones and the overall state of the forest. As the only constant in complex dynamic forest ecosystems is change and therefore present states cannot be preserved, the general concept is that the protection network should include the whole successional series of forest stands including all temporal stages of the development cycle.

Total protection can only secure and preserve a certain number of habitats of rare species in any locality. Therefore silvicultural management is essentially required to maintain large-scale biodiversity in multifunctional production forests (Parviainen, 1998). This includes a large part of the forested areas outside the actually protected area. In most European countries this means at least 80–90% of the forested area. In some western and southern European countries (e.g. Ireland and Portugal) favourable site conditions enable efficient wood production in intensive tree plantations. But in the countries of the boreal and cool temperate zones of Central and Northern Europe, sustainable forestry involves naturalistic silvicultural management over large areas. The chosen concept of silviculture also determines the amount of those forested areas which remain completely outside commercial forestry and which are crucial refuges to ensure the survival of living vulnerable or rare organisms. The time-tested and verified hypothesis is that the closer to nature forestry activities are in multifunctional production forests, the less need there will be for total forest protection. The question is, how to balance the ratio between totally protected areas and managed forests.

Endangered species are seen as indicators of change in the forest ecosystem. Changes in the number of endangered species act as alarm signals when forest quality declines and its species spectrum impoverished due to unsuitable silvicultural practices. A similar indicator of forest status is the increase in environmental strain. Both the number of endangered species and the environmental strain have to be continuously monitored, and critical limits should be explored and defined wherever possible.

2. Problems

The close, variable and complex, direct and indirect interactions between humans and forests, and between forest ecosystems and other categories of land-use systems in Europe, makes it very difficult to assess risks and prospects of protection and conservation schemes and options. The political discussion since 1980 until today has emphasized the separation of protection areas apart from multifunctional forests. This concept favoured especially by politicians, environmental ministries and NGOs leads to many consequences in administration and practical management of protected areas, and may increase risks in stability of forests. However, as a major part of forests in Europe is being used simultaneously for economic, recreational and other multiple use purposes, integrated forest management plays a major role in maintaining biodiversity. Currently the concepts of forest conservation are going through a significant change from static approach towards dynamic approach. In fact, conscious management, ranging from non-intervention to intensive methods, is necessary to assure conservation and dynamic evolution of species and ecosystems.

It is assumed that, to counteract uncertainties, comprehensive forest biodiversity monitoring should be extended beyond the forest border to cover interaction with other land use components and with trees in the landscape (Parviainen and Päivinen, 1998; Puumalainen, 2001). In addition to conventional assessments, multifunctional forest resource assessments should study forests in the landscape context and provide information on the transition zone between forest patches and other types of land cover. Seasonal and diurnal migration and casual crossings between the edges and borders of biotopes are of prime importance for the diversity of specific organism groups and their abundance in nature. For example, in forests and agricultural fields the abundance of species is related to the inner areas and outer fringes of the forest or field. Diversity in structure is related to high species diversity forest stand and landscape levels. Edge effects caused by the mosaic of patches and borderlines inside of forests are not of less importance and can be influenced and even directed by silvicultural methods.

3. Objectives

In this paper we review and discuss the role of protected forests for conserving, preserving and maintaining biodiversity, how the approaches and classifications of forest protection influence on the goal setting of protection and which tools are available for enriching biodiversity in Europe other than simply setting aside forest areas outside multifunctional production forests as totally protected forests.

4. Protection of forests in Europe

In the debate on forest protection, the most important forest policy goals have been to complement protection networks and make them regionally more representative. National networks of protected forests create the basis for organising protection by individual countries, but large-scale international cross-border approaches grossing the boards are required. In the European Union, the protection network for all ecosystems is the Natura 2000 network.

The aim of the Natura 2000 network is to ensure the preservation of biodiversity in the area of European Union. A network of areas is being formed in the Member States

according to the EU Habitats and Birds Directives (Habitats Directive 92/43/EEC and Birds Directive 79/409/EEC), with the aim of preserving the most important habitats, natural habitat types and species. For example, in the European context Finland has special responsibility in the protection of the natural habitat types of the northern coniferous forest zone, such as natural forests of primary succession stages of land upheaval coast, western taiga forests, and Aapa and Palsa mires. Besides forests, the Natura 2000 network also includes other ecosystems, such as waters, fields and meadows, and Alpine areas.

Forming part of the Natura 2000 network does not necessarily limit the use of the area. Movement, berry picking, farming, fishing and hunting with an appropriate permit are still allowed in Natura 2000 areas, so long as the protection of a particular species does not set any seasonal limitations. However, any activities that weaken the status of the area in terms of the preservation of important natural habitat types or the habitats of certain species are prohibited.

In some regions of Central Europe and in the Alps huge proportions of managed forests, mainly private owned, have been notified as Natura 2000 areas. In contrast to the boreal region, most of the concerned habitat types are characterised by a larger spectrum of tree species, mainly broadleaved species, but there are also more possibilities of silvicultural treatments to foster economically interesting tree species. Presently is not entirely clear, which forest measures will be allowed and which not. The prohibition of engraving changes in the proportions of naturally occurring tree species are the main reasons for severe conflicts between forest owners and authorities responsible for the implementation of the EU directives. The question of appropriate compensation payments is still not solved, whereby also a general decline in market value of the properties is to be considered.

A clarification of the state of forest protection in different countries is needed in order to achieve a harmonised discussion. However, compiling consistent information and comparing forest protection in different countries has proved to be more difficult than expected. Data on forest protection has been collected internationally in connection with other forest inventory data through Temperate and Boreal Forest Resource Assessment (TBFRA, 2000) using IUCN classification, by EEA lists on designated protection areas and in the form of maps, e.g. by the IUCN-World Conservation Monitoring Centre (WCMC), in Great Britain. In Europe, the terminology of forest protection, especially that for the status of strictly protected forests, was examined in 1996–1999 in the COST E4 Action: Forest Reserve Research Network (European Commission, 2000). A new COST Action, E27 PROFOR (Protected Forest Areas in Europe), was launched in 2002 aiming to further clarify and analyse the classification of all categories of protected forests.

The studies have produced very varied results on the state and numbers of forest protection in Europe. Reasons for the difficulties in comparison include the different definitions of forest, variation in protection categories and in the activities permitted in protected areas, differences in the naturalness of forests, variation between countries in the fragmentation or continuity of forest cover and differences in protection objectives.

4.1. Strictly/totally protected forests in Europe

The COST Action E4 Forest Reserve Research Network, carried out in 1996–1999 (Diaci, 1999; Parviainen et al., 1999, 2000a,b; European Commission, 2000), was the first systematic analysis of strictly protected forest areas in Europe. Over 100 scientists and nature conservation administrators from 19 COST member countries, Russia and eight central and east European countries participated in the action.

In the COST Action E4 countries, over 90 different categories for protected forests were observed. The terms protected, unprotected and protection tend to be inexact and lack consistency in interpretation among countries and organizations.

Of all the natural forests in Europe, the most interesting category relevant to this COST Action was strictly protected forests. These forests are left to develop freely in a state that is as original as possible. Forests left for free development can be found under various categories of protection, and hence the COST Action E4 surveyed the following categories nature reserves, national parks, old forest protection areas, wilderness areas, cultural sites, etc. in addition to the strict reserves.

According to information contained in the country reports, there are nearly 3 million hectares, of natural free development forests (1.6% of the total forest area) left in strict forest reserves and other protection categories in Europe (i.e. participating COST countries without Russia, see Fig. 1). Most of these remnants are located in forest reserves with protected by law. There are over 3500 strict forest reserves in European countries.

The interpretation of strict reserve varies from country to country. In many cases, game control, fire control, recreation in the reserves and the removal of invading exotic species are allowed. The common denominator for a strict forest reserve is no silvicultural management. The ideal non-intervention concept of developing appreciable areas of real untouched forest is not a realistic scenario for Europe.

The largest natural forests strictly protected in reserves are in Finland, Sweden and the remote areas of central and eastern Europe. Due to the continuous use of forests historically during thousands of years, the largest original forests in Europe can be found only in the boreal forest zone on the European side of the Russian Federation, in the States of Komi and Archangelsk and in some parts of north

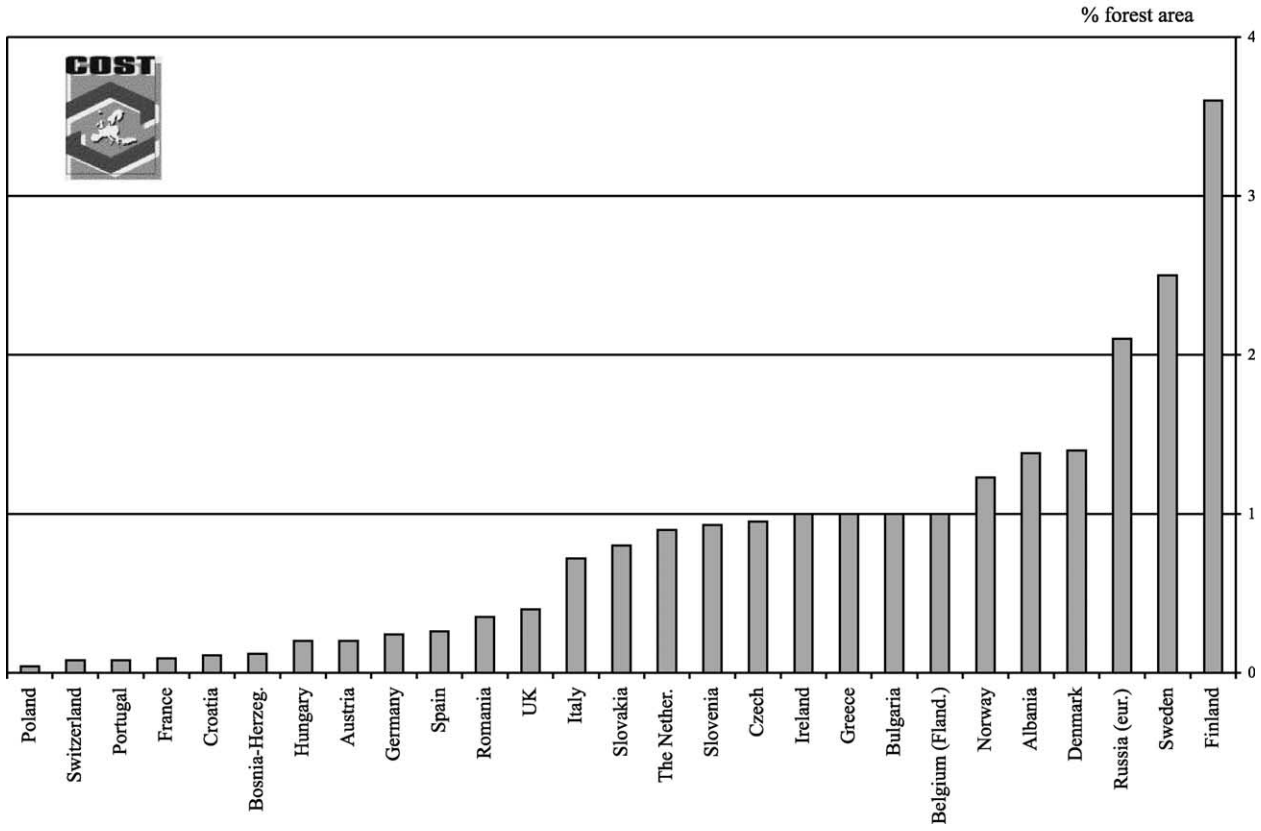

Fig. 1. Strictly protected forest areas to be found in strict reserves, nature reserves, old forest protection areas, core areas of national parks, of wilderness areas or of other protected forests in 26 European countries and European part of Russia (source: COST E4 1996–1999).

western Karelia near the Finnish border. Scattered relics of native forests also survived and still exist in mountainous areas and wetlands especially in the Balkan, Alpine and Carpathian biogeographic regions (Diaci and Frank, 2001).

The settlement of human had direct effects on forests in central Europe, even in the Alps already in the bronze age (2500–900 BC) man settled high altitude regions. For example, copper mining near Kitzbühel was practised in an area of ca. 2000 m above sea level. The nutrition for humans was acquired by creating and using of alpine meadows for cattle (Kral, 1979). The cattle grazing had enormous effect on species composition and dynamics of the upper timberline (Kral, 1971).

Generally, the forests had undergone in central Europe a reduction of 1/3 of the original area over only a few centuries during the middle ages. In the alpine region huge waves of deforestation occurred between the 8th and 14th century. During the middle ages, the upper altitudinal line of cereal growing and cattle breeding was higher than today because of the favourable climate. This human induced decline of the upper timber line in combination with heavy browsing and use of fire had the most severe impact on natural forest succession thus far (Kral, 1979).

Caused by a decline of climatic conditions in the 16th century high altitudinal permanent settlements had been abandoned, and as consequence the use of alpine meadows decreased rapidly. At the same time, the increasing demand on wood, firstly for salt production, later on for charcoal production for expanding iron industry and finally for construction and firewood in expanding settlements and towns led to a strong intensification of cuttings. During the peak of mining industry in the 15th, 16th and 17th centuries huge clear cuttings with an uncontrolled natural regeneration led to a further decrease of the forested area. The economically important spruce was favoured and regenerated also by planting. Pollen analysis and archive material shows an impoverishment of the natural forests during this period.

Beginning 300–400 years ago human impact on forests in northern Europe also became intensive, though less so than in southern and central Europe (Sustainable Forest Management in Europe, 1998; Parviainen et al., 1999, 2001). Between the 17th and 19th centuries, forests in Finland, central Sweden and central Norway were utilized for the production of tar, metallurgy, slash and burn agriculture, hunting and reindeer husbandry.

The reservation concept used in boreal and temperate zone in North America, and Russian Siberia, where large continuous areas are left untouched, cannot be applied to the densely populated European continent (International Forest Conservation, 1999). Because of the historical use of forests in Europe and the forest ownership structure, the European

concept of forest protection has become a more complex and varied one than in other continents with huge areas of untouched forest. In Europe, forest protection includes forest areas where use is limited to a varying degree. Protected areas are often small, located in majority on land owned by the State, local authorities or other bodies and their management and upkeep is linked with the aims of multiple forest use.

Table 1
IUCN categories—protected area management categories, based upon the 1994 system

Protected area management categories (IUCN, 1994) Areas managed mainly for:
I. Strict protection (i.e. strict nature reserve/wilderness area)
II. Ecosystem conservation and recreation (i.e. national park)
III. Conservation of natural features (i.e. natural monument)
IV. Conservation through active management (i.e. habitat/species management area)
V. Landscape/seascape conservation and recreation (i.e. protected landscape/seascape)
VI. Sustainable use of natural ecosystems (i.e. managed resource protected area)
Category Ia: Strict nature reserve/wilderness protection area: managed mainly for science or wilderness protection—an area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.
Category Ib: Wilderness area: protected area managed mainly for wilderness protection—large area of unmodified or slightly modified land and/or sea, retaining its natural characteristics and influence, without permanent or significant habitation, which is protected and managed to preserve its natural condition.
Category II: National park: protected area managed mainly for ecosystem protection and recreation—natural area of land and/or sea designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area, and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
Category III: Natural monument: protected area managed mainly for conservation of specific natural features—area containing specific natural or natural/cultural feature(s) of outstanding or unique value because of their inherent rarity, representativeness or aesthetic qualities or cultural significance.
Category IV: Habitat/species management area: protected area managed mainly for conservation through management intervention—area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats to meet the requirements of specific species.
Category V: Protected landscape/seascape: protected area managed mainly for landscape/seascape conservation of recreation—area of land, with coast or sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.
Category VI: Managed resource protected area: protected area managed mainly for the sustainable use of natural resources—area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while also providing a sustainable flow of natural products and services to meet community needs.

4.2. Seeking common ground in forest protection

Some form of the classification for forest protection is appropriate. The International Union of Conservation of Nature (IUCN) in an approach stressing a global view, has developed six categories of forest protection (Table 1). However, the IUCN categories include all types of ecosystems, and have not been especially well suited to forest protection. In the IUCN classification, forests are often only a part of larger protection areas and the degree of naturalness or the differences in the historical development of a forest are not taken into account. The IUCN classification works when applied describing protection in vast, untouched, continuous forest areas, so its usefulness for Europe is questionable.

A working group established by the Ministerial Conference on the Protection of Forests in Europe (MCPFE) has developed in 1999–2002 a new classification system for forest protection in Europe. The findings of COST E4 were used as a basis for this new classification system (Table 2, Fig. 2). The classification consists of three categories with different management objectives: protected forests safeguarding biodiversity, protected landscapes and specific natural features, and protective functions (for soil, water, and against natural hazards). In addition to the regimes classified in this system, the MCPFE takes into account of protected and protective forests and other wooded land based on voluntary contributions without legal basis. However, data on these forests and other wooded land should be compiled separately.

This classification will be used for comparisons and discussions in the 4th Ministerial Conference to be organized in 2003 in Vienna. The Data from the European countries involved will be delivered for analyses by the TBFRA correspondents. Linkages to IUCN categories and to EEA CDDA (Common Database for Designated Protection Areas) classes have been taken into account.

4.3. Influence of forest ownership structure on the protection networks

European forests are mainly owned by private individuals, so that when organizing forest protection, right of ownership has to be established and the question of compensation has to be sorted out. In practice, what may be the ideal protection network in terms of site and forest structure has to be adapted to suit the forest areas on the basis of the forest ownership structure in each country. It is possible to construct a protection network that corresponds best to natural conditions in areas where State ownership of forests predominates. Nevertheless, the State's financial resources, the dependence of the national economy on forestry and forestry products—wood and non-wood—and the importance of the forests to the employment and

Table 2
Proposal for classification of protected forests in Europe, developed by the ad hoc MCPFE working group in co-operation with EU/COST E4, UN/ECE TBFRA 2000, EEA, IUCN, WWF, EU/COST E27 (PROFOR)

MCPFE CATEGORY	EEA[a]	IUCN[b]	
1: Management objective 'biodiversity'	1.1: 'No active intervention'	A	I
	1.2: 'Minimum intervention'	A	II, (IV)
	1.3: 'Conservation through active management'	A	IV, (V)
2: Management objective 'protection of landscapes and specific natural elements'		B	III, (V, VI)
3: Management objective 'protective functions'		(B)	n.a.

[a] References as identified in the Standard Data Form of the Natura 2000 and Emerald networks, and used in the same way in the framework of the common database on designated areas (CDDA), managed by the EEA on behalf of two other organizations (Council of Europe and UNEP-WCMC). Groups (A, B or C) are related to designation types and not to individual sites.

[b] Indicative reference: the equivalence of IUCN Categories V and VI may vary according to the specific management objective (of the forested part) of each individual protected area. IUCN Category III has biodiversity conservation as its primary management objective. However, it fits more easily under MCPFE category 2 than 1.

standard of living of the local population all affect the scale of the protected areas.

As much as two-thirds of the forests in the EU Member States is in private ownership, with the State the largest owner only in Greece and Ireland (UN, 2000). All in all, there are about 12 million private forest owners, usually families, and they own about 60% of the European forest area. This also means that private forest estates are small in area. In most of the Member States the majority of private forests are less than 5 ha in area, and private forests of over 50 ha represent a very small percentage. The average size of private forests, for example, in Finland is 26 ha and in Germany 7 ha. In Austria 49% of the total forested area are small scale private properties with less than 200 ha, only 16% are owned by the state. The average size of all private forests is 17 ha. Sweden has Europe's highest commercial forest ownership, where forest industry companies, including privatised State forestry, own around half the country's total forest area.

Joining private forests to the networks of protected areas is often a difficult task that needs innovative methods in its resolution. Voluntary protection by agreement is one solution that has worked well in Austria's Natural Forest Reserves Project (Frank and Koch, 1999). This was launched in 1995 when the Federal Ministry of Agriculture and Forestry empowered the Federal Forest Research Centre to carry out the project. The project involves protecting small areas of natural forest to increase biodiversity in production, multifunctional forest areas. The selection of these areas focuses above all on private forests, to find rare remnants of natural forest in different localities and to achieve a wide spread of natural habitats.

The programme aims at systematically establishing a representative network of natural forest reserves and can be regarded as a direct response to the Helsinki Resolution H2, "General Guidelines for the Conservation of Biodiversity in European Forests". In this context, the Natural Forest Reserves project essentially contributes to the implementation of the overall strategy of maintaining and improving forest biodiversity.

The planning and establishment of strict forest reserves network has been laid down in the form of an 'Agreement

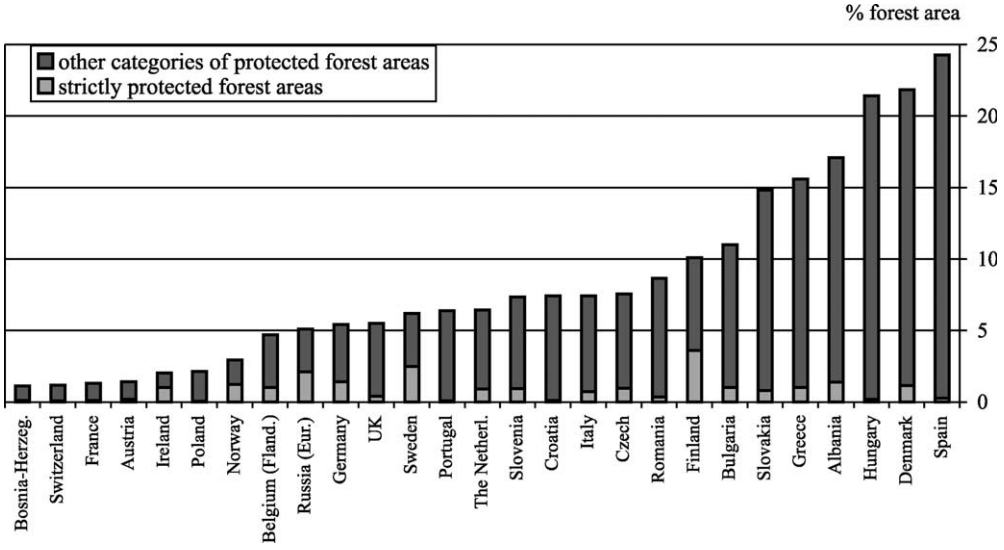

Fig. 2. Protected forest areas in 26 European countries according to various management objectives (source: COST E4 1996–1999).

of principles', which was negotiated by all stakeholders, like forest owner association, ministries, forest authorities, federal state forests, and representatives of large forest enterprises. This agreement of principles is the basis for all further contracts, the selection process of protection areas and the management of the reserves. As a bottom-up approach, all management measures, research programmes and the utilisation of these reference areas for education and training purposes always takes place in close co-operation with the individual forest owner.

Three types of natural forest are protected: standard reserves which cover an area larger than a defined minimum area in which all phases of the development cycle are included (Koop, 1989; Frank, 1998), special reserves for intensive research and natural forest stands 'cells', which occur mainly in the most fragmented forest landscapes of Austria. At the end of 2002 there were 180 of these types of reserves subject to protection by agreement, totalling 8272 ha, 0.16% of the total area of Austrian forests. These small patches, often no bigger than 10–20 ha, are located inside production forest areas.

The legal status of these reserves is based on a contract in private law between the State and the private forest owners for a period of 20 years. After each 20 years, the Partner Republik of Austria has the option to extend the contract by further 20 years. The owner relinquishes all economic activity and utilization of the protected area for this period, apart from hunting rights. In return the State pays compensation for the financial loss incurred by the limitations caused by protection during this period, in full. A basic allowance independent of the stand yield value serves as an additional stimulus for the forest owner to be involved in the programme.

Voluntary protection has aroused the interest of the Austrians. Despite the protection of his forest, the owner receives a continuous annual income and the protection programme has been extended to areas that would not otherwise have come within the scope of protection. For forest owners, the regular income from the forests is important in underdeveloped rural areas and the fear of too much enthusiasm for protection from outsiders has evaporated. Use of the forests can be planned on a long-term basis, so that protection is integrated with other forest-use goals. It also prevents disputes about protection and supports rural development.

5. Forest protection in multifunctional forests

At present, key issues for discussion are how naturalistic silviculture can contribute to maintaining biodiversity in multifunctional production forests, what is the impact of nature-oriented silviculture, and how great is the need to complement forest protection networks? Separation of conservation, production and protection leads to practical consequences and responses in the management and in the administration of forestland. The separate allocation principle is used in countries with low population densities, where the forests are remained untouched like in the USA, Canada, or Russia. (Bruenig, 2001; Bruenig and Klemp, 2002). In Europe because of long human influence on forests and of dense population integration of separate functions has a long tradition.

Naturalistic silviculture includes the introduction of biodiversity characteristics to production forests, and means mimicking natural forest development cycles typical of a particular vegetation zone. It is assumed that naturalistic silviculture in multifunctional forests is able to maintain and enrich the natural biodiversity of forests.

The concept of naturalistic silviculture is currently still rather vague. Silvicultural orientation or conception can be defined as fundamentally different in relation to natural and plantation forests, respectively. High yield plantation forestry uses intensive management methods, such as genetic modification, soil cultivation and fertilization. Since the end of the forest restoration phase in Europe this concept is now relevant only in some cases (plantations on abandoned agricultural land; afforestation). On forestland, new forests after regeneration cutting are established by continuous or periodic natural regeneration, by assisted natural regeneration, mostly supplementing natural regeneration with economically or ecologically particularly valuable species of trees and sometimes shrubs.

The most relevant guiding factor for silvicultural orientation has been the definition of naturalness (Thomasius, 1996; Koch et al., 1997; Naturnähe Österreichischer Wälder, 1997; Peterken, 1997; Grabherr et al., 1998). Generally speaking, naturalness in forests refers to conditions and processes that have been affected very little or not at all by human activity. When applied to forestry, the concept of hemeroby is used. This means potentially natural forests where biosystems are no longer interrupted by man and where vegetation has had time to develop up to its final stage. The concept of naturalness is, however, not straightforward. There are many overlapping or similar terms such as native forest, ancient woodland, virgin forest, old growth forest, primary forest and old forest (European Commission, 2000).

According to historical forest use and data on the present forest structure, multifunctional production forests in Continental Europe are mainly altered or cultivated, whereas in the Nordic countries they are semi-natural (Parviainen et al., 1999). Naturalistic silvicultural approaches thus vary according to the naturalness between the vegetation zones. Nordic countries have focused on differences between large and small natural forest development cycles, fire ecology and stand factors that are crucial in terms of preserving living organisms (Kouki, 1994; Schuck et al., 1994). These factors include charred wood, the percentage of decaying wood, small biotopes and the proportion of deciduous trees in stands. Naturalistic

silviculture is reflected in the management of coniferous-dominated forests for maintaining biodiversity at the regional level according to forest vegetation composition. Here, tree species composition is not one of the main issues as the original tree species predominate.

In continental Europe, the principles of naturalistic silviculture have their origins in the change of the original forest cover due to human influence over centuries (Bruenig and Klemp, 2002). It is based on gap disturbances regulated by the small natural development cycle in forest stands. The aim of naturalistic silviculture is to chart in a site-specific manner the likely original vegetation cover so that the altered tree species composition will resemble the original tree species composition of the site or region. In general the number of tree species and the variety of forest types is much higher than in the boreal region. Consequently the effect of human caused changes in tree species composition is usually much higher than in the Nordic countries.

The implementation of naturalistic silviculture in the boreal forest zone will be effected by means of management recommendations at forest stand level, and by landscape ecological planning at regional level (Parviainen, 1998; Mikkelä et al., 2000). Classifying and mapping forests in context of landscape ecological planning of large tracts of land considers typical natural values across the area. The location of key biotopes, protected natural habitats, cultural sites, game reserves and important landscapes are all carefully noted and preserved. A maintenance or upkeep plan is drawn up for each site to form an overall mosaic of the forest area (Fig. 3). If necessary ecological corridors and stepping-stones are also planned for the area to promote the spread of different species of organism from one area to another.

Landscape ecological planning will soon have been applied in the management of State-owned forests in Finland for ten years, during which time the principle of public participation has also been followed. The planning is carried out in collaboration with local people, individuals and communities, environmental organizations and forest and environmental authorities. Key biotopes are left untouched by silviculture or at least are handled with great care so that the natural state can return and be preserved. In Finland, according to the latest inventories, these kinds of small biotopes cover about 2–8% of the area of multipurpose production forests (Mikkelä et al., 2001). Key biotopes that have to be protected legally under the Forest Act have proved to cover about 1–2%. Small biotopes are also protected within multifunctional forests in the countries of Central Europe. In Germany, for example, these types of site are estimated to cover 2–6% depending on the extent of forest cover (Naturschutz im Wald, 1997). In the alpine countries high shares of forests on steep terrain, or on very harsh sites are not reachable for normal silvicultural treatment or protective forests without commercial yield, e.g. in Austria 19% of the forests are de facto left for free development because of this reasons.

Fig. 3. Typical small scale mosaic—like forest landscape of boreal forest in Karttula, Middle Finland.

Research results confirm traditional wisdom that even a small amounts of decaying wood and dead standing trees in multifunctional production forests diversify the habitat and food base and thereby increase the variety of living organisms. Decaying and rotten wood, old deciduous trees, dead standing trees and storm-felled trees should thus be left in the forest. So far there have been insufficient quantitative scientific studies to show how much decaying wood is needed in a multifunctional production forest to ensure the survival of different groups of organisms. In practice, the 5–10 trunks of rotten wood per hectare that are left in the forests are estimated to be sufficient at least for the preservation of certain species of birds and beetles. However, some latest results from the boreal zone indicate that solely for the endangered species that remain in one place, such as bracket, fungi and lichens, there should be a large amount of rotten wood, even as much as 20 m^3/ha, which in practice is not often possible in silviculture for economic and technical reasons (Siitonen, 2001). Dead standing and lying woody matter in mature-phase pristine high forests in tropical and temperate forests commonly range between 10 and 20% of the total phytomass above ground. Because of the large variety of different forest types in Continental Europe and the Alps, presently no estimations of deadwood volume thresholds are available (Korpel, 1997).

In northern coniferous forests there are about 30–40 species of organism that depend naturally occurred on forest fires (Annila, 1998). As a result of effective fire prevention measures, forest fires have been almost completely eliminated in Sweden and Finland, or at any rate there are very localized and small in area. The species that flourish in charred timber and the plant species that spread because of the heat of the fire and the ash that is formed have become endangered. In order to preserve this special group of organisms, burnt areas and charred wood are needed in the forests. Thus methods of silviculture have to include controlled burning to imitate the effects of forest fires.

6. Conclusions

Maintaining biodiversity in forested areas can be achieved through an adequate network of protected areas and by the implementation of large-scale naturalistic silvicultural management which integrates conservation production and non-production functions. However, multi-functional production forests have the greatest influence in terms of preserving living organisms, as they represent 80–90% of the forested areas in most European countries. Naturalistic silviculture produces economically efficiently wood and at the same time provides large-scale protection and conservation effects by enriching biodiversity at all spatial levels. The significance of this integrating effect has so far been largely ignored or undervalued in the debate on forest protection and conservation.

The national networks of protected forest areas should not be seen in isolation but as part of an overall forest management and protection strategy. Separation of conservation, production and protection leads normally to separate management, control and financing of the areas. Manifold administration may cause confusions by interpretation of management rules and requires overlapping monitoring systems.

The protection should be seen as dynamic process in order to assure dynamic evolution of species and ecosystems parallel to the forest development cycle. Static approach and protection of the old forests alone will limit our efforts to important, but only on one segment of the forests and may lead to increased risks of outbreak of insect, fire or storm calamities into the forest on surroundings. To guarantee various habitats and development stages of protected forests it is necessary to preserve young valuable forests, too.

The basic elements of naturalistic silviculture are known, but their quantification (such as the adequate amount of decaying wood) has still not been thoroughly studied and remains, and probably will remain as intrinsically uncertain as many other processes and states of the dynamic complex living forest ecosystem. In Europe it is important to include comprehensive economic, not only financial, calculations in assessing forest management, because the successful implementation of biodiversity demands requires that forestry remains profitable for forest owners.

In the public debate, voluntary forest certification has sometimes been seen as an overall umbrella to guide sustainability and to increase forest protection. However, this should be viewed only as one tool for promoting sustainable forest management. Even a non-certified forest or even forest plantations might be sustainably managed. Voluntary forest certification cannot resolve the need to protect more valuable forests or to set protected areas outside of multifunctional forest management. Because of the possible compensation for forest owners, the taxation aspects and the possibility of setting aside forest areas and excluding them from wood production permanently, decisions on forest protection have to be made by democratic parliamentary means. Logically, forest certification will then be directed primarily at the management of multi-functional production forests, and can be seen as a simple tool to communicate that wood products come from well-managed forests.

References

Annila, E., 1998. Forest management and threatened species. Metsäntutkimuslaitoksen tiedonantoja, Finnish Forest Research Institute, Research Papers 714, 63–70.

Bruenig, E., 2001. Forest protection, conservation and management: integration or segregation? ATIBT (Association Technique Internationale des Bois Tropicaus) Newsletter, December, 2001. Paris 6, avenue de Saint Mandé, F-75012 Paris.

Bruenig, E.F., Klemp, C.F., 2002. Economic and ecological risk management in near natural forestry. Manuscript. 25 pp.

Diaci, J., (ed.) 1999. Virgin Forests and Forest Reserves in Central and East European Countries. Proceedings of the Invited Lecturers' Reports Presented at the COST E4 Management Committee and Working Group meeting in Ljubljana, Slovenia 25–28, April 1998. University of Ljubljana. 171 p. (includes country reports on Bosnia and Herzegovina, Croatia, Czech Republic, Poland, Romania, Slovenia and Switzerland).

Diaci, J., Frank, G., 2001. In: Internationale Alpenschutzkommission CIPRA, (Ed.), Urwälder in den Alpen: Schützen und Beobachten, Lernen und Nachahmen, Alpenreport, vol. 2. Verlag Paul Haupt, Stuttgart, pp. 253–256.

European Commission, 2000. EUR 19550. COST Action E4, Forest Reserves Research Network, Luxembourg, 377 pp.

Frank, G., 1998. Naturwaldreservate und Biodiversität. In: Geburek, Th., Heinze, B. (Eds.), Erhaltung genetischer Ressourcen im Wald-Normen, Programme und Maßnahmen, Ecomed-Verlagsgesellschaft, Lansberg, pp. 205–238.

Frank, G., Koch, G., 1999. Austria-country report. In: Parviainen, J., Little, D., Doyle, M., O' Sullivan, A., Kettunen, M., Korhonen, M. (eds.). Research in forest reserves and natural forests in European countries—country reports for the COST Action E4: Forest Reserves Research Network. EFI Proceedings 16. 35–53 pp.

Grabherr, G., Koch, G., Kirchmeir, H., Reiter, K., 1998. Hemerobic österreichischer Waldökosysteme. Österreichische Akademie der Wissenschaften. Veröffentlichungen des österreichischen MaB-Programmes. Band 17. 493 p. Bad Vöslau.

International Forest Conservation: Protected Areas and beyond, 1999. A discussion paper for the Intergovernmental Forum of Forests, Commonwealth of Australia, International Forest Section Environment Australia, Canberra, 52 pp.

Koch, G., Kirchmeier, H., Reiter, K., Grabherr, G., 1997. Wie natürlich ist Österreichs Wald? Ergebnisse und Trends. Österreichische Forstzeitung 1, 5–8.

Koop, H., 1989. Forest Dynamics. Silvi Star, A Comprehensive Monitoring System, Springer, Berlin, 230 pp.

Korpel, S., 1997. Totholz in Naturwäldern und Konsequenzen für Naturschutz und Forstwirtschaft (Dead Wood in Natural Forest and Consequences for Nature Conservation and Forestry). Forst und Holz 21, 619–624.

Kouki, J., (ed.) 1994. Biodiversity in the Fennoscandian boreal forests: natural variation and its management. Annales Zoologici Fennici 31 (1), 217 pp.

Kral, F., 1971. Pollenanalytische Untersuchungen zur Waldgeschichte des Dachsteinmassives. Rekonstruktionsversuch der Waldgrenzdynamik.

Veröffentlichungen des Institutes für Waldbau der Universität für Bodenkultur, Wein.

Kral, F., 1979. Spät- und postglaziale Waldgeschichte der alpen auf Grund der bisherigen Pollenanalysen, Veröffentlichungen des Institutes für Waldbau an der Universität für Bodenkultur, Wein, Kommissionsverlag Österr, Agrarverlag, Wein.

Mikkelä, H., Sampo, S., Kaipainen, J., 2000. The state of forestry in Finland 2000. Criteria and Indicators for Sustainable Forest Management in Finland. Ministry of Agriculture and Forestry. Publications 5a/2000. 102 pp.

Ministerial Conference on the Protection of Forests in Europe, 16–17 June, 1993. (1993). Documents. The Ministry of Agriculture and Forestry, Finland. Helsinki. 56 pp.

Ministerial Conference on the Protection of Forests in Europe, 16–17 June, 1993 (1994). Criteria and Indicators for Sustainable Forestry. Ministry of Agriculture and Forestry, Finland. Helsinki. 20 pp.

Naturnähe Österreichischer Wälder, Bildatlas, 1997. Bundesministerium für Land- und Forstwirtschaft, Wien. 39 pp.

Naturschutz im Wald. Generationenvertrag für Mensch und Natur, 1997. Deutscher Forstverein e.V. Niedenstein. 38 pp.

Parviainen, J., 1998. How close to nature should silviculture in Europe develop. Nordic symposium on New stand types in boreal forestry—ecological features and silvicultural consequences, Vaasa, February 10–11, 1998. Metsäntutkimuslaitoksen tiedonantoja, Finnish Forest Research Institute, Research Papers 714, 7–20.

Parviainen, J., 2001. Der Einfluss des Feuers auf die borealen Waldlandschaften Europas. Von der Siedlungsgeschichte zum Werkzeug der Waldbewirtschaftung. In: Busch, B., Goldammer, J., Denk, A. (Eds.), Feuer. Schriftenreihe Forum/Band 10. Elemente des Naturhaushalts II, Wienand, Köln, pp. 299–312.

Parviainen, J., Päivinen, R., 1998. Information Needs for Biodiversity Assessment Derived from International Forestry Discussions. In: Bachmann, P., Köhl, M., Päivinen, R. (Eds.), Assessment of Biodiversity for Improved Forest Planning, Forestry Sciences, vol. 51. Kluwer, Dordecht, pp. 63–70.

Parviainen, J., Bücking, W., Vandekerkhove, K., Schuck, A., Päivinen, R., 2000a. Strict forest reserves in Europe: efforts to enhance biodiversity and research on forests left for free development in Europe (EU-COST-Action E4). Forestry 73 (1).

Parviainen, J., Kassioumis, K., Bücking, W., Hochbichler, W., Päivinen, R., Little, D., 2000. COST Action E4: Forest Reserves Research Network. Mission, Goals, Linkages, Recommendations and Partners. Final Report. Joensuu, Finland, 28 pp.

Parviainen, J., Little D., Doyle, M., O'Sullivan, A., Kettunen, M., Korhonen, M., (eds.) 1999. Research in forest reserves and natural forests in European countries—country Reports for the COST Action E4: Forest Reserves Research Network. EFI Proceedings No. 16. European Forest Institute. 304 pp. (includes a summary of the reports and separate country reports on Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Russia and United Kingdom).

Peterken, G.F., 1997. Concepts of naturalness. Programme and Abstracts of the Conference: Naturalness and European Forests in Strasbourg, France. 26–29/10/1997, p. 112.

Puumalainen, J., 2001. Geneva Timber and Forest Discussion Papers, United Nations, New York and Geneva, pp. 87, ECE/TIM/DP22.

Schuck, A., Parviainen, J., Bücking, W., 1994. A review of approaches to forestry research on structure, succession and biodiversity of undisturbed and semi-natural forests and woodlands in Europe, Working paper 3, European Forest Institute, Joensuu, 62 pp.

Siitonen, J., 2001. Monimuotoinen metsä. Metsäluonnon monimuotoisuuden tutkimusohjelman loppuraportti. Metsäntutkimuslaitoksen tiedonantoja 812, 226.

Sustainable Forest Management in Europe. Special Report on the Follow-up on the Implementation of Resolutions H1 and H2 of the Helsinki Ministerial Conference, 1998. Follow-up reports on the Ministerial Conferences on the Protection of Forests in Europe, vol. II. Third Ministerial Conference on the Protection of Forests in Europe. Liaison Unit in Lisbon. 274 pp.

Thomasius, H., 1996. Geschichte, Anliegen und Wege des Waldumbaus in Sachsen. Schriftenreihe der Sächsischen Landesanstalt für Forsten, Waldumbau, 11–52.Graupa.

UN, 2000. Forest resources of Europe, CIS, North America, Australia, Japan and New Zealand (industrialized temperate/boreal countries). UN/ECE/FAO Contribution to the Global Forest Resources Assessment, 2000. Main Report, Geneva Timber and Forest Study Papers, No. 17, United Nations Publication, New York, 445 pp.