Strict forest reserves in Europe: efforts to enhance biodiversity and research on forests left for free development in Europe (EU-COST-Action E4)

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Summary

Protected forest areas have become increasingly important and strict forest reserves have an important role to play on two fronts: they are in themselves important protection sites, and they also provide the necessary reference data for nature-based silviculture in production forests. The EU-COST-Action E4 (European Forest Reserves Research Network) underlined their importance and found that there is a wide variation in conceptual approach, historical background, size and share of strict forest reserves throughout Europe. These differences are clearly linked to local forest type and forest history, land use and natural forest dynamics. Moreover, the term 'strict' reserve is interpreted very differently in different countries: in many cases game control, fire control and the removal of invading exotic species are allowed. The concept of complete non-intervention does not seem to be realistic for Europe. The total strictly protected forest area, for the 26 countries involved in COST-E4, is calculated to be nearly 3 million hectares or about 1.7 per cent of the total forest area.

However, subjects, goals, methodologies and constraints for scientific research seem to be strikingly similar throughout Europe. Transboundary co-operation is therefore evident, and needs further promotion. For this purpose, an electronic database on strict reserves, which can be consulted through the Internet at http://www.efi.fi/Database_Gateway/FRRN, has been constructed within the framework of the COST action. Judging from the number of visits, it is likely to become an important tool for future scientific co-operation.

Introduction

Public awareness of forestry and its importance for wood production, biodiversity and nature conservation has increased significantly this last decade. This is reflected in discussions on sustainability, protected forest areas, improved silvicultural systems and forest-certification as well as

world-wide campaigns against the exploitation of tropical and other pristine forests, and different international governmental and non-governmental initiatives, e.g. the Rio Declaration, 1992; Ministerial Conferences for the Protection of Forests in Europe in Strasbourg 1990, Helsinki 1993 and Lisbon 1998 and the follow-up of Helsinki criteria and indicators; IPF-IFF United Nations Initiatives since 1994; ITTO initiatives; FSC- and PEFC-certification frameworks; ISO-14000 norms, EMAS-environmental accreditation systems; and 'country of origin' labels (Ministerial Conference on the Protection of Forests in Europe, 1998; Protected Areas for a New Millennium, 1998; Sustainable Forest Management in Europe, 1998; International Forest Conservation: Protected Areas and Beyond, 1999; PEFC and FFCS homepages on the Internet (http://www.smy.fi/certification/)).

On the issue of maintaining biodiversity in forests, two complementary aspects are essential: a substantial, representative network of protected areas, covering all rare, vulnerable and valuable forest ecosystems, and the application of nature-based silviculture in the remaining production forests. Because total protection only secures a certain number of habitats and rare species on a small local scale, nature-based silvicultural practices are essential for maintaining large-scale biodiversity in forests, as the majority of forested areas – in many countries at least 80–90 per cent of the total forest area – is used for production. The hypothesis is that as management activities in production forests are brought closer to nature, there will be less need for total protection of forests.

According to recent Finnish studies on threatened species, 90 per cent survive adequately in properly managed production forests (Parviainen, 1999). Most of the other species have always been rare and only appear in specific habitats which should receive special protection. These habitat types (such as herb-rich forests, ridges, rocks and gorges), which are known as key biotopes, should be left untouched. According to analyses done in southern Finland and in Germany, key biotopes cover approximately 1–8 per cent of the total forest area (Naturschutz im Wald, 1997; Niemelä and Arnkil, 1997).

Key biotopes are usually small elements within the production forests, focusing on species protection. A network of protected areas should also cover 'strict forest reserves', i.e. areas representative of all the major forest types, left for free development, which are large enough to allow natural dynamics and processes to occur.

Strict forest reserves play an essential role in the realization of both aspects of biodiversity maintenance: they will hold a prominent position in the network of protected areas and furthermore they will provide essential reference data for nature-based silviculture. It is generally accepted that natural forests are a good model for the realization of nature-based silviculture (Leibundgut, 1978, 1982, 1986, 1989; Schütz, 1986; Schmidt-Vogt, 1991; Thomasius, 1992; Sturm, 1993; Parviainen and Seppänen, 1994). Strict forest reserves are important in the process of identifying standards of naturalness and biodiversity, and facilitate the assessment of the impact of forestry on forest ecosystems and forest biocoenoses. By studying the stand structure in strict forest reserves it is possible to estimate, for example, the size, shape and frequency of forest gaps or the required share of dead wood component and its quality for maintaining the xylobiotic organisms in production forests (Parviainen, 1999).

The importance of these strict reserves was also recognized by the European Commission by their support of European-scale co-operation on the issue, through COST-Action E4. This paper presents an objective overview of the state of the art of strict forest reserves in Europe, based on national reports (Diaci, 1999b; Parviainen *et al.*, 1999) and enquiries delivered for COST-E4. It points out and explains the differences in concept, history, size and share of strict forest reserves between countries and indicates the possibilities for future transboundary research. At the time of writing, the project is still running, although the main findings and outputs are published here. The recommendations and evaluation of the COST-Action activities and material will be presented in the final report after completion of the Action at the end of 1999.

European co-operation on strict forest reserves within the framework of EU-COST-Action E4

COST is a European Union framework for co-operation in science and technology, which

encourages the co-ordination of national research programmes on a European level. Within this framework, financial support is given for the organization of meetings, specific co-ordination tasks such as databank construction and for the exchange of scientists through the Short Term Scientific Missions programme. The research being co-ordinated is funded nationally.

In 1995, COST-Action E4: Forest Reserves Research Network, was introduced by the COST Commission in order to promote co-ordination and to enhance research in forest reserves. The objectives were to create a European network of forest reserves through a common understanding on definitions, terminology and management of strict reserves, to collect information on published and ongoing research, to investigate the possibilities for harmonizing and standardizing research methodologies and to provide general access to a central databank on forest reserves. The main goals of the Action and the focus of the strict forest reserves are illustrated in Figure 1. Nineteen EU/COST countries are officially involved in the programme and some other (mainly Eastern European) countries have been involved as invited guests.

European strict forest reserves

Based on data supplied through enquiries to national representatives within COST-E4, a state of the art clarification on protected forests and strict forest reserves in Europe was made. The following conclusions are based on this information.

Amount and size of strict forest reserves in Europe

In general, it can be stated that in the countries engaged in COST-Action E4 the need to protect natural forest ecotypes has been recognized and has led to the establishment of strictly protected forest areas.

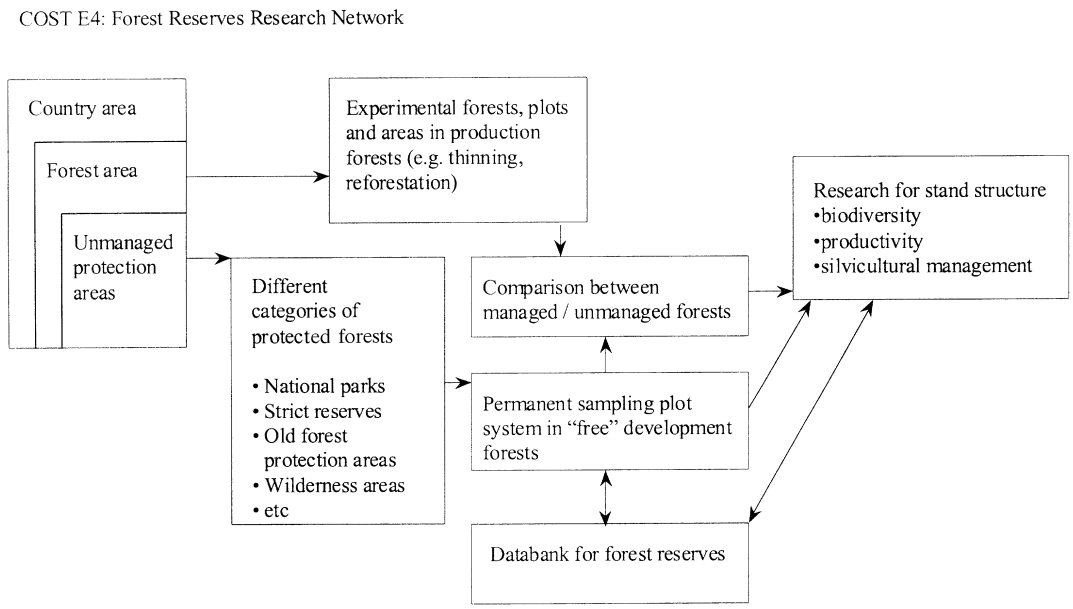

Figure 1. Protected forests analysed for COST-Action E4: focus on unmanaged protection areas (forests allowed to develop freely with minimal or no intervention), which are researched using a permanent sampling plot system. The principal protection category containing forests left to develop freely is the 'strict forest reserve' but other 'freely developing natural forests' are also included in other protection categories.

The European protected forest area concept has been devised to be more versatile than that which exists in countries with huge untouched forests, such as Canada, Russian Siberia or some tropical countries. Protected forests include different degrees and types of restrictions on forest areas with regard to their use. The terms related to protected forests are countless and sometimes contradictory. Areas 'left for free development' can be found in several of these categories mainly as (so-called) strict forest reserves, but also as biosphere reserves, wilderness areas, nature reserves, natural monuments, minimum intervention areas or unmanaged core areas in national parks. Legal protection can be arranged through forest legislation, nature conservation legislation, or both. Additionally, there is a significant area of forest, under different ownership, without management but also without legal protection, so these areas are not really 'strictly protected'. However, they can provide an important pool for research, as their forest structure has not been drastically altered by human interference.

The ownership of the strictly protected areas varies as much as forest ownership may vary: in all countries they are mostly owned by the state; however, they can also be owned by municipalities, private owners, non-governmental organizations and churches etc., legally bound by contracts. Generally either the Forest or the Nature Conservation Administration are the managers of the reserves and are responsible for the protection of the area. Only in a few cases do private or non-governmental organizations have this responsibility.

The number, size and share of strict reserves in European countries are illustrated in Table 1. The share of forest area dedicated to free development currently varies between 0.01 and 6.6 per cent of the forested area of a country. Many countries intend to increase their area of strict forest reserves, and some have clear targets in this respect (0.25 per cent in Austria, 1 per cent in Norway and 3 per cent in Flanders (Belgium)). The absolute area varies widely, between 1250 ha (Flanders, Belgium) and 1530 000 ha (Finland) for strictly protected forests. The whole strictly protected forest area, for the 26 involved countries in COST-E4, without Russia, is calculated to be nearly 3 million hectares or about 1.7 per cent of the total forest area (Parviainen, 1999). The most important protected untouched natural forest in Europe can, however, be found in the European region of Russia, where there are strict forest reserves covering as much as 1.7 million hectares (Pisarenko *et al.*, 1999).

The size of individual reserves varies greatly between one and several hundreds, or even thousands, of ha. In Spain one reserve may cover 7500 ha, while in Finland it may be ten times as large, 71 000 ha. In densely populated countries like the Netherlands the normal size is about 10–30 ha. In Germany the Federal working group 'Strict forest reserves' recommends a minimum area of 30 ha on the plains and 50 ha in the mountains (Bücking *et al.*, 1993), but in some Federal States, e.g. Baden-Württemberg, size standards are set higher, between 100 and 200 ha (Bücking *et al.*, 1993; Bücking, 1997).

However, it would be unfair to compare the amount and area of protected forests between different countries. The large differences are strongly dependent on local climatic and edaphic conditions, traditional use and human pressure on forests, their degree of originality, their natural dynamics, and regional variations in continuous forest cover.

Differences in forest dynamics and in forest utilization history

Natural forests develop in different ways throughout the various vegetation zones. The development of northern, natural boreal forests is interrupted by disturbances and catastrophes, which destroy forests over large areas, thereby promoting forest regeneration (Schuck *et al.*, 1994). The most important disturbance factor in the boreal ecosystem is fire. Even today, millions of hectares of forest may be destroyed by fire over the vast, untouched forest areas in Canada and Russian Siberia in any one year. Depending on factors such as moisture and the tree species composition, forest fires occur at intervals of between 30 and 120 years in the Nordic boreal zone (Esseen *et al.*, 1997). On peatland, on wet soils and on islands, forests have probably been able to develop for centuries without disturbances, including fire. In such cases, forest regeneration occurs through gap dynamics, i.e. through the death of solitary trees in so-called short cycles (Kuuluvainen, 1994).

Table 1: Area of forests and the strict forest reserves and strictly protected forest areas in selected European countries in 1999. (Definitions are based on national definitions)

Country	Forests and other wooded land		Strict forest reserves			
	Area of forests (1000 ha)	Forest cover as % of total land area	Area of strict forest reserves (ha)	No. of strict forest reserves	Size range and average size of strict forest reserves (ha)	Strict forest reserves and comparable categories as % of total forest cover: actual (target)
Albania	1 048	38	14 500	4	3625	1.38
Austria	3 924	47	8 062	191	1–553/42	0.2 (0.25)
Belgium (Fland.)	135	10	1 250	35	4–100/35	1.0 (3)
Belgium (Wall.)	530	31	10	1	10	0.002
Bosnia-Herzeg.	2 589	51	3 125	27		0.12
Bulgaria	3 357	30				1
Croatia	2 485	44	2 856	32		0.11
Czech Republic	2 637	33	25 000	103	2–2500	0.95
Denmark	445	11	6 085	~300	0.5–370/~20	1.4
Finland	23 000	76	1 530 000 (714 300)[1]	311	63–71 000	6.6
France	15 156	28	14 000	30	1–500	0.09 (1)
Germany	10 700	30	24 976	679	3–391/37	0.24
Greece	6 513	49	142 000	39		1
Hungary	1 748	19	3 665	63	8.4–260/57	0.2
Ireland	570	8	5 736	34	7–2500	1
Italy	8 675	29	62 053	119	1–4000	0.72
The Netherlands	334	10	3 078	60	5–450	0.9
Norway	11 950	37	148 000	160		1.23
Poland	8 726	28	3 687	106	44	0.04
Portugal	3 306	37	2827	6	37–1300	0.08
Romania	6 370	27		55	26–2750/408	0.35
Russia (European)	132 341	39	1 726 000		100–721 000/76 500	2.1
Slovakia	1 920	42	15 428	76 (19)	203	0.8
Slovenia	1 110	54	10 420	186	1–700/57	0.93 (1.4)
Spain	12 511	25	32 644	87	375	0.26
Sweden	28 000	69	576 163[2]	849	1–60 000	2.5[2]
Switzerland	1 186	29	1 018	39	30	0.08
UK	2 305	10	10 000	81	123	0.4

Source: Parviainen *et al.* (1999) (partly updated); Diaci (1999b); Ministerial Conference on the Protection of Forests in Europe (1998).

[1]Area and percentage refer to productive forest land (increment >1 m^3/ha/year) and forest land (scrubland) with increment 0.1–1.0 m^3/ha/year. Numbers in parentheses refer to productive forest land.

[2]Area and percentage refer to productive forest land (increment > 1 m^3/ha/year).

In contrast, large-scale disturbances and natural disasters are an exception in the temperate forest zones of central Europe (Schmidt-Vogt, 1991; Thomasius, 1992). Occasionally, storms destroy forests on a large scale. The decisive factor here is the prevalence of the short cycle, which results in forest regeneration through gap dynamics. In central Europe, this is especially true in the typical mixed beech/spruce/fir natural forests where shade-tolerant trees are able to regenerate, even under a very dense canopy layer. Forest dynamics in western Europe are quite similar, although storms play a more active role, and can even become the dominant force (Pontailler *et al.*, 1997).

In southern, central and western Europe, forests gave way to human settlements and were reduced to forest islands by the Middle Ages. Because of settlement activities such as hunting, mining, glass works and traffic, forested areas adjacent to agricultural land were under constant pressure due to human activity (Bücking *et al.*, 1994; Rackham, 1995; Romane, 1997).

Despite what is generally believed, human impact on forests in northern Europe has also been extensive, though not as continuous as in southern and central Europe, lasting perhaps only for 300–400 years. In Finland, between the 17th and the 19th centuries, forests were used for tar production, hunting and reindeer husbandry (Parviainen and Seppänen, 1994). During the same period, forests in central Sweden and central Norway were severely impacted upon by the ore-mining industry (Esseen *et al.*, 1997).

The activity which had most impact on Finnish forests was slash and burn agriculture; this was used especially during the settlement period of the entire southern part of Finland and was initiated during the 16th century. According to Heikinheimo (1915), as much as 50–75 per cent of Finnish forests were subjected to the slash and burn method before the beginning of this century. However, in Finland and Sweden the most significant changes to the forest environment occurred during the last century, due to the rapid expansion of the forestry industry.

Due to the continuous use of forests historically, there are few original, untouched virgin forests remaining in Europe, even in the Boreal zone. The largest remaining natural virgin forests are located in the European part of the Russian Federation, in the states of Komi and Archangelsk and in some parts of north-west Karelia near the Finnish border.

Strict forest reserves and nature-based silviculture

Due to differences in natural dynamics, area of forest cover and differences in traditional forest uses, the concept of nature-based silviculture is different in the Nordic countries than in central Europe.

It is clear that central European forests are fragmented and usually altered or cultivated; whereas in Nordic countries, they are still semi-natural, covering vast areas. This is clearly reflected in the different focuses for nature-based silviculture in the two regions. In central Europe the basic principles of nature-based silviculture are concentrated on gap dynamics, especially disturbances and light factors inherent in short forest cycles. The main goal is to elucidate, on a site-specific basis, the potential, original vegetation cover so that the altered tree species composition can be managed back towards the original tree species composition (Thomasius, 1996). Current silvicultural practices favour mixed forests dominated by deciduous trees (Schütz, 1986).

In Nordic countries, silvicultural trends focus on the differences between long and short rotations or cycles, fire ecology and those stand characteristics which are crucial with respect to the preservation of living organisms. These factors include the presence of charred wood, the proportion of decaying wood, small biotopes and an emphasis on deciduous trees occurring throughout the stand. In order to maintain biodiversity on a regional scale, landscape ecology planning policies have been developed, the primary aim being the maintenance of a mosaic-like structure at a regional level (Kouki, 1994; Angelstam, 1997; Angelstam and Petterson, 1997).

These distinct differences are also reflected in the conceptual approach of strict forest reserves. The first forest reserves in central Europe were established as early as the beginning of the 19th century, protecting the last remains of 'virgin' forest, which, more often than not, survived only in sites unsuitable for cultivation or where logging was unprofitable. This has also affected

the ecological representativeness and size of the resultant protected areas.

By the 1950s, forest academics in central Europe already recognized the importance of strict reserves as reference sites for nature-based silviculture, and urged the selection of new reserves, adjacent to production forests (Leibundgut, 1959, 1966; Mayer, 1969, 1978; Mlinsek, 1976). These areas were no longer 'virgin forests' but mostly had a semi-natural species composition. Improving the representativeness of forest reserves based on plant associations or on forest site type classifications has been the primary aim since the 1970s in many long-running reserve programmes in central Europe (Diaci, 1999a). This approach has been adopted in almost all countries during the last few decades, thereby enhancing nature-based development in production forests (Anon., 1996; Meyer and Spellmann, 1997). Some countries, like Denmark, Germany, the Netherlands and Belgium, as a logical consequence, even include plantation forests in their network of reserves, arguing that these sites also have an important scientific interest (Broekmeyer, 1995; Vandekerkhove, 1998).

In Nordic countries, vast areas had already been selected 60 years ago to become National Parks. The main focus here was nature and landscape protection. Strict forest reserves, called 'nature reserves' and representing old forest areas, were selected for scientific purposes. During the last 10–20 years in the Nordic countries, the main focus of forest protection has been the preservation of old forest remnants and sites that are presumably rich in rare and endangered species. In Finland, the old forest protected area network alone covers over 300 000 ha (Metsien suojelupinta-alat, 1999).

One can conclude that, as a result of historic developments, human pressure, and also different attitudes, forest reserves in central Europe are small, covering only a few to several hundred hectares, and traditionally have a strong link to forestry, while the forest reserves in the Boreal zone are much larger, and have a strong focus on nature conservation, naturalness and maintaining biodiversity through old forest protection.

However, the difference in size also has an ecological relevance: as stated above, large scale disturbances are the driving force in most Nordic forest types, so that large areas are required to allow these disturbances to develop fully. On the other hand, sizes of 50 or even 20 ha might be sufficient to include all the different development phases for some forest types in central and western Europe (Koop, 1981, 1989; Koop and Van Der Werf, 1995).

Limits of relinquishment of management and non-intervention: 'strict' isn't always that strict

Though by definition in strict forest areas 'any intervention is excluded', exceptions are inevitable. It would be better to state that 'human impact that can be avoided' is not allowed. The basic prerequisite should be that silvicultural intervention has to be excluded.

In all countries non-destructive research, and in some cases even some kinds of destructive research, is allowed in all or most of the reserves. Intimately linked to research is teaching and learning: scientific excursions are offered, and systems of excursion paths are maintained.

In addition to scientific and educational activities, some 'eco-tourism' based on rights of way is frequently present and to a certain extent even promoted in densely populated countries. It is generally believed that the support of a broad population of visitors is necessary in order to protect strict areas against other interests in the long run. In some densely populated countries, attempts are made to restrict the completely open right of way strictly to visitor's trails, or to allow visitors only in border or buffer zones.

The problem of protecting neighbouring properties or people's lives from damage caused by the maintenance of strict forest reserves may exist in reserves surrounded by managed forest and agricultural land, especially if in private ownership. For that reason, the borders of reserves are safeguarded. Safeguarding within the reserve, such as cutting down dangerous branches or trees, especially if visitor trails are offered, can be justified. In most countries, however, no such safeguarding is done within the reserves themselves.

The most general impact is due to the necessity to manage game. In central and western Europe, few natural enemies of roe and red deer have survived, and therefore these populations must be regulated artificially. Other problematic animals are elk, chamois and wild boar. Strict forest

reserves offering more food and better cover than the production forests will attract and concentrate animals within the limits of the protected area. In some cases the natural regeneration of trees and shrubs, and even the normal distribution of the plants of the herb layer, is altered to such an extent that it is no longer representative of natural situations. Therefore, many countries allow game management in some, if not all, reserves.

Another crucial point is that biotic damage (e.g. due to local bark beetle populations) may kill trees and destroy stands prematurely. These processes are in congruence with the aims of a strict reserve, as they are natural processes, even natural key factors. Although they will be publicly accepted as far as the reserve is concerned, they nevertheless represent a source of contamination for the neighbouring commercial forests, which is generally not acceptable. As a rule, legal regulations provided for such exceptional situations can be brought into force.

Besides the regulation of biotic damage, abiotic disturbances will also need to be regulated from time to time. It is obvious that densely populated countries with small forest areas will have to legalize more interventions than highly forested countries. Only in very large reserves can decisions be taken independently of the managed surroundings. Avalanches, landslides and erosion by flooding must be dealt with differently in each case. There is almost no opportunity remaining in central Europe for the erosive and transformative power of major rivers like the Rhine or Rhône to create the ecological conditions for riparian forest associations. This means that strict forest reserves in middle Europe, due to their small size, cannot meet the requirement of protecting all disturbance regimes, including destructive erosion.

In the Northern countries, fire plays a key role in coniferous forests, starting the large phase cycle. However, due to the risks involved for adjacent settlements and production forests, spontaneous forest fires are kept under control in almost all cases, even in the strict reserves.

Windthrow is generally tolerated, but there may be problems with windthrown or windbroken stems of spruce because of the risk of bark beetle epidemics.

In some cases, human interference is thought to be necessary in order to protect the natural vegetation types and even natural dynamics. This is the case for exotic trees like *Robinia pseudoacacia* in Austria and Hungary, *Prunus serotina* and *Quercus rubra* in Belgium and Germany and *Acer negundo* along the Rhine and Danube, shrubs like *Rhododendron* spp. in the hyperatlantic climate of the UK and Ireland, and herbs like *Impatiens glandulifera*, *Reynoutria* spp. and *Heracleum mantegazzianum*. In other cases, active human interference in spontaneous competition is even considered in order to save native rare and endangered species like *Pinus montana* in competition with spruce, or even oak versus beech. The reasoning is that the characteristics of the original forests will be lost through the dynamic impact of the artificially introduced newcomers or competitors. In countries where only some remnants of native forests are left this represents a sensible decision. In this case the primary interest is the conservation of a forest type as a monument; scientific interest in dynamics and free development are subordinate.

The forest reserves databank: offering opportunities for co-operation and comparative research

Most countries participating in the COST-E4 Action are determined to establish not only a representative network of strict forest reserves but also, if not already in existence, a detailed research programme, including traditional basic monitoring of vegetation and structural development and in some cases focusing also on biodiversity and/or other ecological aspects (Broekmeyer and Vos, 1993; Projektgruppe Naturwaldreservate, 1993; Parviainen *et al.*, 1999).

In spite of the big differences in their concepts of strict reserves, the research activities taking place in the different countries are strikingly similar: monitoring of changes in species composition and herbal layer, stand structure (gap size, standing volume, dead wood component), soil sampling, monitoring of birds and wood-boring insects (Parviainen, 1999). Also the constraints are similar: providing the data requires labour intensive, long term research and monitoring activities, while at the same time, funds for this type of research are limited, and demands placed on researchers for more practically applicable

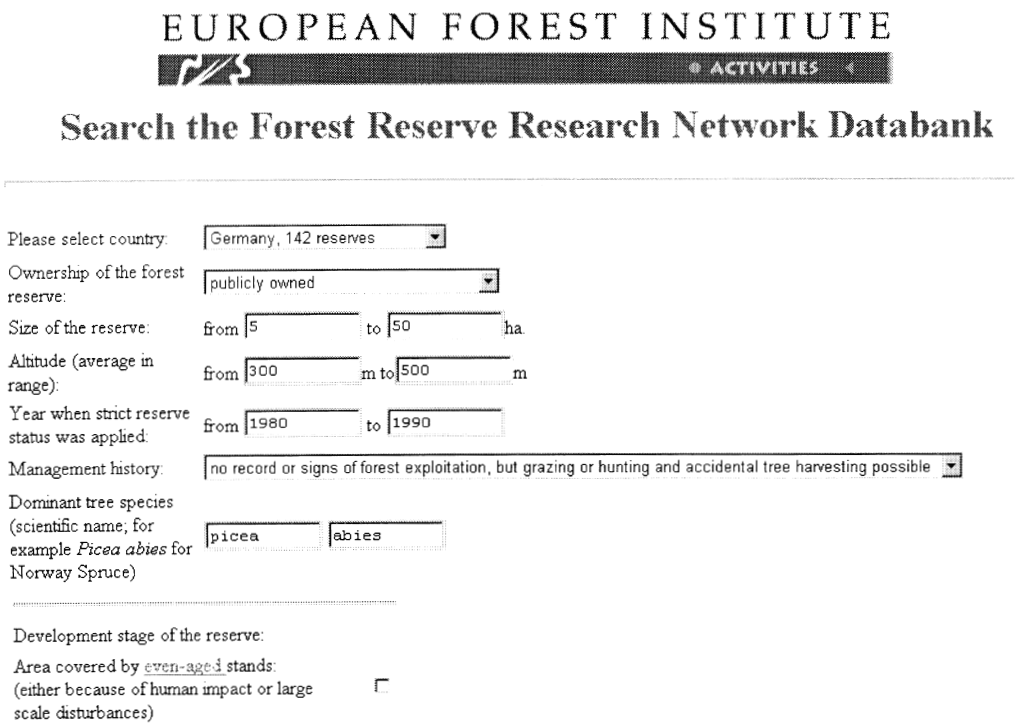

Figure 2. Search page of the FRRN Internet based database (http://www.efi.fi/Database_Gateway/FRRN/search.phtml).

data (e.g. on average gap size, standing volume, species composition, amounts of dead wood in specific forest types) are increasing.

The European Databank and the website on strict reserves have the potential to become some of the most important tools for facilitating co-operation in the exchange and comparison of data. Both the database and the website have been constructed by the European Forest Institute (Finland) and are physically located there (URL: http://www.efi.fi/Database_Gateway/FRRN). The server database is working in a network (Internet) environment and can be accessed through an Internet browser. The website contains extensive information on COST-E4 Action as well as the database on strict forest reserves. Special attention should be given to the comprehensive glossary of international terms of natural forests and natural forest research and the terms and definitions concerning the status of protection of forest reserves and natural forests in European countries.

Data entry, access and contents

The data are arranged in a relational database structure with normal forms to meet the requirements of a well designed database structure. Data input and updating is done by national correspondents who have controlled access for that purpose through individual passwords. EFI monitors the database to ensure the currency and quality of the data. The databank can be utilized through a search function which is freely accessible to the general public. However, national correspondents can block the accessibility of their data to the general public where the data quality and ownership have not yet been clarified. A screenshot from the forest reserves Internet database search page is shown in Figure 2.

The forest reserve is the basic unit of the databank. For every reserve the data supplied cover the following issues:

- general data: name, size, location, management history, adjacent land use, climatic conditions;
- descriptive data: species composition, developmental phases, disturbances, vegetation type;
- research data: monitoring activities with additional information on stand structure, faunistic or other specific research activities (e.g. pollen analysis, soil analysis);
- meta-data: information on the organization that manages and co-ordinates research and short descriptions of research projects carried out in the reserve.

Use of the FRRN databank

The database is constantly receiving new entries for forest reserves, as country correspondents continue the input of data. Data on about 500 forest reserves, currently from 14 different countries, had been entered into the databank by autumn 1999. This represents about 20 per cent of a roughly estimated total of 2500 possible sites in the 19 signatory countries of COST-Action E4.

The fact that there is a definite need for this kind of forum is clearly illustrated by the number of visits to the website. The database still provides only a very fragmentary image of the total potential, so until now only limited publicity has been given to it. Nevertheless, about 2700 hits have been counted on the home-page between July 1998 (opening of the database) and September 1999.

The databank covers a large amount of data, of which most is redundant for researchers interested in specific topics. It therefore contains a detailed search engine which allows researchers to pinpoint their specific interests. In this way, very detailed selections can be made (e.g. all reserves below 600 m altitude, where *Fagus sylvatica* is the dominant tree species, and where research on wood-boring insects is performed).

Conclusions

In Europe, strict forest reserves (i.e. areas in which neither silvicultural measures nor any other avoidable human impacts are allowed) occur in very different protection categories and area sizes. Generally they consist of isolated small scale areas and/or core areas of larger scale protection categories such as national parks, nature parks or biosphere reserves. However, in northern and eastern Europe they can cover many thousands of hectares. The large differences in size and selection prerequisites are clearly linked to local forest history, land use and natural forest dynamics.

In almost all countries the term 'strict' has to be defined, because it is interpreted in slightly different ways according to regional and local traditions. Strict is not absolutely strict: hunting, rare species protection, scientific research, ecotourism, regulation of unwanted tree species, restoration of anthropogenic disturbances, restrictions on non-intervention in natural disturbances because of the small areas involved and neighbours' rights, and other factors are often taken into consideration. The perfect non-intervention concept – the real virgin forest of the future – is not realistic in Europe.

Analyses of the national reports, moreover, indicate that there are many gaps in the protected forest network, especially in the representation of forest types. A European network of strict forest reserves should therefore be officially established and expanded to include all European forest types. National networks should not be seen in isolation but as part of an overall European forest management and protection strategy.

Notwithstanding the diversification of categories with regard to individual legislation, size, geographic distribution and general management rules, there are common goals for all strict forest reserves in the 26 European countries which have participated in the COST Action: the protection of natural processes in forests and the species linked to them and the study of principles, processes and consequences of natural dynamics, both for fundamental scientific knowledge, and for reference building for nature-based silviculture in production forest areas outside the reserves.

It is generally accepted that natural forests are the basic reference model for the realization of nature-oriented silviculture. In strict forest reserves the development cycle of natural forests can be observed, elucidated and understood, and these findings subsequently mimicked in production forests. Therefore, research in strict reserves should not only provide fundamental knowledge, but also supply ready knowledge and guidelines for maintaining biodiversity in production forests, focusing on the main aspects involved in

forest management: gap dynamics, natural regeneration in gaps, dead wood components, maintenance of key biotopes and site congruent species composition of dominant trees. Likewise, it is considered to be mutually beneficial to locate similar silvicultural experimental plots in adjacent production forests for comparative research.

Substantial resources are required for this long-term and labour-intensive research. As objectives and scientific interests are very similar in all European countries, strict forest reserves are ideal objects for international concerted research. The European Forest Reserves Research Network Databank provides an ideal tool to generate such co-operation.

References

Angelstam, P. 1997 Landscape analysis as a tool for the scientific management of biodiversity. *Ecol. Bull.* **46**, 140–170.

Angelstam, P. and Petterson, B. 1997 Principles of present Swedish forest biodiversity management. *Ecol. Bull.* **46**, 191–203.

Anon. 1996 Der Wald hat ein Problem – Wir haben eine Lösung. *AFZ/Der Wald* **19**, 1066.

Broekmeyer, M.E.A. 1995 *Bosreservaten in Nederland. IBN-DLO-rapport 133*, 87pp.

Broekmeyer, M.E.A. and Vos, W. 1993 Forest reserves in Europe: a review. In *European Forest Reserves. Proceedings of the European Forest Reserves Workshop*. M.E.A. Broekmeyer, W. Vos and H. Koop (eds). PUDOC-DLO, Wageningen, 1–301.

Bücking, W. 1997 Naturwald, Naturwaldreservate, Wildnis in Deutschland und Europa. *Forst Holz* **52**, 515–522.

Bücking, W., Aldinger, E. and Mühlhäußer, G. 1993 Neue Konzeption für Waldschutzgebiete in Baden-Württemberg. *AFZ* **48**, 1356–1358.

Bücking, W., Ott, W. and Püttmann, W. 1994 *Geheimnis Wald*. DRW-Verlag, Leinfelden-Echterdingen, Germany, 192pp.

Diaci, J. 1999a Slovenia. In *Research in Forest Reserves and Natural Forests in European Countries – Country Reports for the COST-Action E4: Forest Reserves Research Network. EFI Proceedings 16*. J. Parviainen, D. Little, M. Doyle, A. O'Sullivan, M. Kettunen and M. Korhonen (eds). European Forest Institute, Joensuu, Finland, 225–231.

Diaci, J. (ed.) 1999b Virgin forests and forest reserves in Central and East European Countries: history, present status and future development. In *Proceedings of the Invited Lecturers' Reports presented at the COST-E4 Management Committee and Working Groups Meeting in Ljubljana, Slovenia, 25–28 April 1998*. Department of Forestry and Renewable Forest Resources, Biotechnical University, Ljubljana, 1–171.

Esseen, P.-A., Ehnström, B., Ericson, L. and Sjöberg, K. 1997 Boreal forests. *Ecol. Bull.* **46**, 16–47.

Heikinheimo, O. 1915 Kaskiviljelyn vaikutus Suomen metsiin. Referat: Der Einfluss der Brandwirtschaft auf die Wälder Finnlands. *Acta For. Fenn.* **4**(2), 1–264.

International Forest Conservation: Protected Areas and Beyond 1999 *A Discussion Paper for the Intergovernmental Forum of Forests*. Commonwealth of Australia, 52pp.

Koop, H. 1981 *Vegetatiestructuur en dynamiek van twee natuurlijke bossen: het Neuenburger en Hasbrucher Urwald*. Pudoc, Wageningen, 112pp.

Koop, H. 1989 *Forest Dynamics, SILVI-STAR: A Comprehensive Monitoring System*. Springer Verlag, Berlin, 230pp.

Koop, H. and Van Der Werf, S. 1995 *Natuurlijke bosgemeenschappen A-locaties en boscomplexen; achtergronddocument bij de ecosysteemvisie Bos. IBN-DLO-rapport 162*, 230pp.

Kouki, J. (ed.) 1994 Biodiversity in the Fennoscandian boreal forests: natural variation and its management. *Ann. Zoo. Fenn.* **31**, 1217.

Kuuluvainen, T. 1994 Gap disturbance, ground microtopography and the regeneration dynamics of boreal coniferous forests in Finland: a review. *Ann. Zoo. Fenn.* **31**(1), 35–51.

Leibundgut, H. 1959 Über Zweck und Methodik der Struktur- und Zuwachsanalyse von Urwäldern. *Schweiz. Z. Forstwes.* **110**, 111–125.

Leibundgut, H. 1966 Waldreservate. *Schweiz. Z. Forstwes*. **117**, 900–907.

Leibundgut, H. 1978 Über die Dynamik Europäischer Urwälder. *AFZ* **33**, 686–690.

Leibundgut, H. 1982 *Europäische Urwälder der Bergstufe*. Haupt, Bern, Stuttgart. 308pp.

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, Germany, 6–35.

Mayer, H. 1969 Aufbau und Waldbauliche Beurteilung des Naturwaldreservates Freyensteiner Donauwald. *Centralbl. Gesamte Forstwes.* **86**(3),161–183.

Mayer, H. 1978 Ueber die Bedeutung der Urwaldforschung für den Gebirgswaldbau. *AFZ* **33**, 691–693.

Metsien suojelupinta-alat (Areas of protected forests in Finland) 1999 Suomen ympäristö 300, Helsinki, 43pp.

Meyer, P. and Spellmann, H. 1997 Das Prozeßschutz-Konzept aus Sicht der Naturwaldforschung. *AFZ/Der Wald* **25**, 1344–1346.

Ministerial Conference on the Protection of Forests in Europe 1998 *Follow-up report*. Ministry of Agriculture, Rural Development and Fisheries, Lisboa, 62pp.

Mlinsek, D. 1976 Zur Ausscheidung von neuen Wald- und Urwaldreservaten (am Beispiel von Slowenien). In *Proceedings of the IUFRO World Congress Oslo 1976, Group S1*, 1–3.

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

Niemelä, H. and Arnkil, R. 1997 *Metsäluonnon hoito hakkuissa ja metsänuudistamisessa*. Tapio, moniste, Interim report, 25pp.

Parviainen, J. 1999 Strict forest reserves in Europe – efforts to enhance biodiversity and strengthen research related to natural forests in Europe. In *Research in Forest Reserves and Natural Forests in European Countries – Country Reports for the COST-Action E4: Forest Reserves Research Network. EFI Proceedings 16*. J. Parviainen, D. Little, M. Doyle, A. O'Sullivan, M. Kettunen, and M. Korhonen (eds). European Forest Institute, Joensuu, Finland, 7–33.

Parviainen, J. and Seppänen, P. 1994 *Metsien ekologinen kestävyys ja metsänkasvatusvaihtoehdot*. Metsäntutkimuslaitoksen tiedonantoja 511, Vantaa, 110pp.

Parviainen, J., Little D., Doyle M., O'Sullivan A., Kettunen, M. and 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 16*. European Forest Institute, Joensuu, Finland, 304pp.

Pisarenko, A.I., Strakhov, V.V., Päivinen, R., Kuusela, K., Dyakun, F.A. and Sdobnova, V.V. 1999 *Development of Forest Resources in the European Part of Russian Federation. EFI Research Report 11*. Brill Academic Publishers, in press.

Pontailler, J.-Y., Faille, A. and Lemée, G. 1997 Storms drive successional dynamics in natural forests: a case study in Fontainebleau forest (France). *For. Ecol Manage*. **98**, 1–15.

Projektgruppe Naturwaldreservate 1993 Empfehlungen für die Einrichtung und Betreuung von Naturwaldreservaten in Deutschland. des Arbeitskreises Standortskartierung in der AG Forsteinrichtung. *Forstarchiv*. **64**, 122–129.

Protected Areas for a New Millennium 1998 *The Implications of IUCN's Protected Area Categories for Forest Conservation. A joint IUCN and WWF Discussion Paper*. January 1998. 15pp.

Rackham, O. 1995 *Trees and woodland in the British landscape: the complete history of Britain's trees, woods and hedgerows*. Weidenfeld and Nicolson, London, 234pp.

Romane, F. 1997 Some remarks on spontaneous forest succession in the Mediterranean Region. *COST Action E4: Forest Reserves Research Network. Meeting in Pallas-Ounastunturi, Finland 30.-31.7.1997. Manuscript for COST Action*. European Forest Institute, Joensuu, unpublished.

Schmidt-Vogt, H. 1991. *Naturnahe Fichtenwirtschaft*. Wilhelm-Münker-Stiftung Heft 31, Wilhelm-Münker-Stiftung Siegen, Germany, 56pp.

Schuck, A., Parviainen, J. and 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, 62pp.

Schütz, J.-Ph. 1986 Charakterisierung des naturnahen Waldbaus und Bedarf an wissenschaftlichen Grundlagen. *Schweiz. Z. Forstwes*. **137**, 747–760.

Sturm, K. 1993. Prozeßschutz – ein Konzept für naturschutzgerechte Waldwirtschaft. *Z. Ökol. Naturschutz* **2**, 181–192.

Sustainable Forest Management in Europe 1998 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. Volume II. Third Ministerial Conference on the Protection of Forests in Europe. Liaison Unit in Lisbon*, 274pp.

Thomasius, H. 1992 Prinzipien eines ökologisch orientierten Waldbaus. *Forstwiss. Centralbl*. **111**, 141–155.

Thomasius, H. 1996 Geschichte, Anliegen und Wege des Waldumbaus in Sachsen. *Schriftenr. Sächs. Landesan. Forst*. **6**, 11–52.

Vandekerkhove, K. 1998 *Criteria voor de selectie van bosreservaten in functie van een betere kadering van de Vlaamse bosreservaten in een Europees netwerk*. Mededelingen Instituut voor Bosbouw en Wildbeheer 1998/3, 113pp.